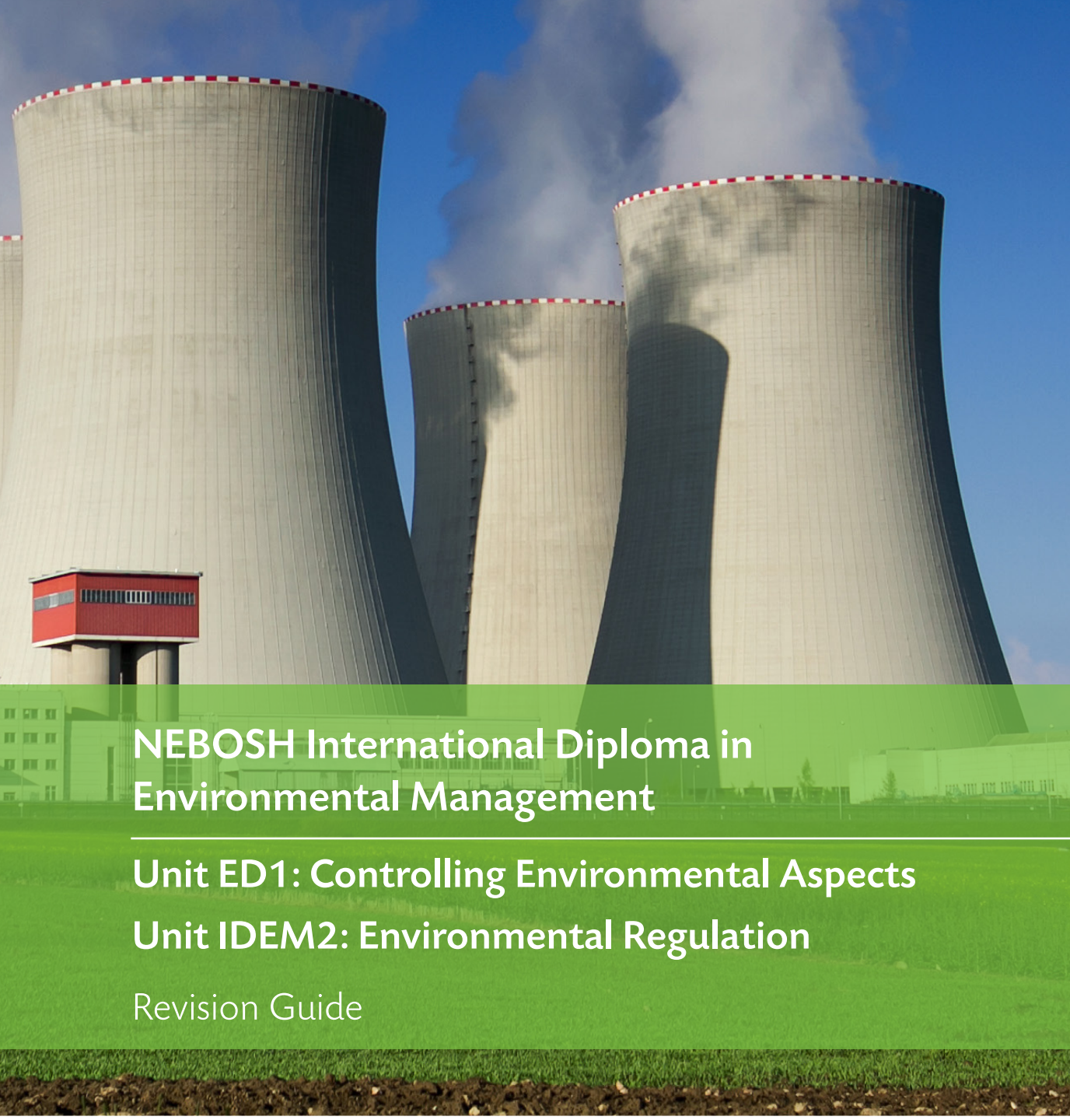

NEBOSH International Diploma in Environmental Management

Unit ED1: Controlling Environmental Aspects

Unit IDEM2: Environmental Regulation

Revision Guide

RRC INTERNATIONAL

NEBOSH INTERNATIONAL DIPLOMA IN ENVIRONMENTAL MANAGEMENT

UNIT ED1: CONTROLLING ENVIRONMENTAL ASPECTS

UNIT IDEM2: ENVIRONMENTAL REGULATION

REVISION GUIDE

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Contents

Welcome to your NEBOSH International Diploma in Environmental Management Revision Guide!

This Revision Guide has been created to help you build a structured revision plan towards your end-of-unit exam for Unit ED1, including some guidance on how to answer exam-style questions and to prepare you for your Unit IDEM2 Practical Application. It's split into elements as defined by the NEBOSH syllabus and each element-section contains two main parts:

- **Revision Notes**

  When revising for an exam, many students rely on either trying to learn the whole course, which is virtually impossible, or spending most of their revision time on topics they believe are likely to come up in the exam - neither are good revision techniques as they leave too much to chance. This part of your Revision Guide provides a summary of the RRC course material; it's designed to remind you of the key principles and ideas you studied in this unit.

- **Exam-Style Questions**

  This part of your Revision Guide provides some example exam-style questions and model answers; it will give you an insight into what your NEBOSH examiner expects from you and some common mistakes to avoid. Within each mock question and answer scenario is an Interpretation, Plan and Suggested Answer; this will provide a framework upon which you can base your approach to answering each question. These model answers have been written as ideal answers and not under exam conditions or time restraints, so it may not always be possible to write up such a detailed answer in the actual exam. It is also worth keeping in mind that some questions will require you to use knowledge from more than one element of the course.

Remember, this booklet has been prepared with the exam in mind - it is not intended to replace a proper course of learning! By combining an overview of each topic with practice exam-type questions, you're revising the course content and improving your exam technique at the same time - it's perfect preparation for your NEBOSH exam.

There's no substitute for hard work, and the more study time you can spare the better, but the key is to use this time effectively.

Revising Effectively

Using the Syllabus

Your secret to success is the Guide to the NEBOSH International Diploma in Environmental Management. This sets out the structure of the course and contains the syllabus. If you don't already have a copy of the syllabus, we strongly recommend that you obtain one, keep it with you and read it every day. All NEBOSH exam questions are set from the syllabus, so as you become more familiar with it you'll be less likely to be 'thrown' by a surprise question.

As exam questions are taken from the syllabus, mapping your study notes against the syllabus can be a very useful revision technique. If you have studied with RRC you will see that the material follows the syllabus quite closely, but this exercise is important to help you appreciate the overall 'picture'. When you're studying one specific section in isolation, it can be very easy to lose sight of how the material fits together, what practical use it is, or how an environmental manager might make use of it in real life. Referring back to the syllabus will put each topic in perspective and help you see how it relates to the field of environmental management generally. It will also help you cross-reference the material with other related topics, which you may have to do in more complex exam questions.

To get this overview, you need to know the elements that make up the course and how they relate to the RRC sections. Each element (e.g. Unit ED1, Element 1: Key Environmental Cycles and the Effects of Human Activity on the Environment) includes two important sections:

- **Learning Outcomes**, which detail what you should be able to explain, describe, outline, etc. after completing the element.
- **Content**, which gives you the topics you should be fully familiar with.

You can use both these sections of the syllabus to test whether you have the relevant skills, knowledge and understanding for each element, or whether you need to look again at certain topics.

An idea for an effective revision technique is to take a pin (blunt, of course, for health and safety reasons!) and randomly stick it in any part of the syllabus. Then write down what you know about that topic. This might be very little at first, in which case go back to your study notes and summarise the key issues that you need to work on. Make a note of this topic, then return to it a few weeks later and see how much more you can remember. If you practise this regularly, you will eventually cover the entire syllabus and in the process find that you understand and retain the material much more effectively.

This is 'active revision', as it actively tests your memory to see what you have learnt - and it is far more effective than 'passive revision' where you simply read your study notes and usually switch off after 30 seconds, taking in little of the material.

You will find it easier if you make sure that you have an overall understanding of the topic first, then fill in the detailed knowledge requirements later. Ask yourself searching questions on each topic such as:

- 'What use is this?',
- 'How would an environmental manager apply this in real life?',
- 'What is the point of this topic?',

until you feel that you fully understand why an environmental manager would need to know about each area. Once you have this level of general understanding, the details will be much easier to retain, and in some cases you may be able to derive them from your own workplace experiences.

Your revision aim is to achieve this comprehensive overview of the syllabus. Once you have done this, you will be able to at least say something about each of the topic areas and tackle any question set on the syllabus content.

Overview of the Exam

Students taking the NEBOSH Diploma in Environmental Management qualification are often very concerned about the assessments that they have to pass.

NEBOSH qualifications are not easy! Each person who passes a qualification has to work hard to do so, which makes it all the more rewarding when you succeed!

But, when you are preparing for the assessment, the practicalities of revision, preparation and exam nerves can get the better of you.

Success in Unit ED1 depends on your performance during just three hours in the exam at the end of your studies for this unit, and your exam performance will depend on two key factors:

- How much you can remember about the different topics.
- How well you can apply that knowledge in the exam situation.

It's no use being good at one thing without also being good at the other. Staying calm under pressure and interpreting questions correctly won't help if you don't have the knowledge to answer those questions. Getting that knowledge is the whole intention of the revision process, but will count for nothing if you can't function in an exam situation.

The overall purpose of this guide is to focus on both of these elements of success: effective revision and good exam technique.

The Exam

You should aim to arrive at the exam venue early. Exams are stressful enough at the best of times. Travelling to get there just in time or, worst case scenario, arriving late will not help your nerves.

You have three hours to complete your answers. Ten minutes' reading time is allowed before the start of the exam during which you may read the exam paper but you may not write anything.

Your answers should be written into a standard answer booklet. This answer booklet consists of lined A4 paper with a cover. You complete the cover with a few personal details as instructed and then write your answers inside. There is a space at the top of each page for you to indicate which question you are answering on that page.

The exam contains eight questions; each of these is worth a maximum of 20 marks. You have to answer any five of these eight questions and you are advised to spend 36 minutes on each of them. Within this time, spend a few minutes at the start writing a plan. At the end, use any remaining time to review your answers for mistakes and look to see if there is any extra information you could add.

Don't forget - you can take a watch into the exam with you. Take your watch off and put it on the table in front of you. As you start each exam question, write the start time and projected finish time on the exam paper next to the question. You don't need to remember what time you started or intend to finish - it is written down in front of you. As you write your answer, make sure that you check your watch to ensure that you do not run over your intended finish time.

If you write the finish time down, check your watch and stick to your intended plan then you cannot go wrong with time management during the exam. If you do not have a plan, or if you have a plan but fail to follow it in the exam room, then time management can go horribly wrong.

Plenty of students run out of time. Don't let it happen to you!

Exam Strategy

Understanding everything in the syllabus is of no use if you have poor examination technique. To achieve maximum marks, you will need to:

- Read the question carefully.
- Understand what information is being requested. It is important to identify the command word within the question, as this will give you an indication of the depth of knowledge required in your answer. Typical command words used by NEBOSH in Diploma exam questions include identify, outline, explain and describe. (The next section of this guide has further information about these command words and their meaning.)

- Understand the breadth of knowledge required.
- Look at the marks available for the question or part of the question - that is a clear indication of the amount of information required and time to be spent on it.
- Read the question again to ensure you understand its meaning.
- Produce a plan to organise your thoughts.
- Provide the information in a logical and coherent way.
- Manage your time effectively - you need to allocate your time evenly throughout the exam to take into account the number of marks allocated per question.

NEBOSH Command Words

It is important to identify the command word within the question as this will help you understand the meaning of the question and the depth of knowledge required in your answer. The following command words are routinely used by NEBOSH in Diploma exam questions:

Command Word	Meaning
Identify	To give a reference to an item, which could be its name or title.
Outline	To indicate the principal features or different parts of.
Describe	To give a detailed written account of the distinctive features of a subject. The account should be factual, without any attempt to explain.
Explain	To provide an understanding. To make an idea or relationship clear.
Give	To provide short, factual answers.

If you have studied at NEBOSH Certificate level you may well recognise these command words from Certificate-level exam questions.

NEBOSH also uses other command words in Diploma exam questions. These words, and an interpretation of their meaning, are presented below.

Command Word	Meaning
Analyse	To divide or break down the subject matter or topic into parts, reasons, aspects, etc. and then examine their nature and relationship.
Assess	To present judgments of the factors raised, their significance, importance and why they are important and/or significant.
Calculate	To ascertain or determine by mathematical processes.
Comment	To give opinions (with justification) on an issue or statement by considering the issues relevant to it.
Compare and contrast	To provide a point-by-point account of the similarities and differences between two sets of information or two areas.
Consider	To offer some detail about an issue or event and to deliberate about the value of that issue/event.
Define	To give the meaning of a word, phrase or concept, determine or fix the boundaries or extent of. A relatively short answer, usually one or two sentences, where there is a generally recognised or accepted expression.
Demonstrate	To prove or make clear by reasoning or evidence how some relationship or event has occurred.
Determine	To come to a decision as the result of investigation or reasoning.
Discuss	To give a critical account of the points involved in the topic.
Distinguish	To present the differences between; to separate into kinds, classes, or categories.
Evaluate	To determine the value or character of something by careful appraisal.
Justify	To prove or show to be valid, sound, or conforming to fact or reason.
Recommend	To bring forward as being fit or worthy; to indicate as being one's choice for something.
Review	To make a survey of; examine, look over carefully and give a critical account.

Further information on these command words and their use is available directly from NEBOSH. A guide giving specific examples of exam questions and examiners' feedback on expected answers is also available at no cost from www.nebosh.org.uk.

Approaching Questions

Another important exam skill is to carefully read and analyse the question so that you are clear about what is required to answer it. Once you have done this, you will be ready to plan your answer (though for some short answers you can get away with not doing a plan). This will help you structure your thoughts in order to provide a coherent response to the question. The other important reason for planning is to allow you to jot down key words, which may help you recall memories associated with those subjects.

Students often make the mistake of going into too much detail on specific topics and failing to address the wider issues. If you only deal with half of the relevant issues you can only achieve half of the marks! Try to give as broad an answer as you can, without stepping outside the subject matter of the question altogether. Ensure that you explain each issue to convince the examiner that you have a sufficient understanding of it. Giving relevant workplace examples is a good way of doing this.

You can find a sample Unit ED1 exam paper in the NEBOSH guide to the Diploma. You can obtain Examiners' Reports from NEBOSH.

Last-Minute Preparation

Finally, a useful way to combine syllabus study with exam practice is to attempt to set and answer your own exam questions. By adding a question word, such as 'explain' or 'describe', in front of the syllabus topic areas, you can produce a whole range of questions. This is excellent exam practice because it serves as a valuable topic revision aid, and, at the same time, requires you to set out your knowledge just as you would under exam conditions.

Element 1
Key Environmental Cycles and the Effects of Human Activity on the Environment

The Environment and Key Natural Cycles

The environment is defined in ISO 14001:2015 as:

"Surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelationships ....

Surroundings can extend from within an organisation to the local, regional and global system ... [and] ... can be described in terms of biodiversity, ecosystems, climate or other characteristics."

Carbon Cycle

The carbon cycle describes the way in which carbon moves between plants and animals and the physical components of the environment (the atmosphere, ground and water bodies).

- Plants photosynthesise, taking carbon in the form of carbon dioxide (CO_2) from the atmosphere and using it to make carbohydrates (sugars).
- Animals obtain carbon from the carbohydrates, proteins, fats and oils they ingest by eating plants, or other animals. They break these foods down, releasing some of the carbon back into the atmosphere as CO_2 through respiration.
- Plants also release CO_2 back into the atmosphere through respiration.
- Dead plant and animal tissues, as well as animal excrement, are digested by decomposers (mainly microbes such as fungi and bacteria), releasing carbon back into the atmosphere as CO_2 or methane.
- CO_2 from the atmosphere also dissolves in the oceans and can be converted, as calcium carbonate, into the shells and skeletons of marine organisms.
- In certain conditions, the remains of living organisms, especially plants, may become fossilised, eventually forming carbon-based fossil fuels (coal, oil and gas).
- Both fossil fuels and dead plant material (wood) may eventually be combusted, releasing the carbon they contain back into the atmosphere as CO_2.
- Volcanoes and grass and forest fires also release large amounts of CO_2 into the atmosphere.

Effects of human activities on the carbon cycle include:

- Burning of fossil fuels and biomass, releasing carbon dioxide.
- Deforestation and other changes to land use, removing a carbon sink.
- Carbonate rocks used in cement manufacture.

Nitrogen Cycle

Nitrogen is an element vital to all life processes on Earth.

Plants may extract nitrogen from the soil when it is a nitrate or ammonium salt. This is known as nitrogen fixation and can occur by:

- Lightning, the power of which can cause atmospheric di-atomic nitrogen particles to divide.
- The Haber process, the chemical reaction used to manufacture ammonia from a reaction of nitrogen and hydrogen.
- Nitrogen-fixing bacteria, which are present in soil and root nodules of leguminous plants.
- Excretion and egestion from animals, or when animals and plants decay, resulting in nitrogen compounds being passed to the soil.

Effects of human activities on the nitrogen cycle include:

- Fertiliser run-off and discharge of sewage, causing nutrient enrichment.
- Fossil fuel combustion, causing acidification.
- Emissions of ammonia from intensive farming.

Phosphorus Cycle

Phosphates are important, as they are a component of energy production within cells. Stages of the cycle:

- Rocks and other terrestrial deposits are weathered over time, resulting in the deliberate discharge of phosphorus into rivers, lakes or oceans.
- Phosphorus (in phosphate form) is extracted from the soil by plants.
- Animals that feed on plants take up such phosphorus-containing substances and they are added to their tissues.
- Discharge of phosphorus to soil and water occurs by excretion of animals.
- Following death, decomposition by bacteria and fungi occurs which change the form of phosphorus and transfer it back to the soil, thus continuing the cycle.

Effects of human activities on the phosphorus cycle include:

- Phosphorus-containing fertilisers can run off into rivers and cause nutrient enrichment.
- Increased erosion due to deforestation releasing phosphorus, causing nutrient enrichment.

Hydrological Cycle

Water moves around the Earth through a system known as the hydrological cycle.

- The initial input of water in the system is in the form of precipitation.
- Plant roots can take up water that has seeped into the soil.
- The water can continue to seep through the soil horizons to reach aquifers (water-bearing rocks).
- As both of these processes are happening, the power of the Sun is driving this cycle by causing evaporation. Warm air rises up into the atmosphere and becomes the vapour involved in condensation.

Effects of human activities on the hydrological cycle:

- Depletion of aquifers.
- Damming of rivers, which will harm fish and other aquatic organisms.
- Deforestation causing flooding.
- Climate change, which is altering the location and amount of water around the planet.
- Changes in land use will increase or decrease flow of water in a catchment.

General Effects of Human Activity on the Environment

Meaning of Ecology, Ecosystems and Biodiversity

Ecology is the study of the relationship between and interactions of living things to one another and their physical surroundings.

An **ecosystem** is a community of interdependent organisms and the physical and chemical environment they inhabit, e.g. estuaries and woodlands.

Ecosystems work because energy and chemicals are constantly cycled through the system. These systems can be affected by pollutants, which can enter the food chain and be absorbed into our bodies, e.g. PCBs.

Biodiversity is the diversity, or variety, of plants, animals and other living things in a particular area or region.

Species are now becoming extinct at an alarming rate, almost entirely as a direct result of human activities.

Biodiversity has many benefits including:

- Ecological.
- Economic.
- Cultural/spiritual/aesthetic.
- Recreation/tourism.
- Education/information.

Composition and Dynamics of Communities and Ecosystems

Ecosystems work on the principle of food chains. Energy from the Sun is cycled through the system. Food chains generally consist of plants, herbivores, carnivores and decomposers.

A combination of food chains is known as a food web.

Humans benefit from the following ecosystem services:

- Provisioning.
- Regulating.
- Cultural.
- Supporting.

Bioaccumulation and Bio-concentration

Bioaccumulation is the term used for the gradual build-up of substances within a living organism by all means possible (such as contact, respiration and ingestion).

Bio-concentration is a similar term but covers the intake and retention of a substance from water in an aquatic system or air in a land-based system.

The increase in bioaccumulated/bio-concentrated pollutants from the base of the food chain to the top is known as **biomagnification**.

Deforestation

Deforestation can lead to the following impacts:

- Climate change.
- Local climate alterations (drier).
- Soil erosion.
- Flooding.
- Biodiversity reduction.
- Habitat destruction.

Desertification

Desertification describes the deterioration of land in arid and sub-humid areas as a result of loss of soil moisture and vegetation.

The main causes are overgrazing, taking groundwater and diversion of rivers for industry and drinking water.

Habitat Destruction

Habitat destruction may be caused by single events such as oil spills, road building or deforestation, or by cumulative incidents such as gradual air or water pollution. Both cumulative and single events have destroyed or damaged available habitats.

Invasive Species

The impact of invasive species can vary but may include negative impacts on native biodiversity and ecosystems, significant financial cost of remedying damage caused by invasive species, in addition to the cost of eradication or control and impacts on human health.

Protection Given to Listed Species and Permits Required for their Removal

It is common for laws to be developed that provide a level of protection for listed plant and animal species.

The International Union for Conservation of Nature (IUCN) maintains a highly respected inventory of the global conservation status of biological species that often influences government policies on nature protection.

In many countries there is a requirement for those who wish to remove endangered plants or animals to gain a permit, licence or similar legal permission.

Precautionary Principle and 'Polluter Pays'

Precautionary principle - identifies a need to implement changes in the absence of absolute scientific proof, as further delay could lead to adverse effects on society and have significant adverse effects on future generations.

Proportionality (cost-effectiveness) is an important factor of the precautionary principle.

It must be ensured that all environmental benefits of precautionary measures are greater than economic and societal costs.

'Polluter pays' principle - that the polluter should pay for any significant damage to the environment that is created by pollution released.

Role of Non-Governmental Bodies and the Media

The following bodies have a significant influence on environmental standards:

- Trade unions.
- Professional bodies.
- Pressure groups.
- The media.
- The public.

Exam-Style Questions

1. (a) **Describe** the advantages of non-governmental pressure groups in environmental protection. (10)

   (b) **Describe** the limitations of non-governmental pressure groups in environmental protection. (10)

2. **Describe** the action that could be taken to reduce the impact of an organisation on biodiversity. (20)

3. (a) **Explain** the operation of the carbon cycle. (15)

   (b) **Outline** how human activities can have a detrimental impact on the carbon cycle. (5)

Model Answers

Question 1

Interpretation

A good understanding of what NGO pressure groups are and what they do is key to this question. NGOs are organisations that have no links to governments, e.g. Greenpeace, Friends of the Earth, Royal Society for the Protection of Birds. Regulators are not classed as NGOs. To gain full marks it is clear that a description of the advantages and limitations of the role of NGOs must be provided.

Plan

(a) Advantages - independence, public acceptance, past experiences, grass roots support, good experience of practical environmental management, innovative, flexible, cost- effective solutions.

(b) Limitations - poor managerial experience, lack of understanding of issues, lack of long-term financial stability, less effective internal communication and co-ordination, answerable to funding bodies, interventions limited in scale.

Suggested Answer

(a) Advantages of the role of NGO pressure groups in protecting the environment include the fact that they are totally independent of government influence and control and as a result are likely to have a greater level of public confidence and trust. Some are also international organisations (e.g. Greenpeace) and therefore have experience of practices in other areas of the world. In comparison to governments they can more easily confront polluters and highlight unacceptable practices. They also tend to have good grass roots support and can promote participatory approaches to managing the environment. Many also have excellent experience in practical environmental management and field-based issues. NGOs can also be more innovative and flexible in their approach in comparison to governments. They may provide more cost-effective solutions since they often have limited finance and rely on raising money through charitable activities.

(b) Limitations of the role of NGO pressure groups in protecting the environment might include the fact that smaller NGO pressure groups (they can exist at a local level as well as international) can be restricted by limited levels of managerial experience and a lack of understanding of issues faced by large organisations. Since such organisations rely on charitable donations they may also be less financially stable in the long term, making effective planning difficult. There can also be a tendency for less effective communication and co-ordination within the organisation. They may also be answerable to funding bodies which can lead to conflicts of principles. Smaller NGO pressure groups may also provide interventions that are limited in scale and relevant only to a limited local area.

Question 2

Interpretation

This question is not limited by a particular scenario. Marks could therefore be gained by describing just about any action that could improve biodiversity (the amount of different plant and animal species in an area).

Plan

Timber, supplies and raw materials, minimising disruption, creating new habitats, encourage wildlife, control of releases, control of noise and light, drainage, pesticides, fertilisers, waste, education/information, policies, biodiversity action plans.

Suggested Answer

A good answer should describe a selection of the following:

- The purchasing of timber from a location that is managed sustainably (Forest Stewardship Council (FSC) certification may be considered).
- Purchasing of supplies and raw materials from sources that are accredited.
- Ensuring that there is minimal disruption to species and habitats when developing land for company expansion, etc.
- Creating new habitats during landscaping schemes and using native plant species that are valuable to local wildlife.
- Facilities that encourage wildlife to exist in the area (e.g. bird boxes, roosting areas for bats).
- Control of releases to air, water and land that may affect wildlife.
- Controlling issues such as noise and light that may disturb wildlife.
- Creation of new wildlife habitats through the implementation of sustainable drainage systems.
- Using pesticides and fertilisers such that they do not significantly affect wildlife.
- Waste containment to stop escape.
- Education and information for staff and others to ensure that they are aware of wildlife issues.
- Providing finance and assistance to projects that improve biodiversity.
- Policies to promote biodiversity.
- Biodiversity action plans.

Question 3

Interpretation

(a) This sub-question requires a detailed explanation of the mechanisms involved in cycling carbon around the globe. Your answer should be in paragraphs as the question is an 'explain' question and should be as detailed as time allows.

(b) This sub-question requires a brief description of five ways in which humans may negatively impact on the carbon cycle.

Plan

(a) Atmosphere: photosynthesis, respiration; land: storage, respiration, run-off, excretion, death; oceans: dissolution, photosynthesis, accumulation; geological: carbonate rocks, volcanic activity.

(b) Fossil fuels burning, biomass burning, deforestation, use of carbonate rocks, extraction and transportation of fossil fuels.

Suggested Answer

(a) The carbon cycle consists of four major stores of carbon linked by carbon exchange pathways. The stores are:

- **The atmosphere** - the two main constituents of the Earth's atmosphere are methane (CH_4) and carbon dioxide (CO_2). Carbon dioxide exits the atmosphere via photosynthesis. This is a process undertaken by plants during the day; it involves taking in carbon dioxide from air and using it to form glucose. Carbon dioxide also exits the atmosphere by dissolving into rainwater or directly into water bodies (lakes, oceans, etc.) where it can be absorbed by rocks. Carbon enters the atmosphere through the respiration of plants and animals and volcanic activity.
- **Land biosphere** - this includes carbon stored in plants, animals and other living organisms as well as carbon present in soils. Organic carbon is a major constituent of all living organisms. Carbon leaves this reservoir and is released into the atmosphere by respiration of plants and animals (the opposite of photosynthesis). It may also be passed to oceans by rivers and streams or remain in soils. Animals take in carbon dioxide by eating plants and other animals; when they respire, excrete waste or die they release carbon to the environment. Waste carbon materials are then digested by microbes or fungi that also respire when breaking down organic matter.
- **Oceans** - carbon enters oceans mainly by dissolution from the atmosphere, but also from rivers. It is converted to organic carbon by photosynthesis where it can pass through the food chain or accumulate in shells as calcium carbonate.
- **Geological** - most of the Earth's carbon is stored in rocks and the upper mantle. This is formed of around 80% calcium carbonates from shells of marine organisms and 20% kerogens (fossil fuels such as coal, oil and gas). Carbon leaves this reservoir through volcanic activity.

(b) The carbon cycle can be significantly affected by human activities, such as:

- Burning of fossil fuel in energy generation and transportation, which releases large quantities of carbon dioxide into the air, contributing to climate change. Normally, this fossilised carbon would be locked away from the carbon cycle.
- Burning of biomass (plants), which releases carbon dioxide to air, contributing to climate change.
- Deforestation and other types of land-use change, which removes plants that are a key sink for atmospheric carbon through photosynthesis. This increases the amount of carbon dioxide in the atmosphere, contributing to climate change.
- Use of carbonate rocks in cement manufacture, which releases carbon dioxide to the air.
- Extraction and transportation of fossil fuels from activities such as coal mining, oil drilling, oil transportation and hydraulic fracturing (commonly known as 'fracking'), which also pose a significant risk of water, land and air pollution.

Element 2
Environmental Leadership

Reasons for Improving Environmental and Social Performance

The reasons for managing environmental risk can be broadly classified as legal, moral and economic.

Moral

The environment is where we live as well as where we work, and our neighbours are owed a moral as well as legal duty.

In many ways, care of the environment is the responsibility of us all and society's attitude towards the environment is much more informed than before.

A key moral reason for improving environmental and social performance is to prevent/minimise the impact of an organisation's activities on the environment.

Legal

The repercussions of failing to comply with relevant legislation can be severe for both companies and individuals. As such it is imperative that an organisation understands relevant environmental laws at the international, regional and national levels.

Key international laws are made as treaties, conventions, protocols and declarations. Key EU laws include Directives and Regulations. National legal systems around the world may vary but can be influenced by international and regional laws.

Economic

The 'Polluter Pays' principle has been implemented through a range of financial tools that can be used to encourage or force organisations to account for the pollution they create through the balance sheet.

- The costs associated with an environmental incident may be:
- **Direct** - calculable costs such as clean-up costs, fines and increased insurance premiums.
- **Indirect** - don't involve payment of money such as business interruptions, loss of orders and loss of corporate image.

The Business Case for Good Standards of Environmental Management

An organisation can benefit in many ways if it maintains a high level of environmental performance:

- Better relations with communities local to the organisation by participation in local environmental schemes.
- Minimised energy costs.
- Decreased cost for managing wastes.
- Improved corporate image.
- The organisation may be competitive on an international basis.
- Improved sales due to enhanced environmental performance of products or services.
- Opportunities for innovation, including improving existing products or developing new products.
- Reduction in the chances of an incident occurring that could cause significant environmental impacts.
- Provides for a better legal defence should an incident occur.
- Reduced insurance premiums, etc.

Supply Chain Pressure

Often, organisations applying Environmental Supply-Chain Management (ESCM) impose certain requirements to bring suppliers in line with the organisation's standards of environmental management.

Integrating specific environmental considerations into existing practices will generate further value, both within the organisation and in its relationships with suppliers.

For suppliers, understanding and meeting environmental requirements of their customers can be a way of developing deeper relationships and increasing market share.

