



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/31

May/June 2024

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

- 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.

- The total mark for this paper is 80.
- 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 **24** pages. Any blank pages are indicated.

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

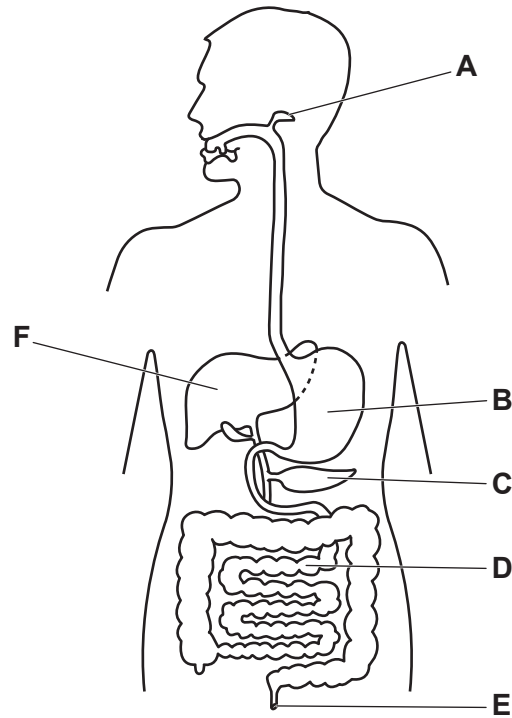


Fig. 1.1

- (i) State the letter on Fig. 1.1 that identifies the position of:
 a salivary gland
 the liver.

[2]

- (ii) Circle **one** function of the part labelled **D** in Fig. 1.1.

absorption

egestion

ingestion

synthesis

[1]

- (b) Enzymes digest food in the human alimentary canal.

Fig. 1.2 shows the effect of temperature on the activity of two different enzymes.

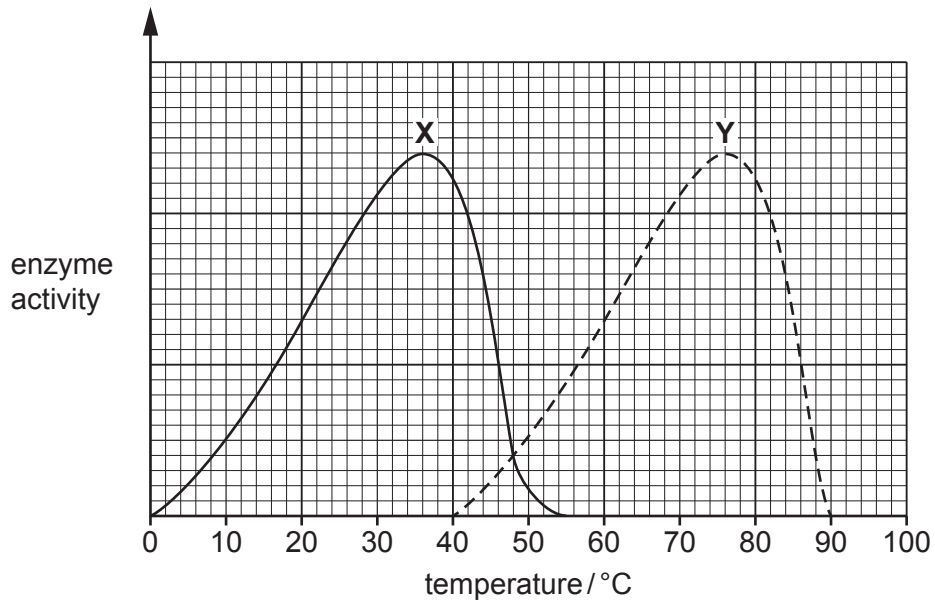


Fig. 1.2

- (i) Identify the temperature where both enzyme **X** and enzyme **Y** have the same enzyme activity.

Tick (✓) the correct box.

15°C	
40°C	
48°C	
55°C	
90°C	

[1]

- (ii) The temperature of the human body is usually within the range 36.5°C to 37.5°C.

State why enzyme **Y** is **not** found in the human alimentary canal.

.....
 [1]

(c) (i) The boxes on the left show some types of biological molecules.

The boxes on the right show some tests used to identify biological molecules.

Draw **one** straight line from each biological molecule to its correct test.

biological
molecule

test

starch

Benedict's solution

biuret

protein

ethanol emulsion

iodine solution

[2]

(ii) State the name of the smaller molecules that large protein molecules are made from.

..... [1]

(iii) Starch is a carbohydrate.

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

..... [1]

[Total: 9]

BLANK PAGE

2 The elements chlorine, bromine and iodine are diatomic covalent molecules.

(a) State the meaning of diatomic.

..... [1]

(b) Complete the dot-and-cross diagram in Fig. 2.1 to show the outer-shell electrons in a molecule of chlorine, Cl_2 .

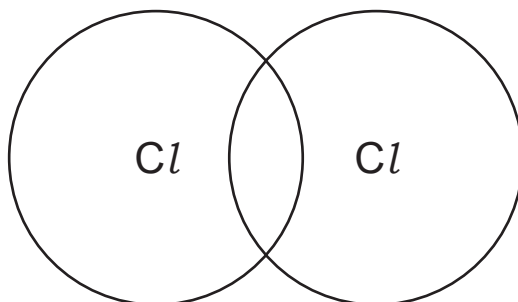


Fig. 2.1

[2]

(c) Chlorine reacts exothermically with sodium to form the ionic compound sodium chloride.

(i) State the meaning of exothermic.

.....
 [1]

(ii) Describe what happens to a sodium atom and to a chlorine atom when they react to form the ionic compound sodium chloride.

Use ideas about electrons in your answer.

sodium atom

.....

chlorine atom

.....

[2]

(iii) Describe the difference in volatility between ionic compounds and covalent compounds.

.....

..... [1]

(d) Solid sodium carbonate reacts with dilute hydrochloric acid to form aqueous sodium chloride, carbon dioxide and one other product.

(i) Identify the solute and the solvent in aqueous sodium chloride.

solute

solvent

[2]

(ii) Complete the word equation for this reaction.



[1]

(iii) The structure of sodium carbonate is shown in Fig. 2.2.

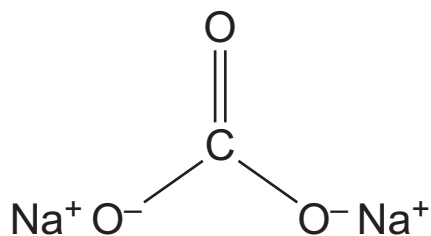


Fig. 2.2

Deduce the formula of sodium carbonate.

..... [1]

[Total: 11]

- 3 Fig. 3.1 shows an aluminium pan containing water, being heated on a hotplate of a cooker.

There is a glass lid on the pan and a thermometer dips into the water.

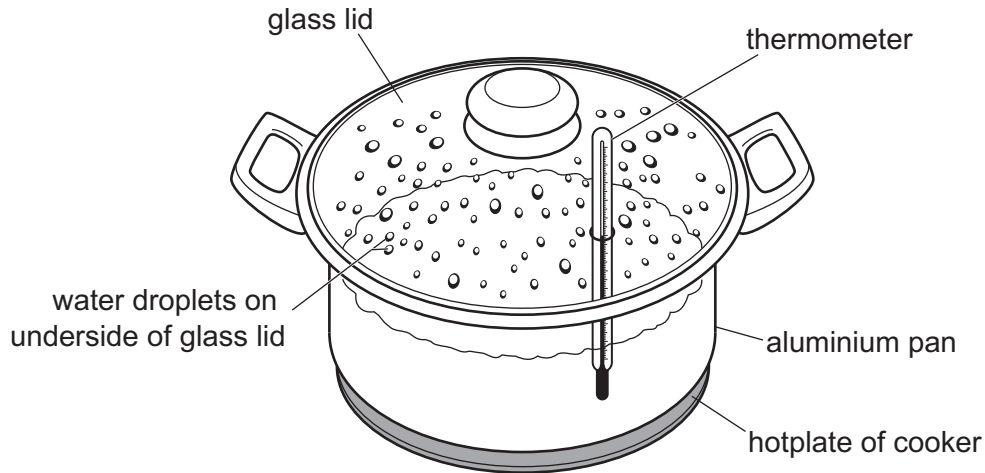


Fig. 3.1

- (a) The thermometer reads 60°C .

Water droplets can be seen condensing on the underside of the glass lid.

- (i) State the process that forms water vapour at 60°C .

..... [1]

- (ii) State the process that happens when the temperature of the water reaches 100°C .

..... [1]

- (b) (i) State the process that transfers thermal energy from the cooker to the water through the aluminium pan.

..... [1]

- (ii) Another pan on the cooker has the same shape but is made of glass.

The pan contains the same volume of water as the aluminium pan, has a lid and is heated on an identical hotplate.

Explain why the water in the glass pan takes a longer time to reach 100°C .

.....

..... [1]

- (c) A thermometer is placed in another pan of water.

Fig. 3.2 shows what an observer sees when viewing the pan from the side.

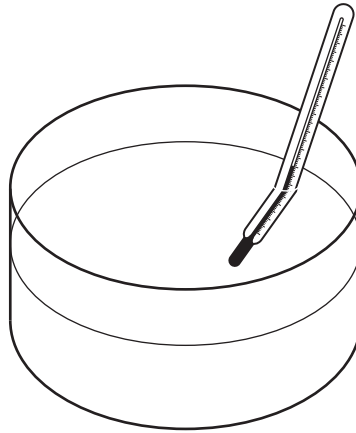


Fig. 3.2

State the property of light that makes the thermometer appear bent.

..... [1]

- (d) A person reads the thermometer when it is reflected in a plane mirror.

Fig. 3.3 shows a ray of light from the thermometer reading to the mirror. The normal at the mirror is also shown.

