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COMBINED SCIENCE

0653/31

Paper 3 Theory (Core)

May/June 2025

1 hour 15 minutes

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.
- 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 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 **20** pages. Any blank pages are indicated.

1 (a) Fig. 1.1 is a diagram of a plant root hair cell.

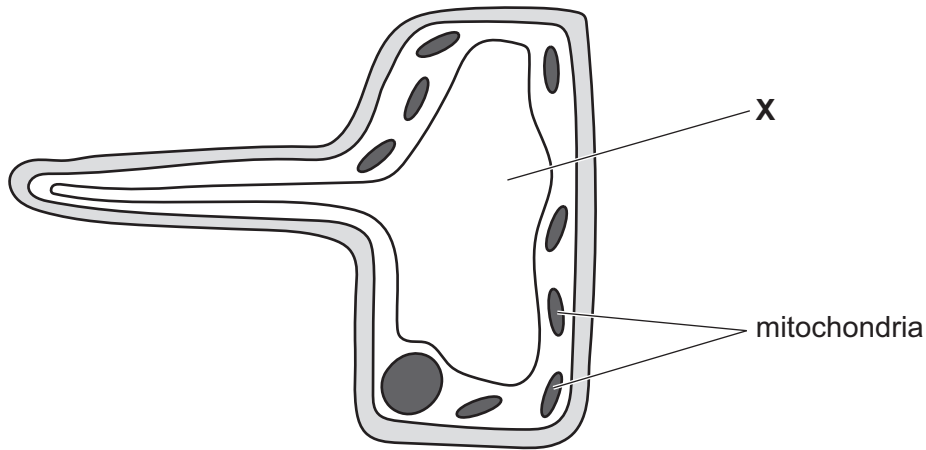


Fig. 1.1

(i) Name the part labelled **X** on Fig. 1.1.

..... [1]

(ii) State the function of mitochondria.

..... [1]

(iii) Suggest why the cell in Fig. 1.1 does **not** have chloroplasts.

.....

 [2]

(b) Water enters the root hair cell from the soil.

(i) Complete the sentence to describe the movement of water into the cell.

Water diffuses through a permeable membrane by

..... [2]

(ii) Water passes through the root to the xylem.

Circle the name of the root cells that water passes through to reach the xylem.

cortex

guard

mesophyll

palisade

[1]



(c) Fig. 1.2 shows part of the carbon cycle.

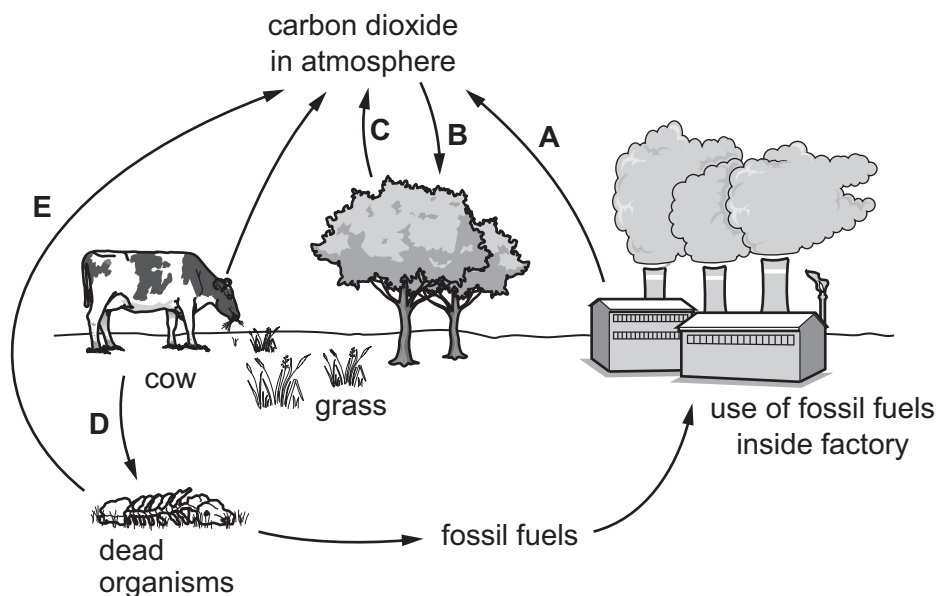


Fig. 1.2

(i) State the letter on Fig. 1.2 that represents:

combustion

decomposition.

[2]

(ii) Use Fig. 1.2 to explain why the cow is described as a herbivore.

.....

..... [1]

[Total: 10]



2 Fig. 2.1 shows the structure of a human heart.

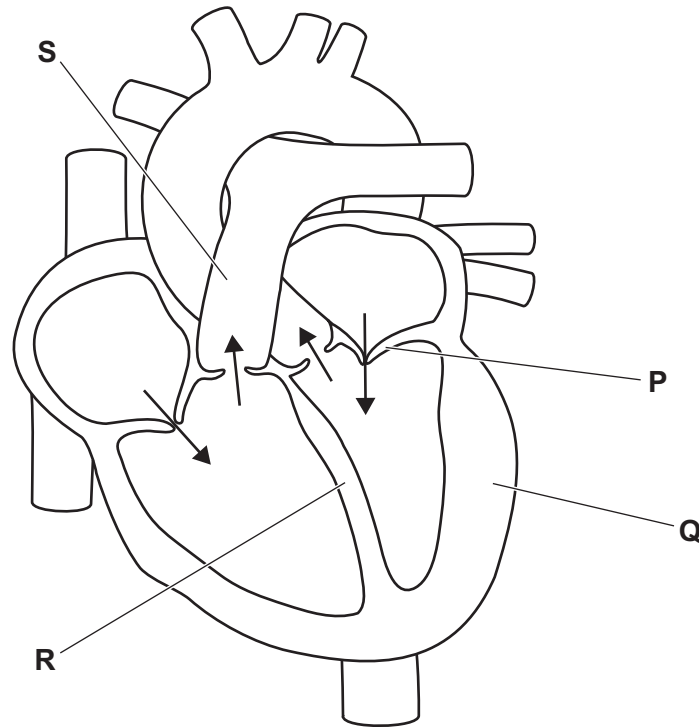


Fig. 2.1

The arrows in Fig. 2.1 show the direction of blood flow through the heart.

(a) Use letters **P–S** to complete the sentences about the heart in Fig. 2.1.

The part labelled is the muscular wall of the left ventricle.

Blood is transported away from the right side of the heart in the part labelled

The part labelled ensures one-way flow of blood.

[3]

(b) The activity of the heart may be monitored by ECG (electrocardiogram).

State **one other** way to monitor the activity of the heart.

..... [1]





(c) Blood contains four main components.

Name the component of blood that:

transports hormones

produces antibodies

contains haemoglobin

[3]

(d) Blood is pumped away from the heart in arteries and returns to the heart in veins.

Describe **two** differences in the structure of arteries compared to veins.

1

.....

2

.....

[2]

[Total: 9]



- 3 (a) Nutrition is one of the characteristics of living organisms.

Define nutrition.

.....
 [1]

- (b) Table 3.1 shows some information about nutrients in bananas.

Table 3.1

nutrient	mass of nutrient per 100 g of banana / g
carbohydrate	12.2
protein	1.1
fat	0.3
fibre (roughage)	2.6
vitamin C	0.0087

- (i) Identify the nutrient in Table 3.1 that helps to keep food moving through the large intestine.

..... [1]

- (ii) A health authority recommends that adults should eat 0.040 g of vitamin C per day.

A person eats 100 g of bananas.

Use Table 3.1 to calculate the percentage of the recommended mass of vitamin C the person eats.

percentage = ... [2]



(c) Banana trees that grow in the wild need to be pollinated before they can produce fruit.

Complete the sentences about pollination.

Use words from the list.

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

anther

fertilisation

filament

germination

ovary

ovule

reproduction

stigma

Pollination is the transfer of pollen grains from the to

the

The pollen nucleus then fuses with the nucleus of the

The fusion of nuclei is called

[4]

[Total: 8]



4 (a) Iron is a metal.

Fig. 4.1 shows the three physical states of iron.

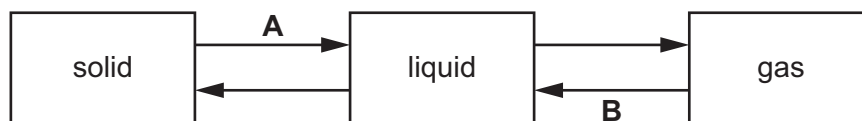


Fig. 4.1

Name the changes of state shown by arrows **A** and **B**.

A

B

[2]

(b) Complete the sentences about the particles in a liquid.

