Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

CO-ORDINATED SCIENCES **0654/31**

Paper 3 Theory (Core) **May/June 2023**

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 or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

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 **32** pages. Any blank pages are indicated.

[Turn over

1 **(a)** Fig. 1.1 is a diagram of the alimentary canal and associated organs.

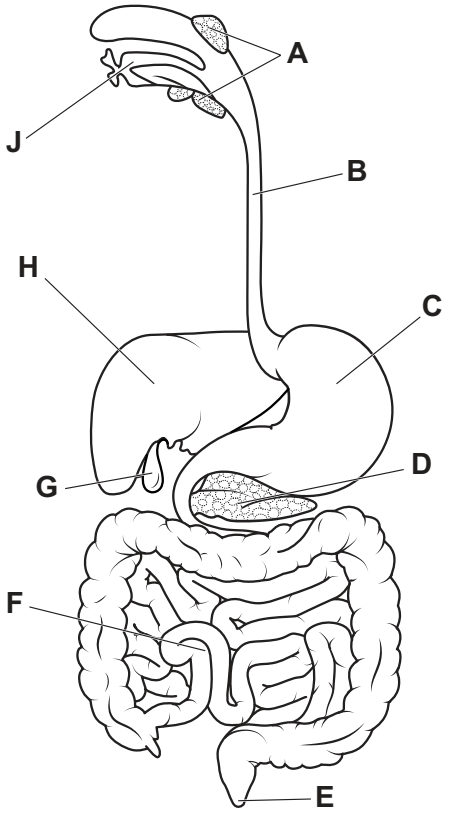

Fig. 1.1

(i) State the letter in Fig. 1.1 that identifies where:

most absorption occurs .....

egestion occurs .....

ingestion occurs .....

saliva is produced. .....

[4]

(ii) State the names of the parts labelled **D** and **H** in Fig. 1.1.

D .....

H .....

[2]

(iii) Complete the sentence to define the term digestion.

Digestion is the ..... of large, insoluble food molecules into small, water-soluble molecules using mechanical and ..... processes.

[2]

(b) The boxes on the left show some nutrients.

The boxes on the right show some principal sources of nutrients.

Draw **one** straight line from each nutrient to its principal source.

nutrient	principal source
	tuna fish
carbohydrate	
	grapefruit
vitamin C	
	rice

[2]

(c) Describe the dietary importance of iron.

.....

..... [1]

[Total: 11]

2 **(a)** **(i)** An iron nail rusts when it is exposed to damp air.

Rusting involves the oxidation of iron.

State what is meant by the term oxidation.

.....

..... [1]

(ii) Describe **one** method used to prevent the iron nail from rusting.

Explain how this method prevents the iron nail from rusting.

method .....

.....

explanation .....

.....

[2]

(b) Complete the sentence.

Metal ores are a finite resource and therefore, metals need to be ..... . [1]

(c) Iron is a transition element.

Put a tick (✓) in the boxes next to **all** the correct statements about iron.

iron acts as a catalyst	☐
iron forms coloured compounds	☐
iron has a low density	☐
iron has a low melting point	☐
iron is brown in colour	☐

[2]

(d) Steel is an alloy of iron.

(i) Suggest why steel is used for making cars instead of pure iron.

.....

..... [1]

(ii) Table 2.1 shows the percentage composition of stainless steel.

Table 2.1

element	percentage by mass in the alloy / %
carbon	1
chromium	18
iron	
manganese	2
molybdenum	2
nickel	12

Calculate the mass of iron contained in 80 kg of stainless steel.

mass of iron = ... kg [2]

(e) Iron is malleable.

State the meaning of malleable.

.....

..... [1]

[Total: 10]

3 (a) (i) Fig. 3.1 shows a skier standing on the snow.

Fig. 3.1

When she stands on the snow without her skis, she sinks into the snow.

When she wears her skis, she can stand on the snow without sinking.

Explain these observations.

.....

.....

..... [2]

(ii) The skier makes a sound near a high wall.

