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CO-ORDINATED SCIENCES

0654/31

Paper 3 Theory (Core)

May/June 2026

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen. Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m/s^2).

INFORMATION

- The total mark for this paper is 120.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **28** pages.

1 Coordination of the body involves reflex arcs and reflex actions.

Figure 1.1 shows a reflex arc.

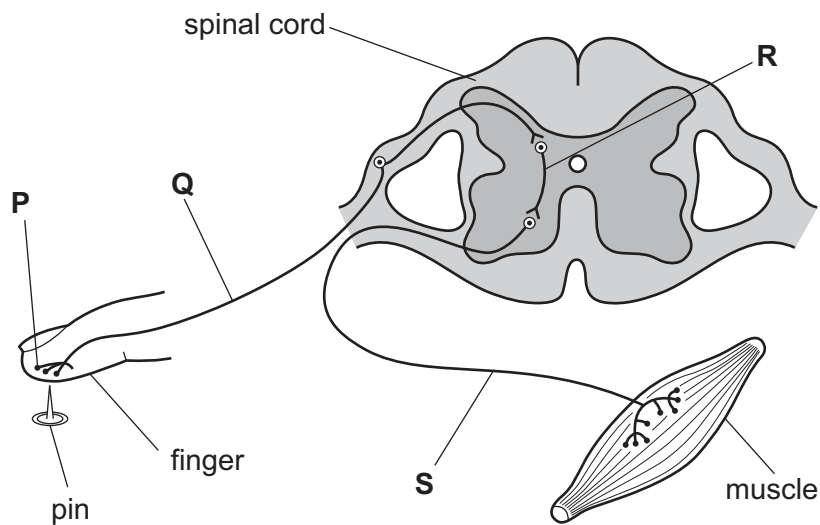


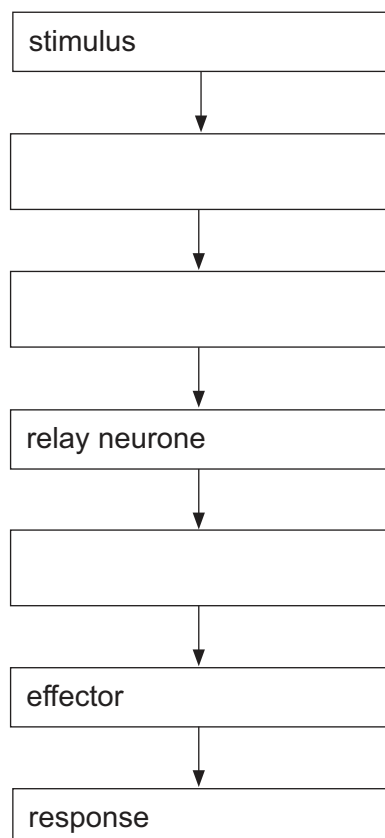
Figure 1.1

- (a) (i) The spinal cord is part of the central nervous system.

State the **other** organ in the central nervous system.

..... [1]

- (ii) Complete the flow chart, using letters **P–S** from Figure 1.1, to describe the reflex arc.



[2]



- (iii) The muscle in Figure 1.1 uses energy to contract and move the finger.

State **two** other uses of energy in living organisms.

1

2

[2]

- (b) (i) Place a tick (✓) in **all** the boxes which describe a reflex action.

automatic

☐

rapid

☐

slow

☐

transports water

☐

uses hormones

☐

[2]

- (ii) The reflex action in Figure 1.1 is a response to pain.

Some substances taken into the body affect the chemical reactions and make the body feel less pain.

Circle the name of this type of substance.

bacteria

carbohydrate

drug

enzyme

[1]

- (c) Sensitivity is one characteristic of living organisms.

Name and describe **two** other characteristics of living organisms.

name 1

description 1

.....

name 2

description 2

.....

[4]



- 2 (a) Eating a balanced diet is important for health.

Describe what is meant by a balanced diet.

.....

.....

..... [2]

- (b) Table 2.1 shows the average daily intake of some different types of food eaten by people living in two countries, **A** and **B**.