Use words or phrases from the list.

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

at the same speed as

more quickly than

stable

more slowly than

regular

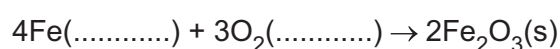
random

The particles in a liquid move in a solid.

Particles in a liquid have a arrangement.

[2]

(c) The symbol equation for the reaction of solid iron with oxygen is shown.



(i) Complete the symbol equation by adding the state symbols.

[1]

(ii) Explain how the equation shows that oxidation takes place.

.....
 [1]

(d) Iron is used as a catalyst in a reaction to make ammonia.

Describe the effect of a catalyst on the rate of reaction.

..... [1]

[Total: 7]





5 Potassium and magnesium are metals.

(a) A solid compound contains potassium ions.

Describe the use of a flame test to identify potassium ions.

.....

.....

..... [2]

(b) A small piece of potassium is added to cold water. An exothermic reaction happens.

(i) Complete the sentence about an exothermic reaction.

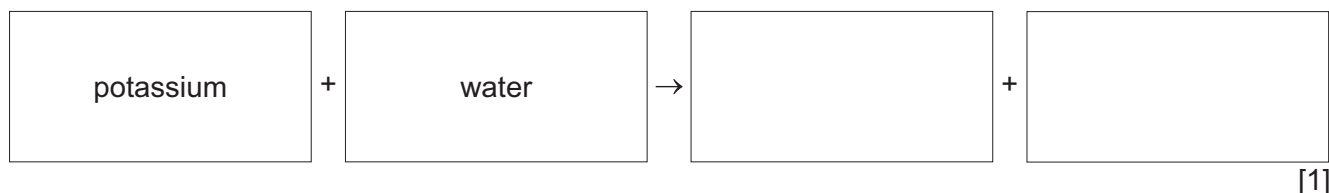
An exothermic reaction transfers energy to the surroundings.

[1]

(ii) State **one** observation that shows this reaction is exothermic.

..... [1]

(iii) Complete the word equation for this reaction.



[1]

(c) Magnox is an alloy of magnesium.

Describe what is meant by an alloy.

.....

..... [1]

(d) The proton number of magnesium is 12.

Determine the electronic configuration of magnesium.

..... [1]



(e) Fig. 5.1 shows the structure of a compound of magnesium.

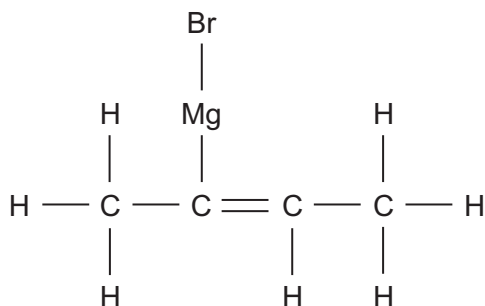


Fig. 5.1

Deduce the molecular formula of this compound.

..... [1]

[Total: 8]



- 6 (a) The formulas of some compounds of carbon are shown.



Use the formulas of these compounds to answer the following questions.

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

State which compound:

- (i) decolourises aqueous bromine

..... [1]

- (ii) is the main constituent of natural gas

..... [1]

- (iii) forms poly(ethene) in an addition polymerisation reaction

..... [1]

- (iv) is a product of the complete combustion of alkanes **and** leads to global warming

..... [1]

- (v) is a toxic gas formed by incomplete combustion

..... [1]

- (vi) is a waste gas produced from digestion in animals

..... [1]

- (vii) is an acidic oxide.

..... [1]

- (b) State what is meant by a hydrocarbon.

.....

..... [1]



(c) Bitumen and refinery gas are obtained from petroleum.

Name **one** use of:

bitumen

refinery gas.

[2]

(d) Coal is a fossil fuel.

During the combustion of coal, a compound that contains sulfur is made.

Name this compound.

..... [1]

[Total: 11]



7 Fig. 7.1 shows an electric motorcycle.

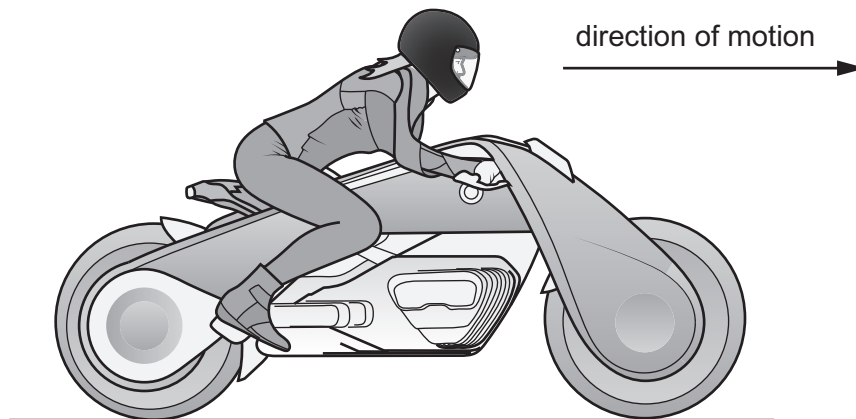


Fig. 7.1

- (a) (i) On Fig. 7.1, draw an arrow to show the direction of the air resistance acting on the motorcycle.

Label the arrow with the letter **R**.

[1]

- (ii) Complete the sentences about the motorcycle.

The motorcycle is moving at constant speed along a level road.

The total resistance force is 250 N.

The driving force must also be 250 N because the force is zero.

[1]

- (iii) Name the unit represented by N.

..... [1]



(b) The motorcycle is powered by a battery.

(i) The motorcycle travels a distance of 24 km at an average speed of 16 m/s.

Show that the time taken to travel this distance is 1500 s.

[2]

(ii) The battery supplies a constant current of 45 A at a voltage of 72 V.

Calculate the power supplied by the battery.

power = ... W [2]

(iii) Use your answer to (b)(ii) to calculate the total energy supplied by the battery in 1500 s.

energy = ... J [2]

[Total: 9]



8 Some cars are powered by petrol (gasoline) engines made of iron.

(a) Petrol burns inside the engine at a temperature of 1800°C .

(i) Iron melts at a temperature of 1538°C .

Suggest why the car engine must be cooled by a flow of cold water.

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

(ii) The mass of iron used in the car engine is 150 kg.

The density of iron is 7900 kg/m^3 .

Calculate the volume of iron used in the car engine.

volume = ... m^3 [2]



(b) A car driver listens to the radio.

(i) Fig. 8.1 shows a wave.

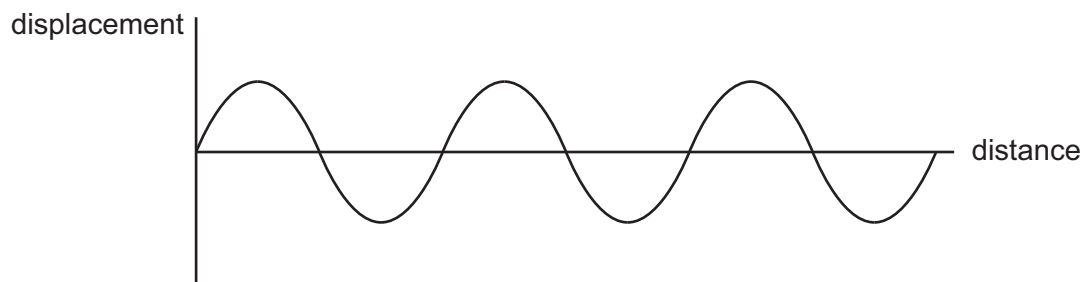


Fig. 8.1

On Fig. 8.1, draw a double-headed arrow ($\leftrightarrow$ or $\updownarrow$) to show **one** wavelength. [1]

(ii) The radio waves have a wavelength of 1200 m.

The speed of the radio waves is 3.0×10^8 m/s.

Calculate the frequency of the radio waves.

Include the unit in your answer.

frequency = ... unit [3]

(iii) Radio waves are used for radio transmissions.

State **one other** application of radio waves.

..... [1]

[Total: 8]



- 9 A spacecraft is on a journey to the planet Saturn.

(a) Fig. 9.1 shows a circuit for an electric motor used in the spacecraft.

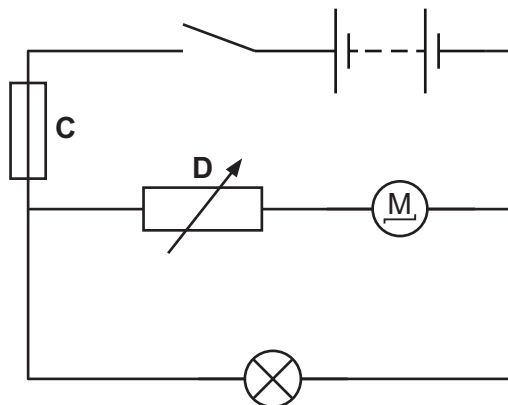


Fig. 9.1

- (i) State the name and purpose of component **C**.

name

purpose
 [2]

- (ii) Describe how component **D** is used to control the current in the motor.