The sound travels through the air as a wave.

The skier hears an echo.

State what happens to the sound wave at the high wall to cause an echo to be heard.

..... [1]

(b) Fig. 3.2 shows the forces acting on the skier on level snow when she is travelling in a snowmobile.

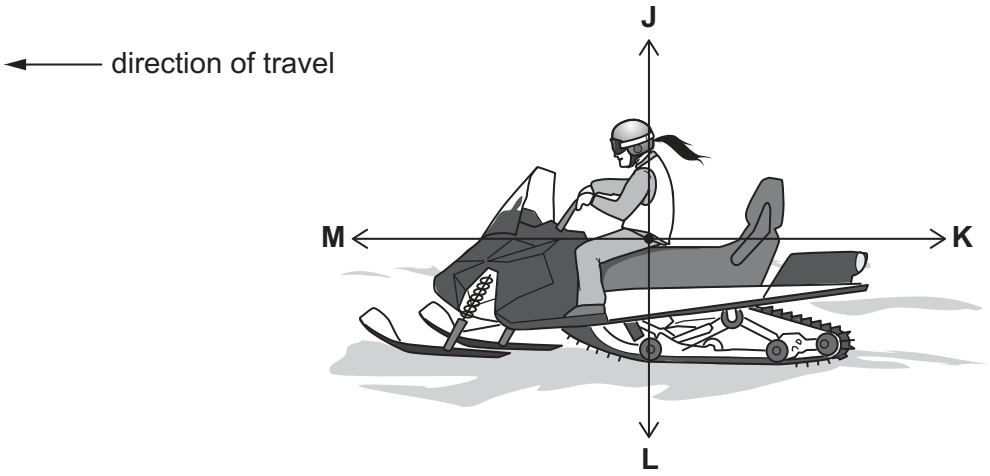

Fig. 3.2

(i) State which force, **J**, **K**, **L** or **M**, is the weight of the snowmobile and skier.

..... [1]

(ii) State which force, **J**, **K**, **L** or **M**, is the friction force acting on the snowmobile.

..... [1]

(c) Fig. 3.3 shows the speed–time graph for the motion of the skier.

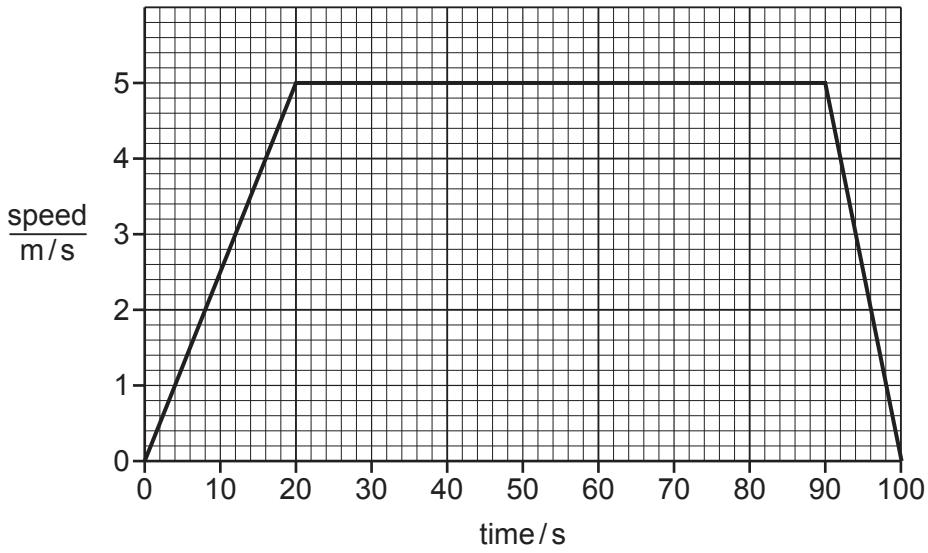

Fig. 3.3

(i) State the maximum speed of the skier.

speed = ... m/s [1]

(ii) The skier is accelerating during the first 20 s of her journey.