Table 2.1

food type	average daily intake in country A/g	average daily intake in country B/g
cereals	381	299
vegetables	153	321
fruits	118	247
dairy	221	698
meat	38	338
eggs	4	43
fish	11	61
fats and oils	20	63
sugar	41	90

- (i) State **two** good sources of fibre shown in Table 2.1.

..... and [1]

- (ii) The recommended average daily intake of meat is 90 g.

Compare the average daily intake of meat in country **B** with the recommended average daily intake.

.....

..... [2]



(iii) Country **A** has a higher risk of individuals developing scurvy than country **B**.

Use Table 2.1 to explain why.

.....

.....

..... [2]

(c) Fish is a good source of protein in the diet.

List **all** the chemical elements that make up proteins.

..... [1]

(d) Not all food ingested is digested and absorbed.

Name the process which is the removal of undigested food from the human body.

..... [1]

[Total: 9]



3 (a) Figure 3.1 shows a leaf.



Figure 3.1

Explain **one** way the shape of leaves is adapted for photosynthesis.

adaptation

explanation

.....

.....

[2]



(b) Figure 3.2 shows a cross-section of the cells in a leaf.

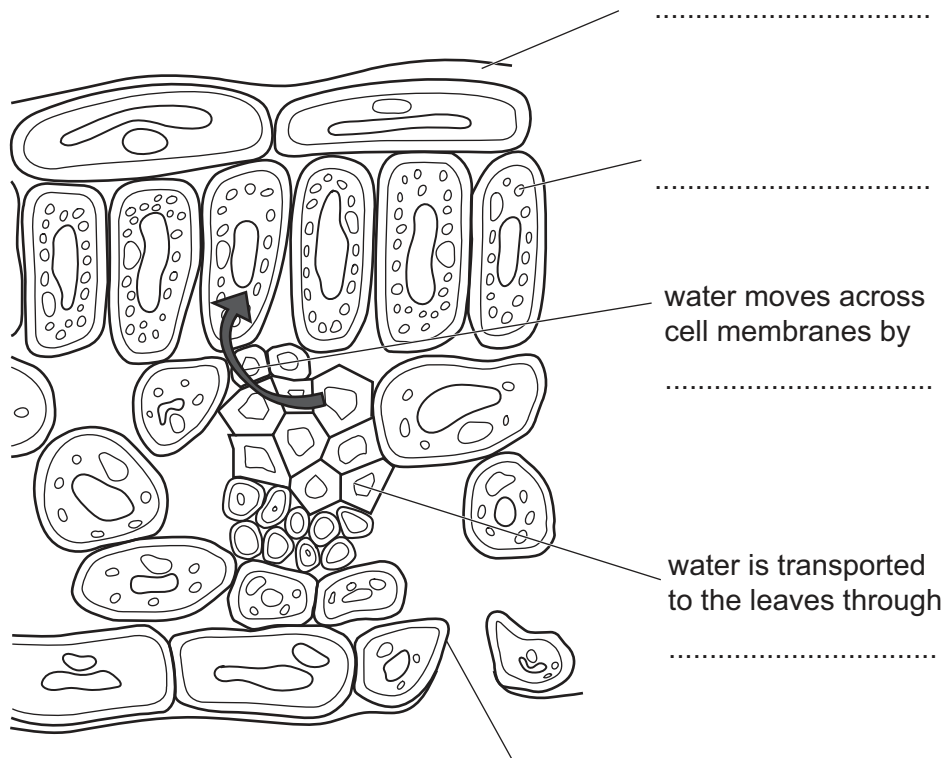


Figure 3.2

Choose words from the list to complete the labels in Figure 3.2.

active transport	chloroplast	cuticle
epidermis	guard cell	osmosis
phloem	stomata	xylem

[5]

(c) Leaves are adapted for gas exchange.

Complete the sentences.

Photosynthesis produces the gas

Gases move through air spaces in the leaf by

[2]

[Total: 9]



- 4 The pupfish is a small fish as shown in Figure 4.1.

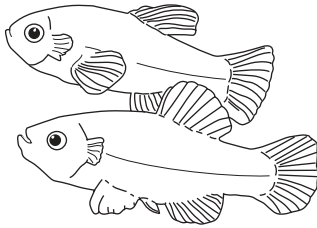


Figure 4.1

There are three different species of pupfish which live in different river systems:

- desert pupfish
- Sonoyta pupfish
- Bighead pupfish.