.....

 [2]

- (iii) The voltage across the lamp is 6.3 V.

The current in the lamp is 0.45 A.

Calculate the resistance of the lamp.

resistance = ... Ω [2]





(b) Complete the sentences about the journey of the spacecraft.

The spacecraft travels directly from the Earth to the planet Saturn.

On the way to Saturn, the spacecraft first crosses the orbit of the

planet and then crosses the orbit of

the planet

[2]

(c) Explain why the planets orbit around the Sun.

.....

.....

.....

..... [2]

[Total: 10]

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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	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 —	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.).

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COMBINED SCIENCE**0653/32**

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May/June 2025**1 hour 15 minutes**

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1 (a) Fig. 1.1 shows a white blood cell.

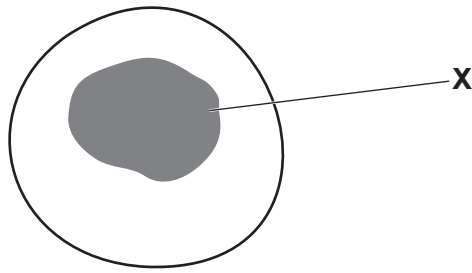


Fig. 1.1

(i) Name the part labelled **X** on Fig. 1.1.

..... [1]

(ii) State **one** function of white blood cells.

..... [1]

(iii) Circle **two** structures found in both white blood cells and bacterial cells.

cell membrane

cell wall

cytoplasm

circular DNA

large vacuole

plasmid

[2]

(b) Blood is part of the circulatory system.

Complete the sentence to describe the circulatory system.

The circulatory system is a system of blood with a pump

and to ensure one-way flow of blood.

[2]



(c) Fig. 1.2 is a graph that shows the heart rate of a person during and after physical activity.

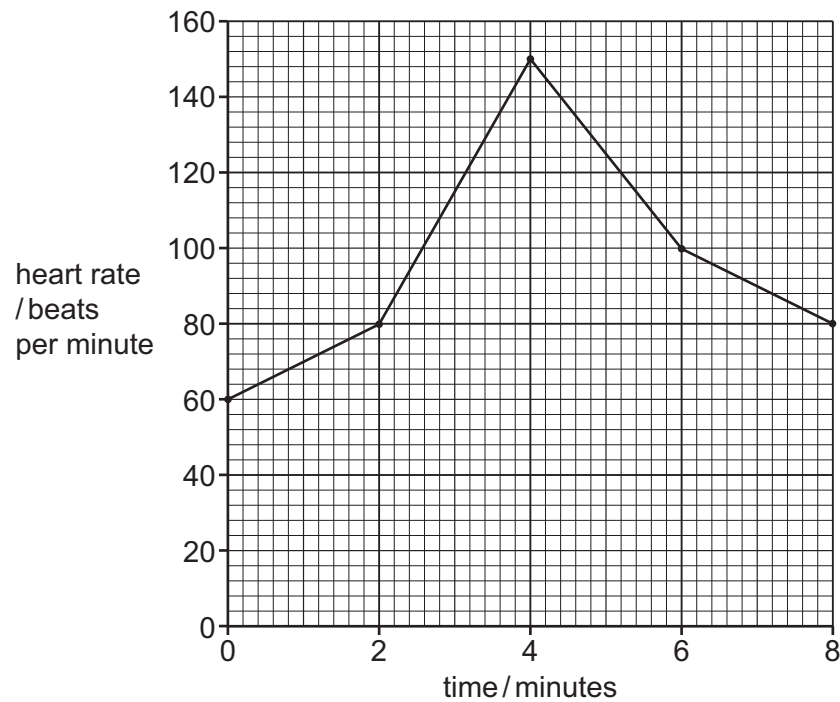


Fig. 1.2

Calculate the percentage increase in heart rate between 0 minutes and 4 minutes of physical activity.

heart rate at 0 minutes of physical activity = ... beats per minute

heart rate at 4 minutes of physical activity = ... beats per minute

change in heart rate = ... beats per minute

percentage increase in heart rate = ... [3]

[Total: 9]



- 2 (a) Fig. 2.1 is a diagram of a cross-section through a leaf.

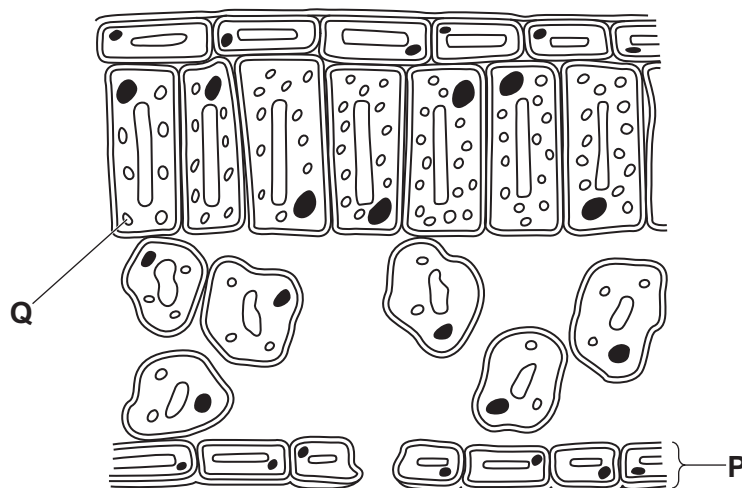


Fig. 2.1

- (i) Name the part labelled **P** on Fig. 2.1.

..... [1]

- (ii) Draw a label line and the letter **S** to identify a spongy mesophyll cell on Fig. 2.1. [1]

- (iii) Name the pigment found in the part labelled **Q** on Fig. 2.1.

..... [1]

- (b) A plant is left in a warm dark room for three days.

After three days, a leaf from the plant is tested with iodine solution.

The iodine solution stays yellow-brown in colour.

Complete the sentences to explain this result.

The yellow-brown colour of the iodine solution indicates that the leaf does **not** contain

.....

The plant has **not** photosynthesised because there is no

[2]



(c) Fig. 2.2 shows part of a food web.

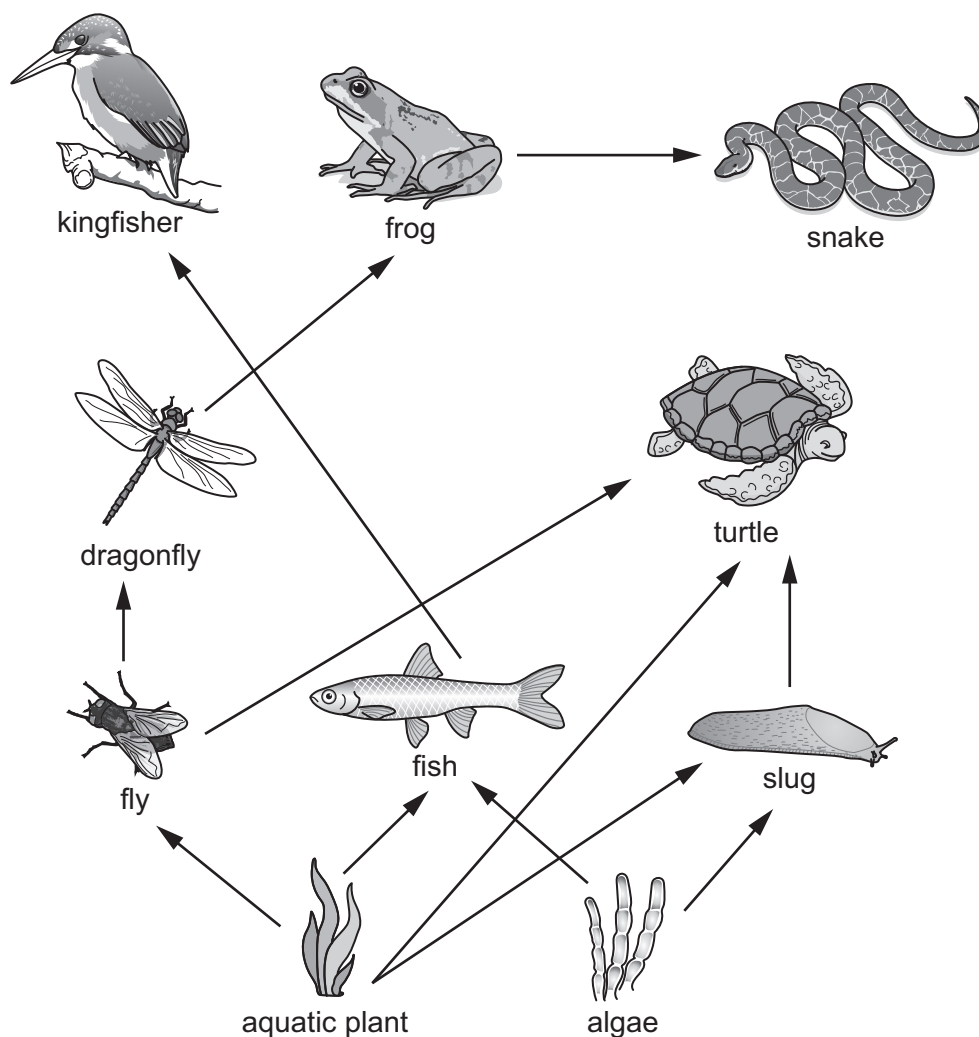


Fig. 2.2

(i) Identify **one** herbivore in Fig. 2.2.