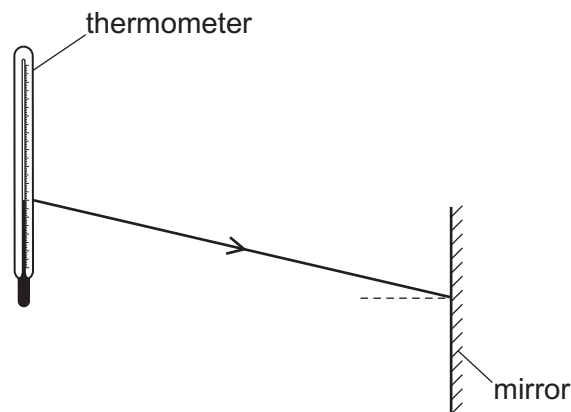


Fig. 3.3

- (i) On Fig. 3.3, complete the ray diagram to show the ray of light reflected by the mirror.

Draw an **X** in a correct place for an eye to see the reflection of the thermometer reading. [2]

- (ii) The thermometer reading on the scale is 30°C as shown in Fig. 3.4.

Complete the right-hand box in Fig. 3.4 to show the image of the reading as seen reflected in the mirror.



Fig. 3.4

[1]

- (e) Visible light is part of the electromagnetic spectrum.

State **one** part of the electromagnetic spectrum with a higher frequency than visible light.

..... [1]

- (f) Microwaves are part of the electromagnetic spectrum.

State **one** use of microwaves.

..... [1]

[Total: 10]

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- 4 (a) Fig. 4.1 shows the pathway taken by water through a plant root.

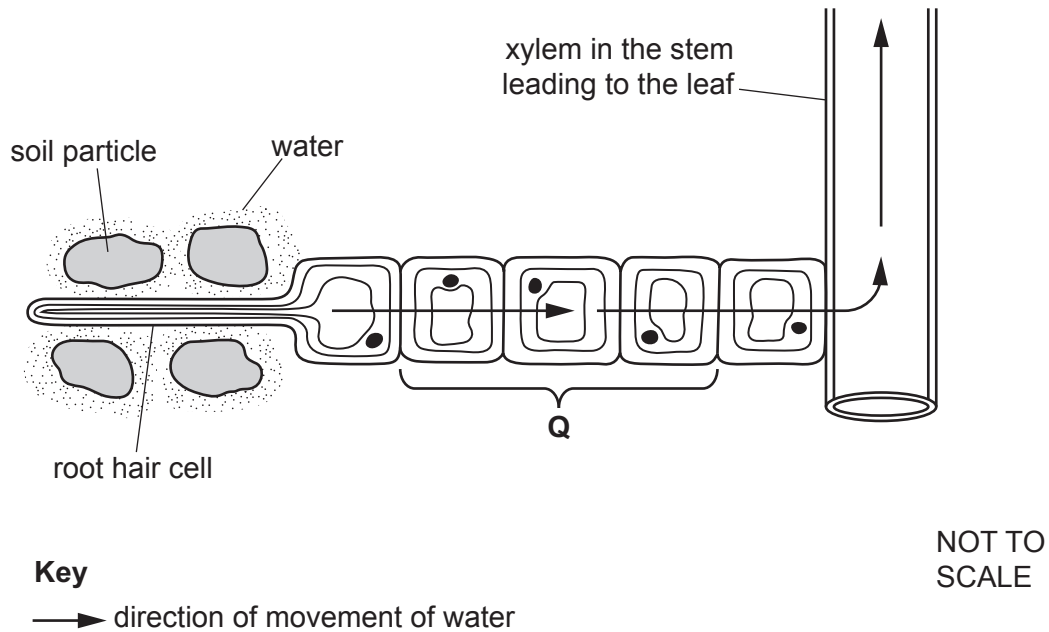


Fig. 4.1

- (i) State the name of the type of cells labelled **Q** in Fig. 4.1. [1]
-
- (ii) On Fig. 4.1, draw a label line and the letter **V** to identify **one** vacuole. [1]
- (iii) Complete the sentences to describe the pathway taken by water through the leaf.

Choose words from the list.
Each word may be used only once.

diffusion

evaporation

osmosis

transmission

transpiration

Water moves from the xylem to the air spaces in the leaf by

..... from the surface of mesophyll cells.

The water vapour then passes out of the stomata by the process of

.....

This loss of water vapour from the leaves is called

.....

[3]

(b) Fig. 4.2 shows a plant reproducing asexually.

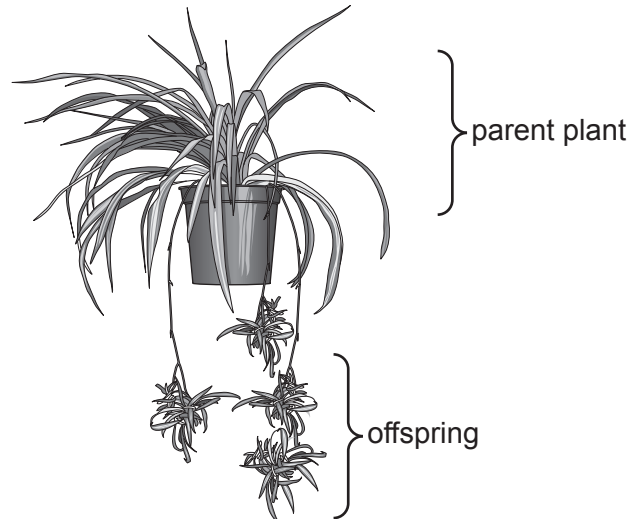


Fig. 4.2

Tick (✓) **two** correct statements about the plants shown in Fig. 4.2.

The offspring are genetically identical to the parent plant.	
The offspring developed from germinating seeds.	
The parent plant needed flowers to produce the offspring.	
Fertilisation did not take place to produce the offspring.	
The parent plant has been pollinated to produce the offspring.	

[2]

(c) (i) Explain why plants are classified as producers in a food chain.

.....

.....

..... [2]

(ii) Fig. 4.3 shows a food chain.

Circle the primary consumer in Fig. 4.3.

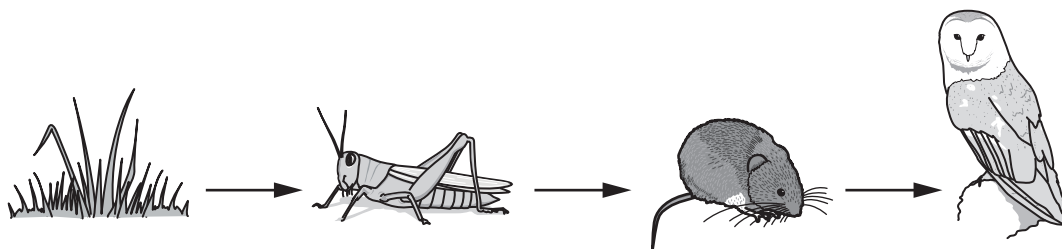


Fig. 4.3

[1]

5 Petroleum is a mixture of hydrocarbons.

Fig. 5.1 shows the process that separates petroleum into hydrocarbons and another process, process **B**.

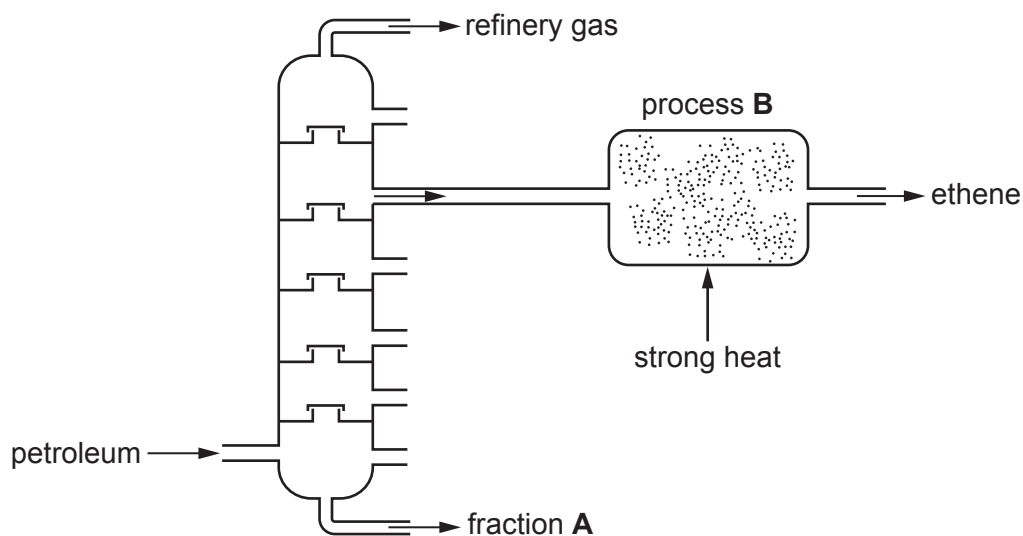


Fig. 5.1

(a) (i) Circle the name of the process that separates petroleum into hydrocarbons.

chromatography crystallisation filtration fractional distillation

[1]

(ii) State **one** use for refinery gas.

..... [1]

(iii) State **one** use for fraction **A**.

..... [1]

(b) Process **B** produces the unsaturated hydrocarbon ethene.

(i) State the name of process **B**.

..... [1]

(ii) Explain why ethene is described as unsaturated and as a hydrocarbon.

unsaturated

.....

hydrocarbon

.....

[2]

- (iii) Describe a chemical test for unsaturated hydrocarbons.

State the observation for a positive result.

test

observation

..... [2]

- (iv) State the type of chemical reaction that converts ethene monomer units to poly(ethene).

..... [1]

- (c) Petroleum is one example of a fossil fuel.

Another fossil fuel has a greenhouse gas as its main constituent.

State the name of this other fossil fuel.

..... [1]

[Total: 10]

- 6 Fig. 6.1 shows a mechanical crane using force **P** to lift a box from the ground to the top of a building.