Describe how the graph shows that the skier is accelerating.

.....

..... [1]

(iii) Show that the distance travelled by the skier during the first 20 s is 50 m.

[1]

(d) The skier is exposed to ultraviolet radiation from the Sun.

Ultraviolet radiation is a form of ionising radiation.

Describe **one** danger to humans of being exposed to large quantities of ultraviolet radiation.

.....

..... [1]

[Total: 9]

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4 **(a)** Fig. 4.1 shows some different sources of pollution of the water in seas.

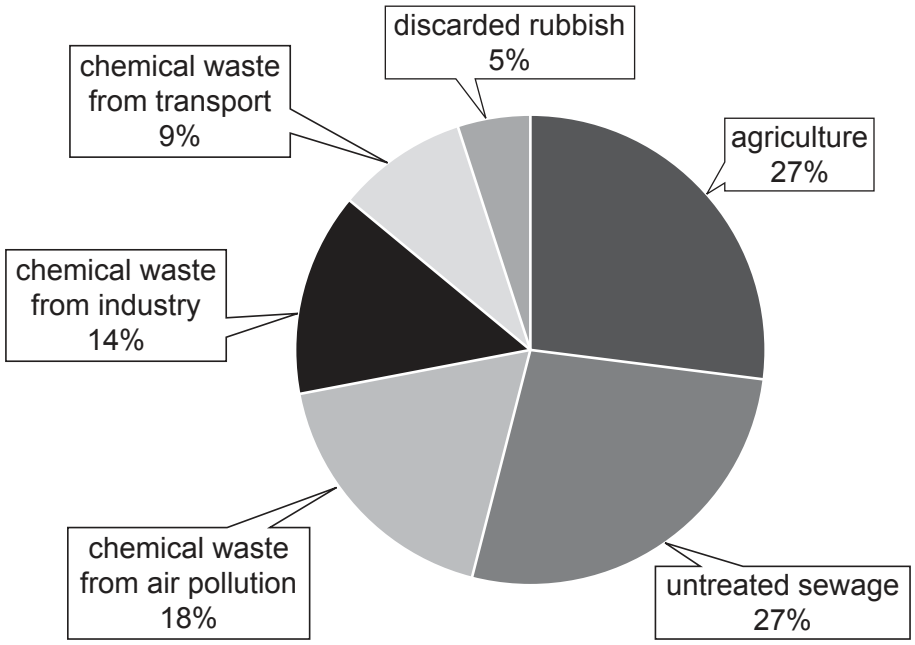

Fig. 4.1

(i) Complete the sentences using information from Fig. 4.1.

The two biggest sources of pollution are ..... and

..... .

The total percentage of pollution caused by chemical waste is

..... %.

The percentage of pollution caused by discarded rubbish is

..... %.

[3]

(ii) Suggest **one** negative impact of untreated sewage on humans.

.....

..... [1]

(b) Polluted water affects the growth of plants.

A scientist measures the height of two pea plants, **A** and **B**, for one month.

Plant **A** is given unpolluted water.

Plant **B** is given polluted water.

Table 4.1 shows the increase in height for each plant.

Table 4.1

plant	type of water	increase in height / cm
A	unpolluted	29
B	polluted	11

(i) Calculate the difference in increase in height between plant **A** and plant **B** from Table 4.1.

..... cm [1]

(ii) Water is needed for germination of seeds.

State two other environmental conditions required for germination.

1 .....

2 .....
[2]

[Total: 7]

5 **(a)** Substances are separated from mixtures of substances using different methods.

Draw **one** straight line from each substance to the correct method of separating it from the mixture.

One line has been drawn for you.

substance separated from the mixture	method of separation
blue dye from black ink	chromatography
gas oil from petroleum	crystallisation
salt from salt water	distillation
sand from sand and water	filtration
water from salt water	fractional distillation

[3]

(b) One reason for separating mixtures is to purify substances.

Explain the importance of purity in the manufacture of substances used in food additives.

.....

