Gary Skinner, Ken Crafer, Melissa Turner and Ann Skinner

Cambridge IGCSE® and O Level

Environmental Management

Workbook

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All questions and sample answers have been written by the authors. Answers to the workbook exercises can be found on the Teacher's Resource CD-ROM.

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Contents

Skills grid

This grid maps the workbook exercises to the Cambridge IGCSE® and O Level Environmental Management assessment objectives.

Assessment objectives	Key skills in Environmental Management	Workbook chapters								
		1	2	3	4	5	6	7	8	9
AO1 Knowledge with understanding										
1 Phenomena, facts, definitions, concepts and theories		1.1, 1.2, 1.5	2.1, 2.2, 2.3, 2.5	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.9, 3.10	4.2, 4.4, 4.5, 4.7, 4.8	5.1, 5.2, 5.3, 5.4	6.1, 6.3, 6.5	7.1, 7.2, 7.3, 7.4, 7.5	8.1, 8.2, 8.3, 8.4	9.1, 9.2, 9.3, 9.5, 9.6
2 Vocabulary, terminology and conventions		1.1, 1.5	2.1, 2.2	3.1, 3.2, 3.5, 3.9, 3.10	4.2, 4.4, 4.5, 4.7, 4.8	5.1, 5.2, 5.4	6.1, 6.3, 6.5	7.1, 7.2, 7.5	8.1, 8.3	9.1, 9.2, 9.5
3 Technological applications with their social, economic and environmental implications.		1.2, 1.3, 1.4	2.2, 2.4, 2.5, 2.6	3.7, 3.8	4.8		6.3	7.1, 7.3		9.6
AO2 Information handling and analysis										
1 Locate, select, organise and present information from a variety of sources	KS.4	1.4	2.2, 2.6	3.1, 3.6	4.8		6.2	7.2, 7.3, 7.4	8.1, 8.3	9.1, 9.3, 9.6
2 Translate information and evidence from one form to another	KS.3, KS.4	1.4	2.2, 2.3, 2.6	3.3, 3.4, 3.6, 3.7	4.3, 4.8	5.1, 5.2	6.2, 6.4	7.2	8.1	9.1, 9.3
3 Manipulate numerical data	KS.5	1.4	2.3, 2.4, 2.6	3.4, 3.6	4.1, 4.8	5.1, 5.3	6.2, 6.3, 6.4	7.2, 7.3, 7.4	8.1, 8.2, 8.3	9.1, 9.3, 9.4, 9.5, 9.6
4 Interpret and evaluate data, report trends and draw inferences.	KS.5		2.3, 2.4, 2.6	3.6, 3.9	4.8	5.2	6.2, 6.4	7.2, 7.4	8.1	9.1, 9.5

→

Assessment objectives	Key skills in Environmental Management	Workbook chapters								
		1	2	3	4	5	6	7	8	9
AO3 Investigation skills and making judgements										
1 Plan investigations	KS.1, KS.2	1.4	2.4	3.4	4.11	5.4	6.5	7.4		9.2
2 Identify limitations of methods and suggest possible improvements	KS.2, KS.6			3.4		5.4	6.5	7.4	8.1	
3 Present reasoned explanations for phenomena, patterns and relationships			2.1, 2.4	3.4, 3.9, 3.10	4.6, 4.7	5.3	6.2, 6.3, 6.4	7.2	8.1	9.1, 9.4, 9.6
4 Make reasoned judgements and reach conclusions based on qualitative and quantitative information.	KS.6	1.3, 1.4	2.4, 2.6	3.1, 3.4, 3.5, 3.9, 3.10	4.2, 4.3, 4.4, 4.6, 4.7, 4.8	5.1, 5.2, 5.4	6.2, 6.3, 6.4	7.2	8.1, 8.4	9.3, 9.4, 9.5, 9.6

Introduction

This book has been written to help you increase your understanding of the topics covered in your Cambridge IGCSE® or O Level Environmental Management course. The exercises in this workbook will give you opportunities to:

- develop your knowledge and understanding of different aspects of the course, including different phenomena, definitions and vocabulary

- practise handling information and solving problems

- develop your investigation and evaluation skills

- practise drawing and interpreting diagrams, including graphs.