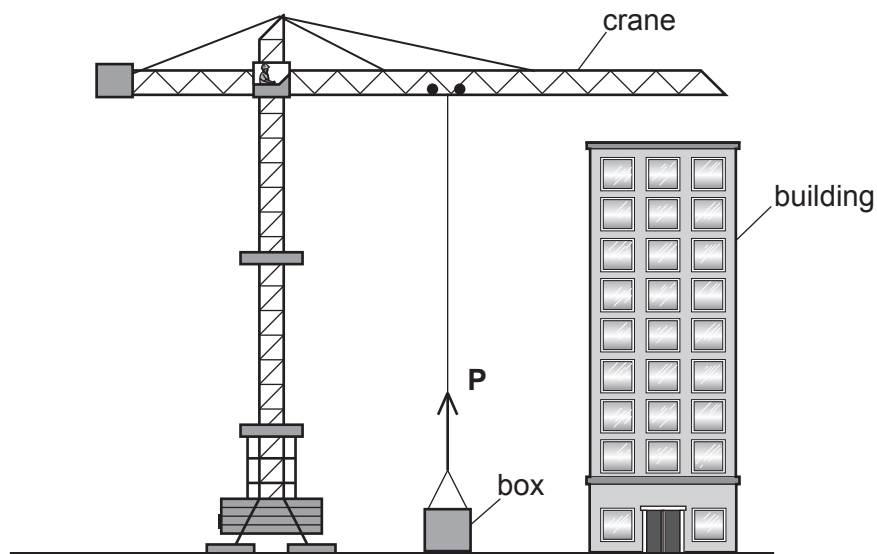


Fig. 6.1

- (a) (i) The box weighs 15000 N.

Calculate the mass of the box.

The gravitational force on unit mass is 10 N/kg.

mass = ... kg [2]

- (ii) The box has a volume of 2.0 m³.

Use your answer to (a)(i) to calculate the density of the box.

density = ... kg/m³ [2]

- (b) When the box is on the ground, the crane applies force **P** of 16 000 N to the box.

Describe what happens to the box when this force is applied.

Use ideas about motion in your answer.

.....

.....

..... [2]

- (c) The building is 56 m tall. The crane lifts the box at an average speed of 0.28 m/s.

- (i) Calculate the time taken to lift the box from the ground to the top of the building.

time = ... s [2]

- (ii) The box gains 825 000 J of gravitational potential energy (GPE) when it is lifted to the top of the building.

The crane lifts a second box of the same weight to the top of the building at an average speed of 0.50 m/s.

State whether the second box gains more, less or the same gravitational potential energy (GPE) as the first box.

Explain your answer.

.....

.....

..... [2]

[Total: 10]

- 7 (a) Fig. 7.1 shows part of the human circulatory system.

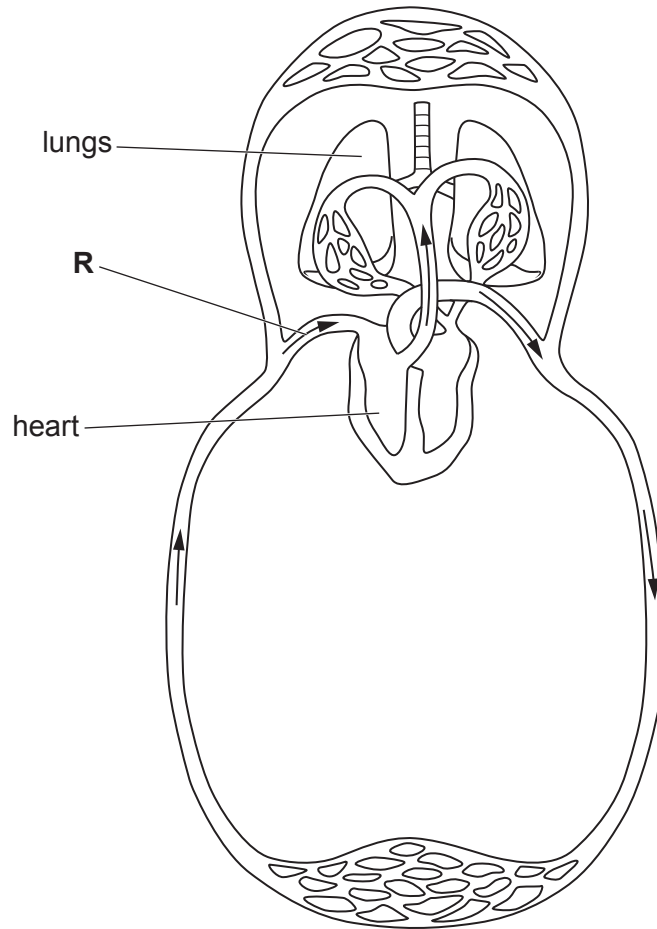


Fig. 7.1

- (i) The arrows show the direction of blood flow in the circulatory system.

Identify the blood vessel labelled **R** in Fig. 7.1.

Circle the correct answer.

aorta **pulmonary artery** **pulmonary vein** **vena cava**

[1]

- (ii) State the function of valves in the circulatory system.

..... [1]

- (b) The pulse rate of a student is measured at rest and during different types of physical activity.

Table 7.1 shows the results.

Table 7.1

physical activity	pulse rate / beats per minute
rest	70
slow walking	112
fast walking	126
running	135

- (i) Calculate the percentage increase in pulse rate between rest and slow walking.

percentage increase [2]

- (ii) Exercise requires increased muscle contraction.

Explain why muscles need more oxygen during exercise.

.....

 [2]

- (c) Humans also have a reproductive system.

State the name of the part of the human reproductive system that produces sperm and the part that produces eggs.

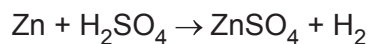
sperm

eggs

[2]

[Total: 8]

- 8 (a) Solid zinc and dilute sulfuric acid react to form zinc sulfate and hydrogen gas.



- (i) A student measures and controls the temperature, the volume and the concentration of the acid.

State **two other** measurements that the student needs to make to investigate the rate of this reaction.

1

2 [2]

- (ii) Describe what happens to the pH number of the reaction mixture during the reaction.

..... [1]

- (b) Dilute sulfuric acid is electrolysed using the apparatus shown in Fig. 8.1.

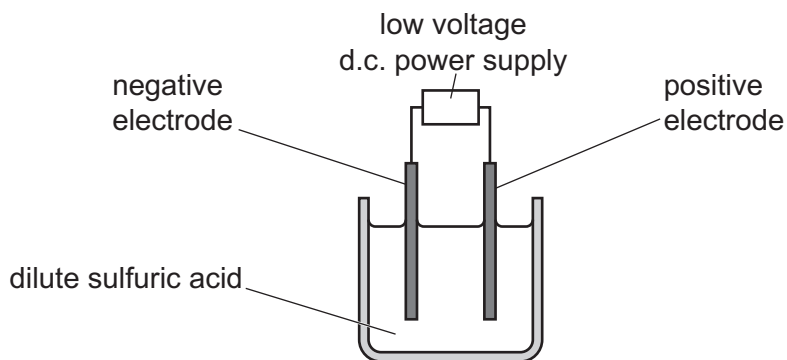


Fig. 8.1

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

..... [1]

- (ii) Identify the product that forms at the positive electrode.

..... [1]

[Total: 5]

- 9 Fig. 9.1 shows an electrical circuit with components labelled **E**, **F**, **G**, **H** and **J**.

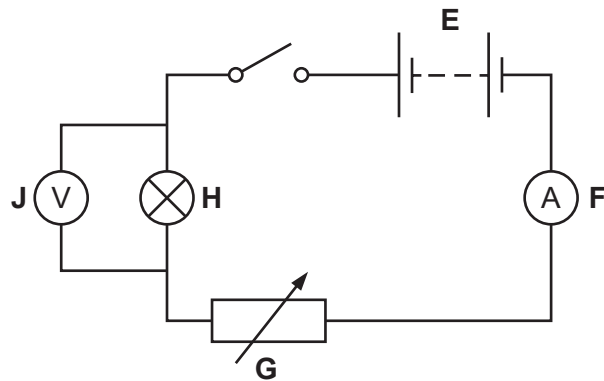


Fig. 9.1

- (a) State the letter of the component that:

- (i) is the energy source for the circuit. [1]
- (ii) is connected in parallel with another component. [1]
- (iii) measures the current in the circuit. [1]
- (iv) can be used to vary the current in the circuit. [1]

- (b) The potential difference across the battery is 3.0V. The current in the circuit is 0.6A.

Calculate the total resistance in the circuit.

Give the unit of your answer.

resistance = ... unit [3]

[Total: 7]

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The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										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 —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —

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 dm³ at room temperature and pressure (r.t.p.).



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COMBINED SCIENCE**0653/32**

Paper 3 Theory (Core)

May/June 2024**1 hour 15 minutes**

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No additional materials are needed.

INSTRUCTIONS

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INFORMATION

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- 1 (a) Fig. 1.1 is a diagram of the male reproductive system in humans.

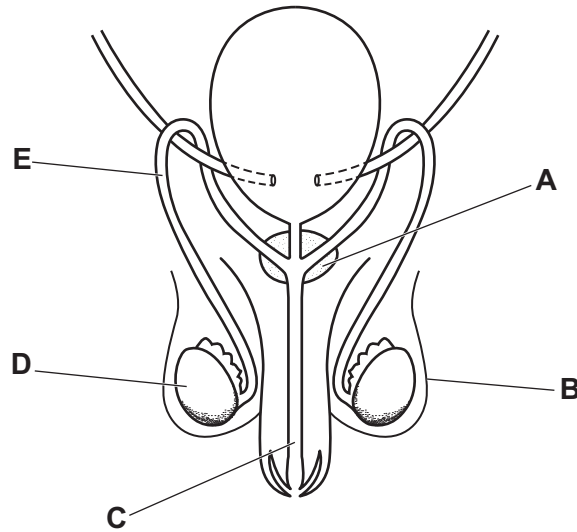


Fig. 1.1

State the letter on Fig. 1.1 that identifies the:

urethra

scrotum.

[2]

- (b) Fertilisation occurs inside the human female reproductive system.

- (i) Circle the site of fertilisation in the female reproductive system.

cervix

oviduct

uterus

vagina

[1]

- (ii) Complete the sentences about fertilisation and early development in humans.

Fertilisation is the fusion of the from a sperm and an ovum.