Corporate Social Responsibility

Corporate Social Responsibility (CSR) is an organisational approach that is very closely aligned with the concept of sustainability. Organisations that pursue CSR seek to embed social, environmental and ethical management at the heart of their businesses.

Cost Savings

Significant amounts of money can be saved through good environmental practices.

- Reducing energy consumption can sometimes lead to significant cost savings.
- Waste can also be managed such that it is prevented or minimised.

Resource management can be defined as using a company's resources in an efficient way. This can include resources such as goods, equipment, finance and labour.

Environmental Leadership

The key elements of effective environmental leadership include:

- **Commitment and accountability** - management must be accountable for the effectiveness of environmental management and committed to achieving it.
- **Resource provision** - resources must be provided when needed and in an efficient way, considering both current and future requirements.
- **Environmental integration into business processes** - for environmental management to be effective it must be integrated into the strategic direction of the organisation and relevant organisational processes.
- **Communication** - it is imperative that the importance of continual improvement in environmental performance is communicated to stakeholders. Reasons for such communication may vary but include ISO 14001 requirements, motivation, consultation and marketing.
- **Ownership** - a key element of successful environmental leadership is ensuring both individual and collective ownership of high standards of environmental management. The more that people are involved in environmental management the greater will be their sense of ownership and job satisfaction.
- **Positive environmental culture** - gained by control, co-operation, communication and competence.

Ethics and Professional Practice

Behaving in an ethical manner is a key part of professional practice for an environmental practitioner. Components of ethical behaviour are:

- Provision of a high standard of service.
- Taking responsibility for their actions.
- Treating others with respect.
- Acting in a manner that promotes trust in the environmental management profession.
- Acting with integrity.

Professional institutes often develop formalised codes of conduct that their members must follow.

Competence

Competence:

- Is defined in ISO 14001:2015 as:

  "ability to apply knowledge and skills to achieve intended results".

- Will be based on experience, training, education or more likely a combination of these factors.
- Is a key way in which organisations will support achievement of legal compliance. Integrated environmental permits, for example, will often state competencies for staff who play an important role in an organisation's environmental management system.

Understanding of the types and levels of competencies required by an organisation can be achieved by the use of competency frameworks. These may be developed into a skills matrix where the individual competencies of an employment role are compared to those of the employee.

Competency checks apply to all those who work under the control of the organisation (including both workers and contractors) who may affect environmental performance. This would include those:

- Whose employment has a potential to cause a significant impact on the environment.
- Who have specific responsibilities in the organisation's environmental management system.

Training and competence are not synonymous; however, training can be an important way of contributing to the achievement of a desired level of competence.

Mentoring schemes may be useful in contributing to the achievement of individual competency. The responsibility for finding the solution to the problem remains with the mentee and the mentor is simply there to guide and support the mentee's exploration.

Exam-Style Question

1. **Explain** how competence can be managed within an organisation. (20)

Model Answer

Question 1

Interpretation

This is quite an open question as it is an 'explain' question and not split into sub-questions. It requires an in-depth explanation of the operation of a competency management framework in an organisation.

Plan

ISO 14001 definition, contractors, ISO 14001 requirements, legal compliance, competency frameworks (skills matrix), training implementation, mentoring.

Suggested Answer

Competence is defined in ISO 14001:2015 as the "ability to apply knowledge and skills to achieve intended results". The skills, abilities, knowledge and understanding of a person enable them to gain the necessary competence. All persons who are involved in delivering work tasks that can affect organisational environmental performance are required to be competent. Competency will therefore be based on experience, training, education or more likely a combination of these factors. Such persons would not just include the organisation's employees but also those who work under its control such as contractors.

High levels of competency are essential for successful environmental management. ISO 14001:2015 provides a framework for competency management that covers the following:

- Determine the competency of persons carrying out work under the organisation's control that may adversely affect its environmental performance or its ability to achieve compliance obligations.
- Ensure that such persons are competent on the basis of education, training or experience.
- Assess the training needs of the organisation that are associated with its environmental aspects and its environmental management system.
- Where applicable, undertake actions to acquire the competency required and evaluate the effectiveness of such actions.

Competence is a key way in which organisations will support achievement of legal compliance. Legal requirements themselves will sometimes state specific competency requirements. Waste permits, for example, will state that an organisation must employ a person who has undertaken a technical competence certificate in waste management.

The understanding of the types and levels of competencies required by an organisation can be achieved by the use of competency frameworks. This is a defined structure that states the individual competencies that are required by those who are employed by the organisation. Competency frameworks may be developed into a skills matrix where the individual competencies of an employment role are compared to those of the employee.

Competency checks will be relevant to all those under the control of the organisation (including both workers and contractors) who may cause a significant environmental impact.

Training can be an important way of contributing to the achievement of a desired level of competence. An organisation should have a formalised environmental training process that includes:

- Identification of organisational training needs.
- A training plan or programme to meet the identified needs.
- Delivery of required training.
- Retention of documentary evidence of training received (such as training evaluation sheets).
- Monitoring of the training received.

Mentoring schemes may be used in the achievement of individual competency. In a mentoring role the aim is an alliance between the mentor and the mentee. The responsibility for finding the solution to a problem remains with the mentee and the mentor is simply there to guide and support the mentee's exploration.

Element 3
Environmental Management Systems and Emergency Planning

Environmental Management Systems

EMS models (including the ISO 14001 standard) are based on the "Plan, Do, Check, Act" model.

BS EN ISO 14000 Series

In the ISO 14001 EMS standard, the "Plan, Do, Check, Act" steps have been expanded into seven EMS clauses:

- Context of the organisation.
- Leadership.
- Planning.
- Support.
- Operation.
- Performance evaluation.
- Improvement.

EMAS

The Eco-Management and Audit Scheme (EMAS) is a voluntary European initiative designed to improve companies' environmental performance.

Although apparently similar in content, ISO 14001 is an international standard, while EMAS is a European standard.

There are a number of subtle differences between the two, including:

- EMAS requires an initial environmental review.
- EMAS requires preparation of a detailed public 'Environmental Statement', which must be verified by a third party (IEMA in the UK).
- EMAS requires that an open dialogue be established with the public and other interested parties.
- EMAS uses stronger and more specific language about legal compliance.

- EMAS is site-based whereas ISO 14001 can be organisation-wide.
- EMAS specifically states requirements for employee involvement in the management system.
- EMAS has a three-year audit cycle - there is no specific audit cycle set in ISO 14001.

BS 8555

This describes how to implement a generic EMS and can be used as a route towards ISO 14001 and EMAS.

The five phases of the standard are:

- Leadership, context and commitment.
- Ensure compliance.
- Plan and develop the EMS.
- Implement the EMS.
- Check and update the EMS.

The Steps in Implementing an EMS

An initial environmental review may be undertaken prior to EMS implementation.

The four stages of the review process are:

- review team selection;
- preparation;
- site review; and
- review report.

Context of the Organisation

An organisation must understand its context.

This includes internal and external relevant issues such as the environmental conditions that: may be affected by the organisation; or could affect the organisation.

The scope of the EMS must be determined and documented and made available to interested parties.

ISO 14001 requires that an organisation establish, implement, maintain and continually improve an ISO14001-compliant EMS.

Leadership

- Top management must demonstrate leadership and commitment to the EMS.
- Environmental roles and responsibilities must be assigned and communicated.

- An environmental policy must be produced. This is a public declaration by the senior management of an organisation of their commitment to protecting the environment.

  The policy must:

  - Be appropriate.
  - Be available to interested parties.
  - Commit to continual improvement.
  - Commit to fulfil compliance obligations.
  - Be documented.
  - Commit to protection of the environment (including prevention of pollution).
  - Provide a framework for setting objectives.
  - Be communicated within the organisation.

Planning

Key requirements are:

- Evaluation of significant environmental aspects and impacts of the organisation's activities, products and services on each occupied site.
- Prepare objectives to help the organisation meet the commitments and goals established in the environmental policy.
  - ISO 14001 is not specific about the type of environmental objectives that should be set.
  - It is common for organisations to set strategic objectives, low level objectives and action plans, all of which link together.
  - Objective types can be categorised as monitoring, management and improvement. An action plan consists of a task, timescale and responsibility for implementation.
- Have access to documented compliance obligations.

Support

The organisation must understand and provide the resources required for the implementation, maintenance and continual improvement of the EMS.

Requirements for competence are present in this part of the standard.

Those who carry out work under the organisation's control must be aware of:

- the environmental policy;
- significant environmental aspects and impacts;
- their contribution to the effectiveness of the EMS; and
- implications of not complying with the EMS.

ISO 14001 requires that an organisation has processes that cover:

- internal communications between the various levels and functions of the organisation; and
- external communication of information relevant to the EMS as stated in the organisation's communication process and required by compliance obligations.

Specific requirements are present in the standard for various information to be documented in addition to information deemed to be necessary for the EMS by the organisation.

There are also document information requirements for creating and updating documented information and document control.

Operation

Certain activities and operations must be controlled within the EMS. The standard states that controls can be both procedural and engineering and may follow a hierarchy of elimination, substitution and administrative.

Organisations must develop and maintain documented processes to identify and respond to accidents and emergencies.

Performance Evaluation

An organisation's environmental performance must be monitored, measured, analysed and evaluated.

ISO 14001 states that audit programmes should cover:

- The activities and areas to be considered in audits.
- The frequency of audits.
- The responsibilities associated with managing and conducting audits.
- The communication of audit results.
- Auditor competence.
- How audits are to be conducted.

The senior management team should carry out regular reviews of the EMS in order to ensure its continued suitability, adequacy and effectiveness.

The management review must include:

- Status of actions from previous reviews.
- Changes in significant aspects.
- Internal and external issues.
- The extent to which objectives have been reached.

- Information on the environmental performance of the organisation such as trends in monitoring results, fulfilment of compliance obligations and audit results.
- How adequate resources are.
- Communications from interested parties (this includes complaints).
- Areas where there are opportunities for continual improvement.

Outputs might include:

- Whether the EMS is still suitable, adequate and effective.
- Decisions that are linked to continual improvement.
- Action when environmental objectives have not been met.
- Areas where the EMS could be integrated with other business processes.
- Implications for the strategic direction of the organisation.

Improvement

- Action is required to eliminate the cause of any non-conformity to ensure that it does not happen again.
- Any corrective action implemented must be reviewed for its effectiveness.
- Documentary evidence must be retained as to the nature of non-conformities, action undertaken to correct them and the results of the corrective actions.

Benefits and Limitations of Integrating Management Systems

Benefits of Integration

- An IMS offers the prospect of more rewarding career opportunities for specialists in each discipline.
- The objectives and processes of management systems are essentially the same.
- Integration should lead to the avoidance of duplication, e.g. in personnel, meetings.
- Integration should reduce the possibility of resolving problems at the expense of creating new difficulties in other disciplines.

Limitations of Integration

- Existing systems may work well already.
- Uncertainties regarding key terms would be exacerbated in an IMS.
- System requirements may vary across topics covered.
- Health, safety and environmental performance are underpinned by statute law, whereas quality management system requirements are largely determined by customer specification.

Presentation of Information on Environmental Management Performance

Sources of Environmental Information Internal to the Organisation

- Inspection/audit reports.
- Maintenance records.
- Job/task analysis.
- Environmental monitoring data.
- Raw-material usage and supply.
- Environmental permits.

Sources of Environmental Information External to the Organisation

- Manufacturers' data.
- Enforcement bodies' guidance documents on compliance with environmental law and promoting good practice.
- Government-supported organisations.
- Trade associations.
- Professional institutions.
- Commercial organisations.
- Encyclopaedias and textbooks.

Environmental Data Types

There are four ways in which environmental data can be collected or expressed:

- **Absolute data on environmental performance** - usually collected over a set period of time, e.g. total annual waste production (tonnes) or total annual water consumption.
- **Normalised data** - ensures that relationships between data are clear by comparing two sets of absolute figures with each other, e.g. waste produced per employee or mileage travelled by litres of fuel.
- **Qualitative ('soft') data** - describes meaning rather than some kind of analytical consideration and generates data that is non-numerical.
- **Quantitative ('hard') data** - represents numbers and frequencies.

A three-stage framework for the management of environmental data:

1. Identification of sources of data.
2. Generating data.
3. Management of data.

Verification and Assurance of Data

Comparison against the following factors is often used to verify and assure the quality of accountancy data and can be applied in a similar manner to environmental data:

- Materiality.
- Completeness.
- Responsiveness.

Corporate Environmental, Sustainability and Social Responsibility Reporting

It is now very rare to find reports that only cover environmental issues - Corporate Social Responsibility (CSR) reporting has become the norm.

There is wide recognition that reporting should cover the three main strands of environmental, social and economic sustainability.

There is also a consensus emerging on good reporting practice. Standards have now been developed to guide reporting organisations, notably the international Global Reporting Initiative.

CSR reporting remains largely a voluntary activity, but is now expected from large organisations, especially companies listed on international stock-markets.

Organisations report on environmental and other corporate social responsibility information in response to a range of drivers:

- Legal.
- Financial.
- Voluntary standards.
- The media, NGOs and the general public.

Producing and Presenting Meaningful Information

There are three main stages to ensuring that this occurs and a report is produced to a high standard:

- Secure management commitment.
- Develop a reporting team.
- Define your reporting objectives and scope.

The **GRI Sustainability Reporting Standards** consist of three **universal standards** (relevant to all reports) and a series of **topic-specific standards** (used to report information on an organisation's specific environmental, social and economic impacts).

The GRI Universal Standards are divided into three standards:

- **GRI 101: Foundation** - sets out the reporting principles for report content and quality.
- **GRI 102: General Disclosures** - used to report contextual information regarding an organisation and its reporting practices.
- **GRI 103: Management Approach** - provides guidance about the way in which an organisation manages a material topic.

The 200, 300 and 400 series are topic-specific standards that are used to report an organisation's economic, environmental and social impacts.

Benchmarking and the Use of Indicators

Benchmarking is internal and external comparative assessment. Its objectives include:

- **Assess significance** - how significant are the emissions or discharges in comparison to similar operations?
- **Identify areas for improvement** - if certain emissions or discharges are relatively high then it may be technically feasible to reduce them.
- **Justify performance** - if certain emissions or discharges are relatively low then this would make their reduction less of a priority.
- **Set performance targets** - it would make sense to set reduction targets in line with what seems achievable.

Environmental Policies, Procedures and Systems of Work

Policies, procedures and systems of work often cover general activities that are carried out within the workplace.

It is imperative where relevant that environmental issues, in addition to safety, quality and other issues, are covered.

For specific health and safety policies, procedures and systems of work a decision should be made as to whether it would be beneficial to integrate environmental requirements.

Policies, procedures and systems of work need to be implemented, which may involve:

- Setting of roles, responsibilities and authorities.
- Competence, training and awareness.
- Communication.
- The development of relevant documentation.

Complaints are likely to be a good indication of the adequacy of environmental measures. If concerns are raised, it is important that they are acted on. Complaints should be recorded.

Principles of Assessing and Managing Contractors

Contractors are used widely in the workplace, either to deliver a specific project or skill or to deliver extra labour when needed.

The way that a client manages contractors can be broken down into three key areas:

- Selecting the contractor.
- Planning the work.
- Monitoring the work.

Contractors are responsible for their own environmental impacts. They must also ensure that they do not create significant environmental impacts for their client from the work that they undertake.

Development, Monitoring and Maintenance of Emergency Plans in Relation to Environmental Pollution

Many environmental impacts are associated with emergency situations. Often the need for an emergency plan will be defined in law.

Natural events, such as high winds, storms or excessive rainfall, can cause emergency conditions to arise at a factory.

Preparation of Emergency Plans

The two emergency plans - internal and external - should be complementary. The internal plan should include details of the arrangements in place to assist with an external emergency.

When the range of major disruptive circumstances that could arise have been identified, individual emergency plans will then cover the following main points with regard to each of the identified hazards:

- Event.
- Location.
- Potential for harm.
- Existing instructions for dealing with the problem.
- Immediate actions to be taken.
- Control of the event.
- Assessment of the event.

- Response.
- Damage limitation action.
- Recovery plan.

It is important that emergency plans are monitored for ongoing effectiveness. One method of undertaking this is by testing to determine:

- Completeness, consistency and accuracy of the emergency plan and other documentation used by organisations responding to an emergency.
- Adequacy of the equipment and facilities and their operability, especially under emergency conditions.
- Competence of staff to carry out the duties identified for them in the plan, and their use of the equipment and facilities.

Types of test include:

- Drills.
- Seminar exercises.
- Walk-through exercises.
- Desktop exercises.
- Live exercises.

It is important to review the lessons learned from testing, to determine whether modifications are required to the emergency plan.

During the planning process for emergencies, it is important that:

- Specific people are identified as being those who will communicate with the media during an emergency.
- All other employees are given clear instruction not to talk to reporters and to direct any enquiries to those members of staff who have been allocated this role.
- Nominated staff members are properly trained in how best to communicate with the media.
- When an emergency occurs, there are systems and procedures in place to ensure that nominated staff are kept fully informed of the situation regarding the emergency.

Exam-Style Questions

1. (a) **Outline** the possible environmental information that could be included in a manufacturing organisation's induction training programme. (12)

   (b) **Explain** actions that could be taken to increase the chances of adherence to the organisation's environmental procedures by employees. (8)

2. **Explain** the meaning of the ISO 14001:2015 term 'significant environmental aspects' and explain how they may be identified. Use pertinent examples to illustrate your answer. (20)

3. An organisation has decided to integrate its environmental and health and safety management systems. **Describe** the benefits and drawbacks of this process. (20)

4. **Describe** the key features of the Eco-Management and Audit Scheme (EMAS). (20)

5. (a) **Identify FOUR** drivers as to why organisations produce publicly available corporate environmental reports. (4)

   (b) **Outline** the information that should be provided in an annual environmental performance report. (16)

Model Answers

Question 1

Interpretation

Part (a) is quite an open question which requires a short description of all of the relevant issues. The answer should be relevant to a manufacturing organisation.

Part (b) takes a little more thought. The key words and phrases are 'explain', 'employees', 'chances of adherence' and 'environmental procedures'. You need to try to explain how adherence to procedures can be achieved.

Plan

(a) Policy, significant aspects and impacts, legal issues, benefits, procedures, action from not following procedures, responsibilities, certification.

(b) Senior management commitment, communication, procedures which are clear and easy to understand, culture, events, campaigns, financial incentives, disciplinary action.

Suggested Answer

(a) Such issues that might be relevant for induction training include the company's environmental policy statement; important environmental issues that affect the business; significant environmental aspects and impacts that occur from various parts of the business; specific legal requirements; benefits that accrue from good environmental management practices; the company's procedures for environmental protection; actions that may result from not following procedures (e.g. disciplinary actions); responsibilities; environmental management certifications such as the Eco-Management and Audit Scheme (EMAS) or ISO 14001, etc.

(b) Relevant points may include demonstrating commitment at the top level and managers and directors leading by example. Procedures must also be effectively communicated to relevant persons and should be clear and easy to understand. Having a culture where environmental issues are seen as being important and promoting involvement through various types of events and campaigns is also relevant. Financial incentives might be implemented. The use of disciplinary sanctions or other mechanisms of action to ensure compliance will also be relevant.

Question 2

Interpretation

Although this is a 20-mark question there are really two parts to it. The first is to explain the phrase 'significant environmental aspects' and the second is to explain how significant environmental aspects may be identified.

Plan

Change in environment, control and influence, examples, abnormal, emergency, environmental concerns, business concerns, risk assessment process (screening, above threshold significant), LCA, EIA.

Suggested Answer

Significant environmental aspects are those activities, products or services that may cause a change in the environment. These aspects must be ones that an organisation can either control (such as on-site activities - emissions from processes, energy and water consumption) or those that it can influence (such as energy supply and product use). Examples include products, by-products, inputs to activities (energy, water, raw materials) and outputs from activities (waste, effluent, noise, vibration). Abnormal activities (such as those that happen on an infrequent basis - e.g. filling of bulk storage tank with oil) and emergency scenarios (e.g. fire, spillage) should also be considered.

When assessing significant aspects both environmental and business concerns should be considered. Environmental concerns relate to actual environmental damage, e.g. the scale and frequency of the impact, and business concerns relate to the implications for the company, e.g. legal exposure, deterioration in public image, the concerns of stakeholders or impacts on process efficiency.

Typically a risk-assessment process is used to identify significance. This involves identifying both the likelihood of environmental aspects and the potential consequences. Initially, this may involve screening aspects using a ranking system based on business and environmental concerns (as mentioned previously). The ones that are above a certain threshold score will be classed as significant.

LCA is also a method of assessing the impacts of the whole life cycle of a product (in addition to environmental impact assessment, which is used to determine significant impacts from developments at the planning phase).

Question 3

Interpretation

This is a relatively open question. Although it is unlikely that you will want to describe an equal number of benefits and drawbacks, in order to gain marks it would be advisable to provide at least a few examples of both. Do not solely describe cost savings that could accrue from integrating health and safety and environmental systems.

Plan

Benefits - cost-saving, avoiding duplication, operational control procedures, minimisation of conflicts, emergency response, decision-making - time reduction, training, audits and other systems.

Drawbacks - complex documents, lack of ownership, harder to change, slower to respond, conflicts of interest, difficult to identify information.

Suggested Answer

Benefits include cost savings through reduced administration of the system, e.g. control of documents. Avoidance of duplication of information in areas where the two disciplines overlap should also be considered, e.g. this is relevant to hazardous substances with regard to assessing risks and providing appropriate storage. Having operational control procedures that cover the requirements of both disciplines would also be beneficial as it would reduce paperwork. Control systems could also be designed to take into account and minimise conflicts between the two issues, e.g. design of a ventilation system that takes pollutants from an activity to the outside atmosphere. Emergency response requirements for environmental and health and safety issues can also be similar so it would make sense to have one emergency plan rather than separate ones for the two disciplines.

Other benefits would include reduction in decision-making time. Training could also be integrated with awareness and auditor training being undertaken once rather than twice (once for each discipline). Audits could also be combined which would save time and expense and result in a reduction of the amount of audits when compared to a company possessing two separate systems. If the integrated system was successful there would be the potential for integration with other systems, e.g. quality and investors in people.

Drawbacks may include more complicated documentation systems due to the increase in the number and type of documents. Those working under the system could also experience a lack of a sense of ownership. Additionally there may be some concern with regards to the complexity of external certification. It is likely that the system would increase in size and could become harder to change and slower to respond to pressure to change. There may also be a conflict of interest in roles with managers in the organisation. It may be more difficult for regulators and other interested parties to identify parts of the system that are relevant.

Question 4

Interpretation

A relatively simple question to interpret. A description of the key parts and requirements of EMAS is required. Although very similar to ISO 14001, your answer should ensure that the requirements of EMAS are quoted.

Plan

Date, EU Regulation, all organisations, voluntary, initial review, ISO 14001 requirements with subtle differences, audit cycle, certification, environmental statement, independent validation.

Suggested Answer

The Eco-Management and Audit Scheme was established by an EU Regulation aimed at businesses of all types improving their environmental performance. EMAS is a voluntary scheme being open to both private and public sector organisations within the EU.

The key requirements of the standard are:

- Initial environmental review has to be produced.
- Compliance with ISO 14001, e.g. context of the organisation, leadership, planning, support, operation, etc. (with some subtle differences).
- An audit cycle of at least three years.
- Certification as part of an approved accreditation scheme.
- A publicly available environmental statement must be produced in line with the requirements in Annex IV of the EMAS Regulation.
- The statement must be independently validated.

Question 5

Interpretation

Part (a) is reasonably straightforward - you need to identify four relevant factors in order to gain maximum marks.

Part (b) requires a brief description of what should be provided in a report, i.e. the issues that an organisation might want to report. This is quite an open question. One approach may be to imagine reading a report - what would you expect to find from beginning to end? For example, a description of responsibilities is likely to be the first item you would encounter.

Plan

(a) Government pressure, EMAS statement, NGO pressure, corporate governance and supply chain pressure, legal requirement.

(b) Statement about responsibilities, scope, set targets, achievement of targets, sustainable development, supply chain impacts, product use, product disposal, EMS compliance, air, water, land, waste, resource use, recycling levels, fines, prosecutions, expenditure, awards, benchmarking.

Suggested Answer

(a) Drivers for corporate environmental reports include government pressure for disclosure. The Eco-Management and Audit Scheme (EMAS) also requires that organisations produce an environmental statement. NGOs and other environmental pressure groups can also cause companies to produce such reports. Corporate governance requiring transparency and supply chain pressure may also be another driver. Some organisations may use such reports to promote a good environmental image and in some countries such reports are actually a mandatory requirement under law (e.g. Denmark).

(b) An annual environmental performance report might include a statement regarding the organisation's environmental responsibilities and identification of the scope of the company's activities to which the report applies. It will also set targets for the forthcoming year in addition to reporting on performance against targets in the previous report. It may also highlight the company's approach to achieving sustainable development (taking into account social and economic issues as well as environmental). The report may also include a description of how the company manages the environmental impacts of its supply chain and product use and disposal. Compliance with an Environmental Management System (EMS) standard such as ISO 14001 may also be identified. Often information regarding emissions to air, water, land; waste production; and resource use is identified. Other information provided might include recycling levels, fines and prosecutions, expenditure on environmental issues, environmental awards gained and benchmarking against other organisations.

Element 4
Environmental Risk Evaluation and Control

Environmental Aspects and Impacts

- **Environmental Aspect**

  Any "*element of an organisation's activities or products or services that interacts or can interact with the environment*".

  (ISO 14001:2015)

- **Environmental Impact**

  Any "*change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's environmental aspects*".

  (ISO 14001:2015)

ISO 14001 requires identification of aspects and impacts that the organisation can:

- **Control** - these are likely to result from direct activities associated with emissions from processes and compliance issues.
- **Influence** - this is much broader and mainly includes indirect issues, such as suppliers, contractors and customer activities. Influencing can be achieved by communication and supply chain pressure.

The **Source Pathway Receptor (or Target)** approach is of fundamental importance in the evaluation of environmental risk and is widely applicable and a relatively straightforward tool to use. It works on the premise of:

- Identification and quantification of sources of hazards (e.g. chemicals, noise).
- Determination and possible quantification of transport (pathway) processes and mechanisms (e.g. air, soil, water).
- Characterisation, distribution and responses of sensitive receptors, such as humans, plants and animals.

Effects on Quality of Life

Nuisances are matters that interfere with the normal common-law enjoyment of use of land or property, e.g. odour.

Visual amenity is an issue that is normally managed through planning law under development control responsibilities. Among other things, these would cover the colour and design of buildings, landscaping, tree-planting, advertising signs, etc.

Environmental issues associated with transportation include:

- Emissions.
- Noise.
- Dust.
- Congestion.
- Changes to the landscape.
- Land-take (for the building of new roads, etc.).
- The effects of refuelling, etc.

The impacts of waste disposal can be significant, including:

- Nuisance caused by:
  - Noise from waste transportation and site activities.
  - Odours from landfill sites or waste incineration.
  - Dust and litter.
- Release of methane-containing landfill gas causing climate change and presenting a fire and explosion risk to those near the site.
- Leachate discharged from a landfill causing water pollution.

Techniques to Identify Aspects and Impacts

These include:

- initial environmental review;
- life-cycle analysis;
- environmental impact assessment;
- environmental audit;

based on criteria such as the scale, severity and duration of the impact, the likelihood of the event occurring, the risk of prosecution, the cost of avoiding the impact, etc.

The three steps in identifying and evaluating aspects and impacts are:

1. Select an activity, product or service.
2. Identify environmental aspects and impacts of the activity, product or service.
3. Evaluate significance of impacts.

A semi-quantitative assessment will often use a matrix or scoring system to establish the relative level of likelihood and severity, then combine these attributes to attach a score that determines whether or not an impact is significant.

Factors to consider when assessing environmental impact significance include:

- Data on environmental problems.
- Sources of information (from regulators, local authorities, government departments and professional bodies).
- Biological indicators.

The risk assessment will, of course, look at existing controls and whether they are considered inadequate in relation to the risk.

The findings of the assessment must be recorded in a manner that is accessible to those who need to access the information (e.g. computer or paper-based).

An aspects and impacts assessment may need to be reviewed if monitoring or other forms of performance evaluation identify the following:

- An incident relevant to the assessment has occurred, particularly if there appear to be inadequate controls.
- Processes and/or equipment changes.
- Staff changes, particularly if there is a loss of experience and/or historical knowledge.
- Legislation changes.
- There has been a lapse of time since the last review.

Principles of Operational Planning and Control

Best Practicable Environmental Option (BPEO) involves the analysis of alternatives. The preferred option is that which minimises harm to the environment as a whole, taking account of what is affordable and practicable.

In order to successfully obtain a permit, operators have to show that:

- Their proposals represent the Best Available Techniques (BAT) to prevent and minimise pollution from the organisation.
- No significant pollution is caused.

BAT can be determined by conducting an Options Appraisal of candidate techniques.

The methodology involves six stages:

1. Define the objective of the assessment and the options for pollution control.
2. Quantify the emissions from each output.
3. Quantify the environmental impacts of each option.
4. Compare options and rank them in the order of the lowest environmental impact.
5. Evaluate the costs to implement each option.
6. Identify the option that represents the best available technique, taking costs and benefits into account.

The selection of appropriate operational controls should be based on the following factors:

- Control hierarchy - in general, the following strategy should be adopted:
  - Elimination.
  - Substitution.
  - Reduction/changes to the process.
- Reduction of emissions and changes to the process.
- Process design.
- Use of competent workers.
- Procedural controls.
- Monitoring and measurement.
- Documentary information.

Factors that affect the choice of control include:

- **Long term/short term** - wherever possible, risks should be 'designed or engineered out'.
- **Applicability** - the relevance of a control technique can be described in law (e.g. BAT).
- **Practicability** - control measures chosen must be usable and practical if they are to be effective.
- **Cost** - the cost of risk reduction is often detailed in law.

In most cases, solving environmental problems will have a positive impact on health and safety. In some situations, however, an action contributes positively to one sector but negatively to the other. Ways to deal with such problems include:

- Addressing most significant environmental risks of products or services at the design stage, with due regard to health and safety.
- Employing competent people to deal with health, safety and environmental matters and obtaining competent advice where necessary.
- Environmental professionals should have access to proper training in key principles of health and safety management, such as hazard and risk assessment.
- Similarly, health and safety professionals should understand how their work might impact on the environment.

Risk Control Measures

Selection of the Best Solution for an Organisation Based on Relevant Risk

Controls will usually involve a mix of both physical and human controls. Examples include:

- **Physical controls:**
  - Leaks in bulk storage tanks can be contained within a bund wall.
  - Spillages can be prevented from reaching a sensitive receptor by spill containment devices and equipment.
- **Human controls:**
  - Information, instruction, supervision and training.

Influences on Control Strategies

- **General Legislation**

  This is in place to reduce harm to health and to the environment from air emissions, waste disposal, etc.