- (a) The adult desert pupfish is on average 7.2 cm long.

Complete the sentence about body length.

Body length is an example of a phenotype with variation. [1]

- (b) Desert pupfish survive in extremes of pH and temperature.

They survive in water that has a temperature as low as 2°C and as high as 45°C.

- (i) The desert pupfish genes have changed to allow them to survive in extreme conditions.

Complete the sentences to describe the changes to genes.

Choose words from the list.

alleles heterozygous monohybrids mutations offspring

Genetic changes are called

These genetic changes sometimes make new alternative forms of

genes called [2]

- (ii) The desert pupfish have specially adapted enzymes that function in this temperature range.

Describe what is meant by the term enzyme.

.....

 [2]



(c) Some species of pupfish are endangered.

(i) One reason they are endangered is habitat destruction.

Suggest **two** ways in which the pupfish habitat is being destroyed.

1

2

[2]

(ii) One other reason the pupfish are endangered is the introduction of new non-native species of fish into the pupfish habitat.

This is less of a problem where the water is at a high temperature or has an extreme pH.

Suggest why.

.....

.....

..... [1]

(iii) The Santa Cruz pupfish is extinct.

This affects the biodiversity of the area where it lived.

Suggest the effect on biodiversity of the extinction of the Santa Cruz pupfish.

Explain your answer.

.....

.....

..... [2]

[Total: 10]

5 (a) Draw **one** line from each process to its description.

process	description
chromatography	a method used to separate an insoluble solid from water
diffusion	a method using a burette to mix an acid with an alkali
filtration	a technique used to separate mixtures of soluble coloured substances
fractional distillation	the result of the constant random motion of particles
titration	used in the separation of petroleum into useful fractions

[4]

(b) Figure 5.1 shows apparatus used to investigate the rate of reaction between calcium carbonate and dilute hydrochloric acid.

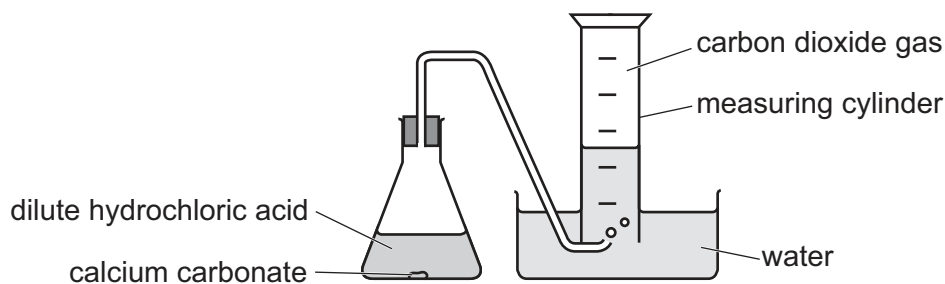


Figure 5.1

The reaction is done three times using the same mass of calcium carbonate and the same volume and concentration of dilute hydrochloric acid.

- Reaction 1 uses 20 small pieces of calcium carbonate.
- Reaction 2 uses 5 medium pieces of calcium carbonate.
- Reaction 3 uses 1 large piece of calcium carbonate.

A student measures the time taken for each reaction to finish.

The three times recorded are 200 s, 100 s and 50 s.



- (i) Complete Table 5.1 to match the time taken for each reaction to finish with the reaction number.

Table 5.1

time taken for reaction to finish/s	reaction number
200	
100	
50	

[1]

- (ii) In all three reactions, 96 cm^3 of carbon dioxide gas is collected.

Calculate the rate at which carbon dioxide gas is collected in the reaction that finished at 50 s.

rate = ... cm^3/s [1]

- (iii) Describe the effect, if any, on the time taken for the reactions to finish if the concentration of the hydrochloric acid is increased.

.....
 [1]

- (c) Carbon dioxide gas is an acidic oxide.

Explain why carbon dioxide is an acidic oxide and **not** a basic oxide.

.....
 [1]

- (d) Calcium is in Group II and Period 4 of the Periodic Table.