Most of the exercises are somewhat different from examination questions. This is because they are designed to help you *develop* your knowledge, skills and understanding.

The Skills grid at the beginning of the book shows how each exercise maps to the course's assessment objectives. The first chapter focuses on developing your investigation and data handling skills. The rest of the chapters put more emphasis on your knowledge and understanding of the course content.

Each exercise starts with an introduction explaining the skills that it will help you to practise. Spaces have been left for you to write your answers. Some of the diagrams are incomplete, and your task will be to complete them.

Chapter 0:
Key skills in Environmental Management

In all IGCSE subjects, certain skills are examined in addition to the knowledge of the content of the syllabus. Science subjects, such as Environmental Management, involve a subset of skills which are dealt with in this chapter. These skills fall into two main categories:

- information handling and analysis
- investigation skills.

The following workbook questions focus on these two groups of skills. In addition, the coursebook questions will very often involve the use of these skills in the context of syllabus topics.

Exercise KS.1 Aims and hypotheses testing, experimental design

> **The aim of the investigation identifies why it is being done. Once the aim has been decided, a hypothesis can be written. To test the hypothesis, scientists will most commonly design an experiment. An experiment is a situation in which one variable (x, the independent variable) is changed and its effect on another variable (y, the dependent variable) is measured. This exercise will help you to improve your understanding of experimental design. It will give you practice in formulating hypotheses.**

1 **a** An investigation has the aim 'to investigate the effects of soil pH on the growth of plants near a mine waste tip'. Suggest a suitable null hypothesis for this investigation.

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b Explain how you could collect data to decide whether the null hypothesis you have written can be accepted or rejected. That is, how would you test your hypothesis?

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c An experiment was carried out and the following results were obtained.
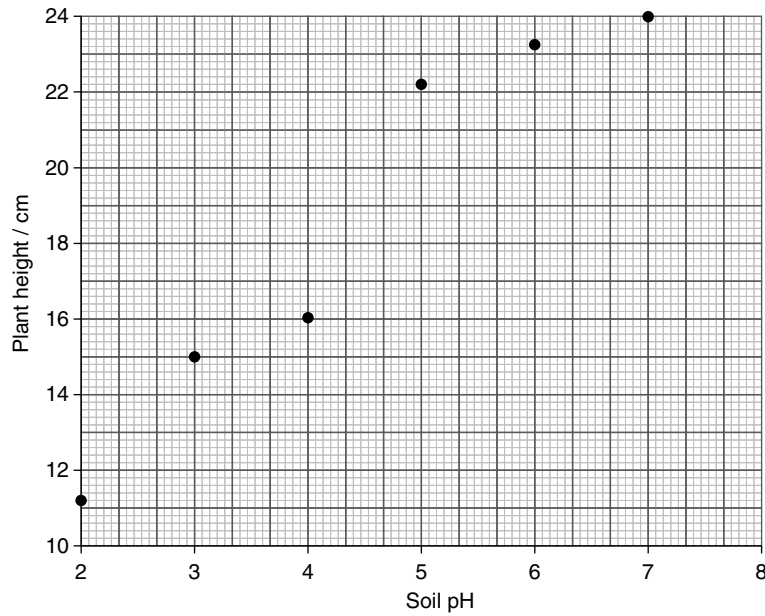
Describe the relationship between pH and plant height, and explain whether you think that the null hypothesis you have suggested in part a will be rejected or accepted in the light of these results.

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2 An agricultural scientist was asked to find out if some heavy-metal pollution, which was getting into the irrigation water on some crop fields, was affecting crop growth. It was decided to do the experiment on plots outside rather than setting it up in pots in the laboratory.