- **Fiscal Strategies**

  These (e.g. carbon taxes) are frequently used as a control strategy.

- **Effects of Government Policy**

  Some control strategies are imposed by governmental policy.

- **Effects of Insurers**

  Most environmental matters will normally be managed through a public liability insurance policy.

  These policies do not give cover for incidents unless they are 'sudden and accidental'. In practice this means that pollution from leaking tanks or run-off from contaminated land would not be covered by a general insurance policy.

- **Effects of Internal Policies**

  Companies may also impose control strategies in the form of an Environmental Policy.

  These policies should be backed up by management systems, appropriate control procedures and associated information and training.

Consideration of Fiscal Controls

Fiscal controls are those that implement policies by using some kind of financial incentive or disincentive, such as:

- Taxation.
- Tariffs.
- Renewables obligation.
- Emissions trading.

Evaluating Risks to the Environment

Cost-Benefit Analysis (CBA)

CBA seeks to compare the monetary value of benefits with the monetary value of costs.

- **Benefit** = anything that increases human well-being.
- **Cost** = anything that decreases human well-being.

Examples of CBA include:

- Environmental impact of an industrial plant.
- Convenience for users of a new railway.

CBA as Applied to Environmental Risks

There are several different CBA techniques which may be used to derive the monetary value of environmental and social costs, including:

- Dose-response approach.
- Replacement cost approach.
- Avertive expenditures.
- Hedonic price methods (house prices approach).

CBA and Sustainability

Opinion differs about the ways in which CBA can be made consistent with sustainable development:

- CBA is seen by some as being a prerequisite for sustainability, since CBA is concerned with ensuring that actions are not taken where costs exceed benefits.
- Others see CBA as not encouraging sustainability as a result of CBA giving cost in the future less weight than cost incurred now.

CBA and Stakeholder Analysis

Although in a particular case, overall policy benefits may exceed policy costs, the spread of those costs and benefits for individual stakeholders may be very different.

Stakeholder analysis enables the decision-maker to identify the potential winners and losers.

Environmental Modelling

Models can be used to explore ideas regarding environmental systems that may not be possible to field-test for logistical, political or financial reasons.

Examples of scenarios include:

- Air quality impact assessments and dispersion analyses.
- Water quality modelling.

Principles and Application of Environmental Modelling

- **Conceptual Models**

  Generally written as diagrams with boxes and arrows, to provide a compact visual statement of the problem.

- **Quantitative Models**

  A set of mathematical expressions, coefficients and data attached to a conceptual model.

  These enable predictions to be made for the values of stated variables under varying circumstances (e.g. differing weather conditions, increase in river flow).

  Sensitivity analysis of a quantitative model can identify which processes and coefficients have the greatest effect on the results.

  Models can be based on:

  – empirical (observed) data; or they can be
  – mechanistic, being based on hypotheses regarding the processes involved.

- **Deterministic and Stochastic Models**

  – A **deterministic** model has no random components and every time it is run with the same parameters and conditions, the same results will be produced.
  – A **stochastic** model has at least one random factor, so as to produce different results each time the model is run, simulating environmental variability.

- **Scaling**

  Scientific knowledge of environmental processes has been developed through their study at a local level. However, the problems affecting us now are often expressed on regional and global scales. Common difficulties include:

  – Difficulties in aggregation of large-scale behaviour from local processes.
  – Different processes predominate at different scales; correlations derived at one scale may not be appropriate at another.
  – The interaction between processes operating at different scales.

- **GIS and Environmental Modelling**

  As many environmental models involve a spatial component, they lend themselves to the use of GIS (Geographical Information and Spatial Referencing Systems).

Example applications:

- Climate change.
- Surface water.
- Groundwater.

Dispersion and Transport of Pollutants in the Atmosphere

A pollutant plume emitted from a single source will be transported in the direction of the mean wind.

Dispersion models describe how pollutants are spread and mixed in the atmosphere. They link measured air quality with emissions data.

Although measurements may form an important part of monitoring, for many purposes, models are often needed to establish larger-scale average exposures or deposition fields.

Dispersion in Water

The impact of a discharge on any water body is dependent on discharge quality and quantity, and prevailing physical and chemical conditions of the waters receiving the discharge.

This assessment is normally made with some form of predictive model to enable simulation of different discharge quality parameters, in combination with the different physical and chemical conditions of the receiving waters.

Limitations of Environmental Modelling

A single sample for one process will seldom be an adequate basis for control decisions.

The means of data collection, the accuracy of the data analysis, and the limits of accuracy of the test/detectable limits and all the factors relating to the reliability of the information, must be sought.

Life-Cycle Analysis (LCA)

Behind the term 'life cycle' is the idea that accurate assessment of the impacts of a product on the environment should take into account the effects of the product throughout its whole life cycle.

Cradle-to-Grave Concept

The cradle-to-grave approach involves a full assessment of the impacts of a process or product.

Principles and Techniques of LCA

There are four key steps to LCA:

- **Definition** - defining the goal and scope of the study.
- **Life-cycle inventory analysis** - gathering data and making a model of the product life-cycle with all the environmental inflows and outflows.

- **Life-cycle impact assessment** - understanding the environmental relevance of all the inflows and outflows.
- **Life-cycle interpretation** - evaluating their relative importance.

- **Circular Economy**
  - An economy where resources are retained in use for as long as possible.
  - Differs from a linear economy, where the raw materials for a product are extracted, the product is manufactured and then used. When the product comes to the end of its use phase it is disposed of either by landfill or incineration without energy recovery.

Assessment of Environmental Toxicity

Meaning of Predicted No-Effect Concentration (PNEC)

Concentration of the substance below which adverse effects are not expected to occur.

Ecotoxicity: Lethal Concentration and Effective Concentration

Ecotoxicology is the study of how chemicals affect the environment and the organisms living in it. The PNEC is one method of determining ecotoxicology on organisms.

Other methods used to assess the effects of chemicals on species include:

- **Lethal Concentration (LC50)**

  The Lethal Concentration 50 (LC50) is a statistically-derived concentration of a test substance in water, which kills 50% of a test batch of organisms within a continuous period of exposure (usually 96 hours).

- **Effective Concentration (EC50)**

  The Effective Concentration 50 is that concentration which has an effect on 50% of a test population of organisms (e.g. immobilisation of daphnia, or reduction in growth of test algae).

Ecotoxicity has been assessed using data from many sources, including commercial databases.

Principles of Environmental Toxicity and Ecotoxicity Testing

Evaluation of the risks from all chemicals is now largely covered by the **European Regulation (EC 1907/2006) on Registration, Evaluation, Authorisation and Restriction of Chemicals** (abbreviated to **REACH**).

REACH also deals with other things such as the requirement to provide safety data sheets, previously covered by other legislation.

REACH now deals with so-called "new substances". These are defined as those that are not already listed in the European Inventory of Existing Commercial Chemical Substances (EINECS). On 1 June 2008, these were brought within the scope of **REACH.** They must be registered.

- Registration involves collecting and collating information regarding the properties of a substance.
- The amount of information required is dependent on the hazards and tonnage of the substance to be registered.
- This information is then required to be used to undertake a risk assessment.
- The assessment and collected information must then be submitted to the European Chemicals Agency (ECHA) in Helsinki.

Environmental Impact Assessment (EIA)

EIA must be carried out on the environmental effects of specified proposed major industrial or civil engineering developments.

These include types of project such as agricultural, extractive industry, energy industry, glass making and chemical industry.

The process of preparing an EIA is usually defined in law which will vary around the world. However, common stages of an EIA will often include:

- Screening.
- Scoping.
- Baseline studies.
- Impact assessment significance.
- Mitigation.
- Application environmental statement.
- Monitoring.

An environmental statement will often be required to cover the following:

- A description of the development.
- A description of the measures required to avoid or reduce significant environmental impacts.
- The data needed to identify and assess the significant impacts which a development is likely to have on the environment.
- An outline of the key alternatives to mitigate significant environmental impacts and the main reasons for the choice made.

A non-technical summary of the environmental statement.

Exam-Style Questions

1. **Explain** the principle of a 'pollution pathway' and comment on the importance of this principle in the assessment of environmental risk arising from the release of polluting substances into the environment. Illustrate your answer with examples of typical pollution pathways. (20)

2. **Describe** the factors involved when selecting measures to control environmental risk. (20)

3. (a) **Outline** the process of life-cycle analysis, quoting relevant standards. (6)
   (b) **Describe** the component parts of a life-cycle analysis. (14)

Model Answers

Question 1

Interpretation

Careful reading of this question is required. It is made up of two parts (although it is a question that has no official sub-parts), the first requiring an explanation of the principle of pollution pathways, including consideration of the importance of the principle when assessing environmental risk. The second part of the question requires examples of typical pollution pathways.

Plan

Pollution pathway principle - source, pathway, receptor, pathway examples, numerous pathways, organisms' dual role, bioaccumulation, effects on pollutants when in pathway (dilution, dispersion, sedimentation, chemical reactions, evaporation, photodegradation).

Assessment of risk - likelihood, exposure/dose, cover all pathways, predicted no-effect concentration, higher risk pollutants (persistence, high level of toxicity, accumulate in certain media, bioaccumulation).

Suggested Answer

The pollution pathway principle is based on the understanding that a pollutant must travel from the source along a pathway to a vulnerable receptor/target, where it causes harm. If this link is broken then no harm to the target will occur and the overall risk to the environment will be minimal.

There are a number of different pathways through which a pollutant can travel before it reaches the target. A valid example could be pesticide being sprayed onto land that then gets washed into a river with the water being drunk by humans and causing harm (the pathways would be air, land and water).

Organisms can also be pathways as well as targets in their own right. For example, some heavy metals and pesticides have the ability to bioaccumulate (build up in the tissue of animals without being excreted). This leads to a greater level of exposure to humans or other animals that might ingest organisms in which bioaccumulation has occurred.

When moving through pathways, pollutants can be affected by processes that alter their concentration, e.g. dilution, dispersion, sedimentation, chemical reactions, evaporation and photodegradation.

Comments on the importance of the pollution pathway principle in assessment of environmental risk could include the fact that risk is dependent on the likelihood that a pathway exists between a source of pollution and a target. The exposure or dose received by the receptor must be great enough to cause harm in some way. An environmental risk assessment should therefore consider exposures through all the different potential pathways, to each potential target group. This is in order to ensure that the Predicted No-Effect Concentration (PNEC) is not exceeded (if the PNEC is exceeded then harm is likely).

Some pollutants that are of a higher risk have environmental persistence, a high level of toxicity, accumulate in certain media (e.g. soils or sediments) and can bioaccumulate in food chains.

Question 2

Interpretation

This question requires an explanation of the following factors that are considerations when selecting control measures: long term/short term, applicability, practicability and cost.

Plan

Introduction, long term/short term, applicability, practicability, cost.

Suggested Answer

The key factors that need to be considered when selecting an appropriate environmental control measure are long term/short term, applicability, practicability and cost.

The primary consideration should always be 'designed or engineered out' risk. This will prevent the possibility of the event occurring. For example:

- A detector to identify a leak in a tank will avoid the necessity of operators having to constantly monitor the situation.
- A pH meter connected to a valve that cuts in as soon as a certain pH value is reached is preferable to an operator carrying out physical checks periodically.
- Providing firewater lagoons of sufficient capacity.

Measures used in a temporary way usually involve higher risk than permanent solutions, e.g. the provision of spillage-control equipment close to a tank containing oil not surrounded by secondary containment. Many examples of this can be found in both health and safety and the environment. Temporary solutions should be closely monitored and removed or made permanent, as soon as practicable.

The applicability of control techniques can be described in law, guidance and industry codes of practice in similar ways to health and safety. For example, organisations which possess an installation environmental permit are required to implement controls that represent the Best Available Technique (BAT). This is a broadly similar concept to reasonable practicability in health and safety in that the cost and benefits of control measures need to be compared. BAT is described in industry-specific guidance notes produced by the regulatory organisations.

Control measures chosen must be usable and practical if they are to be effective. Employees are unlikely to use control measures correctly if they are complicated and difficult to understand. Procedures can be made easy to read and understand by using photos or flowcharts, for example.

Usually, quick gains can be made with relatively little investment, but as risk requirements increase and greater and greater reductions are required, a point of diminishing returns is met where additional risk reductions are only achievable at excessive investment costs.

Here, considerable trade-offs are apparent - for example, the increased energy requirement and subsequent carbon-dioxide release of reducing micro-pollutants to lower concentrations from industrial and municipal wastewaters involves a trade-off between reducing chemicals in the environment and increasing contributions to global warming through energy use.

Again, the cost of risk reduction is often detailed in law. The essence of BAT is that the techniques selected to protect the environment should achieve an appropriate balance between environmental benefits and the costs incurred by organisations. However, whatever the costs involved, no installation may be permitted where its operation would cause significant pollution.

Question 3

Interpretation

For part (a), the answer should provide a brief description of the meaning and purpose of life-cycle assessment (life-cycle analysis). This should be given in the context of the standards that cover LCA.

For part (b), an in-depth explanation of the stages of LCA should be undertaken. A suitable framework for this answer would be considering the LCA process from the start to its conclusion.

Plan

(a) ISO 14040 and ISO 14044, meaning and purpose (products, comparison, impact on environment, cradle to grave).

(b) Definition of goal and scope, inventory analysis, impact assessment and interpretation.

Suggested Answer

(a) There are two international standards which could be referenced: ISO 14040:2006 Life-Cycle Assessment - Principles and Framework, which provides a clear overview of the practice, applications and limitations of LCA; and ISO 14044:2006+A1:2018 Life-Cycle Assessment - Requirements and Guidelines, which defines how an LCA should be carried out.

LCA is often undertaken to determine the environmental aspects and impacts of a product so that it may be compared with other products in order to determine which has the least overall adverse impact on the environment. It takes into account the full life cycle of the product from cradle to grave.

(b) The second part of the question requires a description of each of the component parts of LCA, using a suitable example:

- **Step 1 - Definition of Goal and Scope**

  The scope should be sufficiently well-defined to ensure that the breadth, depth and details of the study are compatible and sufficient to address the stated goal.

- **Step 2 - Life-Cycle Inventory Analysis**

  This mainly involves data collection, e.g. foreground data (very specific data that typically describes a particular product system and particular specialised production system) and background data (for generic materials, energy, transport and waste management systems). During data collection it is important that the data is validated so that data quality requirements can be met. It will then need to be allocated to a part of the life cycle.

- **Step 3 - Life-Cycle Impact Assessment**

  Inventory results are linked to physical impacts on the environment. There are three phases:

  - Classification and characterisation.
  - Normalisation.
  - Evaluation or weighting.

  In the classification phase, all substances are sorted into classes according to the effect they have on the environment. Characterisation provides a basis for aggregation of inventory results within all the categories.

  Normalisation enables a better understanding of the relative size of an effect. Each effect calculated for the life cycle of a product is benchmarked against the known total effect for this class.

  In the evaluation phase the normalised effect scores are multiplied by a weighting factor representing the relative importance of the effect.

- **Step 4 - Life-Cycle Interpretation**

  Interpretation is likely to involve a review of all elements of the LCA process, checking that these have been systematic and that assumptions made are consistent. A report will also be produced.

Element 5
Environmental Performance Evaluation

Performance Indicators

Environmental Management Performance Indicators

Each company will develop its own Environmental Performance Indicators (EPIs), which may include:

- Energy.
- Waste.
- Raw materials.
- Effluent.

The key feature with all the performance indicators is that they are measurable.

ISO 14031 identifies EPIs as being:

- **Management Performance Indicators (MPIs)** - provide information regarding the efforts of management in relation to environmental performance.
- **Operational Performance Indicators (OPIs)** - provide information regarding the environmental performance of operations and are measures of the environmental inputs and outputs from an organisation's activities.
- **Environmental Condition Indicators (ECIs)** - provide information about the condition of the ambient environment surrounding the organisation, which might be affected by its activities.

Incidents

Business may accrue fines and costs as a result of regulatory actions.

These can be associated with EPIs, which will ensure that financial information is reported to stakeholders.

Emissions

Performance indicators often reported include emissions of greenhouse gases, acid rain and smog precursors such as sulphur dioxide (SO_2), nitrous oxides (NO_x), ammonia (NH_3) and carbon monoxide (CO).

Waste

Wastes produced by an organisation can be measured relatively easily (e.g. estimating the number and weight of wastes that leave a site for disposal or treatment).

Water

Common indicators used for discharges to water include discharges of nutrients, organic substances and metals.

Energy

A significant indirect impact from energy use is global warming.

Emissions of greenhouse gases can be determined by contacting the relevant electricity supplier or using a standard factor for UK electricity.

Transport and Travel

EPIs used for travel and transport could include:

- Vehicle miles per average weekday.
- Number of journeys undertaken by sustainable modes (cycling, walking and public transport).

Carbon Dioxide and Carbon (Measurement Conversion)

Many organisations report on the emissions of greenhouse gases (GHGs).

GHG measurement may be directly at source by monitoring or the amounts emitted can be estimated by using activity data (e.g. fuel consumption) and conversion factors.

Monitoring Techniques

Active and Reactive Monitoring

Active means 'before it happens', while reactive means 'after it has happened'.

Active Monitoring Measures

The objective of active monitoring is to check that the environmental plans have been implemented and to monitor the extent of compliance with:

- The organisation's systems and procedures (check that practice reflects the written procedures).
- Legislation and technical standards.

Measurement techniques include:

- Environmental audits.
- Workplace inspections.

Performance can be measured by assessing how well the stated standards are being achieved, e.g. the level of accident rates, numbers of environmental failures identified on inspection. This measurement should be set against the 'levels of acceptability' built into the standard.

Inspections are the least formal activities out of all the environmental improvement tools.

They are scheduled checks on premises, activities or equipment carried out by personnel within that organisation.

Use of Environmental Inspections

To be effective, inspections should be planned according to a published schedule and have the full support of senior management.

Checklists are used to facilitate the inspection.

Role within a Monitoring Regime

Systematic active monitoring will be based on the nature and severity of the risks.

High-risk situations will require a greater depth and frequency of monitoring than situations of lower risk.

There are a variety of means of doing this, including:

- Workplace inspections.
- Performance review.
- Environmental audits.

Reactive Monitoring Measures

The objective of reactive monitoring is to analyse data relating to accidents or other loss-causing events.

Active monitoring is obviously preferable rather than waiting for an event to happen to highlight any shortcomings in the systems.

Accident recording has some value, but it is of limited use in relation to assessing future risk. There are problems with under-reporting of minor accidents.

Reactive Monitoring Data

- **Incidents**

  The likelihood of an incident can be minimised by effective planning through the development of site pollution-incident response planning.

  An effective pollution-incident response system relies on:

  – effective pre-planning (e.g. use of drip trays, bunds, etc.);
  – identification of contact numbers;
  – definition of personnel responsible; and
  – appropriate training.

- **Near-Misses**

  These are defined as an incident that could have resulted in an accident.

  An effective near-miss reporting system will include both mandatory and voluntary reporting. Root cause investigation should be undertaken on all near-misses.

- **Emissions**

  – GHG emissions may be determined by using conversion factors or direct monitoring.
  – Metal discharges to water can be determined by using emissions estimation methods.

- **Waste**

  Processes that produce large and variable amounts of waste can often benefit from improved process control.

- **Water and Energy**

  Water and energy consumption can be monitored by viewing and recording consumption from bills and recording meter readings on a regular basis.

- **Complaints**

  – Complaints and suggestions are likely to be a good indication of the adequacy of environmental measures.
  – Complaints from interested parties such as members of the public living in housing surrounding a site should be recorded.

- **Enforcement Action**

  Any indication by an enforcement officer that standards of the existing arrangements are deficient must be taken seriously.

  In the case of the issuing of notices, action is required immediately (or within a defined timeframe).

Workplace Inspections

Role of Inspections

Inspections all comprise the same three basic elements:

- An assessment of the standards of the workplace against the specified performance standards and risks.
- The identification and reporting of any deficiencies.
- The identification of causes and of action to be taken to remedy the problem.

Factors Governing Frequency and Type of Inspection

The frequency of the inspections will be determined by the nature of the risks and the importance of the measures required to ensure their control.

There are a range of inspection regimes designed to ensure the effectiveness of control systems, for example:

- Routine inspections.
- Maintenance inspections.
- Environmental surveys.

Competence of Inspector

The person responsible for conducting the inspection must be competent to carry out all the necessary checks and draw the correct conclusions.

This will involve reporting problems in the appropriate form to the appropriate person, and may involve identifying causes and remedial action.

Use of Checklists

In order to ensure a consistent and comprehensive approach to checking all the environmental elements, a checklist or inspection form will be developed.

Checklists should also be structured to provide a coherent approach to the inspection process.

Allocation of Responsibilities and Priorities for Action

The various persons involved in inspections could be:

- Individual employees.
- Supervisors.
- Environmental officers.
- Management.

The purpose of inspection is to identify remedial action to be taken in respect of deficiencies.

This needs to be based on an assessment of the causes of the problem - immediate and underlying.

Priority should be given to remedying any immediate causes of risk.

Requirements for Effective Report Writing

A good report should aim to:

- Get the message through to the reader.
- Make the message and arguments clear and easy to understand.
- Make the arguments and conclusions persuasive.

Style

This means the tone of language you use to address the reader. Points to consider:

- Clear.
- Concise.
- Correct.
- Courteous.
- Complete.
- Consistent.
- Convincing.

Structure

Typical components of a workplace report:

- Title and Author.
- Abstract or Short Summary.
- Introduction.
- Main Body of Report.
- Conclusions.
- Recommendations.
- References.
- Appendices.

Emphasis

Visual text devices for adding emphasis:

- Italics or underlining.
- Boldface.
- All-capital letters.

Punctuation marks may also be used:

- Some punctuation marks prompt the reader to give a word or sentence more than usual emphasis.

Choice and arrangement of words tells readers directly that what follows is important by using such words and phrases as especially, particularly, crucially, most importantly, and above all.

Persuasiveness

Features of a good argument include:

- Evidence consisting of facts, opinions (ordinary and expert) and material things is absolutely essential when building an argument.
- Arguments are built using as much observable evidence as possible.
- Assumptions about probable relationships, quantities or results are made and stated when needed to carry the reasoning further.

Auditing

Scope and Purpose of Auditing Environmental Management Systems

An audit is defined in ISO 19011:2018 as a:

"systematic, independent and documented process for obtaining objective evidence and evaluating it objectively to determine the extent to which the audit criteria are fulfilled".

The purpose of an environmental audit may include the following:

- Determination of the extent of conformity of the auditee's management system, or parts of it, with audit criteria.
- Evaluation of the capability of the management system to ensure compliance with statutory, regulatory and contractual requirements.

The audit scope describes the extent and boundaries of the audit.

The audit criteria are used as a reference against which conformity is determined and may include applicable policies, procedures, standards, etc.

Distinction between Audits and Inspections

Monitoring is principally a line management role, undertaken to ensure compliance with the organisation's adopted standards and procedures.

Auditing is a more fundamental examination undertaken by people outside the line management structure, challenging whether the standards and procedures are appropriate, as well as their application.

Pre-Audit Preparations

Prior to the on-site audit, the auditee's documentation should be reviewed. The audit team members or individual auditor will then prepare work documents such as checklists, sampling plans and forms.

Information Gathering

When on the site, an opening meeting should be held with the auditee's management or, where appropriate, those responsible for the functions or processes to be audited.

Information relevant to the audit should be collected by appropriate sampling and should be verified.

The auditor or audit team should determine prior to the closing meeting the conclusions of the audit.

Following the meeting, a report should be produced.

Notifications

A company's management should in most cases be aware of the date of the audit as soon as possible, enabling them to adjust and become used to the concept.

Interviews

The auditor should consider the following:

- Interviews should be held with persons from appropriate levels and functions, performing activities or tasks within the scope of the audit.
- Interviews should be conducted during the normal working hours.
- Put the person being interviewed at ease during the interview.

Responsibility for Audits

The responsibility for managing an audit programme should be assigned to one or more individuals with a general understanding of:

- Audit principles.
- The competence of auditors.
- The application of audit techniques.

Advantages and Disadvantages of External and Internal, In-House and Proprietary Environmental Audit Systems

With any scheme, costs and benefits have to be taken into account. Common problems include:

- Systems which are too general in approach. These may need considerable work to make them fit the needs and risks of the organisation.
- Systems which are too cumbersome for the size and culture of the organisation.
- Scoring systems may conceal problems in underlying detail.
- Organisations may design their management systems to gain maximum points rather than using one which suits the needs and hazard profile of the business.

Range of Environmental Audit Applications

There are many different types of environmental audit, for example:

- Corporate Audit.
- Compliance Audit.
- Environmental Due Diligence Review.
- Site Audit - Environmental Management Audit.
- Activity Audit.
- Single-Issue Audit.
- Audit Against Document or Management System Standard.
- Procedures Audit.
- Sustainability Audit.

Exam-Style Question

1. (a) **Identify** the reasons why environmental audits are undertaken. (4)
   (b) **Describe** the issues that could be covered by an environmental audit. (16)

Model Answer

Question 1

Interpretation

Part (a) asks for a brief description of the reasons for undertaking an environmental audit. Clearly, just a single aim would not be sufficient.

Part (b) asks for a description of the issues that could be covered in an environmental audit. This can apply to any type of environmental audit, not just internal audits (the type that most people are likely to have most experience of undertaking). A good range of issues is required and an in-depth explanation of just the basic requirements of EMS and internal audits will not gain marks.

Plan

(a) Variety, legal compliance, EMS - policies and procedures, risk control systems and procedures, generate awareness of EMS, costs.

(b) Impacts (e.g. waste, air, water), energy efficiency, nuisance, management controls.

Suggested Answer

(a) Environmental audits can be undertaken for a variety of issues such as determining environmental liabilities (due diligence), legal compliance, etc. This is dependent on the reason why the audit is being undertaken in the first place. However, the aims and objectives of most audits are to determine the level of compliance with legal and other requirements, company policies and management system standards (ISO 14001). The efficiency and effectiveness of risk control systems and procedures could also be considered. This might involve determining where such procedures are missing or where current procedures need amending. Audits will also generate awareness of the environmental management system to senior management and employees. From a financial point of view they may also identify cost savings or areas where resources could be used in a more effective way.

(b) As for issues that could be addressed by an audit, there are a very wide range but these might include:

- Waste management and waste minimisation.
- Water and effluent management.
- Controls for emissions to air.
- Energy efficiency of plant.
- Nuisance issues (noise, light, odour, etc.).
- Management controls including requirements of ISO 14001 (e.g. aspects and impacts identification and evaluation, training, documentation, emergency preparedness and response).

Element 6
Sustainability

Principles of Sustainability

Current Definitions of Sustainability

The commonly used definitions of sustainable development are:

"Development which meets the needs of the present without compromising the ability of future generations to meet their own needs".

"The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations."

Sustainable development involves a balance of social, economic and environmental needs.

Importance of Sustainability and Resource Efficiency in Decision-Making

Businesses which incorporate the principles of sustainability can benefit from:

- Resource efficiency - reduction of resources needed to run a business.
- Impacts of climate change.
- Risk management.
- Attracting and retaining quality employees.

Design, Construction and Resource Efficiency with Sustainability as an Objective

A product that has been **designed** with sustainability in mind must take into account social, economic and environmental effects throughout its life cycle.

The **construction** industry can contribute to sustainable development in many ways, including:

- Delivering buildings and structures that improve the health and well-being of users.
- Using materials that have low energy intensity and minimise environmental damage.
- Producing designs that are capable of a long life and have minimum impact on the environment.

Resource efficiency:

- More sustainable business operation, e.g. ensuring businesses are more resource-efficient, can result in significant financial savings.
- Resource-efficient practices can also lead to a better understanding of the environmental impacts of production processes and reduction in their scale.

The precautionary principle and 'polluter pays' (considered earlier) are examples of drivers for sustainability.

Population Growth

Overpopulation does not just refer to the size of the population, but the ratio of population to sustainable resources that are present and the way the resources are used and distributed within a population.

Overpopulation can result from:

- increase in birth rates;
- decrease in mortality rates (due to medical advances);
- increase in immigration; and
- unsustainable use of resources.

When considering the ability of the environment to sustain a population, factors such as clean water, clean air, warmth, food and shelter, etc. should be taken into account.

Increased populations also put pressure on other needs such as housing, education and public services.

Footprints

Ecological Footprint

- A measure of the demand of humans on the ecosystem of the Earth.
- Represents a standardised measure of the demand on nature for products, services, etc. and the plants' ability to regenerate.

Carbon Footprint

- Can be defined as the total emissions of GHGs produced both directly and indirectly from an individual, organisation, event or product.
- Tends to be calculated as carbon dioxide equivalent (CO_2e) so that it takes into account other GHGs as well as CO_2.
- Refers to GHGs produced over the full life cycle of a product from the extraction of raw materials to the final disposal, recycling, recovery, etc. of the product as waste and all stages in between.

GHGs covered by a carbon footprint may include:

- Scope 1 - direct emissions from the organisation such as GHGs from the combustion of fuel in vehicles or boilers or production processes.
- Scope 2 - indirect emissions from electricity, heat or steam bought and used by an organisation.
- Scope 3 - other indirect emissions out of the direct control of an organisation such as outsourced transportation or employee commuting.

Water Footprint

It's possible to produce a water footprint to demonstrate the average total volume of freshwater that is used to produce products and services that are used by an individual, organisation or even country.

Five Capitals Model of Sustainable Development

The Five Capitals Model, developed by the UK charity Forum for the Future, is a framework which considers sustainable development in terms of capitals and income. The Five Capitals are defined as being:

- Natural.
- Human.
- Social.
- Manufactured/built.
- Financial.

Product Stewardship

This concept involves protection of the environment centring on a product. All those involved in the product's life cycle have some responsibility for the impacts that the product could cause.

Ethical Probity

Can be considered to be the evidence of ethical behaviour in a particular process.

Environmental Corporate Responsibility and Self-Regulation

Corporate Social Responsibility (CSR) is an organisational approach that is very closely aligned with the concept of sustainability.

Organisations that pursue CSR seek to embed social, environmental and ethical management at the heart of their businesses.

Appropriate management of CSR is largely achieved by effective corporate governance (the system of rules, practices and processes by which the company is controlled).

CSR involves undertaking actions to improve the sustainability performance of the organisation, in addition to that of others who are controlled or influenced by the organisation's activities.

The control of social irresponsibility is also a key part of a CSR strategy. What requires to be controlled will vary with organisations due to differing activities but common issues include:

- Child labour.
- Forced labour, modern slavery and human trafficking.
- Water abstraction.
- Waste dumping.

CSR goes beyond the direct activities of the organisation. It should also involve the application of life-cycle thinking.

