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COMBINED SCIENCE**0653/41**

Paper 4 Theory (Extended)

October/November 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 male reproductive system in humans.

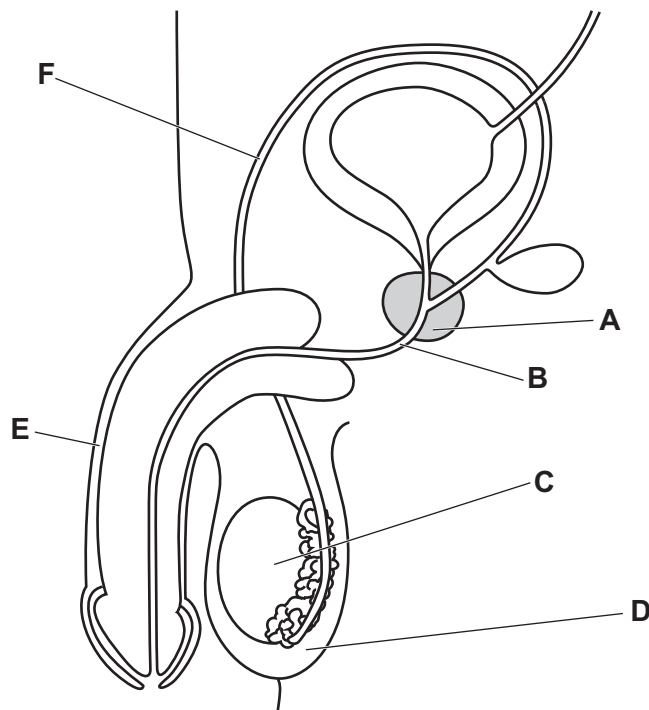


Fig. 1.1

State the letter on Fig. 1.1 that identifies:

the penis

where sperm is produced

where fluid for sperm to swim in is produced.

[3]



(b) Fig. 1.2 is a drawing of a human sperm cell.

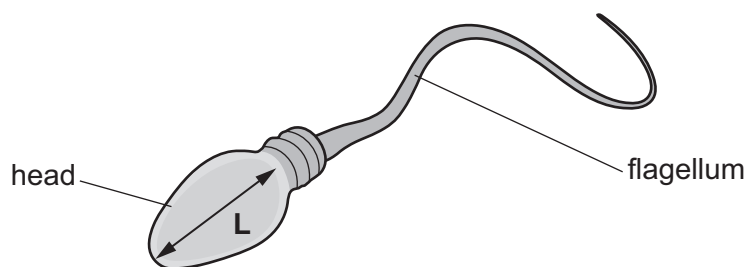


Fig. 1.2

- (i) Arrow **L** in Fig. 1.2 shows the length of the head of the sperm cell in the drawing.

Arrow **L** is 20 mm in length.

The magnification of the drawing is $\times 4000$.

Calculate the actual length of the head of the sperm cell in micrometers (μm).

actual length = ... μm [3]

- (ii) A sperm cell moves its flagellum to swim.

A sperm cell contains a large number of mitochondria.

Describe how a large number of mitochondria helps a sperm cell to move.

.....

.....

.....

..... [2]

[Total: 8]



- 2 (a) Fig. 2.1 shows a plant cell before and after being immersed in a concentrated salt solution.

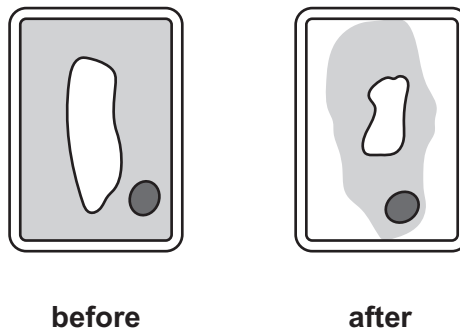


Fig. 2.1

- (i) State the name of the effect shown in Fig. 2.1.

..... [1]

- (ii) The plant cell in Fig. 2.1 is now removed from the salt solution and immersed in pure water for 60 minutes.

Explain the effect of being immersed in pure water on the plant cell.

.....
.....
.....
.....
.....
..... [3]



(b) Plants photosynthesise to produce the carbohydrate glucose.

(i) Glucose is used to make other carbohydrates.

Circle **all** the carbohydrates made from glucose.

amino acids

amylase

cellulose

fatty acids

glycerol

lipase

starch

[2]

(ii) Complete these sentences about photosynthesis in plants.

Photosynthesis requires the raw materials and

.....