After fertilisation the cell that forms is called a

This then develops into a ball of cells called an

[3]



- (c) Sexual reproduction in plants results in the formation of seeds.

A student investigates the effect of temperature on seed germination in one type of plant.

They place seeds at different temperatures and record the number of seeds that germinate.

Fig. 1.2 shows the percentage number of seeds that germinate at each temperature.

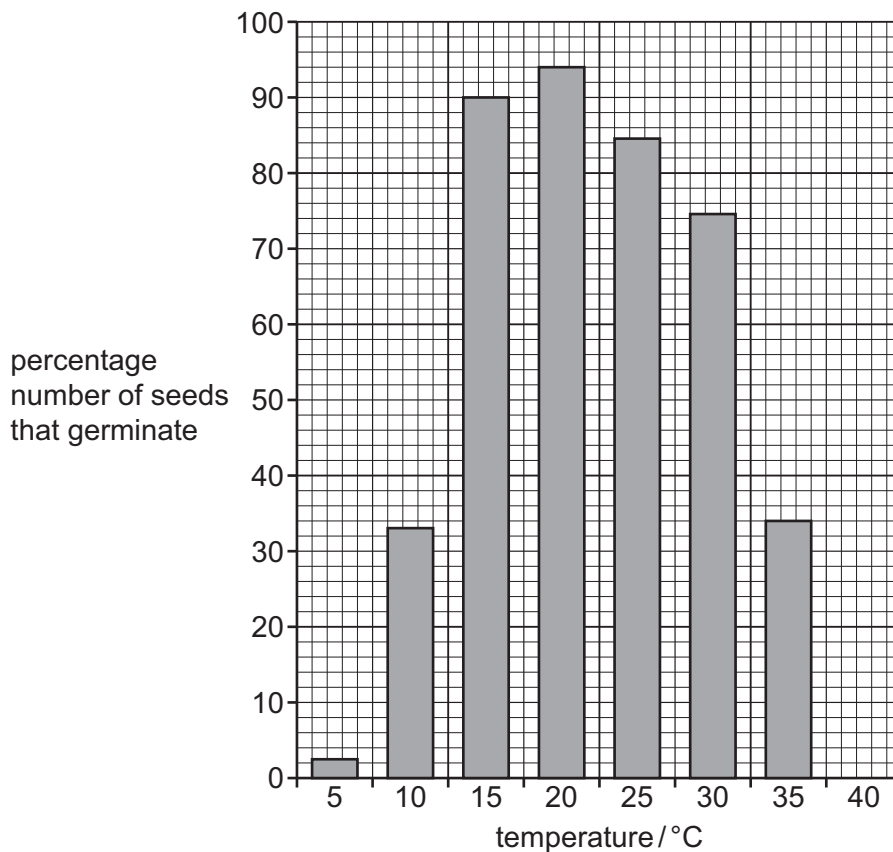


Fig. 1.2

- (i) Describe the effect of temperature on seed germination shown in Fig. 1.2.

Include data in your answer.

.....

.....

.....

..... [2]

- (ii) State **one other** environmental condition needed for the germination of seeds.

..... [1]

- (iii) Seeds contain carbohydrates.

Suggest why plant seeds need carbohydrates to germinate.

..... [1]



- 2 A student investigates the reaction of magnesium with excess dilute hydrochloric acid using the apparatus shown in Fig. 2.1.

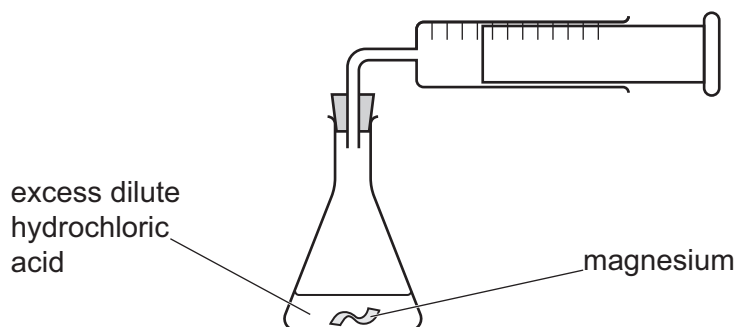
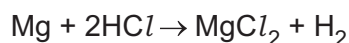


Fig. 2.1

The equation for the reaction is shown.



- (a) The student repeats the experiment at the same temperature, using the same volume of acid with a lower concentration.

Describe the effect of this change on the rate of the reaction.

..... [1]

- (b) Describe the effect of dilute hydrochloric acid on litmus paper.

..... [1]

- (c) Describe a chemical test for hydrogen gas.

State the observation for a positive result.

test

observation

..... [2]





(d) One alloy contains copper and magnesium.

(i) State what is meant by an alloy.

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

(ii) Copper is extracted from copper oxide by heating with carbon.

Magnesium **cannot** be extracted from magnesium oxide by heating with carbon.

Explain these observations.

copper
.....
magnesium
..... [2]

[Total: 7]



- 3 Fig. 3.1 shows an old-fashioned room heater made of iron. The heater burns oil as a fuel. A pan of water is being heated on top.

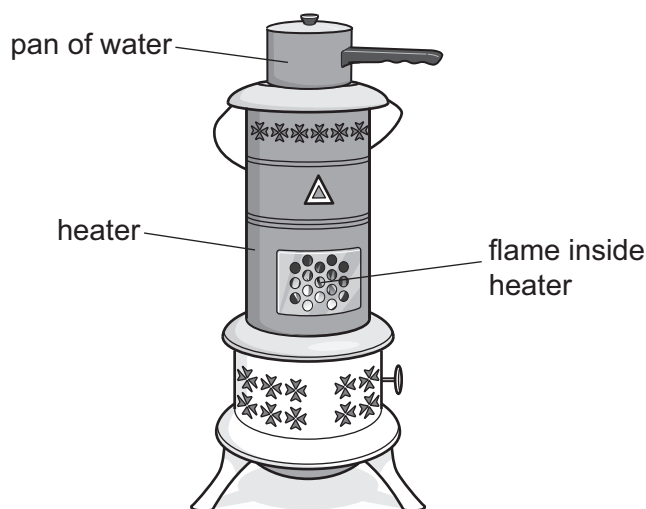


Fig. 3.1

- (a) (i) The oil is a source of stored energy.

State the form in which the energy is stored.

..... [1]

- (ii) State the form of energy produced when the oil burns.

..... [1]

- (b) Energy from the flame is transferred to the top surface of the heater.

State the method of energy transfer.

..... [1]

- (c) The top surface of the heater is at 75°C .

- (i) State the name of the process that forms water vapour inside the pan.

..... [1]

- (ii) State if the water in the pan will boil. Explain your answer.

..... [1]



- (d) Fig. 3.2 shows a person warming their hand near the side of the heater. The person sees light from the flame of the burning oil through the holes in the side of the heater.

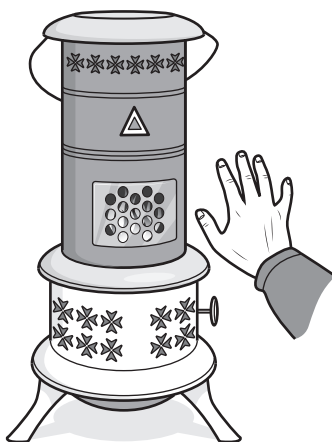


Fig. 3.2

- (i) State the method of energy transfer that is warming the hand.

..... [1]

- (ii) The person has noticed the **two** main forms of electromagnetic wave emitted by the flame.

Add these to Fig. 3.3 in the correct places in the electromagnetic spectrum.

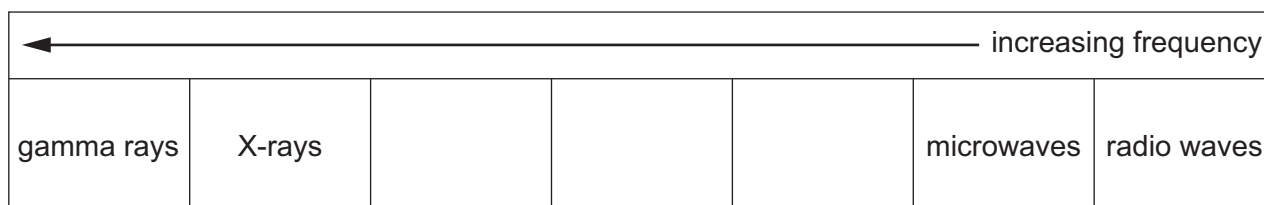


Fig. 3.3

[2]





- (e) The person holds their hand in front of a mirror.
Fig. 3.4 shows the image seen in the mirror.

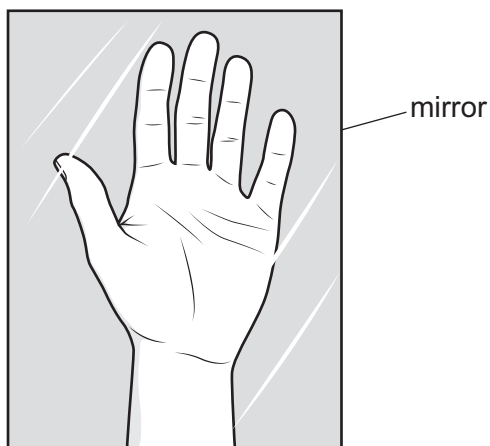


Fig. 3.4

State which hand, left or right, the person is holding in front of the mirror.

Give a reason for your answer in terms of the characteristics of plane mirrors.

hand

reason [1]

[Total: 9]



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9

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4 (a) Fig. 4.1a shows a white blood cell. Fig. 4.1b shows a type of plant cell.



Fig. 4.1a

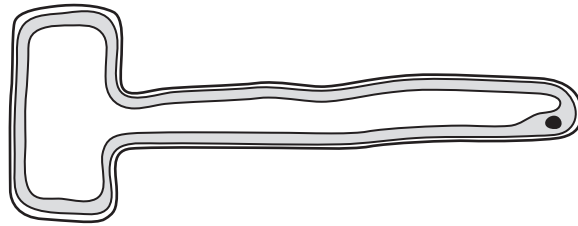


Fig. 4.1b

NOT TO
SCALE

(i) State the type of plant cell shown in Fig. 4.1b.