An effective CSR strategy will encompass the ownership by the organisation of high standards. The key to achieving such ownership is through self-regulation, which may involve the following:

- The setting and maintenance of industry-wide standards by industry bodies.
- Internal control strategy of an organisation for improving its social and environmental performance.
- Voluntary participation of an organisation in schemes administered by non-industry bodies.
- Requirements set in contracts.

Global Recognition of the Importance of Sustainability

Convention on Biological Diversity (CBD)

This was opened for signatures in 1992, coming into force in December 1993. It has three main goals:

- Conservation of biological diversity (biodiversity).
- Sustainable use of its components.
- The fair and equitable sharing of the benefits arising from genetic resources.

The key objective of the CBD is for the development of national strategies to enable the sustainable use and conservation of biodiversity. This is achieved by:

- Co-operation.
- General measures.
- Identification and monitoring.
- *In situ* conservation.
- *Ex situ* conservation.
- Sustainable use.
- Research and training.
- Impact assessment.

International Tropical Timber Agreement (ITTA) 2006

The function of the ITTA is to promote the expansion and diversification of the international trade in tropical timber from forests that are sustainably managed and legally harvested.

The International Tropical Timber Organisation (ITTO) regulates the trade in tropical timber by:

- Providing a framework for consultation, international co-operation and policy development.
- Contributing to sustainable development and poverty alleviation.
- Promoting and supporting research and development.
- Promoting increased and further processing of timber gained from suitable sources.
- Encouraging members to support and develop tropical timber reforestation.
- Strengthening the ability of members to improve forestry law enforcement and governance and to address illegal logging.
- Encouraging members to recognise the role of forest-dependent indigenous and local communities and develop strategies to enhance the capacity of the communities.

Convention Concerning the Protection of the World Cultural and Natural Heritage 1972

This Convention is a key agreement that aims to provide protection of:

- 'cultural heritage' such as monuments, groups of buildings and sites (combined works of man and nature, including archaeological sites which are of outstanding universal value); and
- 'natural heritage' - natural features consisting of physical and biological formations, geological features and natural sites.

Framework Convention on Climate Change 1994

The **United Nations Framework Convention on Climate Change (UNFCCC)** has been the focus of international efforts to reduce GHGs.

The Convention specifically requires that governments:

- obtain and share information on GHG emissions, policies and best practices.
- launch national strategies for addressing GHG emissions and adapting to climate-related impacts (including providing financial and technological support to developing countries); and
- co-operate in the preparations required for adapting to the impacts of climate change.

The **Kyoto Protocol** was adopted by parties to the UNFCCC in 1997, with the intention of establishing a legally-binding framework of GHG emission reductions. 37 industrialised countries and the EU committed to reduce emissions of a set of six GHGs by an average of 5% against 1990 levels.

The Paris Agreement:

- Was developed at the Paris climate conference in December 2015.
- Formally entered into force in November 2016 when a sufficient number of countries (representing at least 55% of the world's GHG emissions) had ratified it.
- Provides a framework to reduce global warming to well below 2 degrees C above pre-industrial levels and plans to achieve climate-neutrality by the end of the century.

Agenda 21

Each local authority has had to draw up its own Local Agenda 21 (LA21) strategy following discussion with its citizens about what they think is important for the area. Sustainable development is required to be a key part of LA21 strategy.

UN Global Compact

This is an international movement of sustainable companies and stakeholders who support companies to carry out business in a responsible manner by aligning strategies and operations with the ten principles of human rights, labour, environment and anti-corruption.

The three environmental principles of the Compact are:

- *"Principle 7: Businesses should support a precautionary approach to environmental challenges;*
- *Principle 8: undertake initiatives to promote greater environmental responsibility; and*
- *Principle 9: encourage the development and diffusion of environmentally friendly technologies."*

UN Sustainable Development Goals and Targets

Rio+20 Conference on Sustainable Development

Key points from the Rio+20 Earth Summit include:

- Commitment to develop Sustainable Development Goals (SDGs) covering the elements of sustainable development (social, economic and environmental).
- Recognition of the key role of the green economy as a massive economic opportunity that countries should adapt to in the future.

2030 Agenda for Sustainable Development

A set of sustainable development goals and targets was developed at the United Nations Sustainable Development Summit in September 2015, for the general categories people, planet, prosperity, peace and partnership.

Exam-Style Questions

1. Your organisation is revising its purchasing procedures in order that they should better reflect health, safety and environmental considerations. In the form of a memorandum to the Purchasing Manager, **outline** the environmental issues that should be addressed when purchasing new equipment and materials. (20)

2. **Explain** what is meant by the terms:
   (a) Corporate Social Responsibility. (5)
   (b) Corporate governance. (5)
   (c) Carbon footprint. (5)
   (d) Environmental Supply-Chain Management. (5)

Model Answers

Question 1

Interpretation

This question has no breakdown in terms of sections or marks. However, I would suggest that ten key ideas are required to win all of the available marks. The question is quite open, allowing many different issues to be considered. One possible framework would be to consider the life cycle of the equipment and materials. The question tests general knowledge on environmental issues rather than being specific to a certain type of issue. As an 'outline' question, it requires a brief explanation of each issue.

Plan

LCA, resource use during manufacture, transportation, impacts during use, waste issues, hazardous substances, nuisance, etc.

Suggested Answer

Memorandum to the Purchasing Manager: Environmental issues to be addressed when purchasing new equipment and materials.

Where appropriate, the need to undertake a Life-Cycle Analysis (LCA) of products may be considered and the supply chain should be checked.

The understanding of the impacts on the environment should also be considered, such as issues surrounding the use of non-renewable resources, e.g. consumption and sustainability.

The environmental impacts of transportation could also be considered, e.g. emissions and noise.

Impacts during use of the product could also be considered, such as atmospheric emissions and energy consumption.

Waste issues should also be included, such as waste produced during use or at the end of the life cycle and whether materials can be re-used or recycled. Packaging required and disposal could also be considered.

Other issues might include avoiding products that contain hazardous substances (e.g. pesticides, cadmium, mercury, etc.) and any permits or authorisations required to store such substances. In addition to hazardous substances and by-products, materials with the potential to cause odour, noise or other nuisances also require consideration.

Question 2

Interpretation

A relatively simple question to interpret - an explanation of the four terms is required. As the question is an 'explain' one and each explanation is worth five marks a reasonable amount of information in the form of a paragraph(s) should be provided.

Plan

(a) Corporate Social Responsibility - sustainability, social, environmental, ethical, heart of business, accountability, stakeholders, promotion of sustainability.

(b) Corporate governance - rules, practices, processes, balance of stakeholder needs.

(c) Carbon footprint - total emissions, direct, indirect, individual, organisation, product, carbon dioxide equivalent, organisation footprint, product footprint.

(d) Environmental Supply-Chain Management - suppliers in line organisation's standards, example of requirements, integration, developing relationships.

Suggested Answer

(a) Corporate Social Responsibility (CSR) is an organisational approach that is very closely aligned with the concept of sustainability. Organisations that pursue CSR seek to embed social, environmental and ethical management at the heart of their businesses. CSR requires that an organisation should be accountable to its stakeholders - customers, investors, employees, suppliers, local communities and society as a whole - for managing its social, environmental and wider economic impacts. CSR therefore plays a key role in promoting sustainability.

(b) Appropriate management of CSR is largely achieved by effective corporate governance. Corporate governance is the system of rules, practices and processes by which the company is controlled. It involves balancing the needs of stakeholders such as the government, regulators, customers and the public. An effectively governed company will embed sustainability principles into the heart of its organisation, ensuring that it takes responsibility for the environmental burdens associated with the organisation.

(c) A carbon footprint can be defined as the total emissions of greenhouse gases produced both directly and indirectly from an individual, organisation, event or product. Carbon footprints tend to be calculated as carbon dioxide equivalent (CO_2e) so that they take into account other greenhouse gases as well as CO_2. A product carbon footprint refers to greenhouse gases produced over the full life cycle of a product from the extraction of raw materials to the final disposal, recycling, recovery, etc. of the product as waste and all stages in between. An organisation carbon footprint includes greenhouse gas emissions from activities across the organisation such as energy used for powering buildings, vehicles or industrial activities.

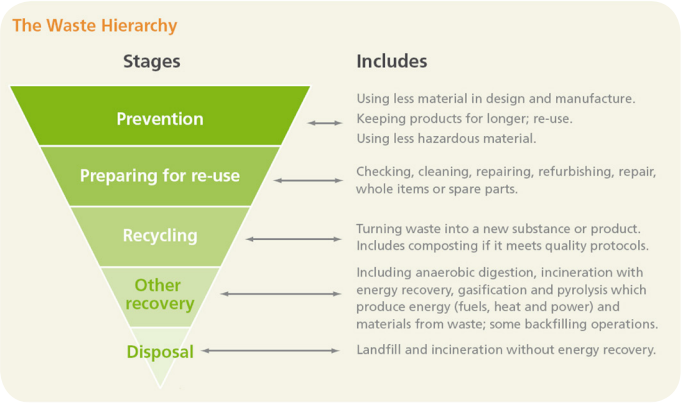
(d) Environmental Supply-Chain Management (ESCM) imposes certain requirements to bring suppliers in line with the organisation's standards of environmental management. Requirements may be specific, such as lists of substances that are banned, restricted or targeted for phase-out, or specifications on recycled content.

There may also be broader requirements, such as conformance to an EMS. For example, Ford and General Motors have mandated that their tier-one suppliers must implement environmental management systems in conformance with ISO 14001. Integrating specific environmental considerations into existing practices will generate further value, both within the organisation and in its relationships with suppliers. For suppliers, understanding and meeting environmental requirements of their customers can be a way of developing deeper relationships with their customers and increasing market share.

Element 7
Waste Management

Responsible Waste Management

The Waste Hierarchy



Source: Government Review of Waste Policy in England 2011, DEFRA, 2011 (www.gov.uk/government/publications/government-review-of-waste-policy-in-england-2011)

Hazardous and Non-Hazardous Landfill

In the EU, landfills are classified as being for hazardous, non-hazardous or inert wastes. Legal requirements also state that some level of pre-treatment of waste must be undertaken prior to going to a landfill for final disposal.

Importance of Responsible Waste Management

The purpose of responsible waste management surrounds:

- Raw material reduction.
- Corporate image.
- Pollution minimisation.
- Morale.

- Energy reduction.
- Cost.
- Employment.

Role of Design in Reducing Waste

Cleaner design can be defined as the design of a product to minimise its environmental impacts over its entire life cycle by considering the following:

- Reduced raw material use.
- Elimination of hazardous materials.
- Reduced use of energy and water.
- Less pollution and waste.
- Increased service life.
- Greater potential for recycling.

Steps to Responsible Waste Management

To ensure that waste is managed appropriately and does not escape from control, the following are required:

- Prevention of:
  - Corrosion or wear of containers.
  - Accidental spills or leakages.
  - Breach of containment by weather.
  - Blowing away or falling from vehicles or storage.
  - Scavenging by vandals, thieves, children, trespassers or animals.
- Protection of waste while it is held (cover skips, store liquids in bunded enclosures).
- Ensuring that waste reaches the next holder intact. (If the next stage is a waste transfer station, it will be sorted and mixed so that excessive packaging is not needed.)
- Segregating incompatible wastes (preventing cross-contamination of waste).
- Ensuring security (secure against waste attractive to scavengers, e.g. building materials). Waste left for collection should be adequately secured and left for a minimum of time.
- Labelling waste where appropriate and in accordance with the hazardous substance legislation.

Transportation of Waste

Transportation is also strictly controlled. In particular, it often requires documentation that follows the waste from the point of production to final disposal, recycling or re-use.

Disposal of Waste

Disposal must be to a permitted landfill site or other point of final disposal, such as an incinerator or treatment works. It is important that you understand where waste is being taken for disposal and ensure the carrier is registered with a competent authority.

Note: The requirements for managing domestic, commercial and industrial waste can differ in many countries.

Benefits of Waste Management

Economic Reasons for Waste Management

An effective system of waste management can bring many economic benefits to an organisation. These result from:

- reduced taxation;
- reduction in raw materials use;
- improved corporate image;
- less chance of prosecution;
- improved health and safety standards; and
- increased employment opportunities.

Setting of Waste Aims and Objectives

The aims and objectives set by an organisation will vary due to differing activities and resultant waste streams. Common areas for waste objectives to be set surround:

- Waste minimisation.
- Waste recovery rates.
- Amount of waste diverted from landfill/incineration.

Education and Training of Workers

As an effective waste management strategy will usually have a significant level of involvement of employees at an organisation, it is important that a strategy is present to ensure that employees are trained and educated in the importance of waste minimisation.

Engagement of Authorised Waste Contractors

There are often specific duties on producers of waste to ensure that wastes are only transferred to persons who are registered to accept or transport the particular types and quantities of waste involved.

Monitoring Waste

Purpose and Benefits of Waste Monitoring

Waste monitoring may be required for many reasons such as compliance with an integrated environmental permit. In such situations it is often the best available technique to monitor:

- the physical and chemical composition of the waste;
- its hazard characteristics; and
- handling precautions and substances with which it cannot be mixed.

Failure to screen waste samples adequately prior to acceptance at a facility has, in the past, led to problems such as inappropriate storage, mixing of incompatible substances, accumulation of wastes and unexpected treatment characteristics.

Sampling and Analysis of Solid Waste

Samples must be clearly labelled and any hazard identified. Sample tracking systems within a site should be present and auditable.

Analysis must be undertaken by a laboratory with a good quality assurance and quality control system.

Waste Reporting

Reporting involves the output of the process of organising waste data into useful summaries in order to monitor how the organisation's informal or formal waste management strategy is performing.

As part of ISO 14001 an organisation's environmental performance must be monitored, measured, analysed and evaluated. This might include:

- What should be monitored and measured.
- The methods for monitoring, measuring, analysing and evaluating.
- What criteria the organisation's performance is compared against.
- The frequency of monitoring.
- When monitoring results should be analysed and evaluated.

Waste Audits

A waste audit analyses an organisation's waste streams in order to identify the type of waste generated, the source of such wastes, the composition of the waste and the volume or weight of waste that is recycled, recovered or discarded. This may be undertaken by following a six-step process.

Control Strategies for Solid Wastes

The techniques used to treat waste may be:

- **Chemical** - using a chemical substance to change the character of the waste in some way.
- **Physical** - sorted and segregated, by hand or machine, to ensure recycling, recovery or treatment of the resultant waste streams.
- **Biological** - using micro-organisms to change the waste's constituents/character.

Incineration

Incineration is a process requiring an installation permit. There are very tight monitoring requirements set by the permit. In the UK, for example, emission limit values apply to incinerators.

The economics of incineration has been affected by a number of factors - for example:

- Increase in the cost of landfill disposal.
- Economic instruments, e.g. the Non-Fossil Fuel Obligation (energy from waste incinerators is classified as a renewable energy source and therefore receives a subsidy from the Government).

Solid waste can be burned in purpose-designed incinerators. It can also be compressed into pellets for incineration in modified boilers.

Benefits of Incineration	Limitations of Incineration
Reduction in volume.	High capital cost and monitoring requirements.
Destruction of hazardous components.	High fuel costs on start-up.
Creation of an easily disposed ash.	Need to carefully control inputs.
Small size of plant.	Incinerators are not suitable for aqueous wastes, wastes containing heavy metals, chlorinated materials (unless special controls are in place), and non-combustible solids.
Immediate and measurable effects.	
Can be used to raise energy by using calorific value of waste.	

Advanced Thermal Technologies (Pyrolysis, Gasification and Plasma Arc)

These technologies, in a similar way to incineration, use high temperatures to break down waste. The key difference is that they use limited amounts of oxygen in comparison to a traditional incinerator.

The four key stages of **pyrolysis and gasification** are:

1. Preparation of the waste feedstock - materials with no calorific value are removed.
2. Heating the waste - in a low oxygen atmosphere to produce gas, oil and ash.
3. Scrubbing the gas - removes particulates, hydrocarbons and soluble materials.
4. Using scrubbed gas to generate electricity or heat - may be achieved via gas engines or steam turbines.

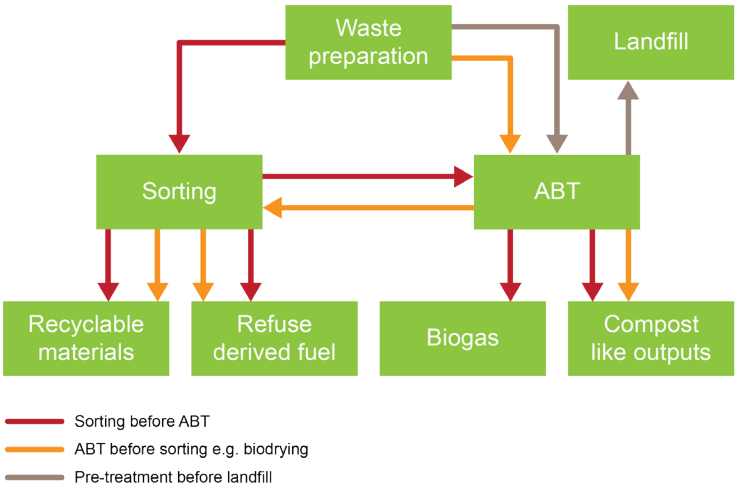
In **plasma arc technologies** waste is heated using a plasma arc (an electric arc used to heat waste).

Benefits of Advanced Thermal Technologies	Limitations of Advanced Thermal Technologies
By using less oxygen, fewer air emissions may be generated in comparison to thermal incineration.	Unless they use residual waste as a feedstock they may undermine waste minimisation efforts further up the waste hierarchy.
Plants are modular and consist of small units that can be added to or taken away as volume or waste streams change.	Feedstock is limited in order for them to work effectively and is unlikely to be truly residual waste.
Plant is relatively quick to construct.	Fuel produced will be less than the energy needed to manufacture new products.
Produce more useful products than conventional incineration, e.g. syngas.	An ash is produced that requires disposal.
Syngas can generate energy more efficiently than a conventional incinerator (using a steam turbine).	

Mechanical Biological Treatment (MBT)

Two types of MBT system exist:

- Type 1 - mechanical, then biological treatment.
- Type 2 - biological, then mechanical treatment (BMT).



Mechanical Biological Treatment Options
Source: Adapted from Mechanical Biological Treatment of Municipal Solid Waste, DEFRA, 2007

Benefits of MBT	Limitations of MBT
Consists of technologies that are proven and used internationally.	Market for outputs may be small.
May remove waste further material that can be recycled from residual waste stream.	Some wastes will still need to be disposed of to landfill.
Produces waste materials that may be used as a source of energy.	Higher operational costs in comparison to alternative techniques.
Can capture waste containing recyclable material in residual waste (kerbside recycling schemes are not 100% successful).	Plants are often large and draw in waste from a wide geographical area with resultant transport impacts.
Significantly reduces waste disposed of to landfill.	Due to cost, plants often operate on long- term contracts and need a fixed amount of waste. This can undermine waste minimisation schemes in an area, particularly those funded by local authorities.

Benefits of MBT	Limitations of MBT
Waste disposed of to landfill from MBT will have much lower biodegradability and as such reduce methane and leachate production in a landfill.	In comparison to kerbside collection of recyclable materials where waste recycled materials are segregated into different types, the recycled materials from MBT are generally mixed and fetch a lower price in the market.
Can recover items that are not always collected for recycling.	
Sorting will ensure that hazardous items do not reach landfill sites.	
Plants are modular and with units added or removed as waste streams or waste volumes fluctuate.	

Composting

This is a means of biologically treating solid wastes. It is a process which stimulates the decay of organic materials by aerobic means. The waste is composted under controlled conditions including aeration and mechanical turning of the material.

Benefits of Composting	Limitations of Composting
Lower capital investment required than for most other alternative techniques.	Requires large energy input to turn and aerate compost piles.
Produces a solid fertiliser.	If run inefficiently may cause odour nuisance.
Less environmental impact than spreading unprocessed waste on land.	A compost plant will require large areas to run efficiently.
Improves the physical, chemical and biological properties of soil (e.g. water retention).	Composted material may retain a heavy metal content, with potential contamination problems.

Anaerobic Digestion (AD)

This is a biological process that happens naturally when bacteria break down organic matter in environments with little or no oxygen. Methane fermentation is part of the anaerobic digestion process, being a system to extract biological gas (about 60% of methane and 40% of carbon dioxide) from organic waste by the action of methane bacterium. This can be burnt to generate heat or electricity.

As well as biogas, AD produces a solid and liquid residue called digestate, which can be used as a soil conditioner to fertilise land.

Benefits of Anaerobic Digestion	Limitations of Anaerobic Digestion
Produces energy in the form of a biogas.	Requires a high level of investment to build AD plants.
A by-product is a solid and liquid fertiliser.	If an AD plant is run inefficiently it may cause odour nuisance.
Can sanitise waste as long as the temperature is held at required level for a predefined time period.	Operating costs of an AD plant are greater than those for aerobic digestion (e.g. composting).
Reduces odour in comparison to unprocessed waste (e.g. at a landfill).	Will not remove non-organic pollutants.
Reduced risk of pollution in comparison to land spreading of unprocessed waste.	
Fertiliser produced is of a higher quality and longer lasting than untreated organic waste.	
Diverts waste from alternative techniques lower on the waste hierarchy.	
Requires little energy to operate an AD plant.	

Landfill

Principles of Landfill Site Selection

Landfill sites must be classified as inert, non-hazardous or hazardous.

They are the most commonly used form of waste disposal.

Modern landfill sites are highly engineered. Works commence with detailed engineering surveys and studies of the geology, hydrogeology, soils, water, groundwater and many other parameters.

Specifications for landfill cover:

- Location.
- Control of water.

The major potential problems concerned with landfill sites are:

- Landfill gas.
- Leachate.
- Nuisance.

Site Management Controls

Control of Gas

- Appropriate measures must be taken in order to control the accumulation and migration of landfill gas.
- Landfill gas must be collected from all landfills receiving biodegradable waste and must be treated and, to the extent possible, used.

Control of Nuisance

Measures must be taken to minimise the nuisances arising from landfill in relation to:

- Emissions of odours and dust.
- Wind-blown materials.
- Noise and traffic.
- Birds, vermin and insects.
- The formation of aerosols.
- Fires.

Access Control

- The landfill must be secured to prevent free access to the site.
- The gates of the landfill must be locked outside operating hours.
- The system of control and access to each facility must provide systems to detect and discourage illegal dumping in the facility.

Exam-Style Questions

1. (a) **Outline** the options that could be used to pre-treat non-hazardous waste prior to disposal to landfill. (12)

   (b) **Describe** practical measures that could be implemented in an office to minimise waste production. (8)

2. (a) **Outline** the reasons why many organisations adopt a 'zero waste to landfill' policy commitment. (12)

   (b) **Describe** the key elements of the design of an effective waste landfill. (8)

Model Answers

Question 1

Interpretation

An answer to part (a) may cover treatment for both liquid and solid waste. To gain full marks, a brief explanation of a number of treatment methods is required.

For part (b) the question must be read carefully as it asks for practical measures to minimise the generation of waste in an office. A description of the recycling options for different types of waste is therefore beyond the scope of what this question actually requires. The answer must also be relevant to wastes that are produced in an office and not another type of workplace.

Plan

(a) Physical, biological and chemical methods.

(b) Returnable packaging, double-sided printing, paperless office, cups/plates, cartridges, re-use of paper, washable towels, re-use of office equipment, purchasing policy, order control.

Suggested Answer

(a) There are many methods that could be used to treat waste prior to being disposed of to landfill. These could be categorised as physical, biological and chemical treatments.

Physical treatments might include:

- Sorting waste to ensure that recyclable or re-usable elements are separated.
- Thermal treatment (e.g. incineration, evaporation).
- Crushing of waste (e.g. waste compaction, baling, etc.).
- Screening.
- Using waste as a fuel (e.g. biofuels).

Biological treatments might include:

- Composting (garden waste).
- Anaerobic digestion (allowing waste to be broken down by micro-organisms under no/little oxygen conditions, producing gas).

Chemical treatments may constitute:

- Neutralisation (e.g. adding an alkali to an acid to ensure that it is of a neutral pH).
- Sterilisation (e.g. using UV light to destroy pathogens).
- Chemical reactions (to reduce the mobility of heavy metal in the waste).

(b) Measures to minimise waste include:

- Ensuring that suppliers use returnable delivery packaging.
- Double-sided printing of e-mails and reports.
- Reading from the screen rather than printing (paperless office practices).
- Washable cups and plates.
- Toner and printer cartridges that are refilled.
- Re-use of surplus paper and card, e.g. for packaging.
- Provision of washable towels rather than paper towels.
- Re-use of surplus office equipment through charities.
- Purchasing policy to require equipment with a long life is bought.
- Order control to reduce chances of over-purchasing.

Question 2

Interpretation

Part (a) requires a short description of reasons why waste should not be sent to landfill. Don't be thrown by the mention of 'zero waste to landfill'. The answer just requires an outline of the negative implications of landfilling waste. Part (b) requires a description of the key requirements of a modern landfill.

Plan

(a) Climate change, health and safety, water and groundwater pollution, resource use, land take, restrictions on land use, concern of local communities, etc., increased cost, transportation, planning permission, management system requirements, need for pre-treatment.

(b) Heavily engineered, technical studies, collection wells and pipes, monitoring, cells, topsoil, planting.

Suggested Answer

(a) There are many reasons why producers of waste are implementing 'zero waste to landfill' policies. These include:

- Climate-change impacts such as methane emissions from the breakdown of waste and carbon dioxide emitted from transportation and other activities.
- Health and safety implications of explosive and flammable landfill gas.
- Water and groundwater pollution from the production of leachate.
- Placing resources underground that could be re-used, recovered or recycled.
- Land take for landfill sites, including restriction on the activities the land can be used for following closure of the site.
- Restriction on development of the land due to health, safety and environmental concerns for buildings that are in the vicinity of landfill sites.

- Concerns of local communities and impacts on organisations of lobbying by environmental groups.
- Increased cost due to landfill tax and stricter regulatory control.
- Greater transport distances due to pattern of fewer larger sites.
- New sites development being restricted due to planning permission.
- Management system requirements such as ISO 14001, meaning that other options for wastes need to be considered, e.g. re-use, recovery, recycling, and other disposal methods.
- Waste for landfill must be subject to pre-treatment.

(b) Modern landfill sites are highly engineered. Works commence with detailed engineering surveys and studies of the geology, hydrogeology, soils, water, groundwater and many other parameters. Today, sites are expected to avoid pollution, so they are usually lined with a plastic or asphaltic liner, followed by the development of a complex of leachate and gas collection wells and pipes. Monitoring of all these systems is required and incorporated. The waste inputs are carefully monitored and checked, and tipping takes place in 'cells', each of which will be virtually self-contained, giving a complex 'honeycomb' of cells in the completed site, which is then capped with a carefully engineered series of different sealants (such as clay and subsoil), before being finished with topsoil and planted.

Element 8
Managing Emissions to the Atmosphere

Emissions to the Atmosphere

Types of Emissions

- **Gaseous**

  Pure gases are substances which remain in the gaseous phase at the process temperatures and pressures, e.g. carbon dioxide, nitrogen and ozone.

- **Vapour**

  Vapours are the gaseous state of materials which are liquid at normal temperature and pressure.

- **Mist**

  Mists are fine liquid droplets, usually nucleated by a particle.

- **Fume**

  Fumes are small solid particles produced by condensation of vapours or gaseous combustion products (i.e. cooling of combustion products from hot processes). Particle size is in the range 0.01 to 1 micron.

- **Smoke**

  Particles in the range 0.1 to 10 microns are seen as smoke.

  There are no clearly established size definitions for these particulates and different publications suggest other overlapping size bands.

- **Dust**

  A dust may consist of any size or shape of particle, crystalline or amorphous.

- **Grit**

  This is defined as particles exceeding 76 microns in diameter.

- **Fibre**

  Fibres are solid particles with an increased aspect ratio (the ratio of length to width).

Pollutant Impacts

Substances	Main Sources	Effects
Particulates	Combustion of fuels and activities such as quarrying and construction. Classified according to size (see above).	Contribute to respiratory and cardiovascular illness. Particles with a mean diameter less than 10 microns (PM_{10}) have been particularly linked to adverse health impacts.
Oxides of carbon	Combustion of fossil fuels, especially in electricity generation and road transport.	Carbon dioxide is the main pollutant implicated in climate change. Carbon monoxide reduces the capacity of the blood to carry oxygen and is especially dangerous to people with heart and circulatory diseases.
Oxides of nitrogen	Any combustion activity taking place in air. Road transport and electricity generation are important sources.	Nitrogen dioxide (NO_2) and nitric oxide (NO) are often referred to together as NO_x. NO_x is linked with inflammation of lung tissue and respiratory symptoms and can reduce leaf growth in plants. NO_x also reacts with VOCs (below) to create toxic ozone and other components of photochemical smog.
Oxides of sulphur	Combustion of fossil fuels containing sulphur, such as coal and heavy fuel oil in power stations.	Sulphur dioxide causes constriction of the airways of the lung and is especially harmful to people suffering from asthma and chronic lung disease. Sulphur dioxide is major contributor to acid-rain deposition, which contributes to the acidification of surface waters and soil and subsequent loss of biodiversity.
Polycyclic Aromatic Hydrocarbons (PAHs)	Road transport and domestic coal and wood fires.	Potentially carcinogenic and linked to lung and skin cancers.
Volatile Organic Compounds (VOCs)	Evaporation of liquid fossil fuels used in transport and solvents used in a range of industrial processes.	VOCs can react with NO_x (above) to create toxic ozone and other components of photochemical smog.

(Continued)

Substances	Main Sources	Effects
Methane	Decomposition of biodegradable waste (e.g. landfill gas), agriculture, fossil fuel production and distribution.	Explosive, flammable and a potent greenhouse gas.
Low-level ozone	• Transportation and industry. • A secondary pollutant formed from the reaction of oxygen, VOCs and nitrogen oxides in the presence of light.	Short-term exposure can cause temporary irritation of the lungs, eyes and respiratory tract. Long-term exposure to low concentration may reduce lung function. Exposure to ozone may worsen respiratory diseases such as bronchitis and emphysema.
Asbestos	Historically, used in a wide range of building materials, such as roofing and lagging, and may be released from construction sites.	Causes respiratory illness and lung-cancer.
Halogens	A family of highly-reactive elements, including fluorine, chlorine and bromine. Fluorine compounds are used in many industrial processes. Halogen-containing gases are used in refrigeration systems.	Toxic and damaging to the growth of plants. Halogenated refrigerant gases (CFCs, HCFCs) are strongly linked to the destruction of the ozone layer and to climate change (HFCs).
Toxic metals	Lead, arsenic, cadmium, mercury and nickel may be emitted from the combustion of coal and a range of industrial processes. Historically, lead was added to road fuels and was an important exhaust pollutant.	A wide range of toxic biochemical effects, including damage to the nervous system.
Other toxics	The combustion of road fuels and a range of industrial processes have the potential to release other toxic substances, notably benzene and 1,3-butadiene.	Carcinogenic.