A large field was chosen where no natural heavy-metal pollution was affecting the irrigation water. Four concentrations of the heavy metal were investigated. The field was divided into four plots. A maize crop was grown in each plot. Each plot was irrigated with pure water or water contaminated with the heavy metal. The total mass of maize cobs harvested was measured.

a Suggest an experimental hypothesis for this investigation.

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b In this experiment, state the name of the independent variable and of the dependent variable.

independent variable ....

dependent variable   ....

c Name **two** control variables in this experiment that are to do with the maize crop.

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d Name **two** control variables in this experiment to do with the physical (abiotic) environment in which the maize is growing.

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e Explain how the design of the experiment will ensure, as far as possible, that the variables you have named in part d will be the same in all four plots.

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Exercise KS.2 Collecting data

> Data, in the context of a scientific experiment, will usually be numbers obtained from the experiment. It is important that you know what type of data have been obtained. There are two main types: quantitative and qualitative. Quantitative data can either be discrete or continuous and qualitative data is information that cannot be measured, like peoples' opinions. People's opinions can be expressed through some kind of interview, which can be structured in the form of a questionnaire. This exercise will help to improve your ability to select equipment for a stated purpose and design questionnaires. It will allow you to practise recognising different types of data.

1 The heavy-metal pollutant mentioned in Exercise KS. 1 question 2 (pages 2–3), was also found to be contaminating streams, rivers and lakes in the area. A zoologist was asked to look at the effect of this on fish growth and reproduction. The hypotheses which were tested were:

'the growth rate of fish will be lower in the presence of higher heavy-metal concentrations in the water'

and

'fish will produce fewer eggs in the presence of heavy metal in the water'.

a Explain how you would make the measurements needed to test the first hypothesis.

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b The particular species of fish investigated produced very large numbers of quite small eggs. Counting all of the eggs produced by a single female fish would not be possible. Explain how you could get a good estimate of the total number of eggs being laid by female fish without having to count them all.

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c i Circle the correct description of the data which will be obtained when testing the hypothesis about fish growth.

qualitative continuous   quantitative continuous

qualitative discrete   quantitative discrete

ii Circle the correct description of the data which will be obtained when testing the hypothesis about fish reproduction.

qualitative continuous   quantitative continuous

qualitative discrete   quantitative discrete

2 In a follow-up study, people in the area where heavy-metal pollution occurred were asked about their concerns using a questionnaire.

Here are some of the questions they were asked:

A How concerned are you about the pollution of your water supply with heavy metals?

very concerned   **concerned**   **don't know**   **not concerned**

B Please tell me about any incidents in which you think you were affected by using water polluted with heavy metal.

C How much water do you drink in a day?

< 1 L   **about 1 L**   **> 1 L**

D Who do you blame for the heavy-metal pollution?

a There are two main types of questions in a questionnaire: closed questions and open questions. Which of questions A to D in the questionnaire do you think are open and which are closed?

open questions   ....

closed questions ....

b After the scientist wrote the questions shown, it was decided that the order in which they were asked could be improved. Suggest a better order for these questions and explain your answer.

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c Suggest **two** further questions that could be asked in this questionnaire. One of the questions should be closed and one should be open.

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Exercise KS.3 Recording data

It is important to have a clear and sensible way of recording your data before starting an investigation. This exercise will give you some practice at deciding how to record results.

1 **a** When counting the fish eggs in the investigation described in Exercise KS.2 question 1b (page 4), a tally chart was used. In one square 73 eggs were counted. Write down the tally chart record of this number of eggs.

b In the same investigation, seven concentrations of heavy metal, including zero, were used. The number of eggs laid by five females at each concentration was estimated. A mean number of eggs per female was then calculated. The heavy-metal concentrations were designated 0 to 6. Draw a table in which the results of this experiment could be recorded, together with the calculated mean.

Exercise KS.4 Presenting data

There are many ways of presenting the data collected in an investigation. Ideally, it should be recorded in a table. Once the data is neatly presented in a table, it can be displayed. This will usually be in the form of a graph or chart. This exercise will help you to practise your graph plotting skills. It will also help you to choose which type of graph or chart to use for different kinds of data.