..... [1]

(c) The element lead is obtained from the compound lead(II) bromide by electrolysis.

(i) Describe the difference between an element and a compound.

.....

.....

..... [1]

(ii) Complete the sentences to describe the electrolysis of lead(II) bromide.

Electrolysis is the breakdown of molten lead(II) bromide

by the passage of ..... .

The gas released at the positive electrode is ..... and

..... is formed at the negative electrode.

The negative electrode is called the ..... .

[3]

(d) A student reacts dilute hydrochloric acid with four metals.

The student's observations are shown in Table 5.1.

Table 5.1

metal	observation
calcium	reacts very quickly
copper	does not react
lead	reacts very slowly
magnesium	reacts quickly

Place the four metals in order of their reactivity from the most reactive to the least reactive.

..... most reactive

.....

.....

..... least reactive

[2]

[Total: 10]

6 **(a)** **(i)** Complete the sentences to describe the energy changes that occur during the generation of electricity in a nuclear power station.

Nuclear fission releases ..... energy which heats up water in a boiler.

When the turbine and generator are turning, they have ..... energy.

The generator produces ..... energy.

[3]

(ii) Nuclear fission occurs in the nuclear power station.

State what happens to the nucleus of an atom during nuclear fission.

..... [1]

(b) The radioactive decay of plutonium-239 produces an isotope of uranium, uranium-235.

$$\text{plutonium-239} \longrightarrow \text{uranium-235} + \alpha\text{-particle}$$

(i) State the charge on an α-particle.

..... [1]

(ii) Describe how the numbers of protons and neutrons change in the nucleus of a plutonium-239 atom when it emits an α-particle.

protons .....

neutrons .....

[2]

(iii) The half-life of plutonium-239 is 24 000 years.

A sample of nuclear fuel contains 6.0 g of plutonium-239.

Calculate the mass of plutonium-239 remaining after 72 000 years.

mass = ... g [3]

[Total: 10]

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7 **(a)** Fig. 7.1 is a drawing of a cross-section of a leaf.

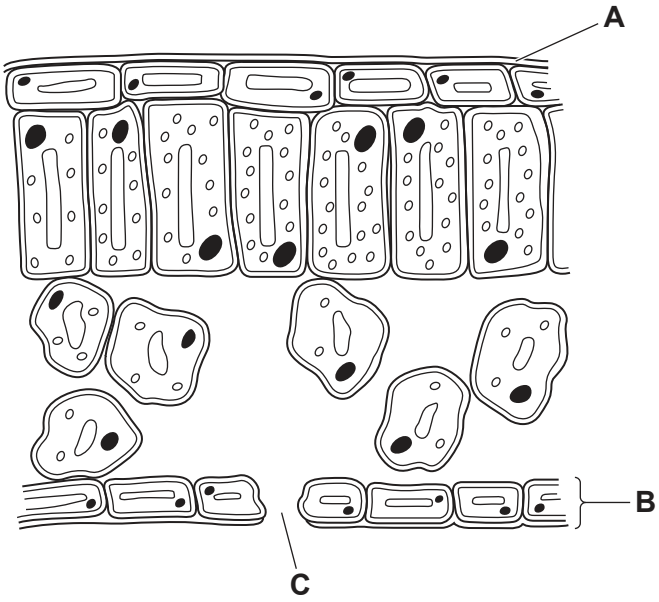

Fig. 7.1

State the names of the parts labelled **A**, **B** and **C** in Fig. 7.1.

A .....

B .....

C .....

[3]

(b) Fig. 7.2 is a cell from the palisade mesophyll layer of the leaf.