Impacts of Pollutants on Air Quality and Health

Progress has been made in controlling some sources of air pollution, but air quality is still declining in many areas of the world, especially in large cities with high densities of road vehicles. Poor air quality may also have detrimental impacts on wildlife and agricultural systems.

- Short-term human health effects from air pollution can include irritation and inflammation of the airways, eyes and mouth, and triggering of asthma attacks in susceptible individuals.
- Longer-term problems are often associated with cardiopulmonary (heart-lung) performance, but some pollutants are also associated with increased incidence of cancers.

Key Air Pollution Issues

The air is essential to all life and we need a supply of clean air to function effectively. Polluted air can directly affect our health as well as the environment.

Climate Change

The greenhouse effect is when the Sun irradiates the Earth with energy and as the Earth warms, it emits energy back into space as infrared radiation.

Releasing greenhouse gases traps more heat and changes climate.

This leads to issues such as sea-level rise, droughts, floods and disruptive weather events.

The Paris Agreement provides a framework to reduce global warming to well below 2°C above pre-industrial levels and plans to achieve climate-neutrality by the end of the century.

The Kigali Amendment 2016 to the Montreal Protocol sets a timetable for the phase-out of hydrofluorocarbons, a group of potent fluorinated greenhouse gases.

Photochemical Smog

Oxides of nitrogen (often referred to as NO_x) can react with atmospheric gases, in the presence of sunlight, to produce harmful low-level ozone.

Acid Deposition

This can occur as acid rain or dry deposition.

The release of oxides of nitrogen (NO_x) into the air and sulphur dioxide (SO_2) from fossil-fuel burning combine with water vapour (clouds) to form **acid rain**, which has impacts on fish, birds, forests, crops and buildings.

Ozone Layer Depletion

Chlorine and bromine free radicals are able to react with, and break down, ozone molecules. This allows higher levels of ultraviolet light to reach the Earth, causing increased risk of skin cancer.

The **Montreal Protocol on Substances that Deplete the Ozone Layer** phases out ozone-depleting-substance use around the world.

National Emission Ceiling Levels

The **Geneva Convention on Long-Range Transboundary Air Pollution 1979** (and eight associated Protocols) aims to limit and gradually reduce pollutants that can cross national boundaries.

The associated **Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-Level Ozone 1999** is made under the Geneva Convention. It sets national emission ceilings for sulphur dioxide, oxides of nitrogen, VOCs and ammonia.

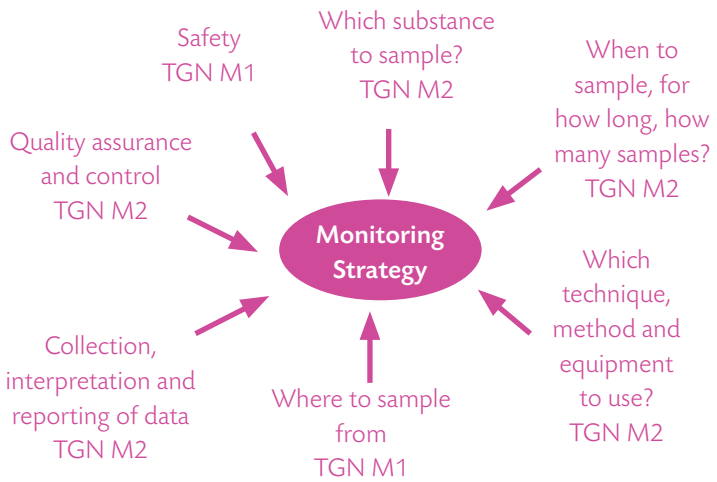
Monitoring Atmospheric Emissions

Legislation often includes specific requirements to sample, monitor and measure emissions from stacks, chimneys and process vents. For example, monitoring of the waste gas stream as it leaves the chimney or flue stack may be required in order to demonstrate compliance with the environmental permits.

Principles of a Monitoring Strategy

Understanding the type of monitoring required will require reference to permits or equivalent legal documents in addition to guidance publications.

A monitoring strategy consists of the elements identified in the diagram below:



Main Elements of a Monitoring Strategy
Source: Adapted from Technical Guidance Note (Monitoring) M2, Monitoring of stack emissions to air, Environment Agency, 2015
(www.gov.uk/government/publications/m2-monitoring-of-stack-emissions-to-air)

Sampling Principles

Key terms in stack emission monitoring:

- **Sampling Point**

  The specific position on the stack where the sample is extracted.

- **Sampling or Access Ports**

  Points on the wall of the stack, duct or flue through which access to the emission can be gained.

- **Isokinetic Sampling**

  'Same speed' sampling - a technique of drawing sampling air through a probe containing a collection filter at the same rate as the gas flow in the stack.

- **Monitoring Approach**

  Whether the monitoring is periodic or continuous.

- **Monitoring Techniques**

  The analytical principles behind the monitoring, e.g. infrared, absorption, chemiluminescence, etc.

- **Monitoring Method**

  The published or documented procedure for using the monitoring approach and technique.

- **Monitoring Equipment**

  The instruments and apparatus used.

Monitoring Approaches

There are two main approaches to measuring stack emissions:

- **Periodic measurement** is a measurement regime carried out at periodic intervals, e.g. six months. Samples are usually taken from the stack and measured elsewhere (grab or extractive sampling).
- **Continuous Emissions Monitoring (CEM)** is measurements taken automatically, with few if any gaps in the data produced.

Measurement can be carried out in situ or the sample gas can be extracted and measured remotely on an instrument permanently located elsewhere.

Competence

The undertaking of atmospheric monitoring requires a high level of competence and is usually undertaken by specialist contractors.

MCERTS provides a framework of standards for regulators and industry that can be used to monitor emissions that have the potential to have a significant impact on the environment.

The techniques used to carry out atmospheric monitoring will usually be defined in standards at the national, European or international level.

Permits or associated guidance will often state the standards that are deemed to be an acceptable means of gaining a sample.

Reporting and Recommendations

Following atmospheric emissions monitoring, a report will be submitted by the contractor outlining the concentrations of measured substances at the sampled emission points.

Comparison of the measured concentrations against Emission Limit Values (ELVs) stated in the permit will need to be undertaken.

Remote Sensing

As part of an integrated observing strategy, satellite measurements provide a context for localised observations and help to extend these observations to continental and global scales.

Remote sensing has many uses including the assessment of air pollution.

Control Strategies and Measures

Control Hierarchy

- Eliminate.
- Minimise.
- Render harmless.

Particulate Control Devices

Settling Chambers

A settling chamber is a relatively simple device that reduces the velocity of an emission to allow dust to settle out by the action of gravity usually in a duct.

Cyclones

These operate by causing the airflow to change direction rapidly into a spiral. This throws the particles out of the air stream toward the walls of the device. The particles then fall down to the bottom of the device for collection.

The running costs and maintenance requirements are low.

Fabric Filters

These remove dust from a gas stream by passing through a fabric.

The fabric must allow air to pass through it and remove the dust particles from the air.

Fabric filters are generally more efficient at removing smaller particles from air streams than cyclones.

Consequently, cyclones are often used as first stage air-cleaning devices to remove the larger particles from the air stream before it is passed into a fabric filter unit.

Wet Scrubbers

Wet scrubbing techniques are used to remove particulates from waste gas streams.

The principle of all wet scrubbers is that water droplets are generated within the device and particles are captured within the droplets.

The droplets are then removed from the air stream, which is now clean.

The droplets are collected as contaminated water and transported out of the device for treatment or disposal.

Scrubber designs include:

- Venturi scrubbers.
- Mechanically-aided scrubbers.
- Pump-aided scrubbers.
- Wetted filter scrubbers.

Electrostatic Precipitators

An electrostatic precipitator (ESP) is a particulate and droplet-control device which uses electrical forces to remove particles from a dust-laden air stream.

An area of ionised air molecules is established, usually around a wire, by maintaining the wire at a very high voltage.

This region of ionised air molecules is called a corona.

As dust particles flow through the corona, they collect the ions, then they themselves become charged.

A plate, called the collector plate, is maintained at the opposite electrical polarity to the wire and the particles, so that the charged particles migrate toward the plate.

Eventually, the particles approach close enough to the plate so that the turbulence drops to lower levels and the particles are deposited.

Water Walls

Water can be used to suppress dust and prevent it escaping from a confined area. This technique is commonly used in construction and demolition, where large amounts of dust can be generated and therefore need to be controlled. There are two common methods: rain guns and perimeter systems.

Gas and Vapour Devices

Absorption Devices

Packed columns are usually vertical steel columns containing small elements over which water flows to coat each element with a thin layer of water.

Another mechanism used to mix pollutant gases in an air stream with a solvent is to bubble the air up through water held on plates (**plate columns**).

Activated Carbon Adsorption Devices

The process of adsorption involves the retention of a gas or vapour molecule on the surface of a particle or droplet.

There are two adsorption mechanisms:

- a **physical** action involving intermolecular Van der Waals forces; and
- a **chemical** action involving activated adsorption.

Adsorbents:

- Activated carbon.
- Activated alumina.
- Silica gel.
- Molecular sieves.

Incinerators

There are three types of incineration devices generally referred to: flare stacks, thermal incinerators and catalytic incinerators.

- **Flare stacks** are usually employed in the petrochemical industry and are seen as tall stacks with visible flames on top.
- Most **thermal incinerators** comprise a chamber containing a burner unit. The burner unit, fuelled usually with natural gas, raises the temperature of the waste gas to the point where it reacts with the oxygen in the air.
- In **catalytic incineration** the use of a catalyst allows the oxidation reaction to take place at much lower temperatures, around 400°C.

Dry Scrubbers

There are various forms of dry scrubber that will usually use a combination of moisture-free air pollution abatement technologies such as bag filters, adsorption, electrostatic precipitators and cyclones.

Dry scrubbing techniques may be used for treating pollutant emissions from numerous sources such as waste incineration, biomass combustion or kilns.

Coolers and Chillers

VOC vapours condense when their temperature is reduced or pressure increased. Techniques using this principle to control pollution are:

- **Contact coolers** - involves spraying cold water into the gas stream and cooling by direct contact.
- **Surface coolers** - devices that present the vapour with a cold surface.

Peat Filter Beds

The beds are typically large steel or concrete containers containing natural peat. The peat was treated with micro-organisms and supplied with water and nutrients to encourage their growth.

Bio Scrubbers

A bio scrubber consists of a gas scrubber that removes pollutants from the gas stream by the use of washwater. The wastewater is then transferred to a biological reactor where pollutants are biologically degraded.

Exam-Style Questions

1. (a) **Identify** how manufacturing activities may contribute to global climate change. (14)

   (b) **Explain** how life-cycle analysis may be used to determine the impact a manufactured product has on global climate change. (6)

2. Air pollution can have significant impact on the environment. **Explain** the sources, pathways, processes and effects of the following:

   (a) global climate change; (5)

   (b) stratospheric ozone depletion; (5)

   (c) acid rain; (5)

   (d) photochemical smog. (5)

3. **Explain** how the following air-pollution control devices operate, referencing the pollutant categories and type of plant that they may be used for:

   (a) bag filter; (5)

   (b) electrostatic precipitator; (5)

   (c) wet scrubber; (5)

   (d) activated carbon adsorption device. (5)

Model Answers

Question 1

Interpretation

The question is in two parts and your answer must be presented in the same way; an answer to part (a) and an answer to part (b).

Part (a) of the question carries 14 marks, with key words being 'manufacturing', 'contribute' and 'global climate change'.

Part (b) requires you to apply the concept of Life-Cycle Analysis (LCA) to the scenario so key words or phrases are 'life-cycle analysis', 'used to determine', 'manufactured product' and 'global climate change'. The concept of LCA must be applied to the scenario - it is not sufficient to just give a general description of the process.

Plan

(a) Direct effects (those that come specifically from the site) and indirect effects (those that occur from raw material and utilities generation, use and disposal of the product).

(b) Cradle to grave, inventory analysis, interpretation, carbon footprints.

Suggested Answer

(a) For direct effects consider activities that may be occurring on the site that may emit one or more greenhouse gases. Energy may be being generated on-site from the use of fossil-fuel-powered generators. Consider transportation including on-site transportation (forklift trucks), haulage fleet and employee travel to and from work. Greenhouse gases may be emitted from the manufacturing process itself (e.g. chemical industry). Service emissions may also occur, such as leakage of refrigerant from an air-conditioning system. Maintenance activities may involve the use of solvents.

Indirect activities would include use of electricity that has been generated by the combustion of fossil fuels. Emissions from the manufacture of raw materials that are used and emissions from the use of a product (e.g. car) are also relevant. Destruction of carbon sinks such as forest and soils is easily missed but could also form part of your answer. Finally, consider the disposal phase - disposal to landfill of a waste that will biodegrade will cause methane emissions. Incineration and/or treatment of the waste would also emit carbon dioxide and other greenhouse gases.

(b) Life-cycle analysis may involve an analysis of greenhouse gas emissions from cradle to grave. Inventory analysis involves making a quantified estimate of the amount of greenhouse gas emissions from each phase of the life cycle. Interpretation of the inventory analysis will involve working out the magnitude of the greenhouse gas emissions at the phase of the life cycle. Reference could be made to carbon footprint, which is a type of life-cycle analysis that constitutes analysis of just greenhouse gas emissions.

Question 2

Interpretation

This question has four parts, each of which is worth five marks. Being an 'explain' question a reasonable explanation is required in the answer. Ensure that the causes, principles of formation and consequences of each are covered. A logical approach would be to use the source-pathway-target approach for each effect.

Plan

Source, pollutant, pathway, process and effects.

(a) Burning fossil fuels and others; carbon dioxide, methane, etc.; increase in greenhouse gas layer; trapping heat; rise in sea level, increase in temperature, change in weather conditions, etc.

(b) Emissions of hydrogen and bromine-containing compounds; VOCs, refrigerants, halons, chlorinated solvents; process of ozone depletion; increased UV; effects of increased UV.

(c) Emissions of acidic gases; NO_X, SO_2, HCl; process of formation (combination with water); effects on vegetation, aquatic systems, leaching of metals.

(d) Emissions of VOCs; NO_X, secondary pollutants mainly ozone; reaction with sunlight and reactive gases; respiratory problems.

Suggested Answer

(a) Global climate change - caused by increases in greenhouse gases such as CO_2 (from burning fossil fuels), methane (from landfill sites), refrigerant gases (from refrigeration systems). Such air pollutants cause the greenhouse gas layer to become more efficient at trapping heat, exacerbating the natural process. This leads to a global warming of the atmosphere. Consequences include climate change, sea-level rises, changing weather conditions and effects on agriculture.

(b) Stratospheric ozone depletion - emissions of ozone-depleting substances (hydrogen and bromine containing), such as refrigerants, carbon tetrachloride, halons and chlorinated solvents. Ozone layer acts to absorb harmful ultraviolet radiation. Substances cause ozone to be transformed into oxygen molecules. Chlorine and bromine are not consumed during process and are available to combine with other ozone molecules. Impacts include skin cancer and damage to crops.

(c) Acid rain - various sources including fossil-fuel burning. Sulphur dioxide (SO_2), nitrous oxides (NO_X), hydrochloric acid (HCl) emitted to air. Such gases rise up to atmosphere and combine with water to produce acids such as sulphuric acid which have a low pH. When clouds, rain or a mist forms, the acid is transferred to the Earth's surface. This can have numerous effects such as release of harmful metal - e.g. aluminium - from soils, damage to limestone buildings, damage to fish and other aquatic organisms, corrosion of metals and depletion of nutrients necessary for plants to be healthy.

(d) Photochemical smog - sources include emissions of volatile organic compounds such as petrol and solvents. React with sunlight and gases (e.g. nitrogen dioxide) to form a mixture of secondary pollutants including ozone. Effects include irritation to respiratory systems and degradation of rubber.

Question 3

Interpretation

This question requires a basic explanation of each of the four air-pollution control devices. Part of the question also asks for reference to the type of pollutants the control device could be used for, in addition to the type of plant it could be used on (so do not forget these two parts of the question in addition to a description of the device).

Plan

(a) Bag filter - dust, fabric filter, shaking device, collection device, type of plant (woodworking, foundry).

(b) Electrostatic precipitator - dust, electric forces, wire and corona, collector plate and rapping, type of plant (any example).

(c) Wet scrubber - droplets, removal, gas stream, types of material (metallic dusts), plant.

(d) Activated carbon adsorption device - surface retention, forces, large surface area, pollutants, plant.

Suggested Answer

(a) Bag filters (also known as fabric filters) remove dust from a gas stream by passing through a fabric. The fabric must allow air to pass through it and remove the dust particles from the air. The layer of dust which accumulates on the fabric surface is called the filter cake. With time, more and more pores are closed and the airflow through the remaining open pores increases. At some point, there are very few pores left open and the airflow through them may be several orders of magnitude higher than that through the pores when they were all open. Bag filter plants employ mechanical shaking devices to vibrate the bag. Generally the bag is open at the bottom and closed at the top. The dust-laden air enters the bag at the bottom and passes up and through the bag to leave the filter plant through vents at the top. Types of plant they could be used on include woodworking, engineering, foundries, etc.

(b) An electrostatic precipitator (ESP) is a particulate and droplet-control device which uses electrical forces to remove particles from a dust-laden air stream. An area of ionised air molecules is established, usually around a wire, by maintaining the wire at a very high voltage, typically 20,000 to 100,000 volts. This region of ionised air molecules is called a corona. As dust particles flow through the corona, they collect the ions, then they themselves become charged. A plate, called the collector plate, is maintained at the opposite electrical polarity to the wire and the particles, so that the charged particles migrate toward the plate. Removal of dust from the plates is

often accomplished by rapping the top of the plates mechanically using a hammer or piston. The types of plant this could be used on include coal-fired boilers, cement kilns, solid waste incinerators, paper mill recovery boilers, petroleum refining and catalytic cracking units, sinter plants, basic oxygen furnaces, open hearth furnaces, electric arc furnaces, coke oven batteries and glass furnaces.

(c) The principle of all wet scrubbers is that water droplets are generated within the device and particles are captured within the droplets. The droplets are then removed from the air stream, which is now clean. The droplets are collected as contaminated water and transported out of the device for treatment or disposal. Wet scrubbing is used to control sticky emissions which may block filter-type collectors; to handle waste gas streams containing both particulates and gases; to recover soluble dusts and powders; and to remove metallic dusts such as aluminium, which may explode if handled dry. Plant where used might therefore include food manufacturing (e.g. flour dusts) and engineering (grinding of aluminium and paint spraying).

(d) The process of adsorption involves the retention of a gas or vapour molecule on the surface of a particle or droplet. The physical adsorption utilises the surface forces present on the surfaces of most solids to attract gas molecules. When these surface forces are stronger than the intermolecular forces between the pollutant gas molecules and the air molecules, the pollutant gas molecules will adhere to the surface of the solid. Activated carbon with many pores and crevices presents extremely large surface areas to gases. Activated carbon is so called because after heating the carbon is activated to remove the volatile components. In the case of coal, high temperature steam is used. Such devices have to be regenerated before they can be used again. The technique can be used to remove many pollutants, e.g. specialist applications include VOC removal, dioxins removal and radioactivity. As such the technique can be used for many types of plant, e.g. wall covering manufacture, metal finishing, sewage treatment, etc.

Element 9
Managing Emissions to the Water Environment

Water Pollution

Generally, water pollutants can be classified as being either:

- **physical** - such as litter, suspended solids, heat and radioactivity;
- **chemical** - such as acids, alkalis and pesticides; or
- **biological** - harmful pathogens in water that cause disease, e.g. viruses and intestinal parasites.

Specific Pollutants

- **Oxygen Stress**

  Plants and animals that live in aquatic environments depend on an adequate supply of oxygen for respiration - just like plants and animals on land.

  Effluents that contain high levels of organic material - e.g. human sewage - strip oxygen from receiving waters.

  Substances (such as iron) will combine with oxygen in water, thus reducing the amount of freely available oxygen for wildlife.

- **Solids**

  The main effects of solids are aesthetic (visible nuisance), smothering plants and animals on the bed of the watercourse, damaging fisheries and interfering with self-purification.

- **Acids and Alkalis**

  Change in pH leads to change in the biodiversity of the watercourse and the release of secondary pollutants such as metals.

- **Phosphorus and Nitrogen Compounds**

  Can indirectly remove oxygen from water by the process of eutrophication (nutrient enrichment).

- **Hydrocarbons**

  Oil may coat the leaves of aquatic plants and other organisms such as birds, in addition to impacting on oxygen exchange.

- **Pesticides**

  Acute release of pesticides in water has been known to kill aquatic life and may cause thyroid disruption.

- **Persistent Organic Pollutants**

  These are a group of substances that can accumulate in the fatty tissues of any organisms and, as they degrade very slowly, can bioaccumulate in food chains, posing high risk to human health and the environment, e.g. a number are carcinogenic.

- **Thermal**

  Raised temperature can have the effect of reducing the amount of oxygen in the water and altering the biodiversity.

- **Pathogens and Parasites**

  Sewage and animal wastes contain pathogenic micro-organisms (viruses, bacteria, protozoa and intestinal parasite eggs) which may cause disease.

- **Chlorine and Chlorine-Containing Compounds**

  Trichloroethylene (TCL) is a common industrial solvent. Ingestion of TCL in drinking water may lead to liver damage and increase the risk of various types of cancer.

- **Heavy Metals**

  Heavy metals such as mercury and cadmium have the ability to bioaccumulate in food chains. The impacts of bioaccumulation will vary depending on the substance, e.g. mercury may cause central nervous system impairment, dizziness, coma and death.

Point and Diffuse Sources of Pollution

- **Point sources** of water pollution are those where there is a distinct controlled discharge into a watercourse.
- **Diffuse sources** are those that do not enter a watercourse through controlled sources.

Practical Means of Pollution Prevention

Identifying, Marking and Maintaining Drains

Many companies or businesses do not know where the drains are or what type (i.e. SWS or FWS) they are.

A drainage plan of a site is a necessity for effective pollution control. Education as to the uses of different drains is also important.

It is recommended that surface-water drains be painted blue and foul-water drains red.

Maintenance of the drainage system is required.

Bunding

- Bunds should be sturdily constructed of, or lined with, material impervious to the substance to be contained.
- They should comprise a base and surrounding walls (with no damp course).
- The capacity of the bund should be the whole capacity of the storage tank, plus 10%.
- If there is more than one tank in the bund, the volume should be related to the capacity of the largest tank.
- Tanks may also be integrally bunded (sometimes known as double skinned); however, they should still follow the same requirements as traditionally bunded tanks.

Pipework

This should be above ground where possible.

Filler pipes should be within the bund and vent and overflow pipes positioned to overflow into the bund.

Deliveries

Ensure delivery areas are isolated from the SW drains, in case of spillage.

Automatic cut-off valves should be fitted to oil delivery points to prevent over-filling.

Drum and IBC Storage

Requirements set for bunding of oil-containing drums are a drip tray of a capacity of 25% of the volume of a drum. For IBCs containing oil, the requirements are 110% of the largest container or 25% of the total volume of the containers - whichever is greater.

Spill Kits

The provision of a suitable spill kit in case of emergencies is sound practice.

These should be appropriate to the substances used on-site and training must be given. Spill kits must be accessible, so their location is important.

Spillage Control Management

A pollution incident control plan should be prepared based on the following spillage control hierarchy:

- Contain at source.
- Contain close to the source.
- Contain on the surface.
- Contain in the drainage system.
- Contain on or in the watercourse.

All spillages must be cleaned up and disposed of in line with legal requirements for waste.

Mitigating the Effect of Fire-Water Run-Off

Control measures which can be implemented to control fire-water include:

- Containment lagoons and sacrificial areas.
- Penstock valves.
- Consulting enforcement authorities.
- Bunding.
- Fire-fighting strategies.

Monitoring of Effluent Discharges

Purpose of Effluent and Water Monitoring

Legislation often dictates requirements to sample and monitor **effluent discharges**. Permits and consents to discharge will identify Emission Limit Values (ELVs).

The monitoring of **water use** by a site is normally undertaken as part of a water minimisation scheme, which will assist in reducing the costs and environmental impacts associated with water use.

Standard tests are available for most common wastewater parameters including BOD, and the use of accredited laboratories is essential if results are to be relied on for monitoring, or for legal purposes.

Environmental Practitioner's Role in Water Pollution Monitoring

Effluent monitoring requires specific competencies in order to be undertaken to standards dictated by law. The MCERTS standards state competency requirements for those undertaking the chemical testing of sewage and trade effluents.

From the general environmental practitioner's point of view, it must be ensured that those who undertake sampling and analysis are competent to do so, falling in line with any competence standards that may be set in permits/consents and/or associated guidance.

Analysis of reports will largely involve comparison of the measured concentrations against ELVs stated in the permit/consent.

The Biotic Index

The Biological Monitoring Working Party (BMWP) score attaches a score between 1 and 10 to species of aquatic invertebrates, depending on their tolerance to pollution (the less tolerant a species is, the higher the score).

Key Monitoring Parameters

- Dissolved oxygen - is the amount of oxygen present in water.
- Chemical Oxygen Demand (COD) - the test measures materials in a water sample that can be chemically oxidised.
- Biological Oxygen Demand (BOD) - measures all the materials in a water sample that can be broken down by the action of microbes.
- Total Oxygen Demand (TOD) - measures all the organic and inorganic compounds present in a sample of water that can be oxidised.
- pH scale - identifies the acidity or alkalinity of an aqueous sample.
- Total suspended solids - the dry weight of particles trapped by a filter.
- Total Dissolved Solids (TDS) - constitute salts, metals and other substances that are dissolved in water.
- Turbidity - cloudiness of a fluid which is caused by particles in the water that are individually invisible to the naked eye.

Wastewater Treatment Processes

Sewage Treatment Works

Sewage is a complex mixture of suspended and dissolved materials which may be characterised by two parameters:

- Suspended Solids (SS).
- Biological Oxygen Demand (BOD).

The sewage entering a sewage treatment plant is mostly liquid, with only a very small solid component.

Wastewater Treatment Processes at Sewage Works

The conventional wastewater treatment process can be described as consisting of three processes:

- preliminary sewage treatment;
- secondary biological sewage treatment;
- tertiary treatment;

followed by:

- sewage sludge treatment and disposal.

Water Treatment

The objectives of water treatment are to produce an adequate and continuous supply of potable water, which is:

- **Clear** - no turbidity or suspended matter.
- **Palatable** - no unpleasant taste.
- **Safe** - no disease, other organisms, or harmful mineral content.
- **Reasonably soft**.

The main methods of treatment are:

Screening	To remove sticks, weeds and large particulates.
Aeration	■ To eliminate certain odours. ■ To remove objectionable dissolved gases. ■ To oxidise some metal salts to enable them to be filtered out.
Coagulation	To enable finely divided matter to be settled out, in order to entrap bacteria and absorb colour.
Clarification	To settle out sediment to provide clear water.
Filtration	To remove particles.
pH adjustment	To ensure that it is chemically neutral.
Disinfection	To remove pathogenic or disease-causing bacteria.
Softening	To remove excess quantities of calcium and magnesium salts.

Effluent Treatment

Both solid and liquid wastes can be treated by using a variety of techniques. These can be classified into three areas: chemical, physical and biological.

Physical Treatment

Examples include:

- Screening.
- Sedimentation.
- Activated carbon.
- Air stripping.
- Filtration.
- Centrifuging.

- Reverse osmosis.
- Flotation.
- Ion exchange.
- Evaporation.
- Sumps.
- Oil-water separation.

Chemical Treatment

Most chemical treatments apply to both liquid and solid wastes and include:

- Neutralisation.
- Oxidation.
- Sedimentation.
- Coagulation and flocculation.
- Metal precipitation.
- Disinfection.

Biological Treatment

This is often used in the treatment of sewage. There are four main types of biological sewage treatment:

- Percolating filter treatment.
- Rotating Biological Contactor (RBC).
- Activated sludge treatment.
- Oxidation ponds.

Desalination

Desalination is the removal of minerals, largely salt, from saline water. It produces water that is suitable for human consumption and agriculture, and salt as a by-product.

Methods of desalination include:

- Multiple stage flash distillation.
- Vapour compression distillation.
- Reverse osmosis.

Advantages	Disadvantages
Provides clean freshwater for drinking and agriculture where no source exists.	Energy consumption and associated impacts are great, for example: ■ Distillation requires large amounts of water to be boiled. ■ Reverse osmosis requires significant energy to overcome natural osmosis.
Uses tried and tested technology that has been in use for many years.	Significant cost - desalination plants are generally expensive to build and maintain. It has been found that desalinated water can be five times as costly as freshwater.
Habitat protection - creating water from the sea means that land-based surface and groundwater is not extracted, so there is less impact on land-based aquatic systems such as lakes and rivers.	Other environmental impacts, in addition to those associated with energy, can be great. Chlorine and other chemicals are often added to water during processing and left behind with waste brine which, if dumped into the ocean, can harm marine life.

Abstraction from the Water Environment

Impacts of **over-abstraction** on rivers and aquifers include:

- Reductions in river-water flow, reducing the size of the populations of aquatic species that the river can support.
- Wetland habitats that are supported by river flows drying up and disappearing.
- Aquifers drying up, removing important sources of water for human consumption and agriculture.
- In coastal areas, removing water from aquifers at an excessive rate can lead to saltwater intrusion, making the water unfit for use.

Water neutrality is a process by which participants try to balance their water usage by reducing water usage and investing in projects that increase the supply of freshwater.

Water Balance

A water balance is a numeric analysis of the quantities of water that enter an organisation, where the water leaves an organisation and water use activities in between.

A water balance is used to:

- Understand and manage water use and effluent production.
- Identify areas that have a significant cost-saving potential.
- Detect areas of leakage.

The stages of a water balance are:

- Water-using activities.
- Water-saving ideas.
- Analyse different options.
- Maintain momentum.

Reducing water usage may be achieved by many means, including:

- **Toilets** - if installing a new toilet, ensure it has a dual flush system which allows less water to be used if a full flush is not required.
- **Fit a water meter** - although not a direct reduction technique, knowing you are being charged for what you use is a great incentive to reduce water consumption.
- **Stop dripping taps** - according to Waterwise (a not-for-profit water organisation funded by the water industry in the UK), a dripping tap wastes at least 5,500 litres of water a year.
- **Water garden plants in the evening** - this ensures that more of the water remains available to the plants and so in the long run less has to be used.
- **Fit diffusers on taps** - they won't make much difference when filling a bowl or basin, but if you wash anything under a running tap they will reduce the amount of water needed.
- **Grey water recycling** - using bath and washing water to flush the toilet can save large quantities of fresh, clean, drinking water from simply being flushed away.
- **Fit low flow showerheads** and take more showers than baths.