..... [1]

(ii) Identify one **visible** structure in the plant cell in Fig. 4.1b that is:

also visible in the white blood cell

not present in the white blood cell. [2]

(b) Water moves into the plant cell from the soil.

(i) Describe the process of water movement into the plant cell.

.....
.....
..... [2]

(ii) State the name of the vessels that transport water up the stem to the leaves.

..... [1]





(c) White blood cells are part of the circulatory system.

(i) State two functions of white blood cells.

1

2 [2]

(ii) Fig. 4.2 shows a photomicrograph of blood vessels from the circulatory system.



Fig. 4.2

Complete these sentences about Fig. 4.2.

The artery has a much wall compared to the vein.

This is because the artery transports blood away from the at high pressure.

[2]

[Total: 10]





5 Aluminium ore contains aluminium oxide.

Aluminium is extracted from aluminium oxide in the process shown in Fig. 5.1.

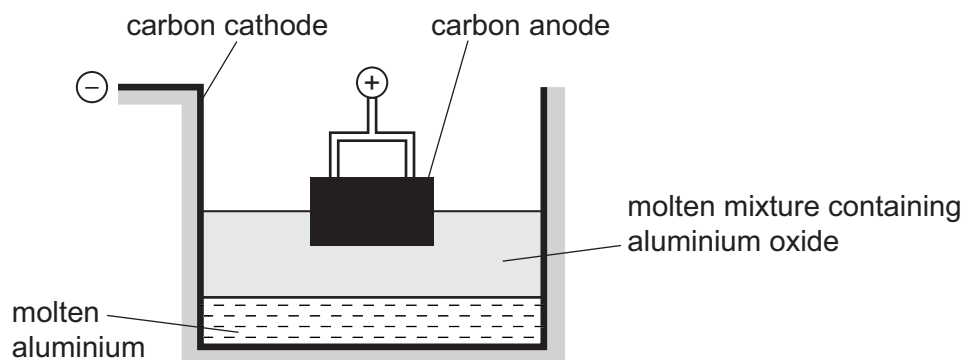


Fig. 5.1

- (a) (i) Circle the name of the process shown in Fig. 5.1.

chromatography

crystallisation

electrolysis

filtration

[1]

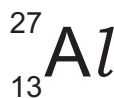
- (ii) State the name of the ore that contains aluminium oxide.

..... [1]

- (b) Explain why the extraction of aluminium from aluminium oxide is a reduction reaction.

..... [1]

- (c) An atom of aluminium is represented as shown.



- (i) Describe what is meant by nucleon number.

..... [1]

- (ii) Deduce the number of neutrons in this atom.

..... [1]



(d) The electronic structure of an aluminium atom is shown in Fig. 5.2.

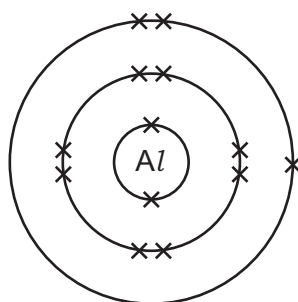


Fig. 5.2

When aluminium reacts, aluminium atoms form aluminium ions.

Complete Fig. 5.3 to show the electronic structure of an aluminium ion.

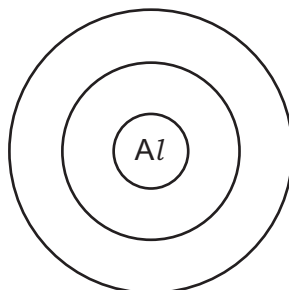


Fig. 5.3

[1]

(e) Aluminium oxide, Al_2O_3 , is an ionic compound.

Ammonia, NH_3 , is a covalent compound.

Complete Table 5.1 to show the electrical conductivity of aluminium, aluminium oxide and ammonia as solids and as liquids.

Use a tick (✓) to show an electrical conductor.

Use a cross (x) to show an electrical non-conductor.

Two have been done for you.

Table 5.1

	aluminium	aluminium oxide	ammonia
solid	✓		x
liquid			

Key

✓ = electrical conductor

x = electrical non-conductor

[2]

[Total: 8]





6 Fig. 6.1 shows a rover vehicle on the planet Mars.

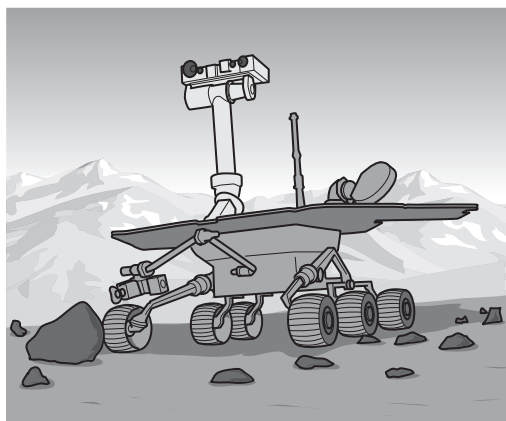


Fig. 6.1

(a) The vehicle travels at an average speed of 0.0089 m/s .

Show that the average speed of the vehicle is 0.032 km/h .

[1]

(b) Fig. 6.2 shows a speed–time graph for the vehicle on one of its journeys on Mars.

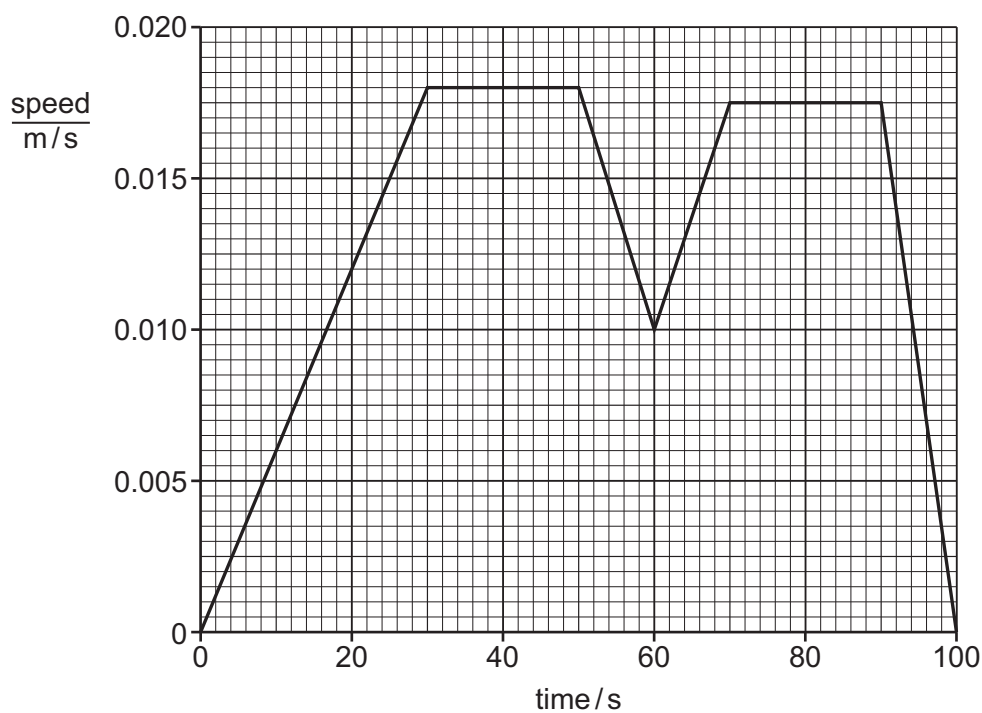


Fig. 6.2

(i) Use Fig. 6.2 to find the maximum speed of the vehicle on this journey.

speed = ... m/s [1]





- (ii) During its journey, the vehicle climbs over a large rock. This causes a change in the motion of the vehicle before it continues.

Describe the motion using data from the graph in Fig. 6.2.

.....

.....

.....

.....

..... [3]

- (c) The vehicle carries a video camera to record pictures and a microphone to record sound.

The camera records the fall of a rock from a cliff at a distance of 120 m.

Energy is transferred by sound waves to the microphone. The microphone records the sound 0.5 s after the rock hits the ground.

- (i) Complete the sequence of energy transfers that occur as the rock falls.

Energy stored as potential energy of the rock on the cliff is transferred to energy of the falling rock. As the rock hits the ground, energy is transferred by sound waves.

[2]

- (ii) Calculate the speed of sound on Mars.

speed = ... m/s [2]

[Total: 9]





7 (a) Fig. 7.1 describes the feeding relationships in one food chain.

- robins are small birds that eat caterpillars
- caterpillars are primary consumers
- a merlin is a large bird that eats robins
- the producer in the food chain is an oak tree

Fig. 7.1

(i) Draw the food chain using the names of **all** the organisms in Fig. 7.1.

..... [2]

(ii) Using the information in Fig. 7.1, identify **all** the organisms that are:

herbivores

carnivores. [2]



(b) Fig. 7.2 shows part of the carbon cycle.