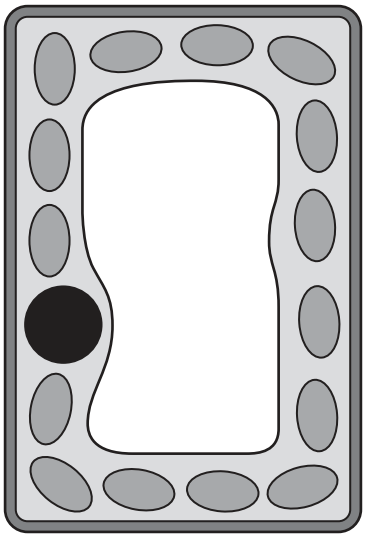

Fig. 7.2

On Fig. 7.2:

- Identify the part where photosynthesis takes place with a label line and the correct name.
- Identify the part that contains the genetic material with a label line and the letter **X**.

[3]

(c) Describe the process of photosynthesis.

.....

.....

.....

.....

..... [3]

(d) Plants need nitrate ions to make an important substance.

Circle the name of this substance.

amino acid **fatty acid** **starch**

glycogen **glycerol**

[1]

(e) State the name of the cell that absorbs mineral ions in a plant.

..... [1]

(f) State the name of the vessels that transport mineral ions in the stem.

..... [1]

[Total: 12]

8 **(a)** **(i)** Complete the dot-and-cross diagram in Fig. 8.1 to show the bonding in a molecule of methane, CH_4.

Show only the outer-shell electrons.

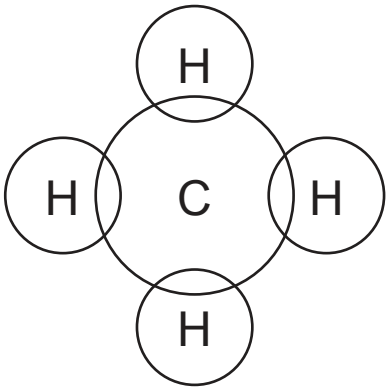

Fig. 8.1

[2]

(ii) State the name of the type of chemical bonding present in a molecule of methane.

Explain your answer.

type of chemical bonding .....

explanation .....

.....

[2]

(b) Complete the word equation for the complete combustion of methane.

methane + ... → ..... + ...

[2]

(c) **(i)** State the name of the pollutant gas produced during the **incomplete** combustion of methane.

..... [1]

(ii) State **one** adverse effect of the gas you have named in **(c)(i)** on the health of humans.

..... [1]

[Total: 8]

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9 Fig. 9.1 shows a washing machine.

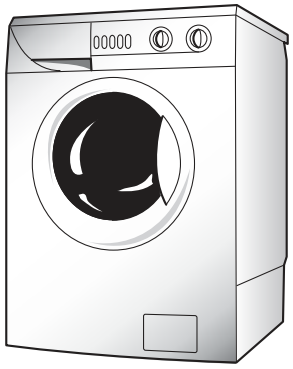


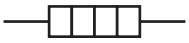
Fig. 9.1

(a) (i) The washing machine uses:

- a heater to heat the water
- a motor to pump the hot water through the machine.

The motor and the heater are connected in a parallel circuit.

The motor and the heater are each operated by separate switches.

The circuit symbol for a heater is 

The circuit symbol for a motor is 

Fig. 9.2 shows an incomplete circuit diagram for the washing machine.

Complete the circuit diagram on Fig. 9.2.

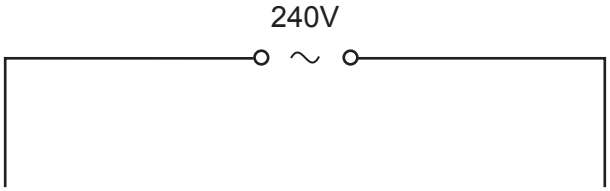


Fig. 9.2

[3]

(ii) The resistance of the heater is 20 Ω.

The resistance of the motor is 80 Ω.

Identify from the list the most likely value for the combined resistance of the heater and motor connected in parallel.

Explain your answer.

16 Ω 20 Ω 50 Ω 80 Ω 100 Ω

combined resistance = ... Ω

explanation .....

.....

[2]

(iii) The current in the wires of the electrical circuit is a flow of charged particles.

State the name of the particles that flow in the wires of the electrical circuit.

..... [1]

(iv) The current-carrying coil in the motor experiences a turning effect.