Water Stress

Water stress can be defined as being when the demand for water resources exceeds the amount available for usage.

The Water Exploitation Index (WEI) or withdrawal ratio is a measure of the vulnerability of water abstractions to over-exploitation.

The warning threshold of water stress is deemed to be 20% (identifying a non-stressed region from a stressed one). Severe water stress is likely to occur with a WEI of over 40%, which indicates significant competition for water.

Risk Assessment of Flood Areas, Consequences of and Control Measures for Flooding

Consequences of Flooding

Flooding has significant direct and indirect consequences. These include:

- **Direct effects** of flooding:
  - Damage to property/equipment/stock.
  - Business continuity issues.
  - Increased insurance premiums.
  - Pest infestations.
  - Health issues.
- **Indirect effects** of flooding:
  - Damage to roads and other infrastructure.
  - Clean-up costs/removal of debris.
  - General health and safety issues.

Factors when Assessing Flood Risk

The following are identified as being key risk factors when determining the risk of flooding:

- Identification of the sources of flooding.
- Typical climate in an area.
- Historical site data.
- Location of floodplains.
- Severity of damage to property and local habitats/eco-systems.
- Climate change.

The probability of a flood occurring in an area can be determined by computer modelling. Such modelling will often take into account some or all of the risk factors identified above.

Control and Mitigation of Flooding

Measures that can be implemented to reduce the chances of being affected by a flood, in addition to mitigating the impacts of a flood should one occur, include:

- Maintenance of existing controls such as pumping stations.
- Emergency plans covering flood risk.
- Monitoring flood updates.
- Flood defences.

Flood control techniques might include building flood walls and installing levees and bunds.

In rural areas, local run-off can be increased by agricultural activities such as the increase in farm and field size.

Urban areas are largely covered by roads, car parks and buildings, which have limited capacity to hold water in comparison to vegetation, soil and land surface depressions.

Sustainable Drainage Systems (SuDS) aim to mimic natural drainage processes to decrease the effects of quality and quantity of run-off from a development, providing biodiversity and amenity benefits.

Buildings can be designed to reduce the impact of a flood. Techniques tend to fall into one of three categories:

- **Avoidance** - constructing a building in a way to avoid it being flooded.
- **Resistance** - constructing a building in a way to prevent floodwater entering the building and causing damage.
- **Resilience** - constructing a building so that, although floodwater may enter, its impact is minimised.

Exam-Style Questions

1. A company has identified that its water supply costs are significant. **Describe** suitable actions that could reduce the cost of water bills without significant capital expenditure. (20)

2. An organisation possesses an environmental permit to discharge wastewater into a nearby river.

   (a) **Describe** the management controls that need to be implemented to ensure compliance with the permit conditions. (15)

   (b) **Outline** the key parameters for which Emission Limit Values are likely to be included in the permit. (5)

Model Answers

Question 1

Interpretation

This question requires a description of methods that can be used to control consumption of water that do not require great capital expenditure. It is a relatively straightforward question to interpret. However, you must ensure that the measures described have no (or very low) financial cost. Any measures that require a large capital outlay will not gain marks. For questions such as this a simple listing will not gain full marks - a full description of relevant methods is required.

Plan

Management, monitoring, patterns of use, action plan, mass balance, staff awareness, controlling plant, efficient equipment, rainwater, treatment, evaporative loss, abstraction, leaks.

Suggested Answer

Methods could include:

- Ensuring that management are committed to the process through development of a formal policy statement and/or improvements to the company's management system.
- Monitoring water consumption (this could be achieved by reviewing bills or installing water meters) and setting targets for water savings.
- Reviewing current patterns of water use and identifying common trends and linkages with certain types of high consumption activities (e.g. cleaning).
- Developing and implementing an action plan to ensure that targets are achieved.
- Undertaking a water mass balance to determine the inputs and outputs of water at the site.
- Raising staff awareness through training, briefings, poster campaigns and suggestion schemes.
- Controlling plant use, e.g. turning off equipment when not in use.
- If cost-effective (as short a payback as possible), replacing equipment with types that use water more efficiently (e.g. controlled flushing of urinals).
- Using collected rainwater rather than town water where possible (e.g. for outside cleaning).
- Treating wastewater from process rather than discharging off-site.
- Lowering process temperature so as to reduce the amount of water that is lost through evaporation.

- Abstracting water for use at the site (providing a licence is gained for this to occur).
- Checking for leaks and ensuring that a planned preventative maintenance system is in place so that they are fixed as soon as possible.

Question 2

Interpretation

The question states that the company is already in possession of a permit so simply explaining that the company needs to apply for a permit would not gain any marks. The term 'management controls' in part (a) is quite broad and can constitute parts of an EMS provided to ensure that the company meets the requirements within its permit. Part (b) requires a brief description of the substances and other parameters for which limits would be set in the permit.

Plan

(a) Monitoring, control of discharges, responsibilities, training/information, emergency response.

(b) Chemical oxygen demand, biological oxygen demand, total oxygen demand, pH scale, total suspended solids, total dissolved solids, turbidity, presence of oil and substance limits.

Suggested Answer

(a) Management controls could include reference to the following mechanisms to ensure compliance:

- Monitoring - regular sampling of the effluent prior to discharge into the river. Following analysis the results should be compared against the parameters that are stated in the permit (e.g. rate of flow, pH, BOD, oil content, etc.). Such comparisons against the limits in the permit will assist in identifying trends and any potential breaches of the conditions.
- Control of discharges - having good knowledge of the drains on the site and where they lead to is vital. A drain plan should therefore be constructed identifying foul and surface water drains and where they discharge external to the site. There should also be some control over discharge into site drainage inlets. This could be achieved by marking drains (e.g. red for foul, blue for surface water) and training staff as to what can be emitted to each.
- Responsibilities - there should be clear and accurate authority and accountabilities for key actions that need to be undertaken to ensure permit compliance, e.g. monitoring, control, emergency response, etc.
- Training/information - training should be given such that all relevant staff and third parties (e.g. contractors) are aware of the system to control discharges.

- Emergency response - in order to ensure that permit conditions are not breached during an emergency situation it should be ensured that there are plans for an emergency, e.g. spillages of liquid materials. This would need to include identification of the possible emergency, in addition to what is required when it does occur (links with training). Emergency plans should also be tested (perhaps by allowing staff to clean up a spill of a non-hazardous material). Adequate spillage response equipment such as bunds, absorbent materials, PPE, etc. should also be provided at appropriate points around the site.

(b) Key parameters for which Emission Limit Values are likely to be set include:

- Chemical Oxygen Demand (COD) - the test measures materials in a water sample that can be chemically oxidised.
- Biological Oxygen Demand (BOD) - measures all the materials in a water sample that can be broken down by the action of microbes.
- Total Oxygen Demand (TOD) - measures all the organic and inorganic compounds present in a sample of water that can be oxidised.
- pH scale - identifies the acidity or alkalinity of an aqueous sample.
- Total suspended solids - the dry weight of particles trapped by a filter.
- Total dissolved solids - constitute salts, metals and other substances that are dissolved in water.
- Turbidity - cloudiness of a fluid which is caused by particles in the water that are individually invisible to the naked eye.
- Presence of oil - no visible oil is often set as a permit condition.
- Substance limits - e.g. limits for heavy metals may be set in the permit.

Element 10
Control of Environmental Noise

Characteristics, Measurement and Assessment of Environmental Noise

Sources of Environmental Noise

Noise may be defined as unwanted sound. People exposed to very high levels of noise, e.g. from machinery and equipment in enclosed spaces, can suffer damage to their hearing, and this is a recognised occupational health issue.

Key noise sources include:

- Manufacturing and related commercial activities.
- Transport.
- Agriculture.
- Construction.
- Quarrying and mining.
- Pubs and clubs.
- Neighbours.
- Rural activities.

Basic Acoustics

- Sounds are the result of air being continually compressed followed by rarefaction.
- The frequency or number of times the compression takes place per second will determine the pitch.
- The pressure exerted by the energy input will determine the loudness.
- The pressure fluctuation of sound may be described as a sine curve or wave.

Definitions Associated with Acoustics

- **Pressure**: 'sound' is the sensation which the brain perceives when pressure variations in the air are detected by the ear.
- **Sound**: is the transmission of energy as vibration. 'Loudness' depends on the sound pressure and frequency.

- **Frequency**: 'Hertz' - the number of times a vibrating system completes a cycle of movement in one second.
- **Wavelength**: is the speed of sound divided by the frequency.
- **Amplitude**: is proportional to the energy of a sound wave.
- **Pitch**: describes the type of sound we hear, such as shrill or piercing (as from a hiss or whistle).
- **Intensity**: the rate of energy flow per unit area transmitted as a sound wave.
- **Power**: Sound Power Level (SPL) is the total energy per second expressed in decibels (dB).

Weighting Scales

Sound is measured as sound pressure.

The lowest sound intensity that the human ear can hear is about 1×10^{-12} Watts per m^2 when the sound frequency is 1,000 Hz.

As this is too large a scale to be represented linearly, a logarithmic scale to represent the range of normal sound and hearing is used.

The Bel (B) and deciBel (dB) Scales

As a Bel is very large, it is normally divided by ten to give the decibel. Sound is measured in decibels, which is a logarithmic scale.

It is important to note that:

- An increase of three dB doubles the sound intensity.
- A decrease of three dB halves the sound intensity.

Noise-Weighting Scales

Meters are used to measure sound and are designed so that they mimic the ear's response.

The usual scale of measurement is corrected or weighted. The most usual weighting is the 'A' scale, i.e. dB(A).

Percentile Sound Levels

Percentile Exceedance Sound Level (Ln)

Ln is a parameter used to express the amount of time a certain level of noise is exceeded, e.g. L10 is the level exceeded for 10% of the time period.

Equivalent Continuous Sound Pressure Level (L_{eq})

The L_{eq} is an average of the energy of the sound.

The noise dose received by a person is the product of the noise level and the duration of the exposure.

The UK **Control of Noise at Work Regulations 2005** establish the exposure criteria associated with **lower and upper exposure action values and exposure limit values**.

Narrow Band Noise

This is noise that has a limited range of frequencies within the audible range. It tends to present as screams, whistles or hisses. Due to its nature it tends to have a high nuisance potential.

Low Frequency Environmental Noise

This tends to incorporate noise that occurs between 20 and 160 times per second (20 Hertz to 160 Hertz). To susceptible people it may cause distress, sleep deprivation and depression.

Measurement of Environmental Noise

Environmental noise measurements have been standardised by ISO 1996: *Acoustics - Description, Measurement and Assessment of Environmental Noise*.

BS 4142:2014

This standard can be used to assess the impact of industrial and commercial sound sources. The method used is as follows:

- The specific sound under investigation is measured and a rating added if the sound has a characteristic that is likely to increase significance of the impact. This is known as the rated sound.
- The background sound levels are then measured.
- The difference between the rated sound and the background sound levels is used to assess the significance of the impact.

The Effects and Control of Environmental Noise

The perception of noise can be quite subjective. A particular noise may be acceptable to one person, but very annoying to another. The main factors that affect the perception of noise are:

- Loudness.
- Pitch.
- Incidence.
- Background levels.

Many complaints of neighbourhood noise arise as a result of:

- Anti-social behaviour.
- Poor planning controls.

- The juxtaposition of incompatible land uses.
- Specific one-off events.
- Sirens or other noise interfering with use of tannoy systems for communication.

Environmental noise can have the following impacts on people:

- Annoyance.
- Sleep disturbance.
- Cardiovascular problems.
- Performance and educational achievement.

Need to Control Noise from Industry and Construction

Noise must be controlled for the following reasons:

- Protect the health of workers.
- Reduce the chance of nuisance.
- Comply with environmental, health and safety legislation.
- Comply with the requirements of a formal environmental management system.
- Ensure good relations with those living close to the site.

Management Controls

Examples include:

- Control of working hours.
- Control of the use of radios.
- Control of public address systems.
- Alternative vehicle routeing.
- Keeping loading doors and shutters closed.

Elimination, Substitution and Maintenance

Primacy should be given to minimisation or reduction at source.

After this comes substitution, followed by isolation and the provision of various barriers.

The noise specification of equipment should always be considered and quiet equipment purchased, wherever practicable. It is always more effective to fit noise-abatement equipment during manufacture than as a retrofit.

Poor maintenance can also be the source of noise problems.

Engineering Controls

Noise travels at different rates through different materials.

The sound heard by the recipient will therefore vary according to a number of factors, e.g. the distance between the source and the receptor, any barriers or buildings, etc.

In the open air, sound decreases by 6 dB for every doubling of the distance away from the source.

The effect of distance is to decrease the intensity of the sound as the sound travels further from the source.

In the workplace, sound barriers may comprise acoustic screens, enclosures and silencers. The design of acoustic barriers is a specialist subject requiring the assistance of a qualified sound engineer.

Proprietary damping compounds may be purchased and used to reduce noise.

An enclosure made from a 'sandwich' comprising two separate skins of material separated by an absorbent compound will provide improved sound deadening.

Environmental Noise Barriers

Suitable barriers could be high walls or fences, purpose-built earth berms or bunds, or other buildings in the vicinity of the noise source.

Noise can be refracted round obstacles, literally travelling round corners. Therefore, hiding a piece of noisy equipment from view will not stop the noise.

A barrier such as a wall or fence will only have a limited effect.

Equipment - Fans, Ventilation, Openings, etc.

Changes in the layout of buildings or equipment may be possible, even if total reorganisation is not practicable. Some practical solutions which may be applicable:

- Repositioning doorways and compressor houses away from residential housing.
- Relocating stockyards away from houses.

Exam-Style Questions

1. A car parts manufacturing company, located in a largely residential area, only operates a day shift. Having secured a new contract, it is now proposing to introduce a night shift.

   Describe:

   (a) The potential sources of night-time noise from the proposal that may cause complaints. (8)

   (b) How night-time noise disturbance could be assessed by the company. (12)

2. A company is planning to construct a new warehouse facility alongside its adjoining factory. Residents living near to the proposed site have complained that construction site noise could be a nuisance for them.

   (a) **Identify** typical sources of noise emission that may occur during construction works. (12)

   (b) **Explain** the management controls that could be implemented to reduce the risk of complaints. (8)

Model Answers

Question 1

Interpretation

Part (a) is relatively straightforward and requires a description (not a list) of sources of potential noise nuisance at the site. These could be many and varied.

For part (b) a description of the British Standard BS 4142 is required, making sure that the answer quotes night-time noise.

Plan

(a) Potential sources - traffic, forklift trucks, delivery vehicles, machinery/equipment, general factory noise, tannoys, radios, shouting.

(b) BS 4142 - calibration, measurement location, specific sound measurement, background sound measurement, rating factor, difference, report.

Suggested Answer

(a) Night-time noise is a common cause of nuisance to residents living near to industrial facilities. There are various noise sources that could be described, e.g. traffic to and from the site (including employees' cars), forklift trucks, delivery vehicles, process machinery and equipment, noise from the site generally escaping through doorways and windows, tannoys, radios, employees shouting instructions.

(b) A noise assessment can determine the likelihood of complaints being caused by the activities of the company at night. This could be achieved by following the requirements of BS 4142 which identifies the method for undertaking a noise assessment for industrial noise. The steps that would have to be taken in line with BS 4142 include initially calibrating the sound level meter. The measurement location should then be chosen, which should be outdoors, at a representative location and height and away from reflecting surfaces. Precautions should be taken to reduce microphone interference in addition to recording of weather conditions. The specific sound level from the site should then be measured for an appropriate period (recommended 15 minutes at night). Background sound level should then be determined. In order to take into account elements of sound that can increase the likelihood of complaints, a suitable rating factor can be added to the specific sound. The difference between the rated sound and background sound is used to assess whether complaints are likely. A difference of greater than 10 dB means the rated sound is likely to have a significant adverse impact, whereas a difference of around 5 dB means that the rated sound is likely to have an adverse impact. Where there is no difference then the rated sound is likely to have a low impact. A report of the assessment should then be prepared covering specified information, such as measurement locations, weather conditions, etc.

Question 2

Interpretation

Part (a) is an 'identify' question requiring a very brief explanation of the noise sources that could cause noise to be emitted from construction. Visualising the potential activities is the key for this one.

Part (b) is an 'explain' question so a fair amount of detail with suitable examples of appropriate noise management techniques is required.

Plan

(a) Access, transport on site, piling, tannoys, radios, people, compaction, mechanical plant, deliveries, tools and equipment, impact noise, pumping of concrete.

(b) Control of working hours, controlling the use of radios, public address systems, vehicle routes.

Suggested Answer

(a) There are numerous different noise sources that could occur from the construction activities, e.g. access to the site, transport on the site, piling, tannoys, radios, noise from people (e.g. shouting), compaction (e.g. rollers and vehicles), mechanical plant (e.g. excavation, mixers), deliveries to the site, tools and equipment (e.g. drills and saws) and impact noise from the pumping of concrete.

(b) Generally, good management is in most cases a source or a pathway control, as it can be used to eliminate or at least reduce noise problems. Examples include:

- Control of working hours - usually to reasonable daytime hours. Most people are out of the home during the day and the level of background noise is also higher than at night.
- Controlling the use of radios - radios used for communication and entertainment can cause a nuisance. Controlling the number of radios on a site and the volume can be important. When using two-way radios, the use of earpieces is advantageous as they prevent other people from overhearing and therefore any nuisance-causing potential.
- Public address systems - these must be properly designed so that sound is directed where it needs to be heard and not past site boundaries. This can be achieved by using more, smaller speakers and being able to reduce the volume at night when background noise levels are generally lower.
- Vehicle routes - vehicles entering and leaving a site, especially large goods vehicles using air brakes and air-assisted gear changes, can create high noise levels. Appropriate routeing of these vehicles, in addition to signage indicating any areas or routes not to be taken, can reduce the likelihood of a nuisance being caused. Driver training can also have a positive effect.

Element 11
Hazardous Substances and Contaminated Land

Need for Safe Supply, Storage, Use and Transportation of Hazardous Substances

Hazardous substances and their impacts fit in well with the source-pathway-receptor model:

- Point sources - drains, vents and chimneys exhausting to water, air or land.
- Diffuse sources - uncontrolled such as run-off of fertilisers and pesticides.
- Pathways - chemicals may move through the environment by means such as diffusion into the air or water, or through bioaccumulation.
- Receptors - these include people, farm stock, plants, surface and groundwater systems, and the land.

Some chemicals may break down in water or be broken down by light, giving rise to other substances.

The key impacts of listed substances are outlined below:

Type of Chemical Released	Impact
Heavy metals, lead and mercury	Health effects include neurological damage and effects on mental development, particularly in the young.
Chlorinated pesticides, e.g. DDT	Concentrate in food chains, causing egg shell thinning in birds, leading to failure of reproduction.
PCBs	Suspected human carcinogens, impact on aquatic environment and chronic effects.
CFCs	Reduction in stratospheric ozone leading to higher levels of ultraviolet light to the surface.
SO_x, NO_x	Acidification of upland lakes and rivers, decline in fish population due to changes in pH levels and disruption of ecological balance.
Release of dioxins from uncontrolled incineration of certain substances	Cancer and reproductive anomalies in humans and other animals.
Non-biodegradable detergents	Foaming in rivers and toxic effects on aquatic life.
Oestrogenic activity of some chemicals, such as phthalates	Effects on reproduction, including viability of male fish and possible effects on humans.

There is usually a strong framework of legislation governing the classification, supply, storage, use and transport of hazardous substances.

The **European Regulation (EC 1272/2008) on Classification, Labelling and Packaging of Substances and Mixtures** covers the classification, information supply and packaging of dangerous substances.

CLP consists of Hazard Statements and Precautionary Statements (covering prevention, response, storage and disposal) which are represented by H- and P-numbers.

Under **CLP**, specific hazard pictograms must also be used. These are in the shape of a red diamond with a white background.

Use of Pesticides

'**Pesticide**' usually refers to a product that is used to control insects, other animals, weeds, or disease-causing micro-organisms that can damage agricultural crops and garden plants.

'**Biocide**' refers to products that control harmful organisms in other situations, e.g. household insecticides, wood preservatives and disinfectants.

The key environmental impacts associated with pesticides are:

- Effects on non-pest species.
- Spray drift.
- Residues in food.
- Groundwater contamination.
- Poisoning.

The WHO Pesticide Evaluation Scheme (WHOPES)

The World Health Organisation Pesticide Evaluation Scheme (WHOPES) key purpose is to promote and co-ordinate the testing and evaluation of pesticides in the interests of public health.

WHOPES has a four-phase testing and evaluation programme which consists of determining the safety, efficacy and operational acceptability of public health pesticides in addition to specifications for international trade and quality control.

Presently the main objectives of WHOPES are:

- To search for alternative pesticide technologies and methods of application that are safe and cost-effective.
- The design and promotion of guidelines, strategy and policies that promote the correct selection and application of pesticides for public health use, and to assist and monitor their application by Member States.

Contamination of Soil and Groundwater

In the UK, contaminated land is defined under the **Environmental Protection Act 1990 Part IIA** as being:

"any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that -

(a) *significant harm is being caused or there is a significant possibility of such harm being caused; or*

(b) *pollution of controlled waters is being, or is likely to be caused."*

Contaminated land can cause many environmental impacts, including:

- Direct risk to human health by ingestion.
- Toxic substances entering the food chain through plant uptake.
- Water contamination.
- Prevention or inhibition of plant growth.
- Odours, fumes and effluvia, particularly when gases (landfill gases) percolate the site.
- Fire and explosion.
- Direct contact with, or inhalation of, certain contaminants.
- Building damage.

The Risk to Groundwater

Groundwater and contaminated land are often interconnected, and pollution from contaminated land can cause groundwater pollution.

The major groundwater contaminants are nitrates and pesticides from agricultural sources, Dense Non-Aqueous Phase Liquids (DNAPLs), such as chlorinated solvents, and Light Non-Aqueous Phase Liquids (LNAPLs), such as hydrocarbons.

Groundwater pollution can spread further than the original spill of substances and can persist for decades.

Land Contamination Mechanisms

Land contamination may occur by the following activities:

- **Accidents** (e.g. spillages when filling, emptying or transporting liquid substances).
- **Leakage** (e.g. from bulk storage tank or pipeline; the risk is increased when underground).
- **Emissions to air** (e.g. contaminants can be released to atmosphere and then fall back to ground).

- **Transfer of ground or surface water** (e.g. leachate may move from a contaminated site by run-off or below ground movement).
- **Movement of toxic or explosive gases** underground.
- **Building demolition** (e.g. fibrous materials such as lead or asbestos may be released to ground).
- **Waste disposal** (e.g. much historical contamination is from the deliberate burial of hazardous wastes in the land).

Methods of Investigating Contaminated Land and Groundwater

Contaminated land investigation follows a three-step process:

- Phase I - Preliminary Investigation (Desk Study and Site Reconnaissance).
- Phase II - Site Investigation.
- Phase III - Remediation.

Soil and Water Sampling: Preliminary Investigation

The preliminary site sampling aims are as follows:

- Locate underground pipes, storage tanks and other structures, and determine their contents.
- Locate, identify and measure soil contamination.
- Measure groundwater or surface water contamination.
- Detect, identify and measure gas or vapour migration from underground storage tanks, landfill sites or other sources.

The preliminary sampling is aimed at providing sufficient information to plan a comprehensive sampling exercise. Therefore, the techniques involve only limited sampling.

Soil and Water Sampling: Comprehensive Sampling Exercise

The comprehensive investigation is designed to measure the presence of contaminants across the site and to determine, within stated confidence limits, the location of hot spots or areas of higher concentrations of contaminants.

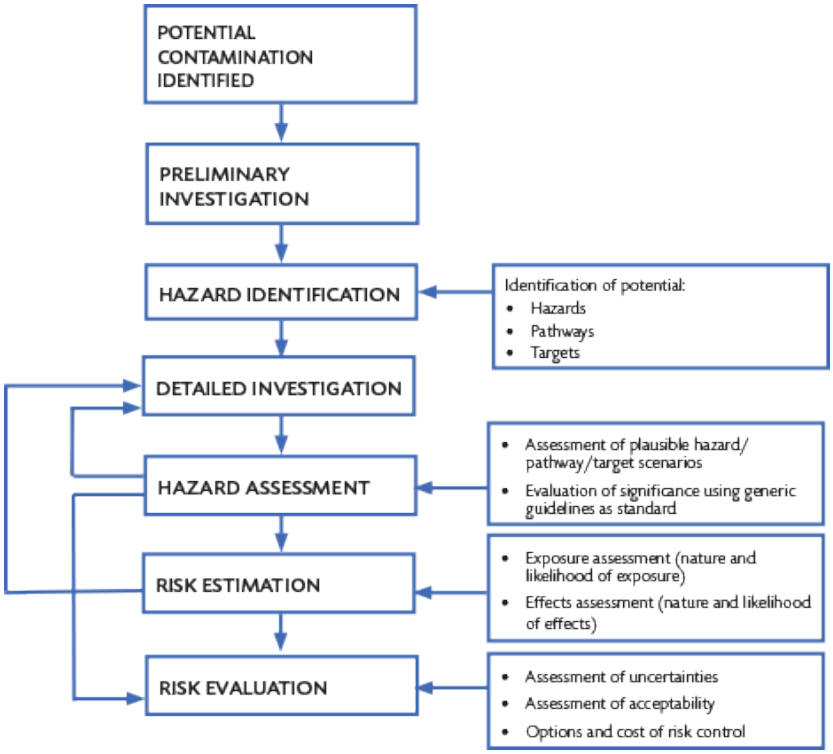
The location of hot spots and the concentration of contaminants present must be known and characterised in order to design appropriate remediation measures.

Assessment of Contamination

In terms of the management and assessment of contaminated land, the UK has adopted the 'fitness for purpose' approach.

Risk Assessment Process

This can be applied to contaminated land assessment as identified in the following figure.



Contamination Risk Assessment Model
(Source: CIRIA Special Publication 103, 1995, Remedial Treatment for Contaminated Land, Vol. III, Site Investigation and Assessment)

Generic Assessment Criteria (GACs)

These provide screening tools for the assessment of contaminated land. The key GACs are Category 4 screening levels (C4SLs). These are levels that, when compared to contaminants in the ground, provide a simple test to decide whether the land is suitable for use and not officially contaminated. Other GACs include Soil Guideline Values (SGVs).

Contaminated Land Exposure Assessment (CLEA)

CLEA uses a series of equations to predict, or simulate, exposure to receptors from a given soil concentration via a number of exposure pathways. It derives C4SLs.

Remedial Techniques for Contaminated Soil and Groundwater

The first stage in a strategy will be to establish what is affected; is the pollution in the unsaturated layer above an aquifer, in an aquifer, or both?

The potential pollutants are also important.

Remediation Methods

The remediation strategy used will depend on the type of contaminant, its depth and concentration, and legal requirements, as well as on the type of site, access, buildings, etc.

Remediation strategies depend on the Source-Pathway-Target methodology, for example:

- Create a barrier between source and target.
- Remove the source.
- Treat (render harmless) the pollutant.

Remediation methods are still under development. Some examples are as follows:

- **Physical Methods**
  - Excavating the land and disposal (dig and dump).
  - Membranes or sheet piling can be used to create barriers between pollutant source and target.
  - Organic pollutants may be removed by de-gassing.
- **Biological Methods**
  - Bioremediation - the use of bacteria to clean up particularly organic pollutants.
  - Bioconcentration - the use of plants, for example, which take up and concentrate pollutants. The plants can be harvested and safely disposed of.
- **Chemical Methods**
  - Solidification, where a binder such as cement is used to encapsulate the contaminated soil.
  - Soil may be treated with chemicals to react with and neutralise the pollutant.
- **Incineration**

  Contaminated soil may be incinerated to destroy contaminants, typical temperatures being 800-1,500°C.

Groundwater Treatment

The affected water may be subject to chemical or physical treatment depending on the precise contamination; although groundwater treatment is very difficult and current methods may be too expensive for treatment of the volumes of water that may be involved.

Exam-Style Questions

1. You have recently identified a number of drums of flammable solvent on a grassed area at the back of the site.
   (a) Draft a memo to senior management, **explaining** why such storage is inappropriate. (12)
   (b) **Describe**, with the help of sketches, the main features of a suitable storage facility. (8)

2. **Demonstrate** your level of understanding of the terms below associated with environmentally hazardous substances. **Give TWO** examples to help illustrate your answer for each.
   (a) Persistence. (4)
   (b) Bioaccumulation. (4)
   (c) Ecotoxicity. (4)
   (d) Biotransformation. (4)
   (e) Half-life. (4)

3. **Describe** the pathways by which contaminated land could affect human and other environmental receptors. (20)

Model Answers

Question 1

Interpretation

Make sure that you read the question closely. The scenario is about solvents and not other substances such as oils, acids, etc. Your answer should therefore be relevant only to the storage of flammable solvents, e.g. oil storage regulations would not apply. For both parts of the question the answer should be in the identified format - a 'memorandum' for part (a) and sketches and text for part (b).

Plan

(a) Ignition, leaks and spills, risk of prosecution (including relevant laws), civil liability, poor publicity, breach of insurance conditions, EMS certification.

(b) Bunding, base impermeable, design specifications (fire-resistant building materials, use of non-combustible materials), security, warning signs, ignition (heat or sunlight), ventilation, separation from other buildings, emergency equipment.

Suggested Answer

(a) The format of a memorandum should be followed taking into account issues such as inappropriate storage of the drums, risk of the solvent in the drums igniting, the risk of leaks and spillages occurring, the risk of the company being prosecuted for pollution of water, contaminated land if the land causes harm or pollution of water, any relevant waste legislation (if the solvent is waste), and breach of environmental permit conditions if the site has an environmental permit. Civil liability should also be considered. The incident may also lead to poor publicity and be a breach of insurance conditions or environmental management system certification (EMAS or ISO 14001).

(b) In describing and drawing a sketch for the scenario, features should include bunding to contain any spillage or discharges, a base which is impermeable to the contents of the drums, design specifications (fire-resistant building materials, use of non-combustible materials), features to improve security (e.g. locks, fencing, etc.), warning signs, methods to protect against ignition (heat or sunlight), adequate ventilation arrangements, separation from other buildings, and provision of emergency equipment (e.g. fire-fighting materials and sprinklers).

Question 2

Interpretation

This question requires a short demonstration of your understanding of the terms identified. It must be in relation to environmentally hazardous substances (not any substances). In order to gain the full marks, in addition to a description of the term two examples should be quoted for each.

Plan

(a) Persistence - resistance, mechanism, examples.

(b) Bioaccumulation - build up, above background, food chain, examples.

(c) Ecotoxicity - effects on ecosystem, examples.

(d) Biotransformation - changes, biological process, examples.

(e) Half-life - reduction, 50% concentration, examples.