..... [1]

(ii) Identify **one** tertiary consumer in Fig. 2.2.

..... [1]

(iii) Animals in the food web produce waste organic material.

Name the type of organism that gets its energy from waste organic material.

..... [1]

[Total: 8]



- 3 (a) Nutrition is one of the characteristics of living organisms.

State **two** other characteristics of living organisms.

1

2 [2]

- (b) Table 3.1 shows some information about the digestive system in humans.

- (i) Complete Table 3.1.

Table 3.1

organ	function of organ
mouth	 and digestion of food
small intestine	digestion and of food into the blood
.....	egestion of undigested food

[3]

- (ii) Fats are digested in the small intestine.

Name the **two** smaller molecules that fats are made from.

..... and [2]



(c) Enzymes are used to digest food in the digestive system.

(i) Fig. 3.1 is a graph that shows the effect of pH on the enzyme activity of one enzyme.

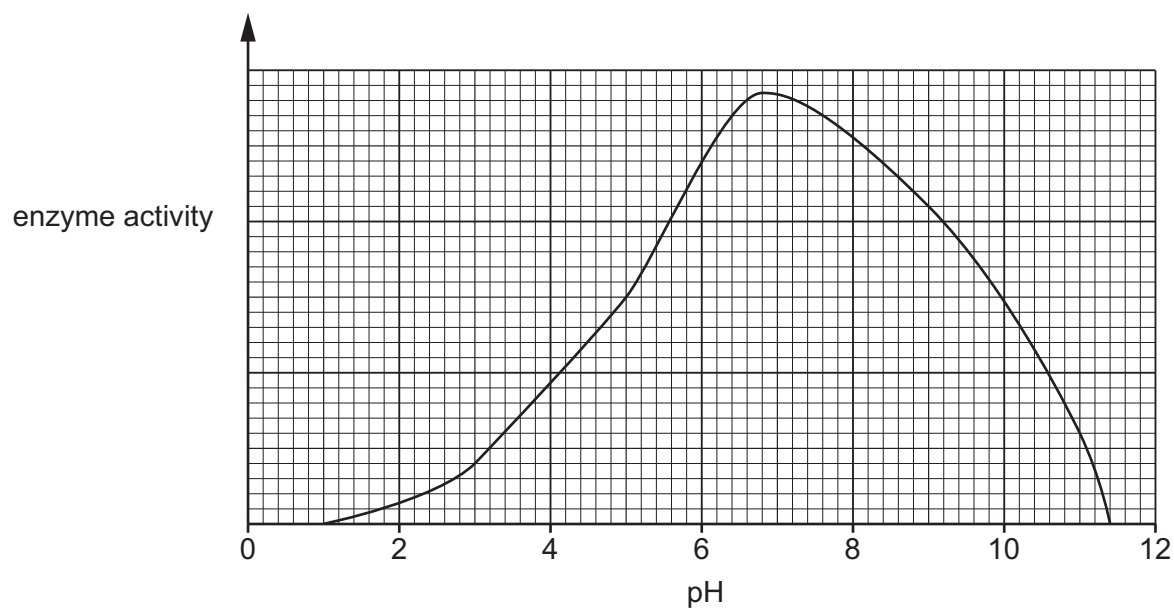


Fig. 3.1

Describe the effect of pH on enzyme activity shown in Fig. 3.1.

Include data in your answer.

.....

 [2]

(ii) State **one** factor that affects enzyme activity, other than pH.

..... [1]

[Total: 10]



4 (a) Solid sodium reacts with water.

(i) Circle the gas that forms when sodium reacts with water.

carbon dioxide

chlorine

hydrogen

oxygen

[1]

(ii) State **one** way the reaction of potassium with water is different from the reaction of sodium with water.

.....
 [1]

(b) Aqueous sodium chloride is a mixture of two compounds, sodium chloride and water.

State **one** similarity and **one** difference between a compound and a mixture.

similarity

.....

difference

.....

[2]

(c) Solid sodium is heated to form a liquid.

(i) Tick (✓) **all** the boxes that show correct properties of a liquid.

A liquid cannot be squashed.

☐

A liquid has no fixed volume.

☐

A liquid takes the shape of its container.

☐

[1]

(ii) The symbol for solid sodium is Na(s).

Complete the symbol for **liquid** sodium by adding the missing state symbol.

Na(.....)

[1]



(d) The noble gases are in Group VIII of the Periodic Table.

Explain how the electronic configuration of neon affects its reactivity.

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

(e) Nitrogen is a gas.

(i) State the percentage of nitrogen gas in clean, dry air.

..... % [1]

(ii) Oxides of nitrogen are air pollutants.

State **one** source of these oxides of nitrogen.

..... [1]

(iii) State **one** adverse effect of oxides of nitrogen.

..... [1]

[Total: 10]



5 (a) Iron is a transition element.

Tick (✓) **two** boxes that show correct statements about the properties of iron and Group I elements.

Iron and Group I elements conduct electricity.

☐

Iron has a higher melting point than Group I elements.

☐

Group I elements have a higher density than iron.

☐

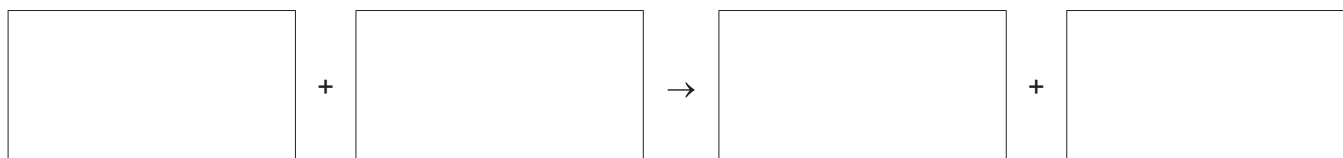
Group I elements form coloured compounds but iron compounds are white.

☐

[2]

(b) Iron reacts with dilute hydrochloric acid.

Write the word equation for the reaction.



[1]

(c) Fig. 5.1 shows three identical iron nails, each in a different test-tube, **A**, **B** and **C**.

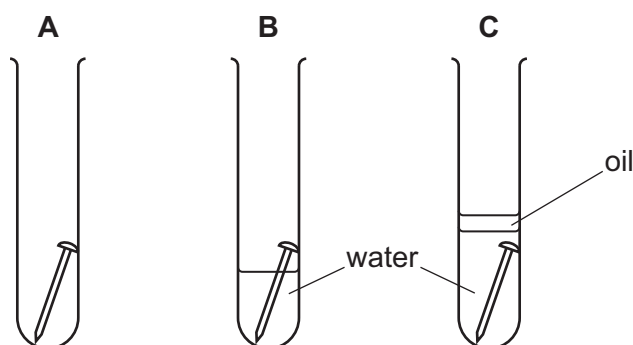


Fig. 5.1

Predict in which test-tube the iron nail rusts most quickly.

Explain your answer.

test-tube

explanation

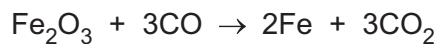
.....

.....

[2]



(d) Iron is extracted from iron(III) oxide in a blast furnace.



Circle the type of reaction when iron(III) oxide forms iron.

combustion

oxidation

reduction

separation

[1]

(e) Aluminium is extracted by electrolysis.

Name the main ore of aluminium.

..... [1]

(f) Part of the reactivity series is shown.

sodium

magnesium

carbon

zinc

hydrogen

copper

(i) Use this reactivity series to name:

- **one** metal that must be extracted by electrolysis
- **one** metal that is extracted by heating with carbon.

metal extracted by electrolysis

metal extracted by heating with carbon

[2]

(ii) Explain why different methods of extraction are needed for the two metals in (f)(i).