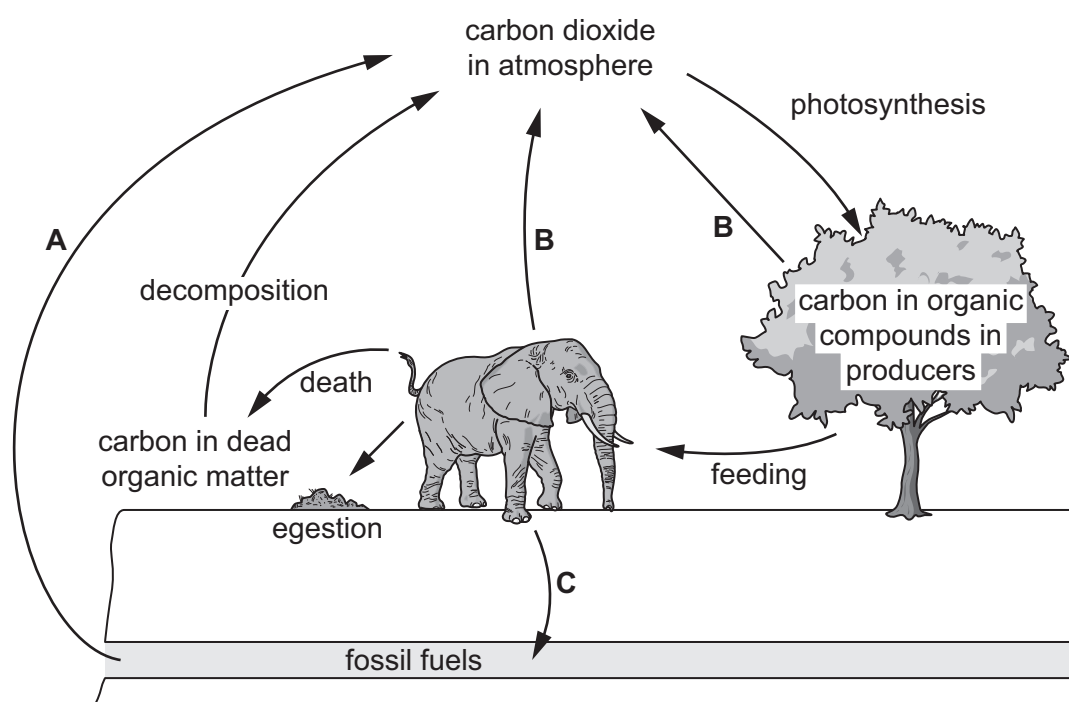


Fig. 7.2

State the name of the processes labelled **A**, **B** and **C**.

A

B

C

[3]

[Total: 7]





8 The structures of compounds **P** and **Q** are shown in Fig. 8.1.

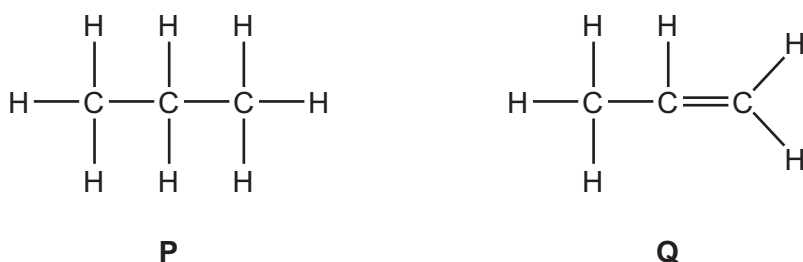


Fig. 8.1

(a) (i) The formula for compound **P** is C_3H_8 .

Deduce the formula of compound **Q**.

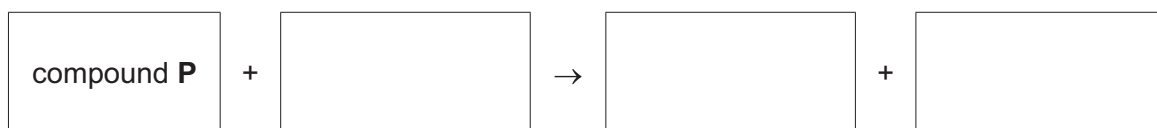
..... [1]

(ii) The combustion of compound **P** is an exothermic reaction.

Describe the meaning of exothermic.

.....
 [1]

(iii) Complete the word equation for the complete combustion of compound **P**.



[2]

(b) Describe the effect, if any, of compounds **P** and **Q** on the colour of aqueous bromine.

P

Q

[2]





(c) Compound **P** is in refinery gas.

Refinery gas is obtained from petroleum using a separation process.

(i) State the name of the separation process used to obtain refinery gas from petroleum.

..... [1]

(ii) During this separation process, some hydrocarbons change state from a liquid to a gas.

State if this change is a chemical change or a physical change.

Explain your answer.

type of change

explanation

..... [1]

(iii) State **one** use for refinery gas.

..... [1]

(d) Petroleum is one example of a fossil fuel.

State the name of **two** other fossil fuels.

1

2

[2]

[Total: 11]





- 9 A student investigates the current in different resistors by connecting them in a circuit with a battery and an ammeter.

- (a) When a 4.0Ω resistor is connected in this circuit, the reading on the ammeter is 1.5A .

Calculate the potential difference (p.d.) across the resistor.

Give the unit of your answer.

p.d. = ... unit [3]

- (b) The student then connects a 6.0Ω resistor and a 2.0Ω resistor in series with the 4.0Ω resistor and the battery.

Calculate the total resistance connected to the battery.

resistance = ... Ω [1]

- (c) Next, the student connects a different circuit.

The 6.0Ω resistor is connected in parallel with the 4.0Ω resistor. Both are connected to the battery and the ammeter.

The reading on the ammeter is greater than 1.5A .

- (i) Fig. 9.1 shows part of this circuit.

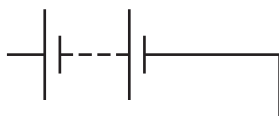


Fig. 9.1

On Fig. 9.1, complete the circuit diagram to show the two resistors and the ammeter connected in the circuit.

[3]





(ii) Explain why the reading on the ammeter is greater than 1.5A.

.....

.....

.....

..... [2]

[Total: 9]







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The Periodic Table of Elements

Group																	
I	II															III	VIII
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass														1 H hydrogen 1	2 He helium 4
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										10 Ne neon 20
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 —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —

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
	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 dm³ at room temperature and pressure (r.t.p.).





CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/33

May/June 2024

1 hour 15 minutes

No additional materials are needed.

- 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.

- The total mark for this paper is 80.
- 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 **24** pages. Any blank pages are indicated.

- 1 (a) Fig. 1.1 is a diagram of the human heart.

Complete the labels on Fig. 1.1.

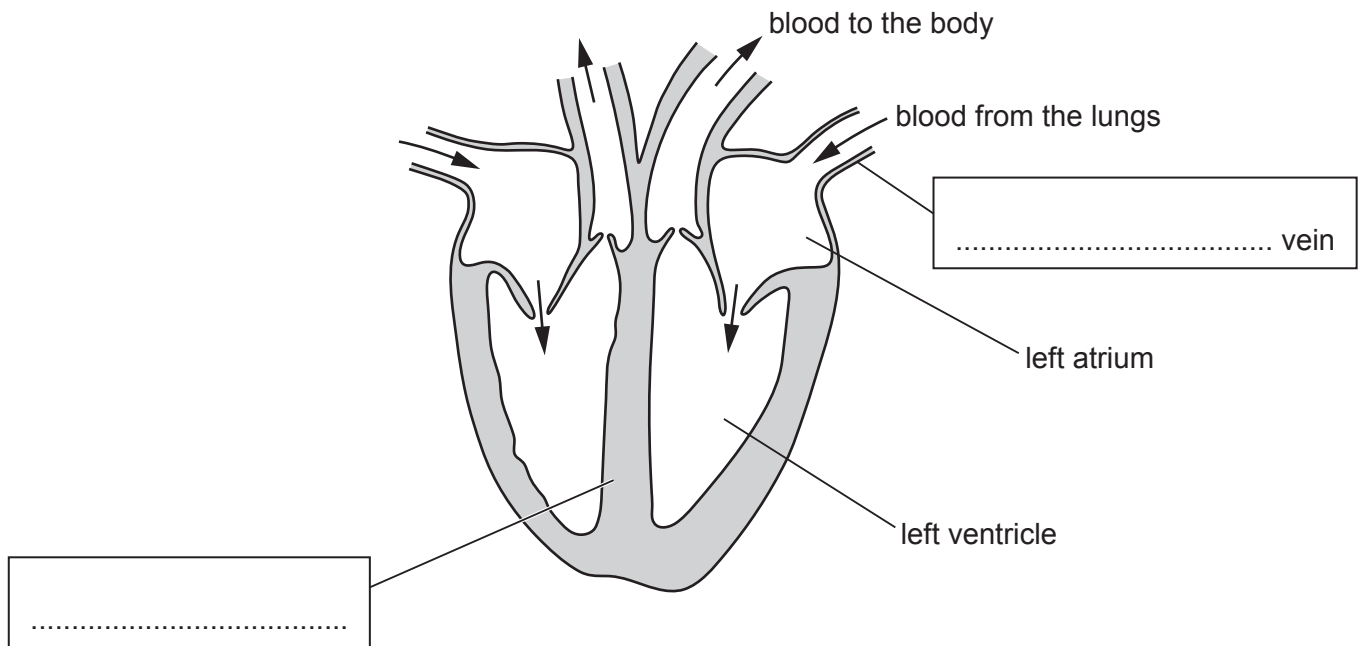


Fig. 1.1

[2]

- (b) The boxes on the left show different components of blood.

The boxes on the right show different functions of the components.

Draw **one** straight line from each component to its function.

component	function
plasma	transport oxygen
platelets	transport ions
red blood cells	blood clotting

[2]

(c) Hormones are transported in the blood.

(i) Circle the words in **bold** that make this definition of hormones correct.

Hormones are **chemical/electrical** substances produced by a **gland/vacuole**.

They are carried in the blood and alter the activity of a specific **excretion/target** organ. [2]

(ii) A patient is given an injection of the hormone adrenaline.

The doctor measures the patient's pulse rate before and after the injection.

Table 1.1 shows the results.

Table 1.1

pulse rate before injection /beats per minute	pulse rate after injection /beats per minute
70	91

Calculate the percentage increase in pulse rate using the results from Table 1.1.

percentage increase = ...% [2]

(iii) State **one** other effect of adrenaline on the body.

..... [1]

[Total: 9]

2 A student investigates the reactions of iron using iron nails.

(a) The student places an iron nail into water, as shown in Fig. 2.1.

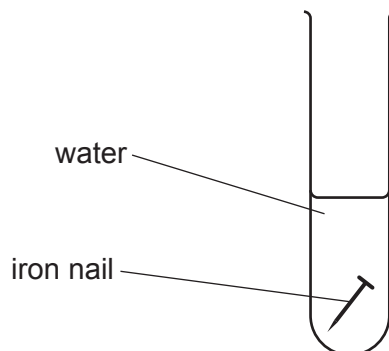


Fig. 2.1

(i) Water is needed for iron to rust.