Suggested Answer

(a) Persistence is the resistance to breakdown of an environmentally hazardous substance. This may include chemical, physical and biological mechanisms when under conditions that would normally be expected. Examples quoted for persistent substances could include toxic metals (e.g. cadmium) and many chlorinated organic compounds (e.g. CFCs).

(b) Bioaccumulation is when a substance has the ability to build up within plants and animals (e.g. tissues and organs) above the usual background level. This may lead to further accumulation of the hazardous substance up the food chain. Examples of hazardous substances that bioaccumulate are mercury, cadmium, pesticides, polychlorinated biphenyls (PCBs).

(c) Ecotoxicity is when a particular substance has toxic impacts upon one or more members of an ecosystem. Any environmentally toxic substances could be referred to as examples.

(d) Biotransformation is the change of a substance into another substance by the action of an organism (often micro-organisms). Methylation of mercury is one example which occurred in the Minamata Bay incident. Another example might be breakdown of hydrocarbons by micro-organisms.

(e) Half-life is classed as the amount of time it takes for a substance to be reduced to 50% of its original concentration. Radioactivity is a good example, although the concept of half-life could be applied to any substance.

Question 3

Interpretation

This question is aimed at testing knowledge on contamination occurring if there is a pathway that links the source to the receptor. Reference to sources and receptors should only be made in the context of a pathway. Some pathways are easy to identify (e.g. water pollution, ingestion and inhalation) but there are other routes also. The question does not ask for information on legislation and remediation techniques.

Plan

Pathways - leaching/washing, vertical migration groundwater, soil migration, crops, ingestion soil, dust transfer, odour nuisance, flammable.

Suggested Answer

Possible pathways might include:

- Leaching from the land or being washed into a river, stream or other surface water and abstraction of the water for drinking water.
- Vertical migration from the land may occur into groundwater which may be hydraulically connected to surface water and abstracted for drinking or abstracted directly from groundwater.
- Toxic, flammable and asphyxiant gases may migrate into the soil and fissures may lead to inhalation and explosion risks.
- Migration may occur through soils and into plastic pipes containing drinking water.
- Contaminants may be directly taken up by crops which could then be eaten by animals and people.
- Children and site workers may ingest contaminated soil.
- Dust may be blown from the surface onto agricultural land or be inhaled.
- Gases and vapours escaping from the land surface may lead to odour nuisance.
- Flammable materials in the ground may combust, leading to serious environmental and health and safety problems.

Element 12
Energy Use

Advantages and Disadvantages of Sources of Energy

Non-Renewable

Fossil fuels are attractive as energy sources. Being very concentrated, they allow significant amounts of energy to be trapped in relatively small volumes. They also allow easy distribution.

- **Coal** combustion produces massive emissions of carbon dioxide (CO_2) compared with other fuels. It also results in sulphur dioxide and particulate discharges. However, these can be reduced by using various abatement methods.
- The combustion of **natural gas** produces lower CO_2 emissions in comparison to coal.
- Oil is the world's most used energy source. The combustion of oil results in reduced CO_2 per unit of energy released in comparison to the combustion of coal, but greater CO_2 than burning natural gas.

Nuclear energy results from release of the large quantities of energy stored in the nuclei of atoms such as uranium-235 and plutonium-239.

- These are split (known as fission) to produce large quantities of energy.
- The heat resulting from nuclear fission is used to raise high-pressure steam, which then drives steam turbines coupled to electrical generators.

A distinct advantage of nuclear power is that no CO_2 emissions occur from its generation. Indirect emissions do, however, occur from uranium mining and the construction of nuclear power plants.

Hydraulic fracturing (also known as 'fracking') is a technique used to release natural gas and oil from shale rocks. It involves drilling into the earth, either horizontally or vertically, and introducing a high pressure mix of water, proppants (such as sand or ceramic beads) and chemicals.

- The pressurised mixture causes the rock layer to crack.
- Once the injection has ceased, the fracturing fluids flow back to the surface.
- The fissures formed are held open by the proppants such that natural gas from the shale can flow up the well to the surface.

Non-Renewable Energy Sources	Advantages	Disadvantages
Fossil fuels	Straightforward combustion process.	Major contributor to climate change.
	Relatively inexpensive.	Cause acid rain.
	Easily transported.	Non-renewable sources that are not sustainable in the long term.
	Large amounts of electricity can be generated in one place, quite cheaply.	Prices are susceptible to changes in global politics so may rise significantly at short notice.
	Gas-fired power stations relatively efficient.	Extracting the raw materials can be dangerous and damaging to the environment.
	Power stations can be built almost anywhere.	Emissions may contribute to poor air quality locally, thereby affecting people's health.
Nuclear	Relatively small amounts of fuel produce a lot of power.	Generates significant volumes of potentially dangerous radioactive wastes.
	Output is reliable and not weather-dependent.	Expensive and time-consuming to construct and decommission.
	Very low emissions of carbon dioxide and other greenhouse gases.	Inflexible in terms of the ability to 'turn on and off' in response to changing power demands.
		High-profile accidents have created a significant degree of public and political opposition.

The **adverse environmental impacts** of combusting fossil fuels are significant and include:

- Acid rain.
- Smog.

- Dwindling resources.
- Health and welfare.
- Climate change.
- Thermal pollution.

Renewable

Examples include:

- **Biomass** - on an industrial scale, bioenergy power plants offer a clean, efficient combustion of straw, forestry wastes or wood chips.
- **Hydropower** - precipitation from clouds flows down into streams and rivers, where its flow can be used to power turbines to form electricity.
- **Solar energy** - solar power can be captured via solar collectors to produce hot water for washing or space heating in buildings. Solar photovoltaics (PVs) directly generate electricity when the sun shines on them.
- **Wave** - examples include 'oscillating water columns' which make use of the rise and fall of waves in a closed chamber to blow and suck air through an air turbine. This is connected to a generator which produces electricity.
- **Wind** - as air flows from warmer to cooler areas, this results in winds which can be used to power wind turbines to produce electricity. Advantages include it is free and there are no greenhouse gases produced during energy generation. Disadvantages include wind is not predictable and some people view turbines as unsightly.
- **Geothermal** - energy from the Earth's internal heat, which is generated from the decay of long-lived radioactive elements. The resulting hot water, or in some cases steam, is used for electricity generation where possible.

Renewable Energy Sources	Advantages	Disadvantages
Solar	■ Remote areas. ■ Close to where energy is required. ■ No emissions.	■ Unable to control how much and when. ■ No power generation at night.
Wind	■ No emissions. ■ Remote areas. ■ Free form of motive power. ■ Small-scale operation as a local source of energy. ■ Plant can be prefabricated off site.	■ Unable to control how much and when. ■ Only generates power when there is wind. ■ Susceptible to damage in very strong winds (over 25m/sec.). ■ Noise generated by turbines. ■ Loss of visual amenity. ■ Construction and maintenance costs can be significant. ■ Have to be large to provide sufficient energy for large-scale demand. ■ Remote from demand means that long supply cables required with subsequent energy transmission loss. ■ Objections by some to turbines.
Hydroelectric	■ Dams and reservoirs provide additional recreational resources. ■ Long useful life of plant.	■ Construction and loss of habitat (e.g. by flooding valleys). ■ Reservoirs can generate methane from anaerobic decomposition (tropical regions).

Renewable Energy Sources	Advantages	Disadvantages
Wave and Tidal Power	■ No emissions. ■ No waste products. ■ Limited running costs.	■ Unable to control how much. ■ Only produce power when there is wave or tidal action. ■ Ensuring the generator and associated equipment remain anchored in place.
Geothermal	■ No emissions to air. ■ Remote locations. ■ Reliable fuel source.	■ Often relatively large amounts of land required.
Biomass	■ Biomass crops can be grown widely in many locations.	■ Uses land that could be used for growing food. ■ Indirect pollution associated with high inputs of artificial fertilisers.

The Need for Energy Efficiency

Energy Efficiency: Relationship to Cost and Profit

Saving energy has many benefits, including:

- Reduced energy costs (increasing profits or releasing resources for other activities).
- Improved environmental performance due to reduced carbon-dioxide and other emissions.
- Improved competitiveness of products or services.
- Enhanced public image with customers and other stakeholders.
- Reduced exposure to Government drivers such as carbon taxes.

Provision of Information Regarding Energy Efficiency

Energy Label

EU Regulation 2017/1369 sets a framework for energy labelling and provides a credible and consistent approach to labelling of a number of categories of household products, including:

- Refrigerators, freezers and fridge-freezer combinations.
- Washing machines.

- Electric tumble-dryers.
- Combined washer-dryers.
- Dishwashers.
- Lamps.
- Electric ovens.
- Air conditioners.

Energy Star

This is an initiative for electrical appliances. The label indicates that the energy consumption of an appliance is under an agreed level when the appliance is in standby mode.

Vehicle Efficiency

EU Directive 1999/94/EC (as amended) requires that:

- New cars carry a standard label that shows fuel economy and CO_2 emissions.
- A poster or similar display is exhibited at the point of sale, showing prominently the official fuel consumption and CO_2 emissions data of all models of new cars offered for sale.
- All promotional literature must contain official fuel consumption and CO_2 emission data.

Energy Performance Certificates (EPCs)

EPCs are a means of providing information to consumers on buildings which they may purchase or rent.

In the EU, under **Directive 2010/31/EU** on the energy performance of buildings, certificates are required to be present in advertisements in commercial media when a building is put up for sale or rent.

Sankey Diagrams

A sankey diagram:

- Provides a graphical summary of the energy transfer taking place within a system. The greater the amount of energy then the thicker the line or arrow.
- Is essentially a form of mass balance.

Building Design and Assessment

Design elements for buildings to reduce energy consumption include:

- Natural ventilation.
- Passive solar heating.
- Windows facing the midday sun in winter and being shaded in the summer.
- Reducing windows on other sides.
- Using suitable insulation to reduce seasonal excessive heat loss and gain.
- Using thermal mass (the ability of the building to soak up heat before it reaches the interior during the day and release it at night).

Energy assessments play an important role in determining the energy efficiency of buildings. Such assessments may be undertaken as a result of legal and voluntary initiatives such as EPCs and the Building Research Establishment Environmental Assessment Method (BREEAM) scheme.

Product Design and Assessment

Products can also be designed with energy efficiency in mind. This may form part of a **clean design** process.

Measures to improve energy efficiency resulting from clean design might include:

- A reduction in the material/energy intensity of goods or services.
- Improved recyclability.
- Maximum use of renewable resources.
- Greater durability of products.
- Increased service intensity of goods and services.

The assessment of energy efficiency of products is sometimes required by law.

Benefits of Managing Energy Use

Reducing emissions of CO_2 and other GHGs is essential if the detrimental effects of climate change are to be prevented or reduced. Some of the main control measures available are:

- Insulation to prevent heat loss.
- Choice of equipment - type of fuel used, efficiency of the equipment.
- Maintenance to ensure it remains efficient.
- Adequate control systems so equipment is only active when required and only using the amount of power required.
- Providing suitable information, instruction, training and supervision to those who will operate the equipment.

Barriers to Good Energy Management

Barriers include:

- Insufficient top-level support.
- Funding.
- Inadequate resources.
- Lack of co-ordination across the organisation.
- Lack of targeting.

Measures to Reduce Energy Consumption

The five steps of a successful energy management strategy are:

1. Management commitment.
2. Understand the issues.
3. Plan and organise.
4. Implementation.
5. Control and monitor energy management and performance.

Insulation

- Effective insulation is a medium-cost measure that can usually be implemented relatively easily.
- Common insulation techniques are loft or roof-space insulation and cavity-wall insulation.

Choice of Equipment

Choosing the right equipment is likely to have a major impact on energy consumption, e.g. electric motors must be matched to the demand required of them.

The common causes of wasted energy with regard to lighting systems are:

- Lights being used unnecessarily.
- Lighting unoccupied buildings or rooms.
- Using lights when daylight provides sufficient light levels.

Significant savings can be made through the use of low energy lighting (e.g. compact fluorescent).

Maintenance and Control Systems

- A system will only remain operating efficiently if it is properly maintained.
- An effective Planned Preventive Maintenance system will help avoid expensive and inconvenient breakdowns.
- There are three main types of controls for heating systems:
  - Simple switches.
  - Complex time switches.
  - Continuous controllers.

  A modern Building Energy Management System (BEMS) can significantly reduce the energy used to heat and cool a building.
- There are two main categories of lighting controls:
  - **Manual** - the simple on/off switch we are all familiar with. Proper labelling allows people to know which lights can be switched off when not required. Significant savings are possible if lights are switched in rows running parallel to the windows and lights nearest the windows can be switched off separately to those further away.
  - **Automatic** - controls such as timers and sensors can be used to automatically turn off lights when not required.

Initiatives

Energy efficiency initiatives can be a positive way to reduce energy consumption in an organisation, e.g. a poster campaign focused on specific issues such as switching off unused equipment and lighting.

Information, Instruction, Training and Supervision

- **Information** - can be provided verbally or in written format; it may be through the use of posters, notices on payslips, memos or e-mails, etc.
- **Instructions** - may be written or verbal but should be clear and unambiguous about what is required of the person being instructed.
- **Training** - should be clear aims and objectives about what the training will achieve and a means of checking that those objectives have been achieved and that learning has taken place.
- **Supervision** - where a more qualified or senior person actually observes the work that is or has been done and ensures it is to the correct standard.

Energy Auditing and Monitoring

Energy Auditing

- The aim of an energy audit is to understand where and how energy savings can be made.
- Key objectives:
  - Quantification of energy consumption for the audit scope (could be site, area or equipment).
  - Identification of opportunities to reduce energy consumption.
  - Quantification of savings in terms of energy and cost.
- Stages in carrying out an energy audit:
  - Baseline study (including quantity and quality elements).
  - Analyse findings (develop a list of key energy uses).
  - Identify opportunities (determine measures to reduce energy - must be technically feasible).
  - Cost-benefit analysis (low cost/no cost measures, larger capital investment).
  - Reporting.

Energy Monitoring

This will involve a continuous strategy of collecting and analysing consumption data, e.g. from meter readings.

Energy monitoring can:

- Understand the reasons for excessive energy use.
- Detect times when energy use is higher or lower than expected.
- Provide a visualisation of trends in consumption.
- Assist in forecasting future energy usage and costs when planning business changes.
- Diagnose specific parts of the organisation which are wasting energy.
- Quantitatively understand the impact of improvements implemented to reduce energy.

Benefits and Limitations of Energy Monitoring/Auditing

The key **benefits** of monitoring and auditing energy are:

- Reduced costs.
- Reduced environmental impact.
- Increased comfort.

- Improved competitiveness.
- Increased operational life of equipment.
- Identification of unaccounted consumption.
- Increased productivity.
- Fulfilment of compliance obligations.

The key **limitations** are:

- Cost of undertaking an audit.
- Audit and monitoring only highlight what needs to be done to reduce energy. Actions need to be implemented.
- Time of staff.
- Perception (burden or assist in reducing costs?).

Exam-Style Questions

1. The burning of fossil fuels has many impacts on the environment.

   Explain the potential impacts of such activities. (20)

2. (a) **Identify** the purpose of monitoring energy in an organisation. (6)
   (b) **Outline** the advantages and disadvantages of energy monitoring and auditing. (14)

Model Answers

Question 1

Interpretation

An explanation of the impacts on the environment (including human health) is required in answer to this question. An answer should not concentrate on just one or two impacts (e.g. climate change) but should discuss a range of potential impacts from the burning of fossil fuels.

Plan

Acid rain, smog, dwindling resources, health and welfare, deforestation, climate change, thermal pollution.

Suggested Answer

Acid rain - acid gases resulting from fossil-fuel combustion combine with water vapour to create acid rain which corrodes buildings, damages and kills trees and destroys life in rivers and lakes. Road transport produces around 51% of acidic oxides of nitrogen (NO_x), while power stations produce 72% of acidic sulphur dioxide (SO_2) and a further 28% of NO_x.

Smog - when gases from vehicle exhausts react with sunlight, smog is formed over cities, damaging trees and crops and affecting health. Road transport produces 90% of carbon monoxide (CO) which contributes most to this effect.

Dwindling resources - fossil fuels cannot be rapidly reproduced - it takes millions of years to produce coal, gas and oil and existing reserves will eventually run out. At current rates of consumption, proven world reserves for fossil fuels are estimated to be 44 years for oil, 56 years for gas and 250 years for coal. It has been estimated that by 2020 energy consumption in the UK will be around 30% greater than in 1990.

Health and welfare - energy production from fossil fuels can have significant effects on health, particularly energy used by transport which results in traffic fumes. Such emissions have acute effects on certain people, e.g. streaming eyes, coughing, breathing difficulties and asthma attacks. Smog can irritate the lungs, cause bronchitis and pneumonia and decrease resistance to respiratory infections.

Deforestation - carbon dioxide is taken from the air by vegetation, which helps regulate the amount of CO_2 in the atmosphere. Every year it is estimated that an area of tropical rainforest one and a half times the size of England is lost around the world. Some deforestation involves large-scale burning, increasing global warming further. In addition to reducing the amount of CO_2, trees can help to reduce the energy demand of buildings by affording shelter from cooling winds.

Climate change - a number of gases are emitted during the combustion of fossil fuels with the most significant being carbon dioxide, which traps heat in the Earth's atmosphere. It has been estimated that over the past 150 years, the burning of fossil fuels has caused a 25% increase in the quantity of carbon dioxide in the atmosphere. Fossil fuels also result in

increased concentrations of atmospheric methane and nitrous oxide. Since the collection of reliable records in the latter part of the 1800s, the world's global average temperature has risen by around 0.5° Celsius. The IPCC (Intergovernmental Panel on Climate Change) identified in a 1995 report that "this is unlikely to be entirely natural in origin" and that "the balance of evidence suggests that there is a discernible human influence on global climate". Scientists have predicted that if temperatures continue to increase, glacial melting will cause sea levels to rise, leading to inundation of low-lying areas such as coastal wetlands.

Thermal pollution - fossil-fuel combustion for electricity production results in heat, which is used to generate electricity. As the process is relatively inefficient, much of the heat is emitted to air or to water that is used as a coolant. Heated water can have effects on aquatic systems.

Question 2

Interpretation

Part (a) requires little detail as it is an 'identify' question. Six reasons are required as the question is worth six marks.

Part (b) is quite an easy question to interpret. A brief description (outline) of the advantages and disadvantages of energy monitoring is required. There does not have to be an equal number of each but your answer should not just state advantages or just state disadvantages.

Plan

(a) Excessive use, times, trends, forecasting, waste, improvements impact.

(b) Advantages: reduce costs, environmental impact, comfort, competitiveness, equipment, unaccounted consumption, productivity, compliance obligations.

Disadvantages: cost, actions, time, perception.

Suggested Answer

(a) The purpose of monitoring energy is to:

- Understand the reasons for excessive energy use.
- Detect times when energy use is higher or lower than expected.
- Provide a visualisation of trends in consumption.
- Assist in forecasting future energy usage and costs when planning business changes.
- Diagnose specific parts of the organisation which are wasting energy.
- Quantitatively understand the impact of improvements implemented to reduce energy.

(b) The advantages of energy monitoring are:

- Reduced costs - reducing costs is a compelling reason for reducing energy. Without undertaking monitoring or auditing the key areas with the potential for significant cost savings would be difficult to identify.
- Environmental impact - an energy audit will allow the environmental impacts associated with energy consumption to be minimised. For example, an organisation's carbon footprint and other energy-related impacts will be lessened.
- Comfort - an energy audit may reveal poorly heated or cooled workplaces. For example, poorly insulated doors or windows could be identified.
- Competitiveness - by spending less on energy an organisation may be more competitive.
- Equipment - ensuring that equipment uses the correct amount of energy can increase the operational life of that equipment.
- Unaccounted consumption - an audit may reveal areas of significant energy usage that were previously unknown.
- Productivity - this may be increased as a result of optimisation of equipment and processes.
- Compliance obligations - for certain organisations it is sometimes a legal requirement to monitor energy. For example, a mandatory energy audit is required for larger organisations in the EU as part of the Energy Efficiency Directive (2012/27/EU). Management system standards such as ISO 14001 and ISO 50001 also often require energy monitoring and auditing to be undertaken.

The disadvantages of energy monitoring are:

- Cost - the cost of undertaking an audit or setting up a monitoring system can be prohibitive. Employing an external contractor or training staff can be costly.
- Actions - energy audits and monitoring are forms of performance review. They will highlight ways to save energy which may be poorly implemented or not at all.
- Time - completing an energy audit or setting up a monitoring system will require the time of staff from their regular duties.
- Perception - some will see an audit, particularly those that are a legal requirement, as being a burden rather than an activity that will assist in reducing costs.

Unit IDEM2

Element 1
Enforcement of Environmental Legislation

Enforcement of Environmental Law

The Role, Function and Limitations of Legislation as a Means of Promoting Environmental Performance

Government policy can be implemented by the setting of legislation; law, therefore, is a means of implementing government policy (policy instrument).

Common types of legislative approaches to environmental management include:

- Environmental permits.
- Prohibitions or restrictions on substances or products.
- Regulatory authorisations.
- Standards of performance.

The advantages of using law as a policy instrument include:

- The rule-based approach of some legislation provides for a consistent means of regulation by enforcing authorities.
- Specific content enables a reasonable degree of certainty.

The disadvantages include:

- Lacking speed to changes in technology, politics or science.
- Enforcement of legislation can be costly.

Mechanisms that may be Used to Enforce Environmental Law

(Based on methods of enforcement in England).

Enforcement and Prohibition Notices

- Enforcement notices under the **Environmental Permitting (England and Wales) Regulations 2016 (EP Regulations)** (Reg. 36) - issued by regulators if they are of the opinion that an operator is in non-compliance with a permit or its conditions.
- Prohibition notice under the **EP Regulations 2016** concerning an activity that might lead to pollution of groundwater.

Simple Caution

- Written acceptance that an offence has been committed where a prosecution could have been brought.
- May be produced before a court if further offending continues.

Abatement Notice

If a local authority has identified a statutory nuisance or one is likely to occur or recur, it must serve an abatement notice on the person who is responsible for the nuisance or the owner/occupier of the premises.

Failure to comply with the conditions of an abatement notice may result in prosecution.

Suspension Notice

May be issued under the **EP Regulations** if:

- the operation of a regulated facility contravenes a permit and there is a risk of pollution; or
- the operation of a regulated facility involves a serious risk of pollution.

Revocation

A permit under the **EP Regulations** may be partially or completely revoked by the regulator if the activities covered by it are causing, or likely to cause, serious environmental harm.

Variation

- Operators must notify regulators of planned changes to activities covered by a permit.
- If substantial changes occur, they must formally apply to vary a permit, which must be advertised.
- Permit conditions can also be varied by regulators at any time.

Remediation Notice

Following designation of land as being contaminated, the enforcing authority is required to serve a remediation notice on the appropriate person(s).

This specifies what needs to be done and the period within which various items of work need to be completed.

Cost Recovery

- Under the EP Regulations, the regulator has powers to carry out work necessary to prevent or mitigate serious pollution.
- It may also recover the cost of taking those steps from the operator.

Fines and Imprisonment and the Right to Compensation

Non-compliance with criminal law can lead to a number of penalties, such as fines and, for more serious offences, imprisonment.

In the UK, for example, non-compliance with the **Environmental Protection Act 1990** (a key environmental law) can lead to an unlimited fine and/or two years in prison.

Non-compliance may also lead to the polluter having to pay compensation to the person who has been wronged in relation to an environmental incident.

Civil Sanctions

The Macrory Report and a review by the UK Government identified that the current framework for dealing with environmental offences was not satisfactory.

Civil sanctions can now be applied to specified environmental offences as an alternative to criminal sanctions.

A civil sanction can only be used where it is identified in a statutory instrument that a civil sanction is available for a particular offence.

The types of civil sanction that have been introduced are:

- **Compliance Notice**

  Written notice that is issued by the regulator to ensure that a person takes steps within a specified time period to ensure that an offence will not continue or happen again.

- **Restoration Notice**

  - Issued by the regulator requiring an individual to take steps to restore harm that has been caused by non-compliance.
  - Position must be restored to what it would have been (or as close as possible) if the offence had not taken place.

- **Variable Monetary Penalties (VMPs)**

  - Monetary penalties that can be used by regulators for cases of more serious non-compliance where they decide that a prosecution is not in the interest of the public.
  - Used in cases where any financial benefit that has accrued from non-compliance is removed, to deter future non-compliance.

- **Enforcement Undertakings**

  - Voluntary, written agreements made by a person to take steps that would make amends for non-compliance and its impacts.
  - It is the regulator's decision whether to accept such an agreement.

- **Third-Party Undertakings (TPUs)**

  When a person receives a notice of intent to impose a compliance notice, restoration notice or VMP, they may offer a Third-Party Undertaking (TPU).

This involves taking action that benefits a third party who has been affected by the offence.

It is the decision of the regulator whether to accept a TPU or not.

- **Fixed Monetary Penalties**

  Relatively low-level fixed penalties that the regulator can impose for specific minor offences.

- **Stop Notice**
  - Prohibits a person from undertaking an activity that is causing (or is likely to cause) serious harm.
  - Also prohibits situations that present (or are likely to present) a significant risk of causing serious harm until the person has undertaken specified steps stated in the notice to remove the risk of serious harm, or to return to full compliance with the law.
  - Non-compliance with a stop notice is a criminal offence.

Enforcement Process for Civil Sanctions

This involves:

- Issue of notice of intent.
- Issue of a final notice.

Appeals can be made to a First-Tier Tribunal for most types of civil sanction.

Role and Function of Enforcement Agencies

There is no harmonised global standard for the enforcement of environmental law.

Each country or region is likely to have one (or more) enforcement agencies responsible for enforcing environmental law. These agencies will usually:

- Provide advice.
- Investigate environmental incidents.
- Take formal enforcement action.
- Start criminal proceedings.

Enforcement agencies are also often involved in authorising activities that can have an impact on the environment. This is often in the form of an environmental permit.

Activities that are often permitted include:

- Discharge to groundwater.
- Keeping, treating and disposing of waste.

- Emissions of pollutants to air.
- Integrated permits (where more than one activity is controlled by a single permit).

An enforcement agency will often be tasked with undertaking inspection of workplaces with the frequency being based on risk.

Different Levels of Standards

Types of international law include:

- Treaty - solemn agreement.
- Convention - broad multilateral agreement.
- Protocol - more detailed and usually linked to a treaty or convention.
- Declaration - non-binding; often declares an aspiration.

Adoption is the term used when an international agreement is developed and established.

Ratification is the formal act whereby a state is bound by the requirements of an agreement.

Entry into force is the date by which states are bound by the requirements of the agreement.

Types of EU law include:

- Directive - must be implemented by member states in their own legal systems.
- Regulation - directly binding on member states.

National law may be influenced by international and/or EU law. Breach of national law is often a criminal offence and may result in a fine and/or prison sentence.

Compensation may have to be paid to those affected by an environmental incident.

An environmentally responsible business must ensure that as a minimum it complies with relevant environmental legal requirements.

Use of UN Statutory Instruments in Relation to Transboundary Pollution and Water Abstraction Issues

The United Nations (UN) have developed numerous international legal requirements.

Two key areas of UN environmental legislative activity are the control of transboundary pollution and the control of water sources.

Examples include:

- Convention for the protection of the ozone layer (Vienna Convention) 1985.
- Convention on long-range transboundary air pollution (Geneva Convention) 1979.
- Convention on the protection and use of transboundary watercourses and international lakes (Helsinki) 1992.

Permitting/Consent Requirements for the Operation of Industrial Installations

It is common in many countries for industrial installations to require an environmental permit to legally operate.

Under **Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (IED)** industrial sectors listed in Annex A must legally apply for an environmental permit. Example industry sectors include:

- Energy industries.
- Production and processing of metals.
- Mineral industry.
- Chemical industry.
- Waste management.

The IED takes an integrated approach to environmental permits, meaning that the full environmental performance must be taken into account.

The conditions that are within the permit and emissions limits are required to be based around the Best Available Techniques (BAT).

The Role and Influence of the United Nations

The United Nations Environment Programme (UNEP) is an Agency of the UN that plays an important role in the global environmental agenda.

Its key aims are to:

- Be an authoritative advocate for the environment.
- Promote environmental components of sustainable development within the UN.
- Promote the development and implementation of international environmental law.

Key activities undertaken by UNEP include:

- Preventing transboundary environmental crime.
- Scheduled development of environmental law.

- Supporting instruments for the sustainable use of freshwater resources.
- Human rights and the environment.
- Law and Environment Ontology (LEO) (a law Web tool).
- Green Customs Initiative.

The Influence of Key International Treaties

National governments are generally responsible for ensuring international obligations are enforced.

In the EU, an international agreement may be implemented as a Directive first and then into a nation's own legal system.

If an international agreement is implemented as an EU Regulation then there is no need for a nation to implement it in its own legal system, as it is immediately binding (a national enforcement law may, however, be developed).

Unit IDEM2

Element 2
Pollution Prevention and Control
Multilateral Treaties

Waste Management Multilateral Treaties

Hierarchy of Control Applied to Solid Wastes

The waste hierarchy is:

- Prevention.
- Preparing for re-use.
- Recycling.
- Other recovery/Energy recovery.
- Disposal.

Prevention

The best thing that can be done to reduce the amount of waste produced is to try to prevent it from being formed at all, e.g. not printing e-mails.

If waste cannot be prevented, the amount that is produced should be kept to a minimum, e.g printing double-sided.

Preparing for Re-use

Re-use implies the direct use of an article or substance without the need for treatment beyond, perhaps, collection or cleaning, e.g. washing and re-use of glass milk bottles.

Recycling

Recycling of materials is distinct from the re-use of materials or articles, in that recycling involves some form of treatment.

Environmental and financial advantages are not always clear-cut. Materials that are recycled usually have to be collected, then treated to become a secondary raw material before they can re-enter the commercial cycle.

Waste composting is the aerobic bacterial processing of biodegradable wastes to produce a reasonably stable, granular material, usually containing valuable plant nutrients. It is on the same level of the waste hierarchy as recycling.

Other Recovery

Recovery techniques generally concern gaining energy from waste. Examples include:

- Incinerating waste and using the heat.
- Using methane from the decomposition of waste in an anaerobic digester.

Disposal

The landfilling of waste is the least desirable waste management option because it:

- Uses up valuable land resources.
- Presents numerous environmental and health issues.

The incineration of waste without operating waste to energy is also a poor option for waste and is viewed as a disposal technique.

Sources of Waste

- **Municipal wastes** - waste streams that arise from households or commercial premises such as shops, offices and other commercial units.
- **Non-municipal wastes** - waste streams that are generated from industry, mining and agriculture.