.....

.....

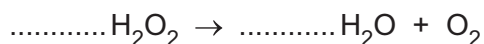
[1]

[Total: 10]



- 6 Hydrogen peroxide, H_2O_2 , decomposes into water and oxygen when a catalyst is added.

(a) Balance the symbol equation for the reaction.



[1]

(b) The oxygen is collected and tested.

Describe the test for oxygen gas.

State the observation for the positive result.

test

observation

[1]

(c) Anhydrous cobalt(II) chloride is used to test for water.

State the colour observed for a positive result.

..... [1]

(d) Describe what is meant by a catalyst.

.....

.....

.....

..... [2]

(e) The temperature of the hydrogen peroxide is increased. All other conditions stay the same.

Predict the effect of this change on the reaction.

..... [1]

[Total: 6]





7 Fig. 7.1 shows a tram powered by electricity supplied through overhead cables.

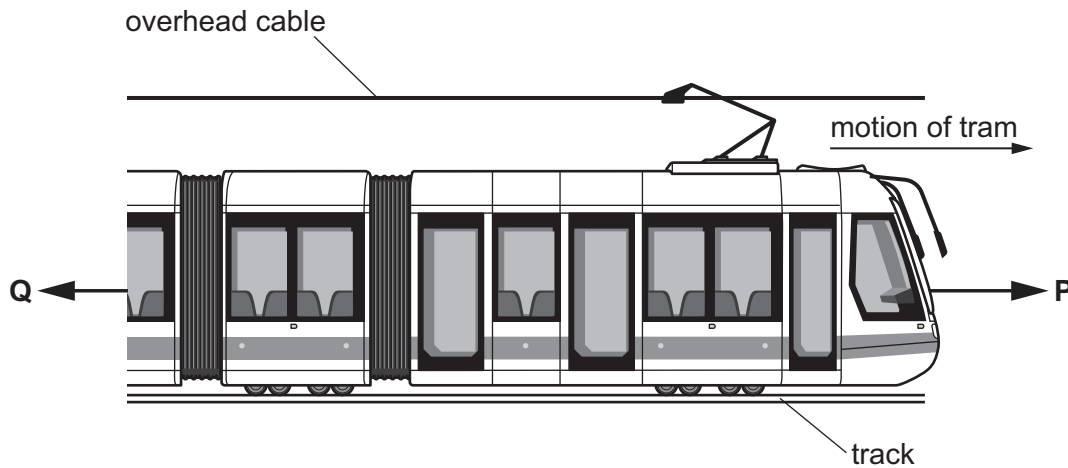


Fig. 7.1

(a) Forces **P** and **Q** act on the tram as it moves along a level track.

Force **P** has a magnitude of 2400 N.

Force **Q** has a magnitude of 1900 N.

(i) Name force **Q**.

..... [1]

(ii) Calculate the resultant force acting on the tram.

resultant force = ... N [1]

(iii) Describe the motion of the tram.

..... [1]



- (b) The mass of the tram is 35 000 kg.

Calculate the weight of the tram.

weight = ... N [2]

- (c) Later in its journey, the tram moves up a hill at constant speed.

Complete the sentence about energy transfers.

Energy is transferred to the energy store of the tram
and the thermal energy stores of the tram and the surroundings.

[1]

- (d) On one journey, the tram travels for 0.24 h.

The electrical power input to the tram is 55 kW.

Energy is supplied at a cost of \$0.25 per kWh.

Calculate the total energy cost for this journey.

total energy cost = \$ [3]

[Total: 9]



8 Fig. 8.1 shows an electric heater that heats a room.

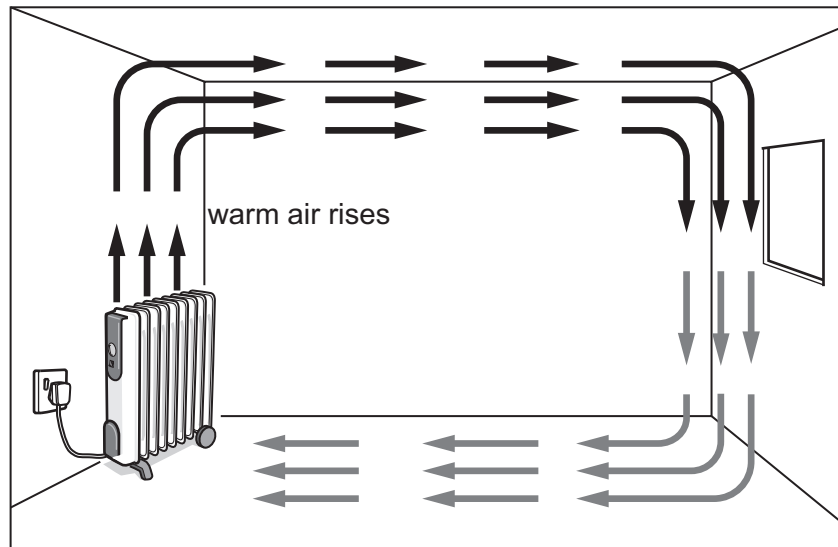


Fig. 8.1

- (a) (i) Circle the correct word in **bold** to complete the sentence.

The warm air above the electric heater rises. Thermal energy is mainly transferred around the room by **conduction** / **convection** / **radiation** .

[1]

- (ii) When air is heated, its temperature and volume increase.

Explain why this happens.

Use ideas about particle motion and separation in your answer.

temperature increases because

.....

volume increases because.....

.....

[2]



(b) Fig. 8.2 shows a circuit diagram for the electric heater.

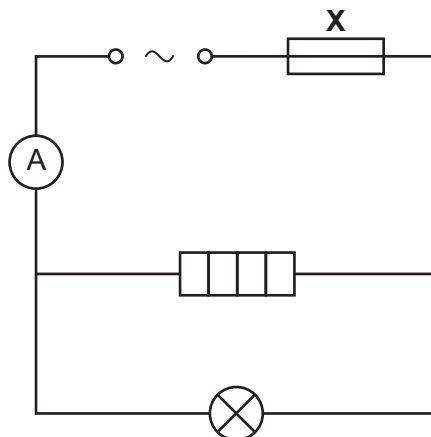


Fig. 8.2

The current in the electric heater is 3.2 A.

(i) Name component X.

..... [1]

(ii) The resistance of the heater is $35\ \Omega$.

Calculate the voltage of the power supply.

voltage = ... V [2]

(iii) The current in the lamp is 0.20 A.

Determine the reading on the ammeter.

reading = ... A [1]

(c) State the difference between direct current (d.c.) and alternating current (a.c.).

.....

 [2]

[Total: 9]



- 9 (a) Fig. 9.1 is a drawing of our galaxy showing the approximate location of the Sun.

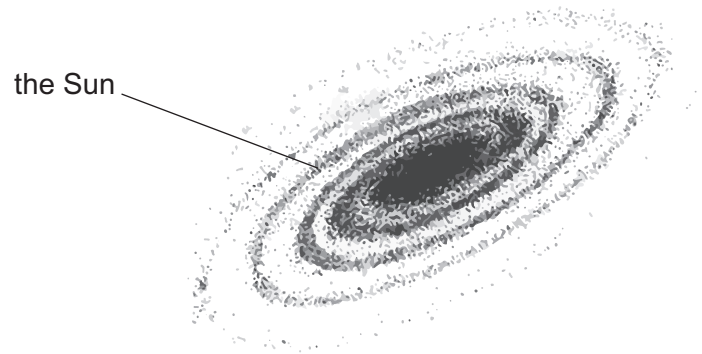


Fig. 9.1

- (i) Name our galaxy.

..... [1]

- (ii) The Sun is a distance of 25 000 light-years from the centre of our galaxy.

State the time taken for light to travel from the Sun to the centre of our galaxy.

Include the unit in your answer.

time = ... unit [1]

- (iii) Most of the energy radiated from the Sun is in three regions of the electromagnetic spectrum.

One of these regions is visible light.

On Fig. 9.2, tick (✓) **two** boxes to show the other two regions.

gamma radiation	X-rays	ultraviolet	visible light	infrared	microwaves	radio waves
			✓			

Fig. 9.2

[2]



- (b) Electromagnetic radiation of wavelength $6.0 \times 10^{-7} \text{ m}$ travels through space at a speed of $3.0 \times 10^8 \text{ m/s}$.

Calculate the frequency of the radiation.

Include the unit in your answer.

frequency = ... unit [3]

- (c) An astronomer looks at a distant star.

