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National
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X826/76/01

Environmental Science Paper 1

WEDNESDAY, 22 APRIL

12:45 PM – 1:30 PM



Fill in these boxes and read what is printed below.

Full name of centre

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Town

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Forename(s)

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Number of seat

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Date of birth

Day

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Month

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Year

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Scottish candidate number

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Total marks — 20

Attempt ALL questions.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. You should score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Do not remove any exam materials. You must leave this booklet on your desk; if you do not, you could lose all the marks for this paper.



Total marks — 20
Attempt ALL questions

All coastal countries have an Exclusive Economic Zone (EEZ) that stretches 370 km from their coast. Within their own EEZ, each country has the right to explore and manage the natural resources. Beyond this limit lie international waters, which account for around two-thirds of the World's oceans.

The United Nations Convention on the Law of the Sea (UNCLOS) is an international treaty that establishes a legal framework for all marine and maritime activities. This includes the seawater, known as the water column, and the seabed. The International Seabed Authority (ISA) has responsibility for managing all seabed exploration and mining activities in international waters.

Metallic ore deposits on and in the seabed have been discovered at depths of 4000–6000 m. Polymetallic nodules are the most accessible of these deposits. Forming in deep areas that experience weak ocean currents and no tectonic activity, it is thought that the nodule formation process could be as slow as 1 mm per thousand years. The nodules contain commercially significant amounts of manganese, nickel, copper, and cobalt. These minerals are essential for the manufacture of 'clean energy technologies'. It is estimated that global demand for these minerals could increase by as much as 600% over the coming decades.

The largest known concentration of nodule deposits is found in the Clarion-Clipperton Zone (CCZ) in the Pacific Ocean. Covering approximately 6 million km², the seafloor in the CCZ lies at depths of up to 6000 m. Extraction of the deposits at such depths is known as deep-sea mining.

The ISA is currently developing regulations, backed by science, around deep-sea mining.

The ISA must consider three main conditions before deep-sea mining is permitted: it must be for the benefit of all humanity; it must consider the interests and needs of developing nations; and any mining projects must ensure the absolute protection of the marine environment.

The ISA has granted approval to several mining companies to conduct small-scale exploratory dives in the CCZ. Their aim is to test nodule collection equipment and to assess possible environmental impacts.



1. During Earth's formation, many metallic ore deposits originated from extra-terrestrial impacts.

State the main energy change that occurs as a result of an extra-terrestrial impact.

1

2. **Source B** describes major zones present in the water column, based on depth and light penetration.

Explain the impact that reduced light penetration will have on primary productivity in oceans.

2

3. The ISA has estimated that 36 million tonnes of polymetallic nodules could be collected from the CCZ each year.

One mining company proposes to use a robot to collect the nodules.

Source D shows the steps in the proposed collection process.

- (a) It is estimated that the robot collector could gather 400 tonnes of nodules per hour.

For every tonne of nodules gathered, approximately 5.5 tonnes of sediment will also be gathered.

Around 90% of this sediment will be discharged by the collector.

- (i) Calculate the maximum mass of sediment a robot collector would discharge over 24 hours.

2

Space for working

- (ii) Suggest one reason why the company's estimated nodule collection rate may not be realistic.

1



* X 8 2 6 7 6 0 1 0 3 *

3. (continued)

(b) The mining company must provide the ISA with details of all possible significant environmental effects arising from the planned collection of the nodules.

(i) Name the process that requires a planning authority to be provided with full knowledge of possible significant environmental effects of a proposed development.

1

(ii) As part of this process, the company must also provide details of ways to mitigate the identified impacts.

Describe what is meant by *mitigation*.

1

(iii) The extent and depth of the CCZ means ecological research has been very limited.

During one survey, an area was found to have a 'high species richness but low species density'.

Explain what is meant by this finding.

2

(iv) Sediments discharged by the robot collector will settle to the seabed. Finer sediments suspended in the water will take the longest to settle.

Suggest why finer sediments could be problematic for marine organisms.

1



* X 8 2 6 7 6 0 1 0 4 *

3. (b) (continued)

- (v) The mining company must consider the overall ecological impacts of their proposed operation.

Other than the impact of sediment discharge, describe one possible **ecological** impact that may result from collecting the nodules from the seafloor using the proposed process.

2

- (vi) Opponents believe that there are more sustainable alternatives to the exploitation of marine metallic ores for obtaining the commercially desirable minerals needed for clean energy technologies.

Suggest one way in which current practices could be made more sustainable.

1

4. Source F shows the current supply risk for some minerals used in the renewables sector. These include minerals found in polymetallic nodules.

Suggest why the current supply of cobalt is classed as 'moderate risk', while nickel and copper are 'very low risk'.

1

[Turn over



5. Debate over whether deep-sea mining in international waters should be permitted has been ongoing for many years.

Using information from the sources and your knowledge of environmental science, decide whether deep-sea mining of polymetallic nodules should be permitted in **international waters**.

Justify your decision.

5

☐

Permit deep-sea mining of polymetallic nodules

☐

Do not permit deep-sea mining of polymetallic nodules

[END OF QUESTION PAPER]



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

DO NOT
WRITE IN
THIS
MARGIN



* X 8 2 6 7 6 0 1 0 7 *

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

DO NOT
WRITE IN
THIS
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