This turning effect can be increased by increasing the number of turns on the coil.

State two other ways to **increase** this turning effect.

1 .....

2 .....

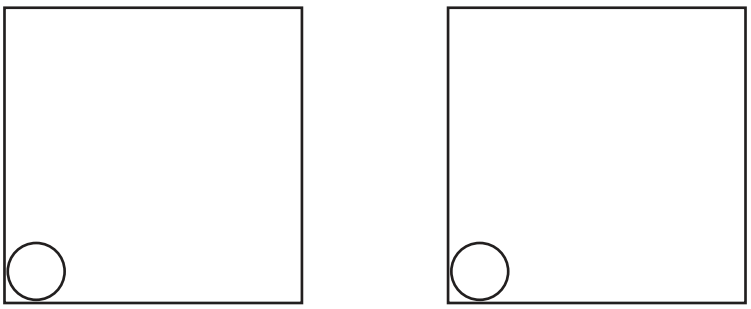
[2]

[Turn over

(b) Inside the washing machine, some of the water evaporates.

During evaporation, water changes state from a liquid to a gas.

(i) Complete the diagrams in Fig. 9.3 to show the arrangement and separation of molecules in a liquid and in a gas.



liquid gas

Fig. 9.3

[2]

(ii) During evaporation, the water does not boil.

State the boiling point of water.

..... °C [1]

[Total: 11]

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10 **(a)** A person touches a hot pan and instantly removes their hand.

This is a reflex action.

The reflex arc is shown in Fig. 10.1.

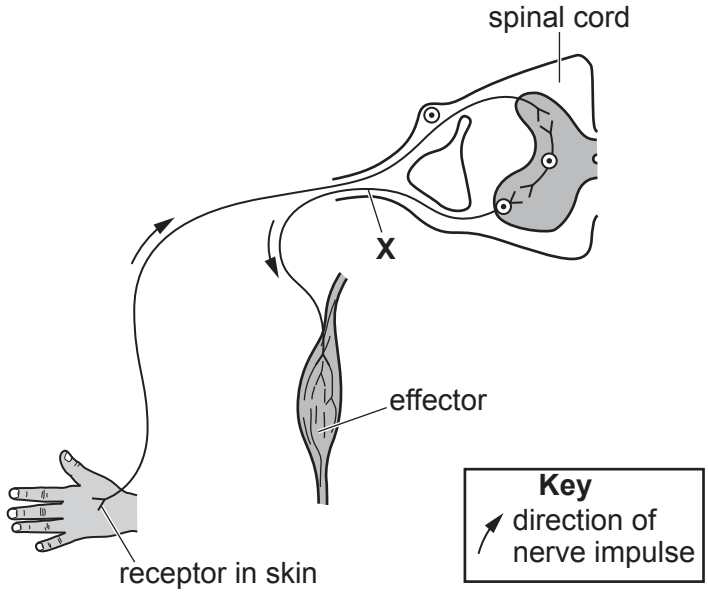

Fig. 10.1

(i) State the names of the stimulus and the effector in this reflex arc.

stimulus .....

effector .....
[2]

(ii) State the name of the neurone labelled **X** in Fig. 10.1.

..... [1]

(iii) The spinal cord is one part of the central nervous system.

State the name of the other part of the central nervous system.

..... [1]

(b) Neurones are the longest cells in the body.

One neurone measures 1.5 m in length.

One plant cell measures 0.1 mm in length.

Calculate how many times longer the neurone is than the plant cell.

..... [2]

(c) Hormones and nerve impulses both carry information around the body.

Identify if each statement is about **hormones** or **nerve impulses**.

They are carried in the blood. .....

They are produced by glands. .....

They are electrical signals. .....

[2]

(d) Adrenaline is a hormone released in 'fight or flight' situations.

Describe two effects of adrenaline on the body.

1 .....

2 .....

[2]

[Total: 10]

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11 **(a)** Limestone is insoluble in water.

Limestone is mixed with water and poured through filter paper.