Fig. 9.3 shows the astronomer's eye and two parallel rays of light from the distant star.

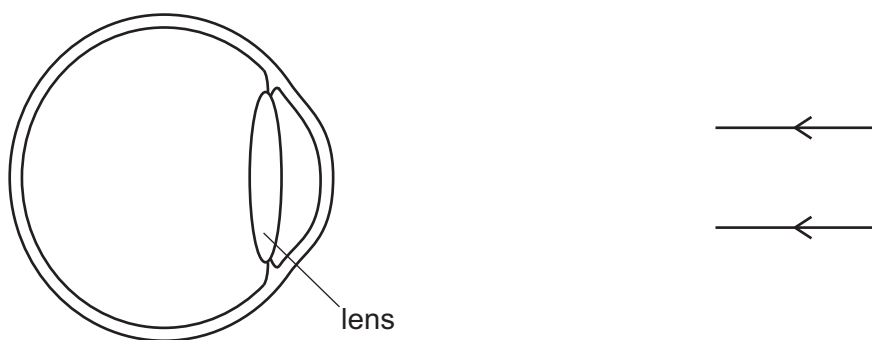


Fig. 9.3

Complete Fig. 9.3 to show the two rays focused onto the back of the astronomer's eye by the lens.

[2]

[Total: 9]

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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	21 Sc scandium 45	20 Ca calcium 40	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	53 I iodine 127	86 Rn radon —
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	36 Kr krypton 84	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	86 Rn radon —	118 Og oganesson —
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	54 Xe xenon 131	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 —	118 Og oganesson —	—
87 Fr francium —	88 Ra radium —	89–103 actinoids	86 Xe xenon 131	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.).



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COMBINED SCIENCE

0653/33

Paper 3 Theory (Core)

May/June 2025

1 hour 15 minutes

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.
- 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 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 **20** pages. Any blank pages are indicated.

1 (a) Fig. 1.1 is a diagram of the female reproductive system.

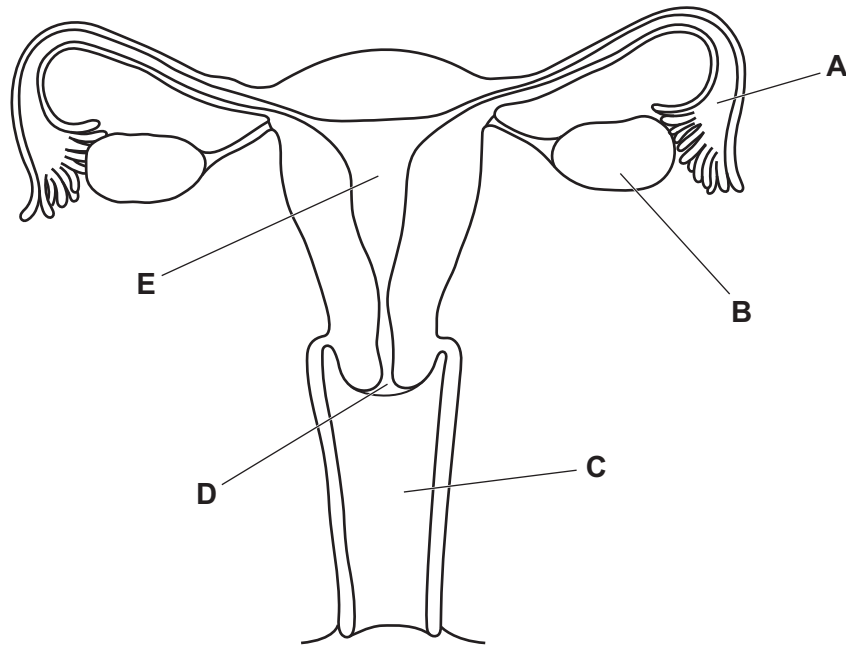


Fig. 1.1

State the letter on Fig. 1.1 that identifies:

the cervix

the oviduct

where female gametes are produced.

[3]

(b) The boxes on the left show some parts of the male reproductive system.

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

Draw one straight line from each part to its function.

part	function
scrotum	holds testes outside the body
prostate gland	passes sperm-containing fluid out of the body
urethra	produces fluid that mixes with sperm

[2]



(c) Fig. 1.2 shows the carpel from an insect-pollinated flower.

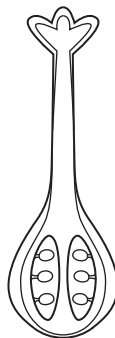


Fig. 1.2

(i) Draw a label line and the letter **S** on Fig. 1.2 to identify the style. [1]

(ii) Describe pollination.

.....

.....

.....

..... [2]

(d) A scientist describes an area of insect-pollinated flowers as having a high biodiversity.

Describe what is meant by biodiversity.

.....

.....

.....

..... [2]

[Total: 10]



- 2 (a) A student investigates the effect of different physical activity on heart rate.

Fig. 2.1 is a bar chart of the results.

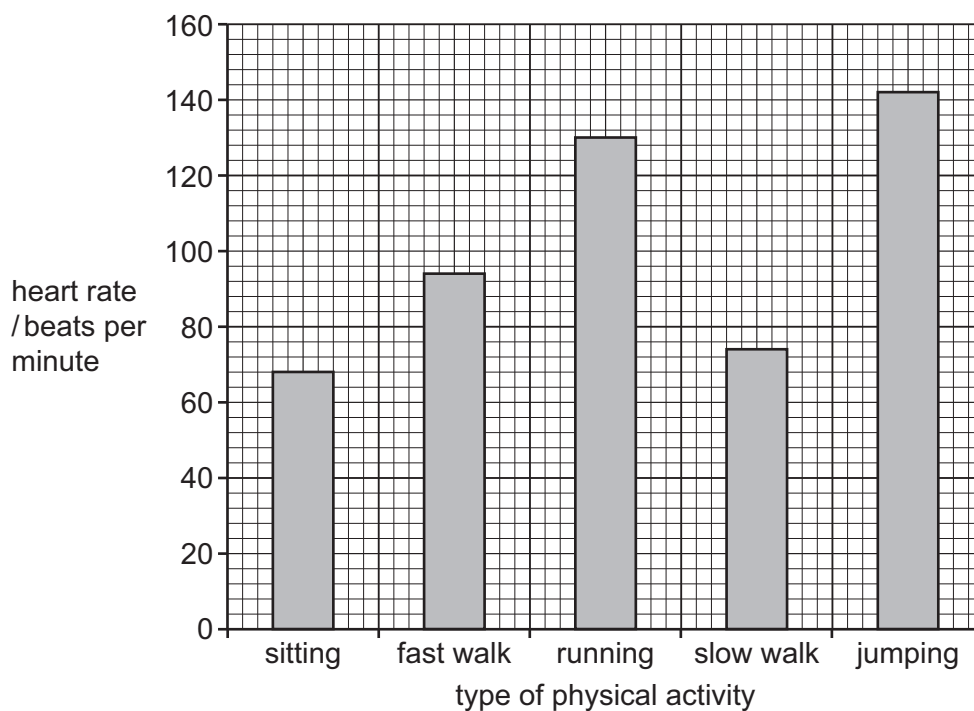


Fig. 2.1

- (i) Identify the type of physical activity in Fig. 2.1 that:
- results in the highest heart rate
- results in a heart rate of 68 beats per minute. [2]
- (ii) Calculate the difference in heart rate between fast walking and slow walking in Fig. 2.1.
- beats per minute [1]
- (iii) The student measures pulse rate to monitor the activity of the heart.
- State **one** other way to monitor the activity of the heart.
- [1]



(b) Physical activity uses energy from respiration.

(i) State the word equation for aerobic respiration.

..... [2]

(ii) Name the structures inside cells where aerobic respiration takes place.

..... [1]

(c) Biological molecules in the diet are a source of energy.

Chemical digestion breaks down large biological molecules into smaller ones.

Complete the sentences about chemical digestion.

Choose words from the list.

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

absorption

amino acids

assimilation

egestion

fatty acids

glycerol

ingestion

sugars

Proteins are large molecules made from smaller molecules called

.....

The smaller molecules move from the small intestine into the blood by the process of

.....

The smaller molecules travel in the blood to cells.

The smaller molecules are taken up by the cells and used. This process is called

.....