1 a In the investigation described to test the two hypotheses in Exercise KS.2 question 1 (pages 4–5), the data obtained were treated in two different ways. In one case the data were growth rates (expressed as gain in mass per day) and in the other the number of eggs. In both cases the scientist was looking at the effect of heavy-metal concentration on these variables.

There are generally five ways in which you might choose to present data. These are a line graph, a bar chart, a histogram, a pie chart and a scattergraph. State which of these you would use to present the data that were obtained to test the two hypotheses in Exercise KS.2 question 1 (pages 4–5). Explain why you have chosen this method.

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b Another study was done which measured the percentage of various species of fish in which egg laying was reduced by the heavy-metal pollutants. The results are shown in the table.

Category of effect of heavy metal on fish egg laying	Percentage of fish species affected in this category
unaffected	7
slightly affected	23
significantly affected	52
very badly affected	18

State which of the data presentation techniques you would use to display these data. Explain your answer. Give an alternative method that would still be suitable.

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c The data on which this categorisation was based are shown below.

Number of eggs laid as a percentage of the number laid with no heavy-metal pollutant	Number of species laying this percentage of normal number of eggs
100–80	2
<80–60	15
<60–40	17
<40–20	29
<20–0	59

Calculate how many species of fish were investigated.

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d Explain which method of data presentation you would use with the data in part c. Explain your answer.

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Exercise KS.5 Analysing data

When analysing the data you have collected and presented, you should be doing one or more of a number of possible things:

- **looking for trends**

- **looking for patterns**

- **looking for associations**

- **calculating means, modes and/or medians**

- **working out the range.**

This exercise will help you to practise these skills.

1 **a** Look at the diagram below and describe
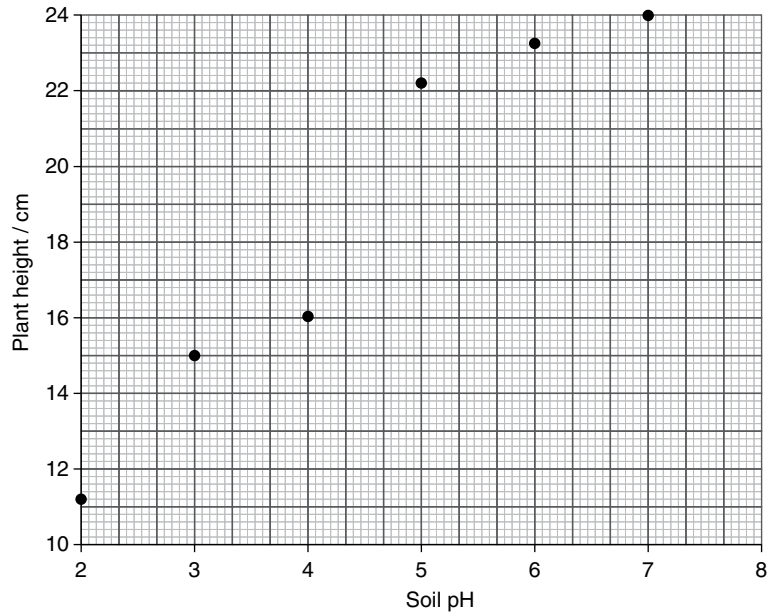
i the trend shown

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ii the patterns shown.

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b In the study in which five females were investigated at each of seven heavy-metal concentrations (see Exercise KS.3, pages 6–7) the following results were found at a heavy-metal concentration of 2.

Female 1: 79 eggs, Female 2: 98 eggs, Female 3: 64 eggs, Female 4: 90 eggs, Female 5: 79 eggs.

Calculate the mean, the median, the mode and the range of these data.

mean   ....

median   ....

mode   ....

range   ....