Categories and Definitions of Waste

Directive Waste (**Waste Framework Directive (2008/98/EC)**) is:

> *"Any substance or object which the holder discards, intends to discard, or is required to discard."*

Key waste categories are:

- Non-hazardous waste - degradable waste that is not hazardous.
- Hazardous waste - contains one or more hazardous categories such as wastes that are flammable, toxic or infectious.
- Inert waste - stable waste that does not significantly degrade.
- Clinical waste - harmful healthcare waste.
- Toxic waste - wastes that present a significant danger to human health such as pesticides or carcinogens.
- Radioactive waste - "waste that contains, or is contaminated with, radionuclides at concentrations or activities greater than clearance levels as established by the regulatory body".

The key law covering waste management in the EU is the **Waste Framework Directive (2008/98/EC**). Key provisions are:

- Encourages the implementation of the waste hierarchy (see above).
- Waste must be recovered or disposed of without endangering human health or the environment.
- Establishes an integrated and adequate network of disposal installations.
- Those who carry out waste operations are required to obtain a permit from the competent authority.
- Those who collect or transport waste on a professional basis are required to be registered with competent authorities.
- Sets recycling targets.
- Sets requirements for hazardous waste (not mixed, record keeping and movements covered by a manifest).

Classification and Coding of Waste

Waste must be classified and coded to ensure that arrangements can be made for its safe storage, transportation and disposal.

The List of Wastes (LoW):

- Was established by the **List of Wastes Decision 2000/532/EC**.
- Introduced a six-digit mechanism to code different waste types.

In the UK the steps to classify hazardous waste are:

- Step 1 - Check if the waste needs to be classified.
- Step 2 - Identify the code or codes that may apply to the waste.
- Step 3 - Identify the assessment needed to select the correct code(s).
- Step 4 - Determine the chemical composition of the waste.
- Step 5 - Identify if the substances in the waste are 'Hazardous Substances' or 'Persistent Organic Pollutants'.
- Step 6 - Assess the hazardous properties of the waste.
- Step 7 - Assign the classification code and describe the hazardous properties.

Other systems of hazardous waste categorisation are covered in the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 1992 and the US Hazardous Waste Listings.

Regulatory Documentation

Whenever waste is removed from a premises, there is often a requirement to retain information regarding the waste and to ensure that the information is transferred with the waste. The information has different names around the world but is often known as a manifest, transfer note or written information.

Landfill Disposal

The **EU Landfill Directive 1999/31/EC** (as well as other EU Directives) requires that a competent authority classify a landfill site for:

- Hazardous waste.
- Non-hazardous waste.
- Inert waste.

Key requirements of the **Landfill Directive** include the banning of disposal to a landfill of:

- Certain waste types, e.g. flammable waste, tyres.
- Unidentified wastes whose effects are unknown.
- Wastes that do not meet acceptance criteria.

Waste sent to landfill may also be taxed so as to discourage disposal in this manner. In the UK, for example, a landfill tax is levied on most wastes that are disposed of to landfill.

Specific Waste Types

Electrical and Electronic Equipment

Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE) aims for the prevention of WEEE. Key requirements of this Directive are:

- Member states must develop and maintain a register of EEE producers.
- Householders must be able to take WEEE to a collection facility at no cost.
- Development of targets for WEEE collected separately from households.
- Distributors and retailers are responsible for making arrangements to take back WEEE for free, in a way that is convenient for the customer.
- Introduction of recovery and recycling targets for WEEE for various categories.
- Producers to mark EEE products with the 'crossed-out wheelie-bin' symbol.

Directive 2011/65/EU on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment sets limits on specific hazardous materials in EEE.

Waste Batteries

Key requirements of **Directive 2006/66/EC** on Batteries and Accumulators and Waste Batteries are:

- The use of cadmium and mercury is prohibited above certain limits in batteries.
- Specific labelling is required to facilitate recycling.
- Appliances that use batteries are designed so that the batteries can easily be removed.
- Battery producers have to register with a regulator and join and finance a battery compliance scheme.
- Portable-battery sellers have to take back waste (i.e. spent) portable batteries (free of charge).
- Waste industrial and automotive batteries must not be disposed of by landfill or incineration.

End of Vehicle Life

Key requirements of the **End-of-Life Vehicles (ELV) Directive (2000/53/EC)** are:

- **Producers (Vehicle Manufacturers)**
  - Marking of components to aid identification.
  - Restrictions on the use of certain heavy metals in vehicle manufacture.
  - Free take-back of vehicles paid for by producers.
  - Producers are obligated to provide accessible networks of Authorised Treatment Facilities (ATFs) and collection points.
  - Producer and ATF obligations in respect of achieving recovery and recycling.
- **Vehicle Owners and Operators**
  - It must be ensured that the site has an environmental permit or a waste management licence and is classed as an ATF.
  - A car or van can be taken to an ATF free of charge.
- **Sites Accepting Motor Vehicles**
  - These sites must be classed as an ATF.
  - Only ATFs are allowed to issue Certificates of Destruction (CoDs) to the final holder, owner or company representative.

Packaging Waste

EU Directive 94/62/EC on Packaging and Packaging Waste;

- Covers packaging placed on the market in the EU.
- Sets targets for packaging recovery and a number of essential requirements for packaging.

Basel Convention

Key requirements of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 1992 include:

- Hazardous waste for recovery is not permitted to be exported to non-OECD (Organisation for Economic Co-operation and Development) countries.
- Non-hazardous waste for recovery can be freely traded between EU member states and OECD countries.
- Hazardous waste shipped for recovery between emerging states and OECD countries must have prior written notification from the competent authority of despatch, destination and transit and their consent prior to shipment beginning.
- Possible controls for non-OECD countries include prohibition, prior written notification and consent (these are set out separately in **EU Regulation 1418/2007**).

Multilateral Treaties for Managing Emissions to Atmosphere

Geneva Convention

The Geneva Convention on Long-Range Transboundary Air Pollution 1979 (and associated Protocols) aims to limit and gradually reduce pollutants that can cross national boundaries. Key requirements include:

- Develop strategies and policies to combat transboundary air pollution.
- Exchange information on, and review, policies, scientific activities and technical measures.
- Consultations held between contracting parties at risk of transboundary air pollution.
- Research, exchange of information and monitoring of the cost-effectiveness of methods to reduce air pollution.
- Initiation of, and co-operation in, research and/or development of technology for reducing air pollutants:
  - Instrumentation and techniques for monitoring and measuring emissions.
  - The effects of air pollutants.
- Various types of data must be exchanged between contracting parties.

The associated Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-Level Ozone 1999 is made under the Geneva Convention. It sets national emission ceilings for sulphur dioxide, oxides of nitrogen, Volatile Organic Compounds (VOCs) and ammonia.

Phase-Out of Harmful Substances to the Atmosphere

The Vienna Convention for the Protection of the Ozone Layer 1985 requires nations to take appropriate measures to protect people and the environment against the impacts resulting from human activities that modify, or are likely to modify, the ozone layer.

More specific requirements on the banning and phasing-out of Ozone-Depleting Substances (ODSs) are present in the Montreal Protocol on Substances that Deplete the Ozone Layer 1987.

EU Regulation 1005/2009 (which consolidates and replaces previous provisions) implements within the EU commitments agreed by the parties to the Montreal Protocol. Key requirements include:

- The supply and use of CFCs and halons is banned in the EU.
- Virgin hydrochlorofluorocarbons (HCFCs) cannot be used in any new refrigeration equipment, or for maintenance of existing equipment.
- Reclaimed or recycled HCFCs may have been used for plant maintenance until 31 December 2015.
- Leak-testing for ODSs must be carried out.
- If a repair to a leak has been made then the system should be checked.
- Minimum qualifications must be held if specific tasks are undertaken.

The Kigali Amendment 2016 to the Montreal Protocol 1987 sets legally binding targets that specify the phased reductions of the hydrofluorocarbons (HFCs), a potent group of fluorinated greenhouse gases (F-gases).

Key requirements of **EU Regulation 517/2014** on fluorinated greenhouse gases (repealing EC Regulation 842/2006) are:

- Restrictions on the use of F-gases for various uses.
- Cap and phase down of F-gas use.
- Prevention of leakage.
- Checks for leaks.
- Automatic leak detection.
- Recovery of F-gases.
- Certification of personnel who leak-test.
- Labelling.

United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC 1994 has been the focus of international efforts to reduce greenhouse gases.

The Convention specifically requires that governments:

- Obtain and share information on greenhouse gas emissions, policies and best practices.
- Launch national strategies for addressing greenhouse gas emissions and adapting to climate-related impacts (this includes providing financial and technological support to developing countries).
- Co-operate in the preparations required for adapting to the impacts of climate change.

The Kyoto Protocol was adopted by parties to the UNFCCC in 1997, with the intention of establishing a legally-binding framework of GHG emission reductions. 37 industrialised countries and the EU committed to reduce emissions of a set of 6 greenhouse gases by an average of 5% against 1990 levels.

The Paris Agreement was developed at the Paris climate conference in December 2015 and formally entered into force in November 2016 when a sufficient number of countries (representing at least 55% of the world's greenhouse gas emissions) had ratified the agreement.

Multilateral Treaties for the Management of Watercourses

The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki) 1992 entered into force in 1996.

It introduced a legal framework for international co-operation on shared water resources, including both groundwater and surface water. Key requirements are:

- States must take all appropriate measures not to cause significant harm to other watercourse states.
- Special regard must be allocated to human needs and the protection of ecosystems of international importance.
- Co-operation must occur for planned measures that may affect international watercourses.
- States must ensure that new sources of pollution are prevented and must reduce and control existing sources.
- States must take necessary measures to prevent the introduction of invasive species.
- The marine environment is required to be protected and preserved.

- States are required to co-operate to regulate the flow of international watercourses.
- Measures must be taken to prevent or mitigate conditions that cause harm, from both human conduct and natural causes (e.g. floods and droughts).
- States are required to notify affected states and competent international organisations of emergency situations.
- States and international organisations must also prepare a contingency plan to respond to emergency situations.

Water Framework Directive 2000

Directive 2000/60/EC embodies the concept of integrated river-basin management and sets objectives for water status, including:

- Ecological and chemical parameters.
- Common monitoring and assessment strategies.
- River-basin administration and planning.
- Measures to meet the objectives.

The Directive:

- Introduces the concept of river-basin districts.
- Analyses the state of the rivers, and the human and natural needs in them.
- Establishes monitoring programmes and management plans.
- Introduces measures to bring about the desired improvements.

The **Water Framework Directive** identifies that water quality should be assessed using the ecological (e.g. fish and invertebrates) and chemical (e.g. heavy metals, pesticides and nutrients) status of the watercourse.

The Reasons for Establishing Emission Limit Values for Substances Released to the Water Environment

Emission limit values are often set for discharges of liquid effluent into either surface water, groundwater or a public sewer.

They are usually set by a competent authority and, as they quantify the quality and quantity of a pollutant, they enable it to be measured.

In the **Directive on Environmental Quality Standards (2008/105/EC)** substances are classed as priority substances and priority hazardous substances. Annex I of the Directive identifies limits on 45 priority substances.

The key objective of the Protocol on Water and Health 1999 is to provide protection of human health and well-being by effective water management, that includes the control and reduction of waterborne diseases and the protection of water-related ecosystems.

Procedures for Discharge of Substances with Limit Values

In England and Wales, under the **Environmental Permitting (England and Wales) Regulations 2016**, a water discharge activity permit is required for discharge of materials into controlled waters (such as rivers, streams or lakes).

Discharges of effluent made to the public sewerage system are regulated by a consenting system by the utility company that is responsible for the sewers under the **Water Industry Act 1991**.

Limits may vary in a permit or a consent but are often set for the following parameters:

- Sampling/monitoring.
- pH.
- Temperature.
- Volume.
- Times of discharge.
- Chemical Oxygen Demand (COD).
- Toxic metals.
- Suspended solids.
- Ammonia.

The Purpose and Use of Water Abstraction Licences/ Authorisations

An abstraction licence issued by a competent authority:

- Specifies the amount of water that may be abstracted from groundwater, surface water or tidal water and the times at which it may be removed.
- Will not be granted if the rate of abstraction exceeds the average rate of replenishment.

The Supply, Storage, Use and Transport of Hazardous Substances

The United Nations Globally Harmonised System

The UN Globally Harmonised System of Classification and Labelling of Chemicals (GHS) is a non-legally-binding, but internationally agreed, chemical classification and labelling scheme.

It standardises many elements of chemical management such as hazard-testing criteria, universally applied hazard warning pictograms and harmonised safety data sheets.

The aim of GHS is to standardise the laws governing the classification and labelling of chemicals globally, the principle being 'one chemical - one label worldwide'.

Prior to the introduction of GHS, there were many different systems around the world for hazard classification.

In Europe, the standard of note is the **European Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures (CLP)**, which is aligned to GHS.

Under **CLP**, manufacturers and suppliers must:

- Classify dangerous chemicals using the new scientific criteria agreed under GHS.
- Provide information to the end user in the form of a label that will make use of new hazard warning symbols (pictograms) agreed under GHS.
- Package the chemical safely.

The Purpose of the ILO Prevention of Major Industrial Accidents Convention,1993 (C174) and Associated Recommendation (R181)

This Convention applies to Major Hazard Installations (MHIs).

An MHI is defined as an installation that "produces, processes, handles, uses, disposes of or stores, either permanently or temporarily, one or more hazardous substances or categories of substances in quantities which exceed the threshold quantity".

Key requirements of the Convention with regard to MHI operators are:

- Identification and notification to the competent authority.
- Produce a documented system of major hazard control.
- Prepare a safety report (with reviews at planned intervals and also when there are significant changes).

- Inform the competent authority in the event of a major accident.
- Inform and train workers.

Competent authorities are required to:

- Prepare an off-site emergency plan.
- Inform the public about safety measures and the behaviour to adopt in an emergency.
- Warn the public when a major accident arises.
- Inform other countries (in the event of transboundary incidents).

The ILO Recommendation R181 - Prevention of Major Industrial Accidents, 1993 provides additional requirements to the Convention. It sets requirements for the international exchange of information.

The Purpose of the 2001 Stockholm Convention on Persistent Organic Pollutants in Respect of Chemicals

Persistent Organic Pollutants (POPs) are a group of substances that can accumulate in the fatty tissues of any organism and, as they degrade very slowly, can bioaccumulate in food chains, posing a high risk to human health and the environment.

The Stockholm Convention on Persistent Organic Pollutants 2001 sets key requirements for POPs:

- Ban or restrict the production, use, import or export of intentionally produced POP chemicals.
- Reduce or eliminate releases from POPs that are intentionally produced.
- Ensure that stockpiles and wastes containing or contaminated with POPs are safely managed.
- Exchange information.
- Measures must be implemented to reduce the formation of POPs from by-product.

The Specific Environmental Requirements Relating to the Transportation of Hazardous Substances

General

The **UN Recommendations on the Transport of Dangerous Goods - Model Regulations, 19th ed., 2015**, also known as 'the Orange Book', provide the basis for the development of all international regulations concerning the international transport of dangerous goods, as well as most national legislation.

This publication covers all modes of transport - road, sea and air - and the following key areas:

- Classification of dangerous goods.
- Listing.
- Use, construction, testing and approval of packaging and portable tanks.
- Consignment procedures.

Road and Rail

The European Agreement concerning the International Carriage of Dangerous Goods by Road is referred to by the abbreviation ADR, and the agreement concerning rail by RID.

Specific requirements of ADR and RID address issues such as:

- Training requirements.
- Compliance with safety obligations.
- Radioactive goods.
- Appointment of Dangerous Goods Safety Advisers.
- Reporting accidents or incidents.
- Security provisions.

Maritime

The International Maritime Dangerous Goods (IMDG) Code is an international code that standardises the safe carriage of dangerous goods and the prevention of pollution to the environment.

It covers issues such as packaging, container traffic and stowage, with particular emphasis on segregation of incompatible substances.

Air

The International Air Transport Association (IATA) **Dangerous Goods Regulations (DGR)** incorporate a harmonised system for operators so that they can accept and transport goods in a safe and efficient manner.

When shipping goods by air, there are four classifications under the **DGR**.

Labels used are usually the same as for the other applications of the **UN Model Regulations**.

The shipper has responsibility for providing the airline with information that applies to the goods. This may be provided in the form of a Shipper's Declaration for Dangerous Goods.

Training is required to be provided or verified upon the start of employment of persons involved in specific roles stated in the **DGR**.

Mercury

The Minamata Convention on Mercury of 2013 provides restrictions on mercury and mercury compounds. Key requirements include:

- Prohibits mercury mining (after entry into force).
- Identification of stocks of mercury over 50 metric tonnes.
- Parties must not export mercury without written consent of importing parties.
- Various phase-out dates are set for mercury-containing products.
- Phase-out or restriction of manufacturing activities.
- Strategies for identifying, assessing and reducing the risks associated with mercury-contaminated sites.

Multilateral Treaties Relating to Land, Wildlife Preservation and Pesticide Use

Convention on Biological Diversity

The Convention on Biological Diversity (CBD) was opened for signatures in 1992, coming into force in December 1993. It has three main goals:

- conservation of biological diversity (biodiversity);
- sustainable use of its components; and
- the fair and equitable sharing of the benefits arising from genetic resources.

The key objective of the CBD is for the development of national strategies to enable the sustainable use and conservation of biodiversity. This is achieved by:

- Co-operation.
- General measures.
- Identification and monitoring.
- *In situ* conservation.
- *Ex situ* conservation.
- Sustainable use.
- Research and training.
- Impact assessment.

Convention Concerning the Protection of the World Cultural and Natural Heritage 1972

This Convention is a key agreement that aims to provide protection of:

- 'cultural heritage' - monuments, groups of buildings and sites (combined works of man and nature (included in this are archaeological sites which are of outstanding universal value)); and
- 'natural heritage' - natural features consisting of physical and biological formations, geological features and natural sites.

The key requirements of the Convention are:

- Each country must:
  - Identify, protect, conserve and rehabilitate cultural and natural heritage.
  - Develop services for the protection of natural and cultural heritage.
  - Take the necessary legal, scientific, technical and administrative measures, and create development centres for training in identification, protection, conservation, presentation and rehabilitation of its heritage.
- Such heritage relevant to the Convention is defined as 'world heritage'.
- Protection of world heritage involves a system of internal co-operation and assistance.
- Establishment of the World Heritage Committee.
- Establishment of a World Heritage Fund.

Protection Given to Areas/Features Considered to be of Outstanding Value to Humanity by World Heritage

The following sites are listed on the World Heritage List as natural sites of outstanding international importance (apart from the Great Wall, which is a cultural site of outstanding international importance):

- The Great Barrier Reef - a highly biodiverse coral reef on the north-east coast of Australia.
- The Lake Malawi National Park - of international importance as a result of biodiversity, in particular fish diversity.
- Giant's Causeway - an internationally important area in Northern Ireland for the study of basaltic volcanism as a result of 40,000 large black regularly shaped polygonal basalt columns that rise from the sea to form a pavement.
- Canadian Rocky Mountain Parks - provides classical examples of glacial processes such as icefields, remnant valley glaciers, canyons and important examples of erosion and deposition.

- The Great Wall - in China is of a length of over 2,000 kilometres. It consists of walls, tracks for horses, watchtowers, wall shelters, fortresses and passes.

Other Designations for Protected Sites

- Ramsar Convention (The Convention on Wetlands of International Importance) - an intergovernmental treaty that provides the framework for national action and international co-operation for the conservation and wise use of wetlands and their resources.
- OSPAR Convention (The Convention for the Protection of the Marine Environment of the North-East Atlantic) - implementation of systems to identify threats to the marine environment in the north-east Atlantic and implementation programmes and measures that ensure national action is taken to combat them.
- Natura 2000 - EU-wide network of nature conservation sites comprising Special Areas of Conservation (SACs) and Special Protection Areas (SPAs):
  - SACs - series of protected sites that are established as a result of specific habitat type and/or species.
  - SPAs - require EU member states to identify and classify the most suitable territories in size and number for rare or vulnerable bird species.

Illegally Harvested Timber

EU Regulation No. 995/2010 identifies requirements for those who place timber and timber products on the market in the EU.

The requirements of the Regulation are designed to counter the trade in illegally harvested timber and timber products. This is achieved by:

- prohibiting the selling of illegally harvested timber;
- requiring traders to have a framework to identify and mitigate illegally harvested timber; and
- keeping records.

Rotterdam Convention on Prior Informed Consent

The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade 1992 sets the following general requirements:

- Promotion of a shared responsibility of parties involved in the international trade of hazardous chemicals to protect the environment and human health.
- Contribution to the sound use of such chemicals by:
  - facilitating information exchange about their characteristics;

- providing for a national decision-making process surrounding their export and import; and
- communicating this information to other parties.

The Convention provides coverage of a range of pesticides and industrial chemicals that have either been banned or are restricted for environmental or health reasons by parties to the Convention.

A Decision Guidance Document (DGD) is developed that includes information surrounding the chemical and the regulatory decision to ban or restrict the chemical on health or environmental grounds.

The Convention also promotes a mechanism for the exchange of information.

EU Regulation 649/2012 on Prior Informed Consent implements the Rotterdam Convention in the EU and covers the export of certain chemicals to non-EU countries.

Stockholm Convention on Persistent Organic Pollutants in Respect of Pesticides

Examples of pesticides banned or restricted by the Convention include:

- Aldrin.
- Chlordane.
- Endrin.
- Pentachlorobenzene.
- Toxaphene.
- DDT(1,1,1-trichloro-2,2-bis (4-chlorophenyl) ethane).
- Mirex.

Multilateral Treaties Relating to Energy Use

Emissions Trading

Tradable allowances are derived for emissions of specific environmentally hazardous substances (e.g. tonnes of carbon dioxide) that can be bought or sold.

The amount of allowances that can be allocated is, however, capped.

Those that release over their cap can buy extra allowances on an open market where those that have emitted under their cap can sell allowances.

This works as a financial incentive to organisations which have emitted under their cap and a financial disincentive to those which have emitted over their cap.

The Emissions Trading System (ETS) is a European system with the objective of reducing carbon dioxide emissions and mitigating climate change. It is implemented by Directive 2003/87/EC (establishing a scheme for greenhouse-gas emissions allowance trading).

The EU ETS installation requirements are relevant to energy-intensive organisations such as power stations, iron and steel manufacture, food and drink, engineering and vehicle manufacture. The EU ETS also sets requirements for emissions trading for aviation.

Production of Energy-Related Products and Energy Efficiency in Buildings

Directive 2012/27/EU on Energy Efficiency states mandatory requirements to assist the EU in achieving its 20% energy-efficiency target by 2020. Key requirements include:

- Energy savings targets for energy distributors.
- Purchase of energy-efficient buildings by governments.
- Energy efficiency renovations on government buildings.
- Free and easy access to energy consumption data.
- National incentives for small and medium-sized organisations to undertake energy audits.
- Mandatory energy audits for large organisations.

Ecodesign Directive 2009/125/EC

This legislation sets a framework for the reduction of environmental impacts (including energy consumption) for the design phase of a product. This enables the reduction of environmental impacts and energy consumed across a product's life cycle.

The Directive applies to most types of energy use and energy-related products (but not transportation) such as air conditioners, dishwashers, computers and televisions.

Specific Regulations have been made for various product groups based on the Directive. They must include:

- Assessment of the product's impacts on the environment.
- Design and construct the product so that it complies with ecodesign requirements.
- Affixing of required ecolabels.
- Undertaking of a conformity assessment (this is usually a self-assessment).
- Affixing of a CE mark to the product.

Examples of product-specific Regulations that implement the Ecodesign Directive include:

- **EU Regulation 2016/2281** Ecodesign requirements for air-heating products, cooling products, high temperature process chillers and fan coil units.
- **EU Regulation 617/2013** Ecodesign requirements for computers and computer servers.

Labelling

EU Regulation 2017/1369 sets mandatory requirements for energy labelling of household electrical products such as freezers, washing machines, lamps and air conditioners.

Advertisements and manufacturers' literature are required to have this information. It must be provided wherever these products are bought or hired.

The Regulation will also enable the general public to access product labels and information from a product registration database, so as to ease the comparison of the energy efficiency of electrical items.

The key requirements of the Regulation from its introduction on 1 August 2017 are:

- **Manufacturers:**
  - luminaires (complete electric light units) to be accompanied by a printed energy-efficiency label;
  - manufacturers to provide free printed labels;
  - efficiency classes and range of classes to be provided in advertisements (not radio advertisements); and
  - suppliers prohibited from placing products on the market whose performance changes under test conditions.
- **Dealers:**
  - Traders can request printed energy-efficiency labels from manufacturers, which must be provided within five days of request free of charge.
  - Efficiency classes and range of classes to be provided in advertisements (not radio advertisements).

Energy Star

- An initiative for electrical appliances.
- The label indicates that the energy consumption of an appliance is under an agreed level when the appliance is in standby mode.

Energy Performance of Buildings

To help improve energy efficiency in buildings, **Directive 2010/31/EU** on the energy performance of buildings has been developed. The Directive's key requirements for EU countries are:

- Provide energy performance certificates in all advertisements for the sale or rental of

buildings.

- Establish an inspection system for heating and air-conditioning systems or implement measures that have an equivalent effect.
- All new buildings by 31 December 2020 (public buildings by 31 December 2018) must be close to zero energy.
- Minimum energy performance requirements for new buildings, major renovations or retrofit of certain building elements.
- Develop a list of national financial measures that are designed to increase the energy efficiency of buildings.

The **Energy Efficiency Directive 2012/27/EU** also sets some requirements for buildings, including:

- A requirement to make energy-efficiency-related renovations to government buildings.
- Governments to only purchase buildings that have a high level of energy efficiency.
- Development of long-term government National Building Renovation Strategies (NBRSs).

Unit IDEM2

Practical Application

This section of your Revision Guide will focus on what's required for the Environmental Practical Application and the steps you need to take to ensure success.

This assessment is your chance to prove you understand the content from Units ED1 and IDEM2, and can apply it in a practical workplace environment.

There are other sources of information available on the IDEM2 Practical Application. NEBOSH publish guidance on the Practical Application on their website (www.nebosh.org.uk). If you haven't already downloaded a copy of this guidance, we strongly advise you to do so. Course providers also publish information and guidance on the IDEM2 Practical Application.

This Revision Guide doesn't replicate these other sources of guidance; it is actually intended to complement them and give detailed practical guidance and advice on completing the assessment. We recommend that you check all of your course materials for any other sources of information that might supplement this revision aid.

Aim of the Practical Assignment

The aim of the assignment is for you to review and critically analyse your organisation's Environmental Management System (EMS) in eight different areas; the review will also include a synopsis of environment regulation as it could apply to your organisation.

After the review and analysis of the EMS, you will be required to produce a report for top management on the overall performance of the EMS. Your report must highlight three environmental concerns, which can be taken from any of the areas reviewed, and make recommendation/s for improvement for each of these.

The assignment should include the following:

- **An executive summary.**
- **An introduction (including background on environmental regulation).**
- **Review and critical analysis of your organisation's EMS.**
- **Evaluation of the top three environmental concerns and identification of improvements to be made for each.**
- **Conclusions and recommendations which summarise the main issues identified and lead to justified recommendations.**
- **Bibliography and referencing.**
- **Appendices.**

Practical Assignment Location

The Unit IDEM2 assignment must be carried out in your own workplace. Where you not have access to a suitable workplace, your accredited course provider should be consulted to help in making arrangements for the you to carry out the assignment at suitable premises.

The chosen area must be:

- Accessible to you.
- Sufficiently simple and small to allow you to complete the practical application within approximately three hours.
- You should obtain prior agreement from senior management.

Supervision is not required when carrying out the assignment, but you must sign a declaration that Unit IDEM2 is your own work.

You and your employers should be aware that the status of the report undertaken to fulfil the requirements of Unit IDEM2 is for educational purposes only. It does not constitute an assessment for the purposes of any legislation, regulations, or standards.

Assignment Submission

Assignment reports should be submitted before the set submission date; there are four submission dates each year in February, May, August and November.

The actual dates are published by NEBOSH.

Before submission, you must register through your accredited course provider using the appropriate form and paying the appropriate fee.

Neither your name nor your accredited course provider's name/number should appear anywhere in the assignment.

Following registration, you will receive a pre-submission email which confirms your registration and includes instructions for electronic submission of your assignment.

Assignments must be submitted electronically and by doing so you:

- give permission for the work to be screened by Turnitin UK and understand that it will be added to the Turnitin database; and
- declare that the work is original and does not include work from other sources except where identified by reference.

Cases of plagiarism or collusion will be dealt with severely and are liable to result in the assignment being disqualified and you being banned from future registrations. Any candidate who provides an opportunity for another candidate to use his/her assignment inappropriately shall be liable to the same sanction.

You are strongly advised to keep a copy of your assignment.

Assignment Marking

The Unit IDEM2 assignment is marked by appropriately qualified Examiners appointed by NEBOSH. You must achieve the pass standard (50%) in order to satisfy the criteria for the qualification.

Further Information

Further detailed information regarding Unit IDEM2 including forms and mark schemes will be produced in a separate guidance document for students and accredited course providers available from the NEBOSH website (www.nebosh.org.uk).

A Note from the Author

Students taking the NEBOSH International Diploma in Environmental Management qualification are often very concerned about the assessments that they have to pass at the end of the whole study process.

NEBOSH qualifications are not easy to achieve and each person who passes a qualification does so on their own merits. In some ways, this should be very rewarding and reassuring. It represents one of the times in life when there are no shortcuts.

But, when you are preparing for the end of course assessments, revision and preparation can take up so much of your time and exam nerves can take over.

Students often spend a lot of time and effort preparing for written exams. This is only natural as the written exam is the harder element of the assessment process (at least this is what the published pass rates show). Unfortunately, in their efforts to do well in the written exam, students often push the practical assessment to the back of their thoughts. This can mean that students are poorly prepared to undertake the practical assessment. In some cases, students fail to achieve the 50% minimum pass mark required by NEBOSH for the Environmental Practical Application. This is a great shame as a little preparation can ensure a good performance in this part of the assessment process.

The Practical Application is not easy! You can't assume that you will get a pass without putting in the effort, but with a little preparation and thought there is no reason why you shouldn't do well in it.

And Finally...

Hopefully, this Revision Guide has provided you with relevant practice questions and some ideas for tackling them in the exam, and some helpful guidance for your practical assessment.

It should have shown you that the exam questions are straightforward, but that it is vital that you READ THE QUESTION and answer the question that is written (not the one that you want it to be!).

It is really important to practise as many exam questions as possible - the Examiner's Reports for previous exams are available from NEBOSH (+44(0)116 263 4700 or online at www.nebosh.org.uk). These Examiner's Reports don't provide model answers, but nevertheless highlight important points that should have been included in your answer.

Lastly, don't panic, but do ensure that you are prepared - you want to make sure that all your hard work will be rewarded.

Good luck!