Photosynthesis also requires from light and the

green pigment

[3]

(c) The information in Fig. 2.2 is about organisms in a food chain.

- crabs eat starfish
- limpets eat algae
- sharks eat crabs
- starfish eat limpets

Fig. 2.2

(i) Construct a food chain using **all** the organisms in Fig. 2.2.

..... [2]

(ii) Identify the primary consumer in Fig. 2.2.

..... [1]

[Total: 12]



3 (a) Fig. 3.1 is a diagram of a human heart.

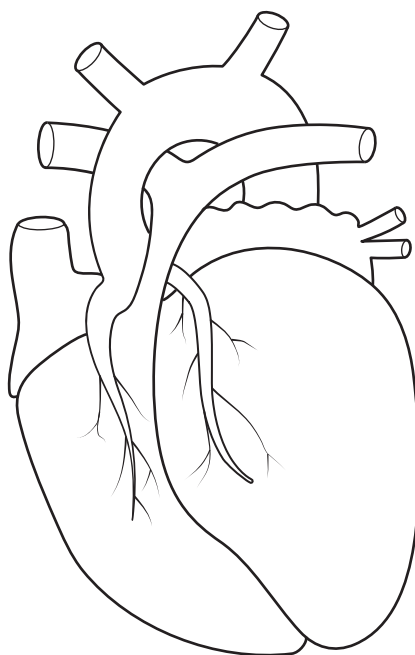


Fig. 3.1

- (i) Draw a label line and the letter **C** to identify a coronary artery in Fig. 3.1. [1]
- (ii) Describe what happens to the coronary artery when a person has coronary heart disease.
-
- [1]
- (iii) Diet is one risk factor for coronary heart disease.
- State **two** other risk factors for coronary heart disease.
- 1
- 2 [2]



(b) Arteries transport blood away from the heart.

Explain how the structure of an artery is adapted to its function.

.....

.....

.....

.....

.....

..... [3]

[Total: 7]



4 Copper metal reacts with oxygen to form copper oxide, CuO.

(a) Write the balanced symbol equation for this reaction.

..... [2]

(b) A student investigates the reaction between excess copper metal and oxygen in air.

The student uses the apparatus shown in Fig. 4.1.

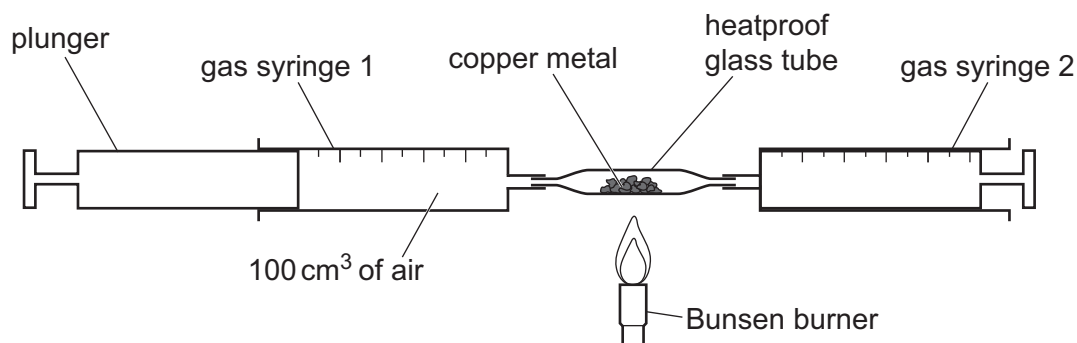


Fig. 4.1

There is initially 100 cm^3 of clean dry air inside gas syringe 1.

The student pushes the plunger on gas syringe 1 all the way in. Air moves over the hot copper metal into gas syringe 2. The plunger in gas syringe 2 moves outwards.

The student then pushes the plunger on gas syringe 2 all the way in. Air moves over the hot copper metal into gas syringe 1. The plunger in gas syringe 1 moves outwards.

The process is repeated until all the oxygen in the air has reacted with the copper.

Predict the total volume of air remaining in the gas syringes at the end of the reaction.

Give a reason for your answer.

volume of air = ... cm^3

reason

..... [2]



(c) Fig. 4.2 is a reaction pathway diagram for a reaction catalysed by copper.