Exercise KS.6 Drawing conclusions and evaluating

In an experimental investigation, the conclusion usually involves deciding whether the null hypothesis can be rejected or accepted. You should be able to give reasons for the decision you make.

The evaluation involves looking for any problems with the investigation and, most importantly, suggesting how they might be solved. This exercise will give you a chance to practise drawing conclusions and evaluating.

1 a Looking back through all the data in this workbook chapter, explain whether you think it is justifiable to state that the heavy-metal pollution causes a reduction in both the growth rate and reproductive capacity of fish. Give reasons for your decision.

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b Suggest how the experiment which looks at the effect of pH on plant growth (Exercise KS.1, pages 1–3) could be improved and extended.

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Chapter 1:
Rocks and minerals and their exploitation

This chapter covers the following topics:

- how different rock types are formed – the rock cycle
- methods of extracting rocks and minerals
- the impacts of rock and mineral extraction
- managing the impact of rock and mineral extraction
- sustainable use of rocks and minerals.

Exercise 1.1 The rock cycle

> This exercise will help you to understand the basics of the rock cycle, including important terms.

1 Insert these words into the correct spaces on the diagram.

| igneous rocks | sedimentary rocks | weathering |
| metamorphic rocks | transportation | magma |

uplift to surface

deposition, sedimentation

crystallisation

melting

squashing, heating

burial, compression
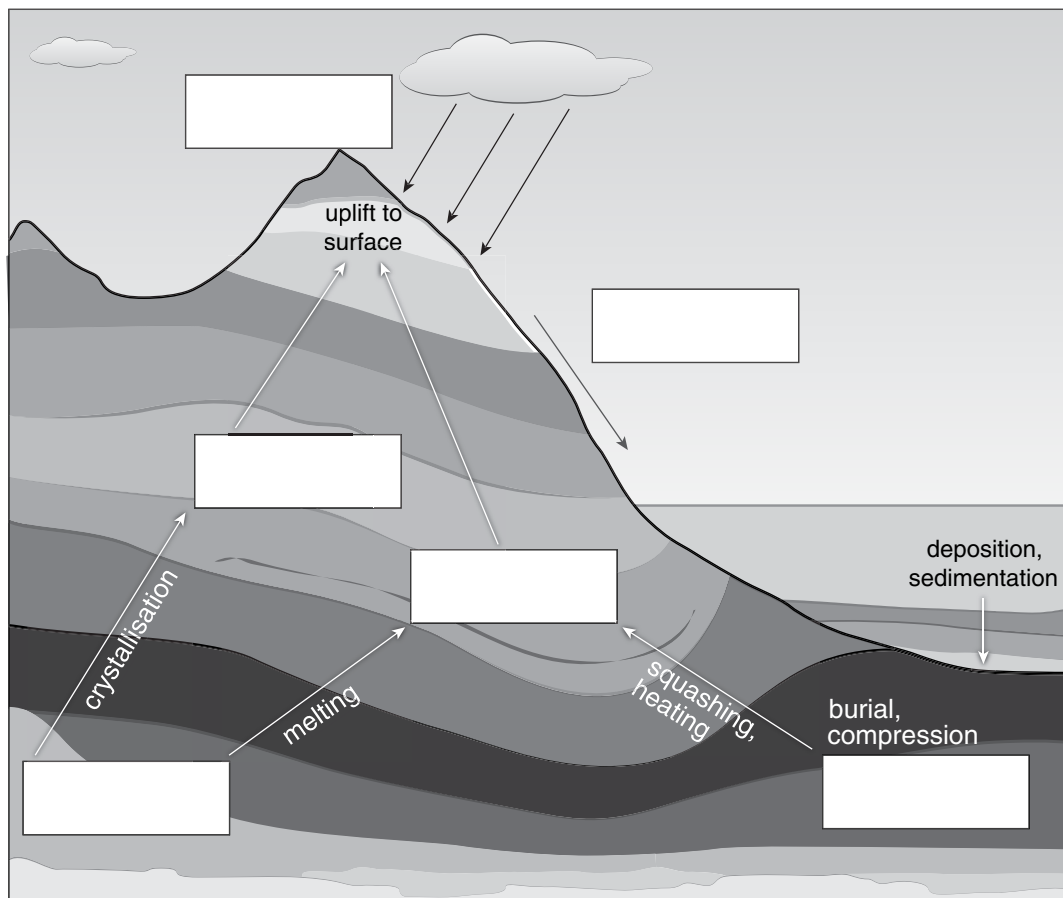
2 Complete this 'Yes/No' decision chart (also known as a key) to allow a young student to be able to find out what rock they are looking at from the list below.