State **one other** substance needed for iron to rust.

..... [1]

(ii) Suggest **one** method used to stop iron nails rusting.

..... [1]

(b) In another experiment, the student compares the rates of reaction of iron and three other metals with dilute hydrochloric acid.

The student places equal-sized pieces of the four metals in dilute hydrochloric acid of the same concentration at the same temperature. Then the student collects the gas produced for 2 minutes, as shown in Fig. 2.2.

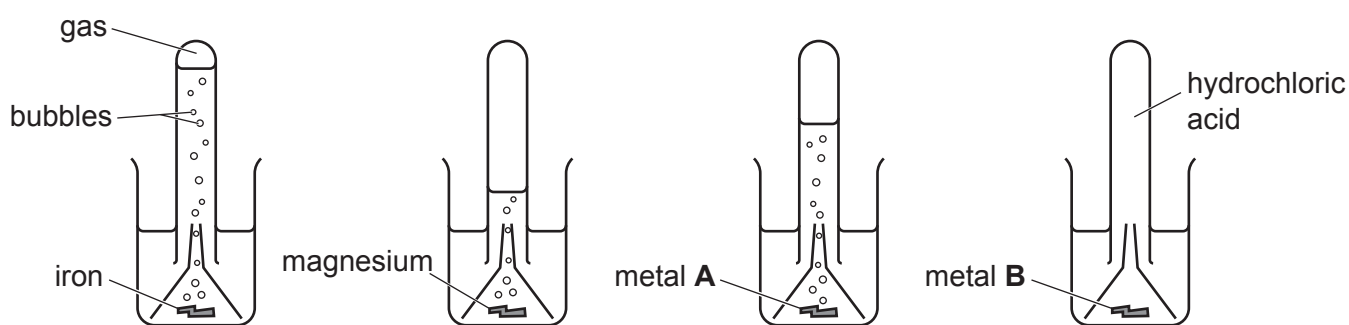


Fig. 2.2

(i) Identify the gas produced in the reactions shown in Fig. 2.2.

..... [1]

- (ii) Suggest the identity of metal **A** and the identity of metal **B**.

Explain your answer.

metal **A**

metal **B**

explanation

.....

.....

.....

[3]

- (iii) Suggest **one** change to increase the rate of the reaction of iron with dilute hydrochloric acid.

..... [1]

- (c) An atom of iron is represented as shown.



Deduce the number of protons, neutrons and electrons in this atom.

number of protons = ...

number of neutrons = ...

number of electrons = ...

[2]

[Total: 9]

- 3 Fig. 3.1 shows three forces, **Q**, **R** and **S**, acting on a bus moving along a level road at constant speed.

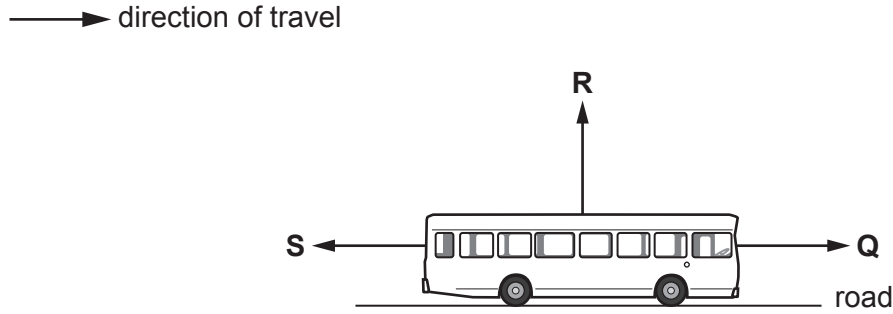


Fig. 3.1

- (a) The gravitational force acting on the bus is **not** shown on Fig. 3.1.
- (i) On Fig. 3.1, draw an arrow to represent the gravitational force acting on the bus and label it **P**. [1]
- (ii) State the name of the gravitational force **P**.
 [1]
- (b) The driving force **Q** of the bus is 2500 N as it moves.
- (i) Explain why force **S** must also be 2500 N as the bus moves along a level road at constant speed.

 [1]
- (ii) Force **Q** is increased to 3000 N. Force **S** does not change.
 Find the resultant of the forces **Q** and **S** acting on the bus.
 resultant = ... N [1]
- (iii) Describe the effect on the motion of the bus of the resultant force in (b)(ii).
 [1]

(c) Fig. 3.2 shows a speed–time graph of the motion of a bus between two bus stops.

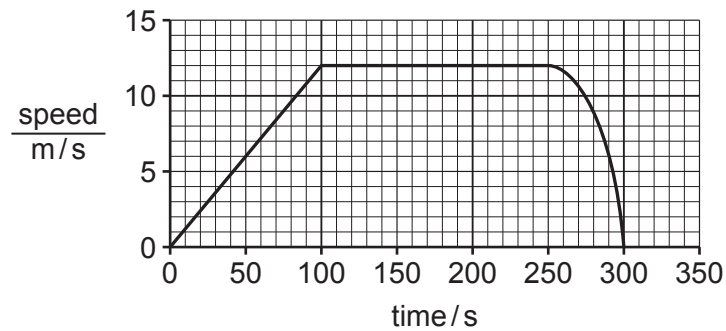


Fig. 3.2

(i) Determine the speed of the bus when it is travelling at constant speed.

speed = ... m/s [1]

(ii) Determine the time when the bus begins to decelerate and the time when it ends decelerating.

begins at time = ... s

ends at time = ... s
[1]

(d) The bus uses batteries to supply energy to the electric motors that drive the wheels of the bus.

Complete the sentence by identifying the energy transfers that happen when the bus is moving. One has been done for you.

Energy is transferred from potential energy in the batteries
to electrical energy in the motors and then to
energy of the motors and the moving bus.

[2]

[Total: 9]

- 4 (a) Fig. 4.1 shows some of the parts of an insect-pollinated flower.

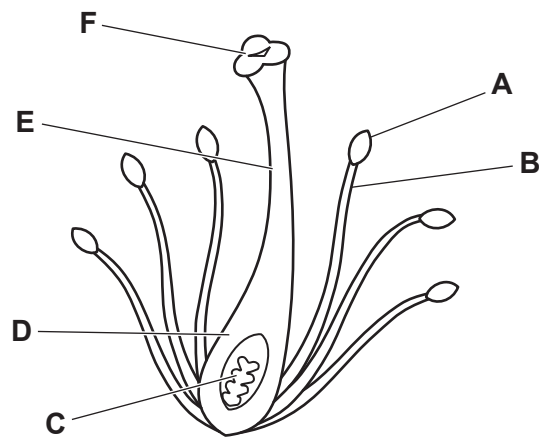


Fig. 4.1

- (i) State the letter on Fig. 4.1 that identifies:

an ovule

where pollination occurs.

[2]

- (ii) Fig. 4.1 does **not** show the sepals and petals of the flower.

State the function of:

sepals

petals.

[2]

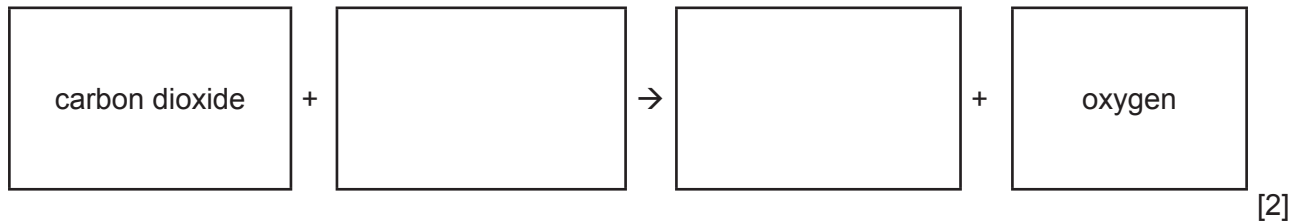
- (b) An animal gets its energy by eating **only** plants.

State the term that describes this type of animal.

..... [1]

(c) Plants use carbon dioxide for photosynthesis.

(i) Complete the word equation for photosynthesis.



(ii) Fig. 4.2 is a graph showing the effect of carbon dioxide concentration on the rate of photosynthesis.

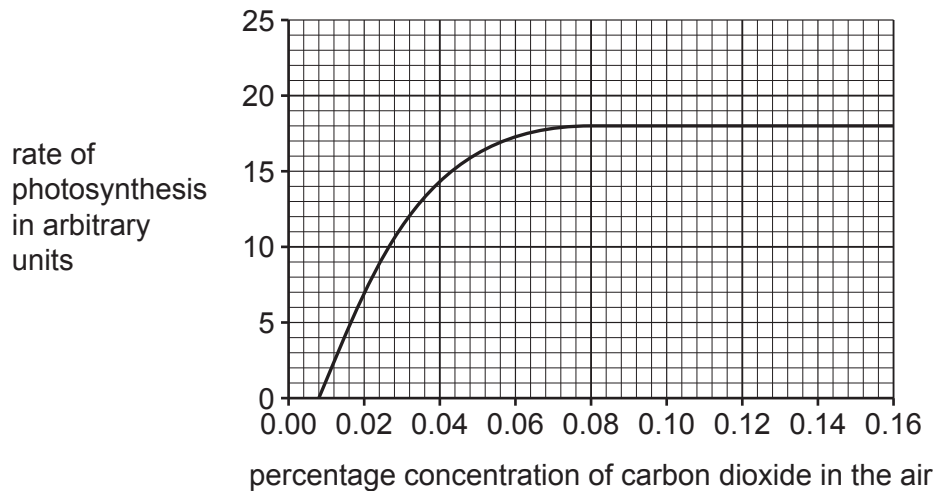


Fig. 4.2

Describe the effect of increasing carbon dioxide concentration on the rate of photosynthesis shown in Fig. 4.2.

Include data in your answer.

.....

.....

.....

..... [2]

(d) Deforestation causes an increase in carbon dioxide concentration in the atmosphere.

State **two other** undesirable effects of deforestation.