[3]

[Total: 10]



3 Fig. 3.1 shows part of a food web from a coral reef habitat.

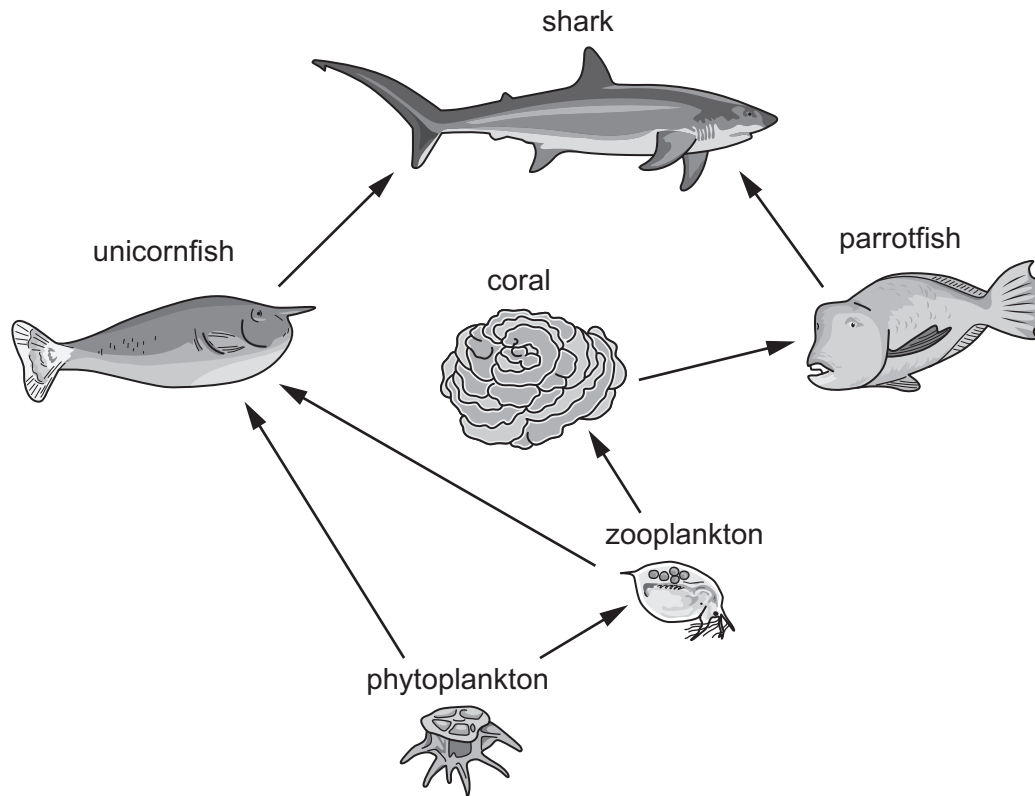


Fig. 3.1

(a) (i) Circle the word that describes the phytoplankton in the food web in Fig. 3.1.

animal

decomposer

herbivore

producer

[1]

(ii) Identify **one** primary consumer shown in Fig. 3.1.

..... [1]

(iii) Explain why the shark shown in Fig. 3.1 is described as a carnivore.

.....
 [1]



(b) Coral is being damaged by marine pollution.

(i) Use Fig. 3.1 to explain the effect this has on the number of parrotfish in the habitat.

.....

.....

..... [2]

(ii) Pollution of freshwater and marine environments is one cause of habitat destruction.

Describe **one** other cause of habitat destruction.

.....

..... [1]

(c) Coral reef habitats release carbon dioxide into the atmosphere.

State a process in the carbon cycle that removes carbon dioxide from the atmosphere.

..... [1]

[Total: 7]



4 Lithium fluoride, LiF, is an ionic compound.

(a) Complete the sentences to explain why lithium fluoride has a high melting point.

Choose words from the list.

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

configuration

attraction

conduction

gases

molecules

weak

strong

solids

An ionic bond is a electrostatic between ions with opposite charges.

Ionic compounds are at room temperature and pressure.

[3]

(b) Lithium fluoride contains lithium ions, Li^+ , and fluoride ions, F^- .

Fig. 4.1 shows the dot-and-cross diagram for lithium fluoride.

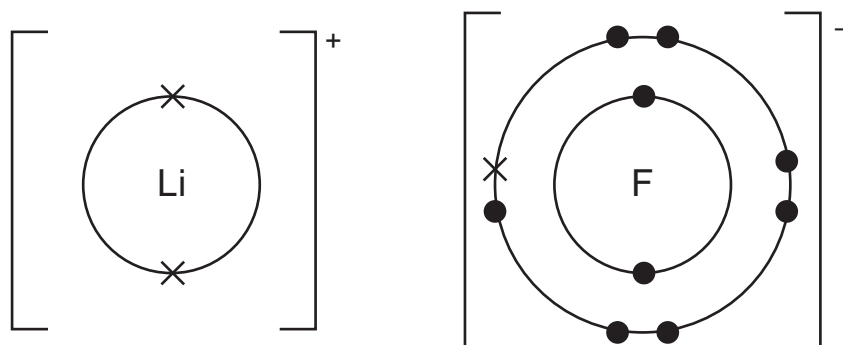


Fig. 4.1

Use Fig. 4.1 to describe what happens when a lithium atom and a fluorine atom form ions.

lithium

.....

fluorine

.....

[2]



(c) The Periodic Table gives information about an atom of fluorine, as shown in Fig. 4.2.

9
F
fluorine
19

Fig. 4.2

Deduce the number of protons and neutrons in this atom of fluorine.

number of protons

number of neutrons

[2]

(d) Fluorine is in Group VII of the Periodic Table.

Complete the sentences about elements in Group VII.

Choose phrases from the list.

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

more than

less than

the same as

The reactivity of bromine is the reactivity of fluorine.

The density of iodine is the density of fluorine.

The number of electrons in the outer shell of fluorine is the number of electrons in the outer shell of chlorine.

[2]

[Total: 9]



5 Dilute sulfuric acid is used in an electrolysis experiment.

(a) Universal indicator is used to measure the pH of the dilute sulfuric acid.

Describe how to use universal indicator to measure pH.

.....

.....

..... [2]

(b) Fig. 5.1 shows the electrolysis.

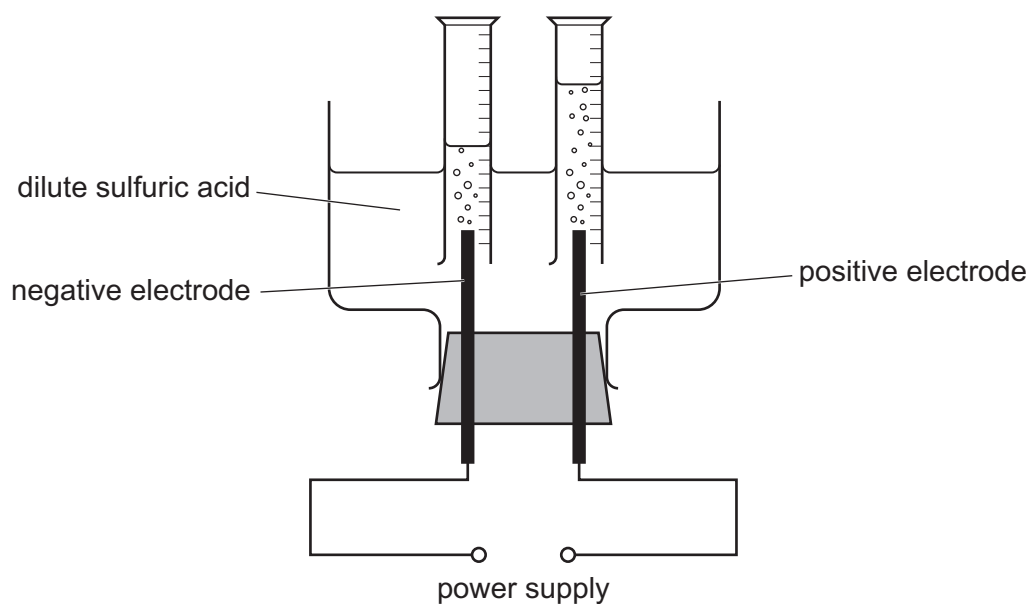


Fig. 5.1

(i) Identify the gas formed at each electrode.

negative electrode

positive electrode [2]

(ii) State the name of the positive electrode.

..... [1]

(iii) Identify the electrolyte in this electrolysis.

..... [1]



- (c) The volume of gas formed at each electrode is measured every 30 s for 2 min. The results are shown in Table 5.1.

Table 5.1

time /s	volume of gas at the negative electrode /cm ³	volume of gas at the positive electrode /cm ³
0	0	0
30	18	9
60	36	18
90	54	27
120		36

- (i) Use Table 5.1 to predict the volume of gas given off at the negative electrode at 120 s.

volume = ... cm³ [1]

- (ii) Use Table 5.1 to calculate the volume of gas formed per second at the positive electrode.

volume = ... cm³/s [1]

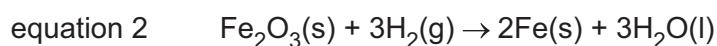
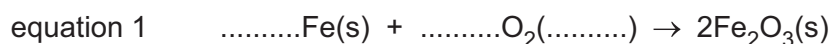
[Total: 8]



- 6 Scientists are investigating the use of iron as a fuel in cars.