Decision chart

1 Does the rock have lines or strata?   If YES go to 2. If NO go to 3

2 Does the rock have extremely small or invisible grains?   If YES go to 4. If NO go to 5

3 Does the rock contain crystals?   If YES go to 6. If NO go to 7

4

5

6

7

8

9

10

Rock types

| basalt | limestone | sandstone | |
| marble | slate | granite | shale |

3 Draw lines to link the following 'M' words with their correct definitions.

magma	Naturally occurring inorganic substances with a specific chemical composition
mineral	Molten rock below the surface of the Earth
metamorphic	An example of a metamorphic rock
marble	Rocks formed from existing rocks by a combination of heat and pressure

4 Describe how a sedimentary rock forms.

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Exercise 1.2 Extracting rocks and minerals

> **Rocks and minerals are valuable resources: their discovery in the ground and their location will affect the way they are extracted. This exercise will help you to understand these processes.**

1 Describe **three** methods used to search for deposits of minerals that may be found in the Earth.

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2 A new source of minerals has been found. It is decided that the minerals should be extracted from this new source. Explain how the following three factors might affect the way the minerals might be extracted.

Geology

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Environmental impact

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Market price for the minerals

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3 Complete the table to identify the advantages and disadvantages of these different types of mining.

Mine type	Advantages	Disadvantages
Open pit mining		
Strip mining		
Drift mining		
Shaft mining		

Exercise 1.3 The impacts of rock and mineral extraction

This exercise will help you to understand the impacts of rock and mineral extraction on local communities and ecosystems.

The photo shows part of a stone quarry. The quarry produces large blocks of stone that will be carved for important buildings.

1 How might the extraction of this stone be of benefit to the local people?

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2 Describe **three** negative impacts the development of this quarry could have on the local community.

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3 Suggest **three** ways in which the local ecosystem might be affected by the development of the quarry.

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4 The removal of topsoil has resulted in the local extinction of a small flowering plant. Suggest why this loss may be important.

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5 Which of the **four** extraction methods listed in Exercise 1.2 question 3 (page 15), is likely to have the least impact on a rare plant? Give a reason for your answer.

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Exercise 1.4 Managing the impact of rock and mineral extraction

Minerals are a finite resource. Global demand for minerals is increasing, putting additional pressures on habitats and local areas. This exercise will help you to evaluate different ways in which this impact can be managed and will help you to apply these principles to new or unfamiliar scenarios.

1 A mining company has the responsibility to ensure that a mining site is left in good condition once excavation has been completed. This is often planned before a licence will be granted to allow extraction from a site.

Give an evaluation of the suitability of the following proposals for an old site with a large bowl-like crater. Make sure that you include the strengths and weakness of each proposal.