(i) Explain how filter paper separates limestone from water.

.....

.....

..... [2]

(ii) The filtrate is tested to find its pH number.

One way of finding the pH number is to use a pH meter.

Describe **one** other way to find the pH number of the filtrate.

.....

.....

..... [2]

(b) Limestone is sometimes added to soil to reduce soil acidity.

Limestone is mainly calcium carbonate which reacts with acid.

(i) This soil treatment adds carbon dioxide to the atmosphere.

State **one** other reason why the amount of carbon dioxide in the atmosphere is increasing.

..... [1]

(ii) Describe how an increase in carbon dioxide in the atmosphere affects the environment.

.....

..... [1]

(c) A student investigates the rate of reaction between excess dilute hydrochloric acid and a piece of limestone.

Fig. 11.1 shows the apparatus used.

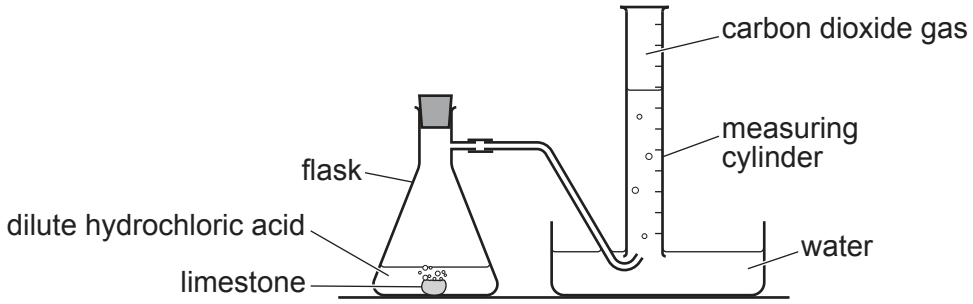

Fig. 11.1

The student measures the volume of carbon dioxide in the measuring cylinder every 20 seconds for 280 seconds.

A graph of the student's results is shown in Fig. 11.2.