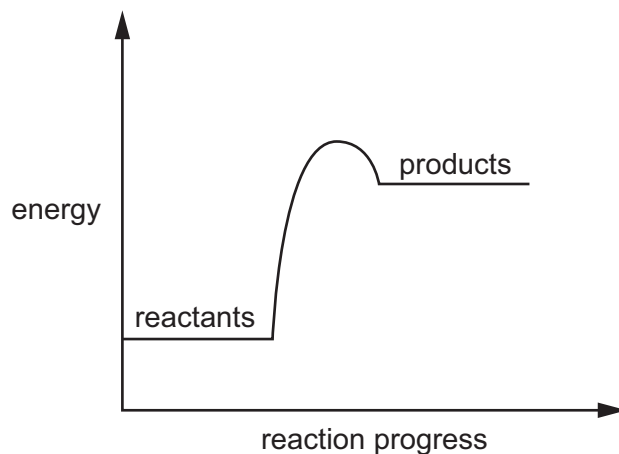


Fig. 4.2

- (i) Identify the type of chemical reaction shown in Fig. 4.2.

Explain your answer.

type of chemical reaction

explanation

.....

.....

[2]

- (ii) Draw an arrow on Fig. 4.2 to show the activation energy for this reaction. [1]

- (iii) Define activation energy.

.....

.....

.....

..... [2]

- (iv) Describe what is meant by a catalyst.

.....

.....

.....

..... [2]

[Total: 11]



- 5 (a) Fig. 5.1 shows the electrolysis of molten zinc chloride, ZnCl_2 , using inert electrodes.

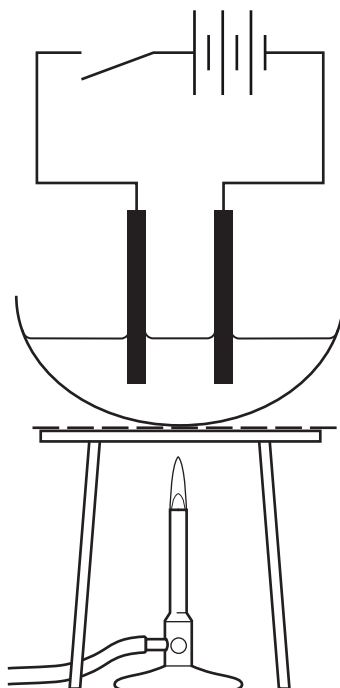


Fig. 5.1

- (i) The switch is closed.

Describe the observation at the positive electrode.

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

- (ii) Write the ionic equation for the formation of zinc.

Include state symbols in your equation.

..... [2]



(b) A metal alloy contains metal **A** and metal **B**.

Fig. 5.2 shows an atom of metal **A** and an atom of metal **B**.



Fig. 5.2

(i) The alloy contains 80% of metal **A** and 20% of metal **B**.

Sketch a possible structure for this alloy in Fig. 5.3.

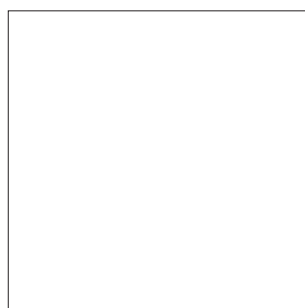


Fig. 5.3

[2]

(ii) This alloy is harder and stronger than pure metal **A** and pure metal **B**.

Explain in terms of structure why this alloy is harder and stronger.

.....

.....

.....

..... [2]

[Total: 7]



6 Fig. 6.1 shows the structure of ethene.

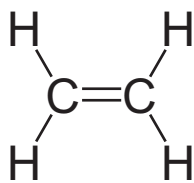


Fig. 6.1

(a) Tick (✓) **all** the statements that are true for ethene.

It is part of the alkane homologous series.

☐

It is formed by cracking large alkanes.

☐

It reacts with hydrogen to form ethane.

☐

It is a polymer.

☐

It decolourises aqueous bromine.

☐

[3]

(b) Complete the dot-and-cross diagram in Fig. 6.2 to show the bonding in an ethene molecule.

Show **only** the outer-shell electrons.

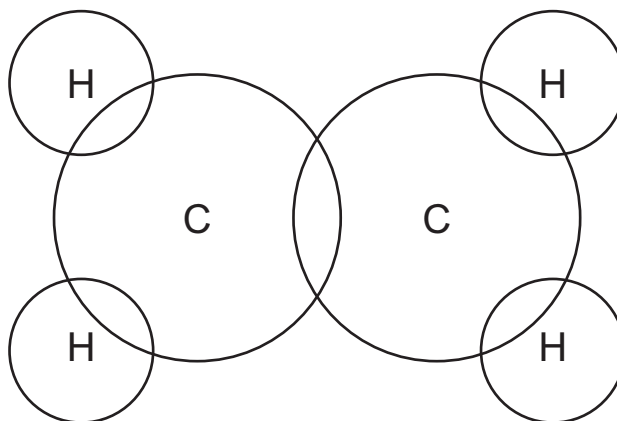


Fig. 6.2

[2]



(c) Complete the sentences about a reaction of ethene.