- (i) Describe the change in metallic character of the elements across Period 4 of the Periodic Table.

.....
 [1]

- (ii) State the number of electrons in the outer shell of a calcium atom.

number of electrons = ... [1]

[Total: 10]

[Turn over]



- 6 (a) Draw the displayed formula of a molecule of methane, CH₄.

[2]

- (b) State the type of chemical bonding in a molecule of methane.

[1]

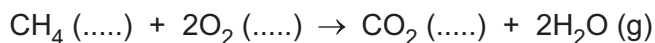
- (c) Methane is an alkane.

An alkane is a saturated hydrocarbon.

State how a saturated hydrocarbon differs from an unsaturated hydrocarbon.

[1]

- (d) The equation for the complete combustion of methane is shown.



- (i) Complete this equation by giving the state symbols.

[1]

- (ii) During this reaction, thermal energy is transferred to the surroundings.

State the name of the type of reaction that occurs during the complete combustion of methane.

[1]



(e) Methane is an air pollutant.

(i) State **one** effect of higher levels of methane in the atmosphere.

.....
..... [1]

(ii) The combustion of methane reduces the amount of methane but increases the amount of carbon dioxide in the atmosphere.

Describe **one** other strategy to reduce the amount of methane being released into the atmosphere.

.....
..... [1]

(f) Carbon and hydrogen are elements.

Methane is a compound.

Using only the words **elements** and **compounds**, complete the sentences.

..... are made from just one type of atom.

..... are made when two or more different are
chemically bonded together.

[1]

[Total: 9]

- 7 (a) Ice is a solid, water is a liquid and steam is a gas.

Figure 7.1 shows four changes of state, **A**, **B**, **C** and **D**.

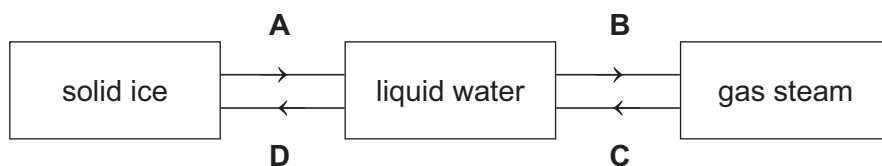


Figure 7.1

State the name given to each of the **four** changes of state **A**, **B**, **C** and **D**.

A

B

C

D [2]

- (b) A student measures the melting point of a sample of sea water.

The student finds that the melting point is between -2°C and -3°C .

State why the melting point is **not** 0°C .

.....

..... [1]



- (c) The treatment of the domestic water supply uses four processes: sedimentation, filtration, use of carbon and then chlorination.

Describe the purpose of **three** of these processes.

sedimentation

.....
.....

use of carbon

.....
.....

chlorination

.....
.....

[3]

- (d) State the colour change observed when water is added to anhydrous cobalt(II) chloride.

from to

[2]

- (e) Iron rusts when exposed to water and a gaseous element.

Name this element.

..... [1]

- (f) State the names of the **two** gaseous elements used in a fuel cell to produce electricity with water as the only chemical product.

..... and [1]

[Total: 10]

- 8 (a) The formula of sulfuric acid is H_2SO_4 .

Calculate the relative molecular mass M_r of sulfuric acid.

$[A_r : \text{H}, 1; \text{O}, 16; \text{S}, 32]$

relative molecular mass $M_r = \dots\dots\dots$ [2]

- (b) Figure 8.1 shows the electrolysis of dilute sulfuric acid using inert electrodes.

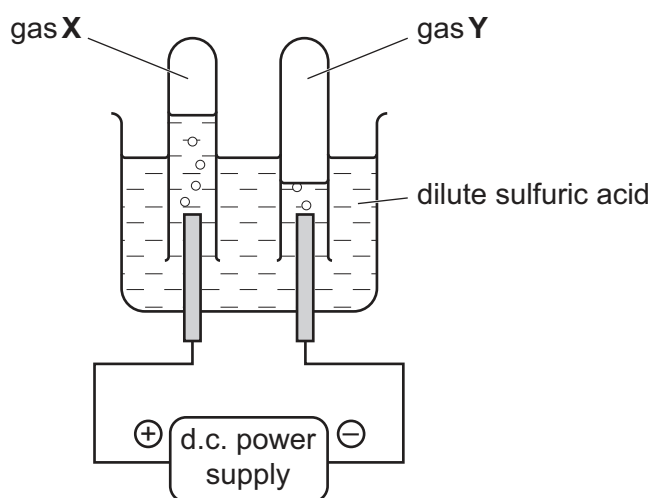


Figure 8.1

- (i) Identify gas X and gas Y.

gas X

gas Y [2]

- (ii) State the name of the negative electrode.