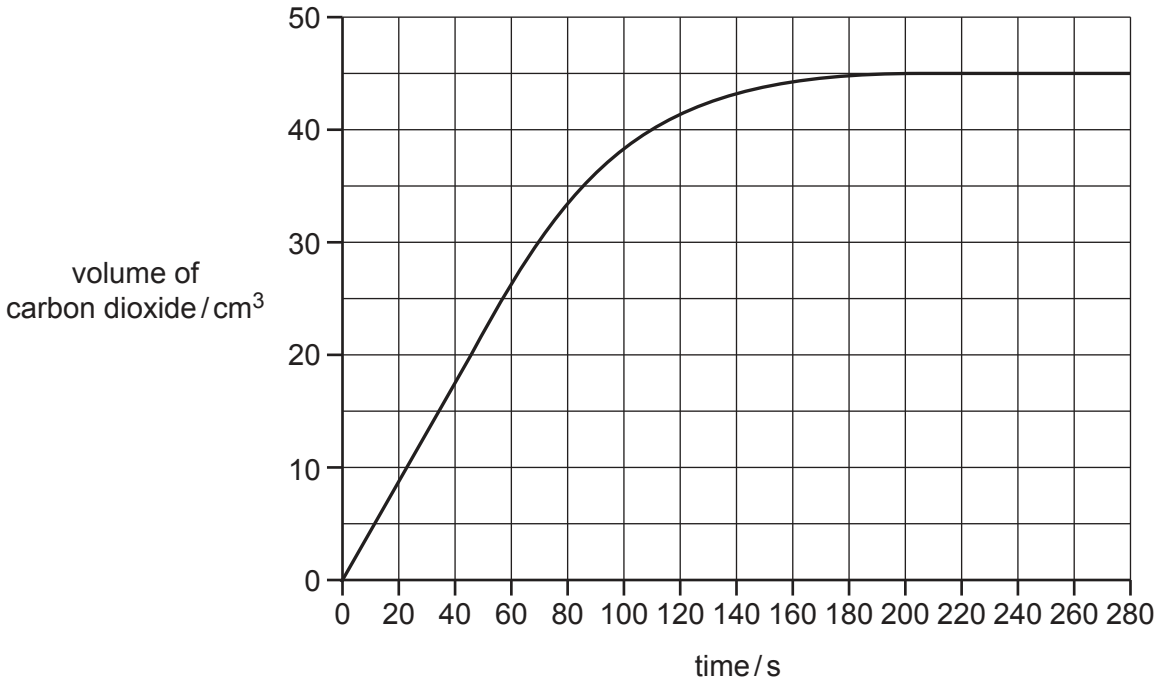

Fig. 11.2

(i) Use Fig. 11.2 to find the total volume of carbon dioxide released.

volume = ... cm^3 [1]

(ii) Use Fig. 11.2 to find the time when the reaction finished.

time = ... s [1]

(iii) The student repeats the experiment at a **higher** temperature.

On Fig. 11.2, sketch a line to show the results. [2]

(iv) Increasing the temperature increases the rate of reaction.

State two other ways the student can increase the rate of the reaction.

1 .....

2 .....
[2]

[Total: 12]

12 **(a)** The mass of the Sun is 1.97×10^{30} kg.

The average density of the Sun is 1410 kg / m^3.

Calculate the volume of the Sun.

volume = ... m^3 [2]

(b) The Sun is made of very hot gas.

(i) Suggest the main method of thermal energy transfer from the inside of the Sun to the surface of the Sun.

..... [1]

(ii) State the main method of energy transfer that occurs when infrared waves travel from the Sun to the Earth through space.

..... [1]

(iii) Sound energy is produced by the Sun.

Explain why we are unable to hear this sound on Earth.

.....

..... [1]

(c) **(i)** Fig. 12.1 shows an incomplete electromagnetic spectrum.

Write infrared radiation in its correct place.

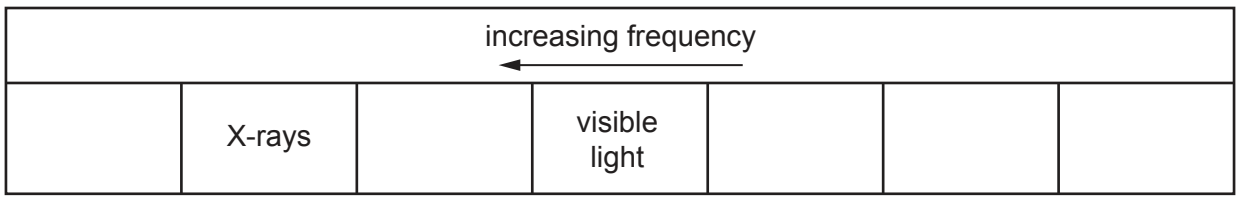

Fig. 12.1

[1]

(ii) State the electromagnetic radiation which has the highest frequency.

..... [1]

(iii) Explain why it takes the same time for infrared and visible light to travel from the Sun to the Earth.

..... [1]

(d) Fig. 12.2 shows a sound wave.

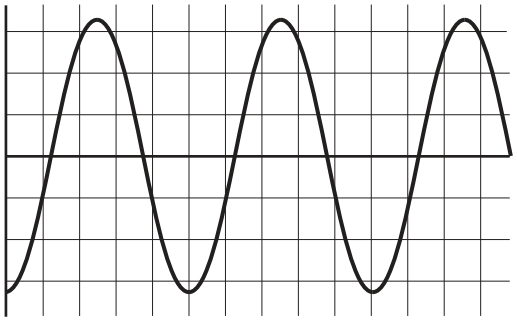

Fig. 12.2

(i) On Fig. 12.2, label the amplitude of the wave with a double-headed arrow (↔) or (↕) and the letter **A**. [1]

(ii) On Fig. 12.2, label the wavelength of one wave with a double-headed arrow (↔) or (↕) and the letter **W**. [1]

[Total: 10]

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

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 europium 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
actinoids	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 mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).