1

2 [2]

[Total: 11]

5 Part of the Periodic Table is shown in Fig. 5.1.

Group																	
I	II											III	IV	V	VI	VII	VIII
								H									He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

Fig. 5.1

(a) (i) Draw **one** straight line to show the trend in metallic character across a period.

decreases across a period
from left to right

metallic
character

increases across a period
from left to right

stays the same across a
period from left to right

[1]

(ii) State the name of the collection of metals that includes iron, Fe, and copper, Cu.

..... [1]

(b) Lithium, Li, sodium, Na, and potassium, K, are in Group I of the Periodic Table.

State the trend in the melting point and the trend in the reaction with water of these elements going down Group I.

melting point

.....

reaction with water

.....

[2]

- (c) Sodium, Na, reacts with fluorine, F, to form sodium fluoride.

Fig. 5.2 shows the electronic structure of a sodium atom and of a fluorine atom.



Fig. 5.2

When sodium atoms react with fluorine atoms, sodium ions and fluoride ions form.

Complete the dot-and-cross diagrams in Fig. 5.3 to show all of the electrons in a sodium ion and in a fluoride ion.

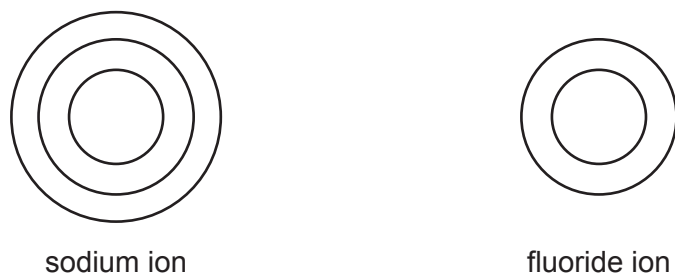


Fig. 5.3

[2]

(d) The electronic structure of an atom of element **Z** is shown in Fig. 5.4.

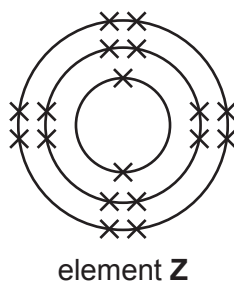


Fig. 5.4

(i) Use the Periodic Table to identify element **Z**.

..... [1]

(ii) Sodium and element **Z** do **not** easily form a compound together.

Use the electronic structure shown in Fig. 5.4 to explain this observation.

.....
.....
..... [2]

[Total: 9]

BLANK PAGE

- 6 The list shows some types of wave.

infrared waves

microwaves

radio waves

sound waves

visible light waves

water waves

- (a) Choose types of wave from the list to answer these questions.

Each wave may be used once, more than once or not at all.

- (i) State the type of wave used in intruder alarms.

..... [1]

- (ii) State **two** types of wave that are **not** part of the electromagnetic spectrum.

1

2 [2]

- (iii) State the type of wave which is the electromagnetic wave with the lowest frequency.

..... [1]

- (b) The air temperature is 15°C .

A sound wave in the air takes 2.6 s to travel from the source to a person hearing the sound.

The speed of sound in air at 15°C is 340 m/s.

- (i) Show that the distance of the person from the source is 884 m.

[1]

- (ii) The speed of sound in air increases as the temperature of the air increases.

At 35°C the speed of sound in air is 352 m/s.

Estimate the speed of sound at 25°C .

speed = ... m/s [1]

- (c) (i) State the equation used to calculate the density of a substance from known values of mass and volume.

..... [1]

- (ii) Explain why the density of air decreases when the temperature of air increases.

.....

.....

..... [2]

[Total: 9]

- 7 (a) Table 7.1 shows information about some fruits.

Table 7.1

fruit	mass of nutrient per 100g of fruit /g			
	carbohydrate	protein	fat	fibre
apple	13.8	0.3	0.2	2.4
avocado	8.5	2.0	15.0	6.7
blueberry	14.5	0.7	0.3	2.4
orange	13.0	0.9	0.1	2.2
strawberry	7.7	0.7	0.3	2.0

- (i) Identify **two** fruits with identical fat content per 100g of fruit.

..... and [1]

- (ii) Eating fruit helps the movement of food through the alimentary canal.

Explain why avocados are the best fruit in Table 7.1 to eat for this process.

..... [1]

- (iii) A student mixes 20g of crushed avocado into a biuret solution.
After 5 minutes the biuret solution changes colour.

Use Table 7.1 to explain this observation.

.....

 [2]

(b) Complete these sentences about the digestion of food in the alimentary canal.

Choose words from the list.

Each word may be used once, more than once or not at all.

absorption

egestion

ingestion

insoluble

osmosis

soluble

Food is taken into the mouth by the process of

Digestion breaks down large food molecules into
small water food molecules.

The small molecules then move through the wall of the intestine by the process of
.....

[3]

[Total: 7]

8 (a) The fossil fuel petroleum is a liquid mixture of hydrocarbons.

(i) Complete the sentence about hydrocarbons.

Hydrocarbons are molecules that contain and only. [1]

(ii) Describe the arrangement and motion of particles in a liquid.

arrangement

.....

motion

.....

[2]

(iii) Explain why the change in state from a liquid to a gas is described as a physical change.

.....

..... [1]

(b) A diagram of the equipment used to separate petroleum is shown in Fig. 8.1.

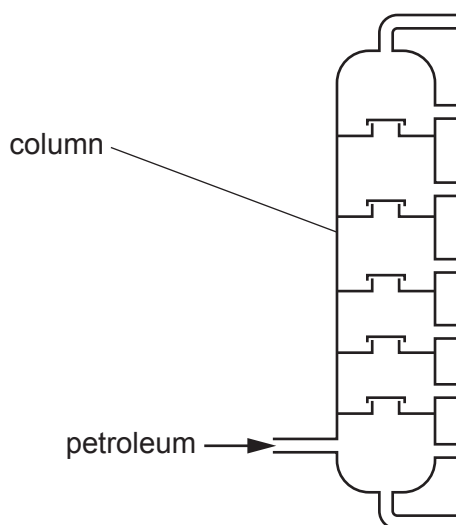


Fig. 8.1

State the name of the separation process that uses this equipment.

..... [1]

(c) Ethene is an unsaturated hydrocarbon.

(i) Describe what is meant by unsaturated.

..... [1]

(ii) Naphtha is obtained from petroleum.

Naphtha undergoes a process to produce ethene.

State the name of the process that produces ethene from naphtha.

..... [1]

(iii) State the name of the type of chemical reaction that changes ethene into poly(ethene).

..... [1]

[Total: 8]

- 9 Fig. 9.1 shows a circuit containing two identical lamps.

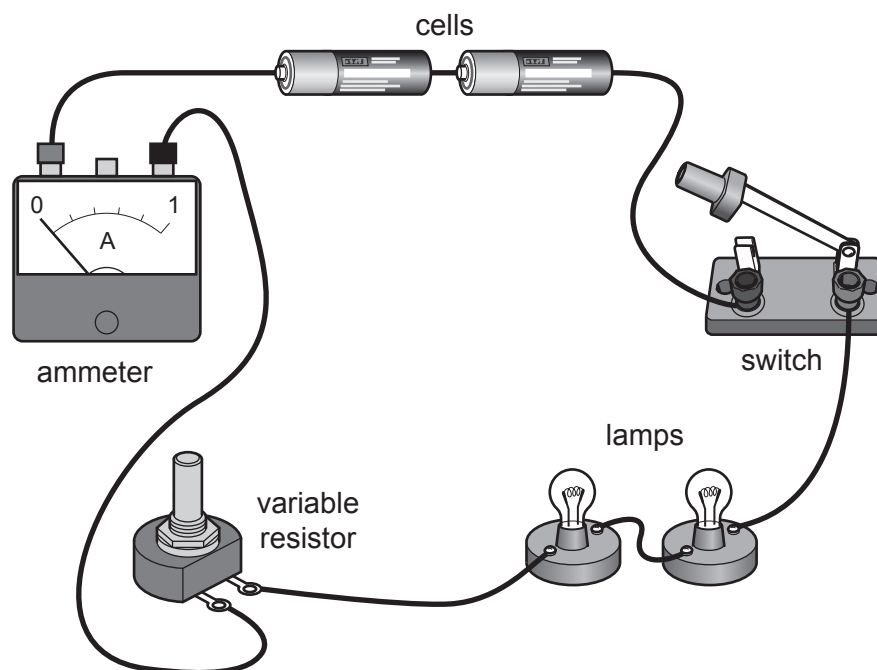


Fig. 9.1

- (a) The variable resistor is at its minimum resistance and the voltage across the battery is 3.1 V.

When the switch is closed, both lamps are brightly lit.

- (i) The ammeter reads 0.55 A.

Calculate the total resistance of the circuit.

Give the unit of your answer.

resistance = ... unit [3]

- (ii) When the variable resistor is at minimum resistance, its resistance is zero.

Use your answer to (a)(i) to calculate the value of the resistance of each lamp.

resistance = ... [1]

(b) The circuit remains switched on for a long time. The lamps become less bright.

(i) Predict what happens to the reading on the ammeter during this time.

..... [1]

(ii) The lamps become less bright because the cells are 'running down' and need replacing.

Suggest what measurement is made to check that the cells are 'running down'.

..... [1]

(c) On Fig. 9.2, complete the circuit diagram for the circuit shown in Fig. 9.1.

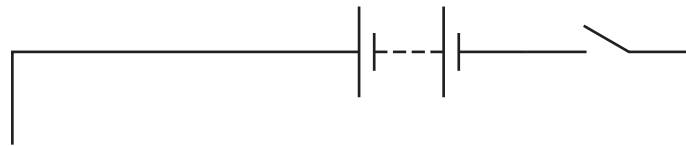


Fig. 9.2

[3]

[Total: 9]

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The Periodic Table of Elements

Group																		
I	II	Key										III	IV	V	VI	VII	VIII	
		atomic number atomic symbol name relative atomic mass										1 H hydrogen 1						
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	2 He helium 4	
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 —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganeson —

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
	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 dm³ at room temperature and pressure (r.t.p.).