..... [1]

- (iii) Suggest a suitable material for use as the inert electrodes.

..... [1]



(c) Dilute sulfuric acid reacts with some metals.

(i) Suggest the pH of dilute sulfuric acid.

pH = ... [1]

(ii) Dilute sulfuric acid reacts with magnesium to produce magnesium sulfate and a gas.

This gas makes a squeaky pop with a lighted splint.

Construct the word equation for this reaction.

..... + ... → + ... [2]

(iii) State the name of **one** metal that does **not** react with dilute sulfuric acid.

Explain your answer with reference to the reactivity series.

metal

explanation

..... [2]

[Total: 11]

9 (a) Five different types of power stations that generate electrical power are listed.

- A geothermal
- B fossil fuel
- C hydroelectric
- D tidal
- E wind

(i) Identify **two** types of power station that use a renewable energy source.

..... and [1]

(ii) Identify **one** type of power station that produces carbon dioxide when generating power.

..... [1]

(b) State the name of the process by which energy is obtained in a nuclear power station.

..... [1]

(c) The radioactive isotope strontium-90 is produced in a nuclear power station.

(i) A sample of strontium-90 has a mass of 2.0 g.

The half-life of strontium-90 is 29 years.

Calculate the mass of strontium-90 remaining after 116 years.

mass = ... g [2]

(ii) Strontium-90 decays by β -emission.

State the charge on a β -particle.

..... [1]



- (iii) Use the words **electron**, **neutron** and **proton** to complete the sentence describing the change in the nucleus that occurs during β -emission.

One changes into one and one [1]

- (iv) State the names of **two** other types of radiation emitted when radioactive isotopes decay.

..... and [1]

- (d) Radioactive materials are stored at a nuclear power station.

Suggest how the radioactive materials are stored safely.

.....
..... [1]

[Total: 9]

10 (a) Figure 10.1 shows an aircraft moving along a runway.

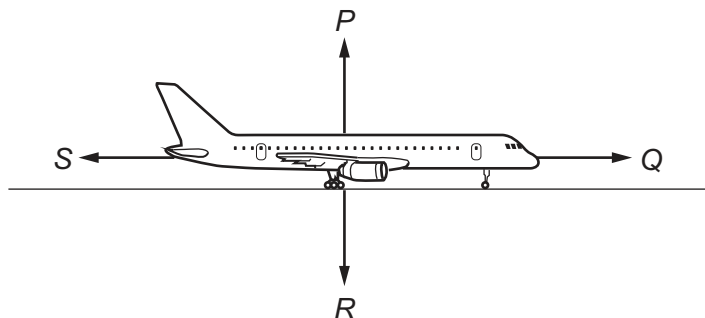


Figure 10.1

Four forces, P , Q , R and S , acting on the aircraft are shown.

(i) State which force, P , Q , R or S , is the weight of the aircraft.

force

[1]

(ii) The aircraft accelerates when force Q is greater than force S .

Explain why.

.....

..... [1]

(iii) The weight of the aircraft is 2 500 000 N.

Calculate the mass of the aircraft.

mass = ... kg [2]



- (iv) The aircraft has 14 tyres.

Each tyre has an area of 0.050 m^2 in contact with the ground when the aircraft is on the runway.

The aircraft is **not** moving.

Calculate the pressure exerted by the aircraft on the runway.

pressure = ... N/m^2 [3]

- (b) During a flight, the average speed of the aircraft is 195 m/s .

- (i) Show that the average speed of the aircraft is about 700 km/h .

[1]

- (ii) The aircraft travels at this speed for a distance of 5400 km .