Ethene reacts with to form ethanol.

This is an reaction.

The reaction happens in the presence of an catalyst.

[3]

[Total: 8]



7 A student rides a bicycle along a straight, level road.

(a) Fig. 7.1 shows the speed–time graph for part of the student's journey.

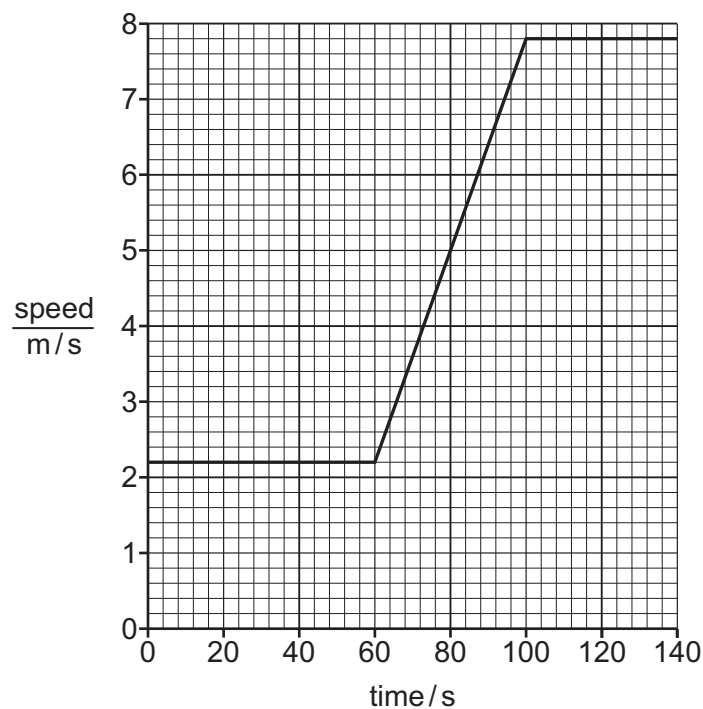


Fig. 7.1

(i) Define the acceleration of an object moving in a straight line.

.....
 [1]

(ii) Determine the acceleration of the student between 60 s and 100 s.

Include the unit in your answer.

acceleration = ... unit [3]



- (b) The student throws a ball of mass 0.060 kg vertically upwards.

The kinetic energy of the ball as it leaves the student's hand is 0.15 J.

- (i) Calculate the speed of the ball as it leaves the student's hand.

speed = ... m/s [2]

- (ii) Calculate the maximum change in height Δh of the ball.

Ignore any air resistance acting on the ball.

Δh = ... m [3]

[Total: 9]



8 This question is about the transfer of thermal energy.

(a) An example of a material which is a good thermal conductor is copper.

(i) Complete the sentences about a **bad** thermal conductor.

An example of a material which is a bad thermal conductor is

.....

A bad thermal conductor is called a thermal

[2]

(ii) Copper is a metal.

Describe **two** ways that thermal energy is transferred in a metal.

1

.....

2

.....

[3]

(b) Thermal energy is transferred from the Sun to the Earth by infrared radiation with a frequency of 410 GHz.

The speed of infrared radiation in space is 3.0×10^8 m/s.

Calculate the wavelength of the infrared radiation.

wavelength = ... m [3]

[Total: 8]

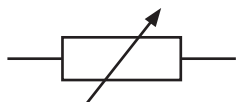


- 9 (a) Complete the definition of potential difference (p.d.).

Potential difference (p.d.) is the work done by a unit moving between two points in a circuit.

[1]

- (b) State the names of the electrical components with the symbols shown.



.....



.....

[2]

- (c) A student assembles the circuit shown in Fig. 9.1.

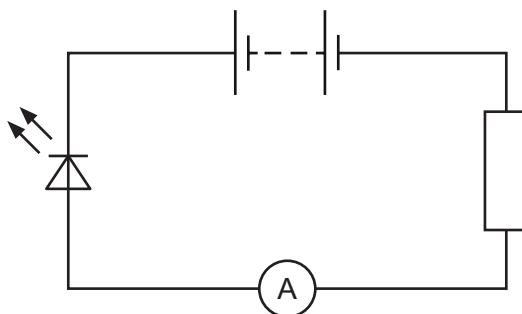


Fig. 9.1

The student makes an error in the assembly of the circuit.