The diagram shows an old mining site which now needs to have another purpose.
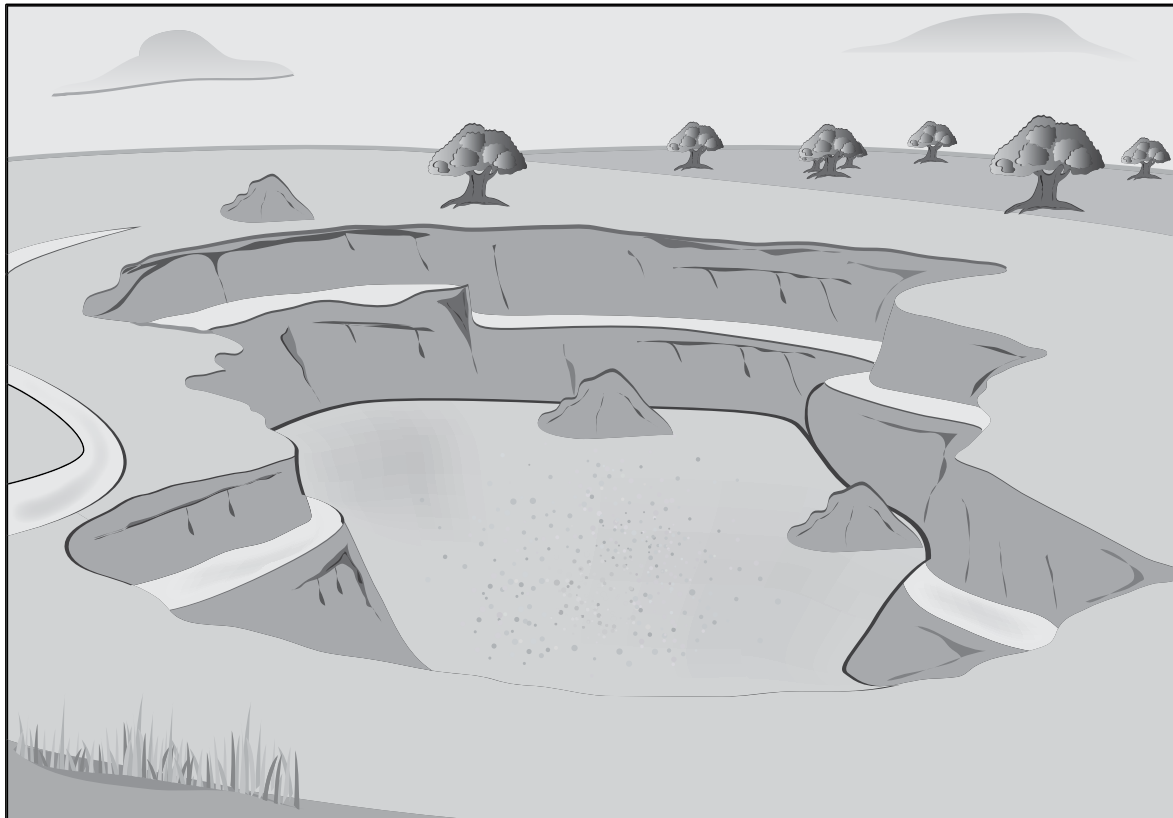
Potential use	Evaluation
Waste disposal site for household waste	
Naturalising the area by planting trees and sowing wild flower seeds	
Conversion of the crater into a race track	
Flood the crater for use as a fish farm	
Develop a shopping centre in the crater	

2 Describe a way the waste from mining activities could be disposed of safely. Describe the checks the mining company should do to ensure that the waste materials are not causing damage to the local environment.

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3 Mining companies will often include tree planting in their plans for the restoration of a site. It is often observed that the growth of these trees is very slow compared to trees planted at other sites.

Suggest reasons why this might be the case.

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4 Tree planting can be labour intensive. In Canada, a company pays $0.11 for each young tree planted as part of its reforestation programme.

How much would a worker earn if they planted 1600 trees per day?

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5 It is estimated that only about 40% of the young trees in question 4 survive for more than 5 years. How many trees will survive for more than 5 years from one worker's day of planting?

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6 A manager plans to look at the survival rate of trees to see whether the percentage could be increased. Outline an investigation that could be done to evaluate whether additional training given to tree planters would have an effect.

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Exercise 1.5 The sustainable use of rocks and minerals

> The price of most rocks and minerals is increasing as the supply is limited and demand is increasing. This exercise will help you to understand many of the key terms and definitions used when describing sustainable use and extraction.