Calculate the time taken, in hours, to travel this distance.

time = ... hours [2]

[Total: 10]



- 11 (a) Figure 11.1 shows a cooking hob with two hotplates.

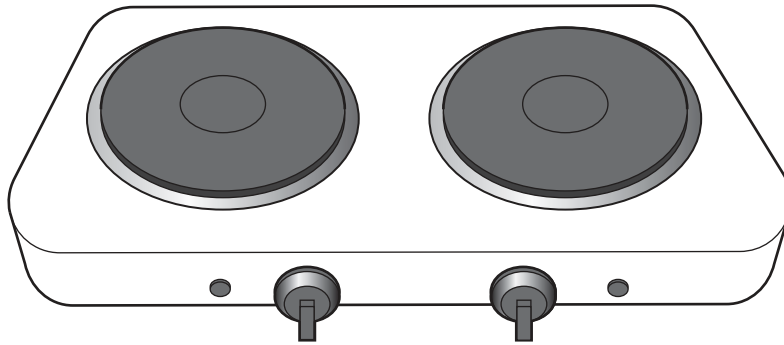


Figure 11.1

The two hotplates are connected in parallel with each other across an a.c. power supply.
Each hotplate has a separate switch.

- (i) Draw the circuit diagram.

Use the symbol for a heater for each hotplate.

[3]

- (ii) Each hotplate has a resistance of $50\ \Omega$.

One value in the list is the correct value for the combined resistance of the two hotplates connected in parallel.

Circle this value and explain your answer.

25 Ω **50 Ω** **100 Ω** **2500 Ω**

explanation

.....

[2]



(b) Figure 11.2 shows water in a steel saucepan being heated by a hotplate.

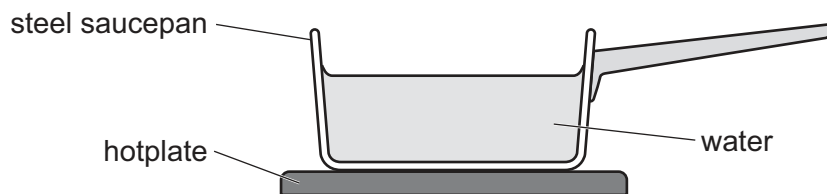


Figure 11.2

The water boils, and some of the water changes to steam.

(i) State the main method of thermal energy transfer through:

the saucepan

the water.

[2]

(ii) State the boiling point of water at standard atmospheric pressure.

boiling point = ... °C [1]

(iii) Figure 11.3 shows the three ways that particles are arranged in a solid, in a liquid and in a gas.

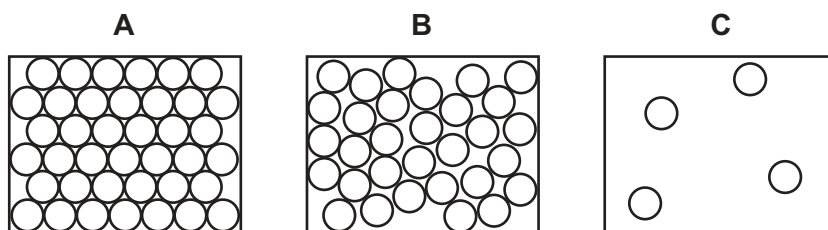


Figure 11.3

Identify the diagram that represents:

liquid water

gaseous steam.

[1]



- (c) The saucepan is made from steel.

State **one** difference between the magnetic properties of magnets made from steel and magnets made from soft iron.

.....

.....

..... [1]

- (d) The mass of steel used to make the saucepan is 0.60 kg.

The volume of the steel used to make the saucepan is $7.6 \times 10^{-5} \text{ m}^3$.

Calculate the density of steel.

density = ... kg/m^3 [2]

[Total: 12]





Turn over



- 12 (a) A student sits on a beach on a sunny day.

The student is exposed to radiation emitted by the Sun.

The Sun radiates most of its energy in three regions of the electromagnetic spectrum.

Ultraviolet is one of the three regions.

- (i) State the **two** other regions of the electromagnetic spectrum in which the Sun radiates most of its energy.