The light-emitting diode (LED) does not emit light and the ammeter shows there is no current in the circuit.

Identify the error in the assembly of the circuit.

.....

..... [1]





(d) Two wires, **A** and **B**, are made of the same metal.

Wire **A** has length 2.5 m, diameter 0.75 mm and resistance $0.16\ \Omega$.

Wire **B** has length 7.5 m and diameter 1.5 mm.

Calculate the resistance of wire **B**.

resistance = ... Ω [3]

(e) A satellite orbits the Earth with an orbital speed of 7800 m/s and an orbital period of 5400 s.

The radius of the Earth is 6.38×10^6 m.

Calculate the distance of the satellite above the Earth's surface.

distance = ... m [3]

[Total: 10]



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The Periodic Table of Elements

Group																		
I	II											III	IV	V	VI	VII	VIII	
1 H hydrogen 1 Key atomic number atomic symbol name relative atomic mass																		
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 —	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

0653/42

Paper 4 Theory (Extended)

October/November 2025

1 hour 15 minutes

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- The number of marks for each question or part question is shown in brackets [].
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This document has **20** pages.

- 1 (a) Fig. 1.1 is a diagram of a cross-section through a leaf.

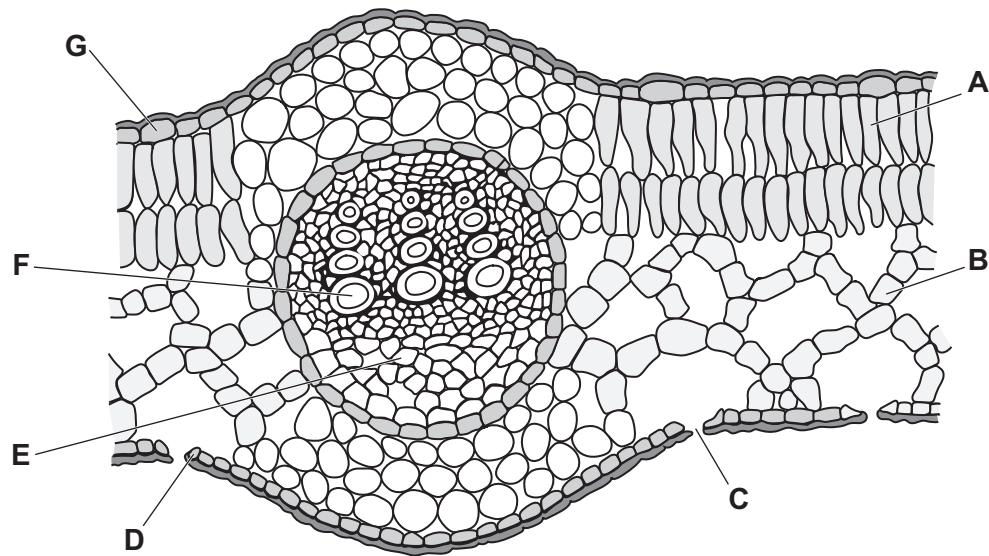


Fig. 1.1

State the letter on Fig. 1.1 that identifies one of the:

stomata

spongy mesophyll cells

cells that transport sucrose.

[3]

- (b) Plants produce carbohydrates by the process of photosynthesis.

State the balanced symbol equation for photosynthesis.

..... [2]



(c) Fig. 1.2 is a graph showing the effect of temperature on the rate of photosynthesis in a plant.