1 Fill in the words in this puzzle to reveal a method that organisations can use to help ensure mineral resources are used appropriately. (Some of the letters in each word have been put in to help you.)

1	E			A	M					N	
2		T		A							
3		A									
4		E	L								
5	R										
6		G		S			T				
7	F			C							

1 The method of collecting, extracting and re-using scrap metal. (11)

2 Removing the useful metal from ore. (7)

3 A widely mined fossil fuel. (4)

4 The percentage of a mineral obtained from the rock. (5)

5 The method of breaking down large rocks into smaller pieces to obtain the minerals. (5)

6 A way that a government can control the use and extraction of minerals. (11)

7 The effective use of extracted minerals. (9)

2 Suggest **four** reasons why the amount of recycled metals used in industry may be less than the amount potentially available.

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3 Give **three** ways a government might ensure that a higher proportion of metals in the home are recycled.

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4 Give **two** reasons why people in certain neighbourhoods might consider an increase in the recycling of metals to be a poor idea.

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Chapter 2:
Energy and the environment

This chapter covers the following topics:

- fossil fuels
- energy resources
- the demand for energy
- conservation and management of energy resources
- impact of oil pollution
- management of oil pollution.

Exercise 2.1 Fossil fuels

> **Understanding the processes that allow fossil fuels to form is fundamental knowledge. This exercise will help to embed the basic concepts in your mind.**

1 Use words from this list to complete the passage about fossil fuels and their formation.

organic	plants	pressure
sediment	ground	coal

Fossil fuels are not actually made from fossils, but it is a useful term to describe the amount of

time it takes to produce them. Fossils fuels are produced from the decay of ....

and animals. These remains formed .... matter that became covered

in layers of ....

Over millions of years, and buried deep in the .... by the addition of further

layers of sediment, the organic material is subjected to high .... and heat.

The precise conditions, and the type of animal and plant material available, will determine whether

...., oil or natural gas is produced.

2 Explain why it is not possible to produce more coal or oil simply by collecting and composting organic waste matter, which is easily available.

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3 Why are fossil fuels normally found buried under deep layers of rock?

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Exercise 2.2 Energy resources

This exercise will help to develop your skills in identifying the type of energy source that is being used. It is important to be able to classify renewable and non-renewable sources correctly.

1 Organise the following energy sources into the columns of the table.

oil	geothermal	hydroelectric	wave
coal	nuclear	tidal	natural gas
wind	solar	biofuels	

Non-renewable energy sources	Renewable energy sources

2 Describe how a wind turbine may be used to produce electricity.

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3 Solar power is often used as an energy generation source. It is also used in the home to provide light. How else might solar energy be used in the home?

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4 Renewable energy schemes are not always popular. Complete the table by giving a reason; economic, social or environmental, why people might not be in favour of a new renewable energy scheme in their area.

Issue	Reason given
Economic	
Social	
Environmental	

Exercise 2.3   The demand for energy

This exercise will help you to explore the factors affecting the demand for energy and how factors such as the world economy have an impact on overall demand. These are complex subjects and will need some careful thought.

1   How will the following changes affect the demand for energy? Tick the correct box for each.

	Increase	Remain the same	Decrease
A change in employment types in a country from farming to industrial			
A downturn in the world economy			
Increased average household wages			
A warmer than expected winter temperature in a temperate country			
The building of a more affordable car in an LEDC			
A law meaning power companies must use more renewable sources of energy			
An increase in population			

2   The table below shows an estimate of the annual amount of power used by twelve countries. To make a fair comparison, the total power used in a country has been divided by the population size. This gives the average power consumption for a citizen of that country. The highest usage would be ranked 1 and the lowest ranked 12.

Country	Power use (average per person)/GJ
Afghanistan	3.78
Angola	30.09
Australia	234.92
Bangladesh	8.77
Belgium	234.59
Cambodia	14.93
India	23.76
Japan	163.73
Qatar	537.58
United Arab Emirates	347.40
United States of America	300.91
Zambia	26.37