Iron reacts with oxygen, as shown in equation 1. This reaction releases energy.

The iron oxide formed is converted back to iron, as shown in equation 2.



- (a) Balance equation 1 and add the missing state symbol for oxygen. [2]

- (b) State the name given to a chemical reaction that releases thermal energy.

..... [1]

- (c) Use the substances in equation 1 and equation 2 to answer the following questions.

- (i) Identify the compound that exists as simple molecules.

..... [1]

- (ii) Identify the transition element.

..... [1]

- (d) Explain why equation 1 shows that iron is oxidised.

.....
 [1]

- (e) Most cars burn fuels that contain carbon.

Explain why using iron as a fuel may cause less harm to the environment than using fuels that contain carbon.

.....

 [3]

[Total: 9]





7 Fig. 7.1 shows a toy car, powered by a battery.

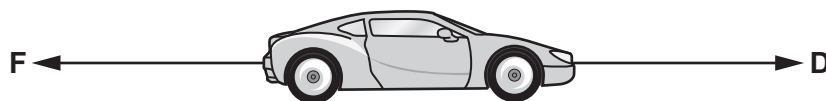


Fig. 7.1

(a) Fig. 7.1 shows the driving force **D** and the total friction force **F** acting on the car.

(i) On Fig. 7.1, draw a force arrow labelled **W** to show the weight of the car. [1]

(ii) The car moves at a constant speed along a level surface.

Force **D** is 16 N.

State the value of force **F**.

F = ... N [1]

(b) The car travels a total distance of 18 m at a constant speed of 1.2 m/s.

(i) Calculate the time taken for the car to travel 18 m.

time = ... s [2]

(ii) The driving force acting on the car is 16 N.

Calculate the work done in moving the car a distance of 18 m.

Include the unit in your answer.

work done = ... unit [3]



(c) The car now travels up a slope **at constant speed**.

Complete the boxes to show the changes in energy stores.

.....
energy store of the car battery decreases



gravitational potential
energy store of the car increases

+

.....
energy store of the surroundings increases

[2]

[Total: 9]



- 8 Fig. 8.1 shows a Bunsen burner with the air hole closed, burning with a yellow flame.

X

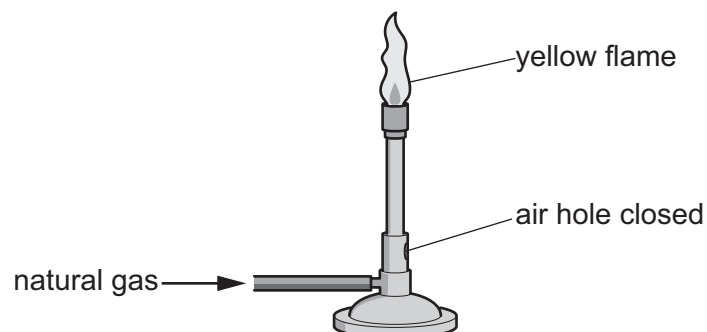
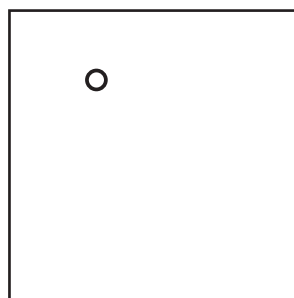


Fig. 8.1

- (a) The Bunsen burner uses natural gas.

Draw a simple particle diagram in the box to show the arrangement of particles in a gas.

Draw 5 particles similar in size to the one that has been drawn for you.



[1]

- (b) An object is placed at position **X** in Fig. 8.1, about 20 cm above the flame.

State the main method of thermal energy transfer from the flame to the object in position **X**.

..... [1]



- (c) Circle the correct word or phrase in **bold** in each sentence to describe what happens to a gas when it is heated at constant pressure.

When a gas is heated at constant pressure, the temperature of the gas

increases / **decreases** / **stays the same**.

The kinetic energy of the gas particles **increases** / **decreases** / **stays the same**.

The speed of the gas particles **increases** / **decreases** / **stays the same**.

The gas expands and the volume of the gas **increases** / **decreases** / **stays the same**.

[2]

- (d) When the air hole on the Bunsen burner is opened, the flame turns from yellow to blue.

State the colour in the visible spectrum between yellow and blue.

..... [1]

- (e) The blue flame produces sound waves with a range of frequencies.

- (i) State the approximate range of frequencies audible to humans.

from Hz

to Hz

[1]

- (ii) The speed of sound in air is 340 m/s.

Calculate the wavelength of a sound wave with a frequency of 810 Hz.

wavelength = ... m [2]

[Total: 8]



- 9 Fig. 9.1 shows a large telescope used for studying the Solar System.

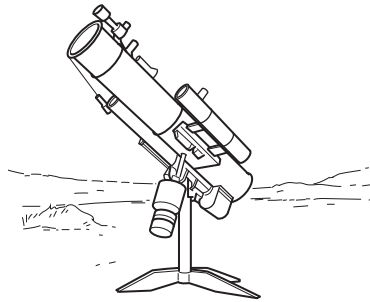


Fig. 9.1

- (a) Fig. 9.2 shows the Sun and the eight planets in the Solar System.

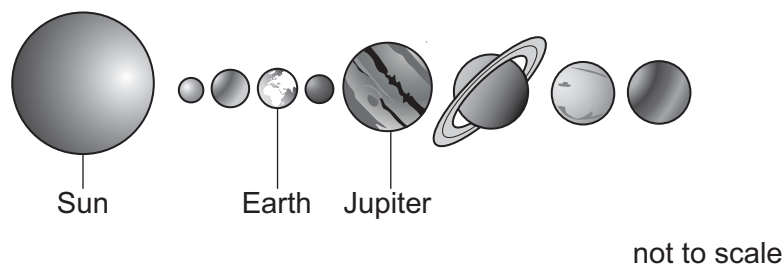


Fig. 9.2

- (i) Name the planet between Earth and Jupiter.

..... [1]

- (ii) State **two** other types of objects in the Solar System that are **not** shown in Fig. 9.2.

1

2 [2]

- (iii) The Sun is a small mass star.

Complete the labels in Fig. 9.3 to show the stages in the life cycle of a small mass star.

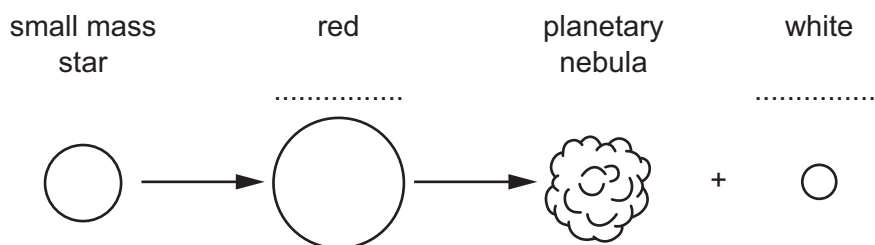


Fig. 9.3



- (b) The telescope contains an electric motor that is powered by a battery.

Fig. 9.4 shows the circuit diagram.

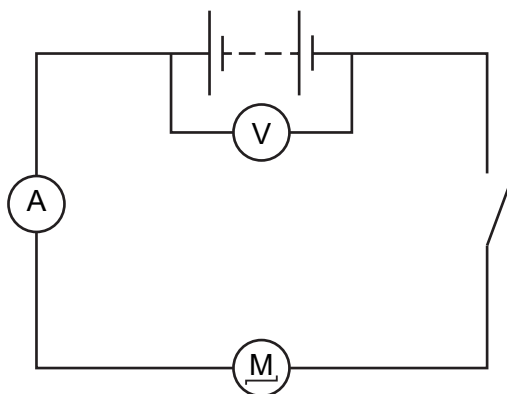


Fig. 9.4

The circuit is switched on.

The voltmeter reading is 3.2 V.

The ammeter reading is 0.080 A.

- (i) Calculate the resistance of the electric motor.

resistance = ... Ω [2]

- (ii) When fully charged, the battery stores 4600 J of energy.

Calculate the time, in hours, that the battery can supply energy to the motor.

time = ... h [3]

[Total: 10]

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The Periodic Table of Elements

Group

Group																			
I	II											III	IV	V	VI	VII	VIII		
												1 H hydrogen 1							

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.).