1

2 [2]

- (ii) Describe **one** harmful effect on people of excessive exposure to ultraviolet radiation.

.....

..... [1]

- (iii) State **one** useful application of ultraviolet radiation.

.....

..... [1]

- (iv) Place ultraviolet radiation into the incomplete electromagnetic spectrum shown in Figure 12.1.

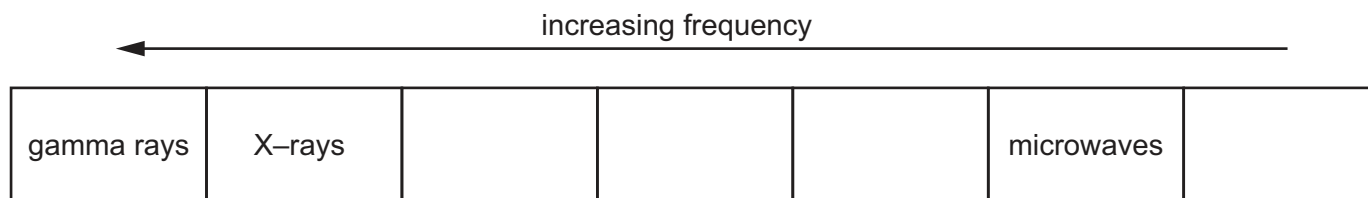


Figure 12.1

[1]



(b) The student watches the waves on the sea.

Figure 12.2 shows a displacement-distance graph for a water wave on the sea.

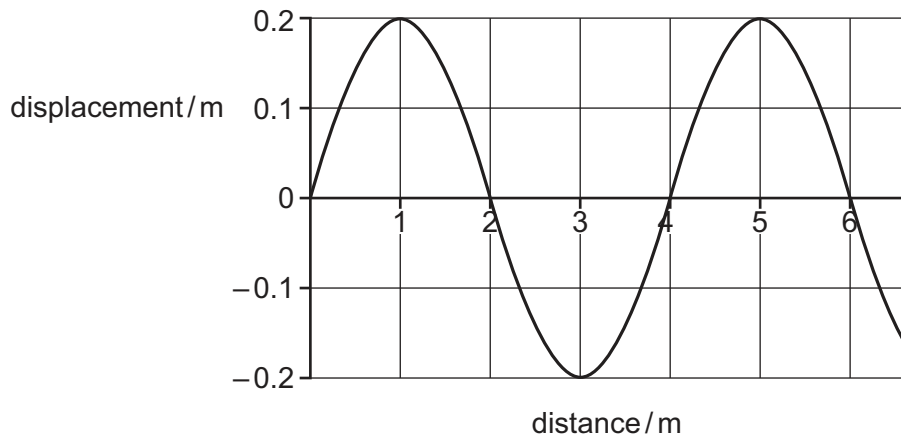


Figure 12.2

(i) Determine the amplitude and wavelength of the wave.

amplitude = ... m

wavelength = ... m
[2]

(ii) The water in the sea is warmed by the Sun.

Some water molecules evaporate.

Complete the sentence to describe the process of evaporation.

Evaporation is the escape of the more particles
from the of a liquid.

[2]

[Total: 9]

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The Periodic Table of Elements

Group											
I	II										

lanthanoids

57	La	lanthanum	139	58	Ce	cerium	140	59	Pr	praseodymium	141	60	Nd	neodymium	144	61	Pm	promethium	–	62	Sm	samarium	150	63	Eu	euroium	152	64	Gd	gadolinium	157	65	Tb	terbium	159	66	Dy	dysprosium	163	67	Ho	holmium	165	68	Er	erbium	167	69	Tm	thulium	169	70	Yb	ytterbium	173	71	Lu	lutetium	175
89	Ac	actinium	–	90	Th	thorium	232	91	Pa	protactinium	231	92	U	uranium	238	93	Np	neptunium	–	94	Pu	plutonium	–	95	Am	americium	–	96	Cm	curium	–	97	Bk	berkelium	–	98	Cf	californium	–	99	Es	einsteinium	–	100	Fm	fermium	–	101	Md	mendeleevium	–	102	No	nobelium	–	103	Lr	lawrencium	–

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