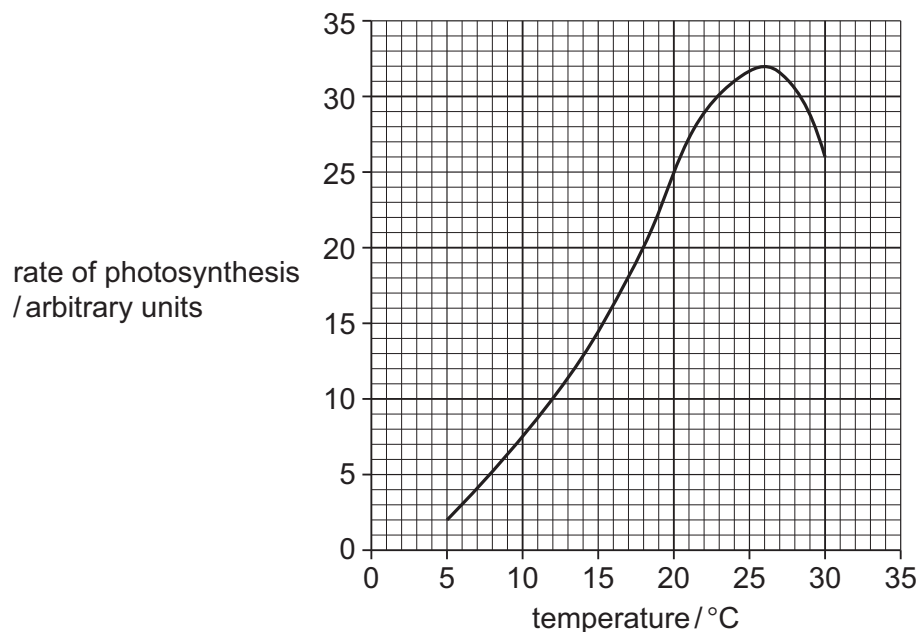


Fig. 1.2

- (i) Calculate the difference in the maximum and minimum rates of photosynthesis shown in Fig. 1.2.

difference in rates of photosynthesis = ... arbitrary units [2]

- (ii) Enzymes are involved in photosynthesis.

Explain the shape of the graph between 10°C and 15°C shown in Fig. 1.2.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]



2 (a) Fig. 2.1 is a diagram of a bacterial cell.

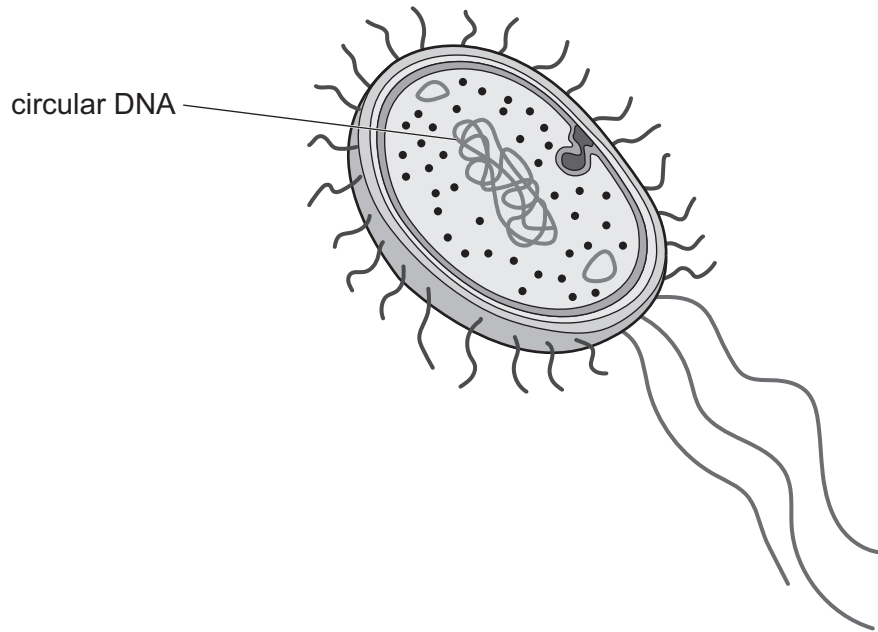


Fig. 2.1

(i) Circular DNA provides the code for the production of proteins in protein synthesis.

On Fig. 2.1:

- draw a label line to identify a structure that is the **site** of protein synthesis
- label the line with the name of this structure.

[2]

(ii) Respiration and protein synthesis are linked.

Complete the sentences.

Protein synthesis requires from respiration.

Respiration is a chemical reaction in cells that breaks down

..... molecules.

[2]

(iii) The list shows some cell structures that are **not** found in bacterial cells.

chloroplasts

mitochondria

nuclei

vacuoles

Use **one** word from the list to complete the sentence.

In animal and plant cells, aerobic respiration takes place in structures called

.....

[1]



(b) Some bacteria cause diseases.

(i) Describe how platelets in the blood help prevent bacterial infection.

.....

.....

.....

..... [2]

(ii) Explain why some treatments of bacterial infections have become less effective.

.....

.....

.....

..... [2]

(c) Providing a clean water supply helps reduce the spread of diseases.

State **two** other ways to reduce the spread of diseases.

1

.....

2

.....

[2]

[Total: 11]



3 Fig. 3.1 shows a food web from a grassland habitat.

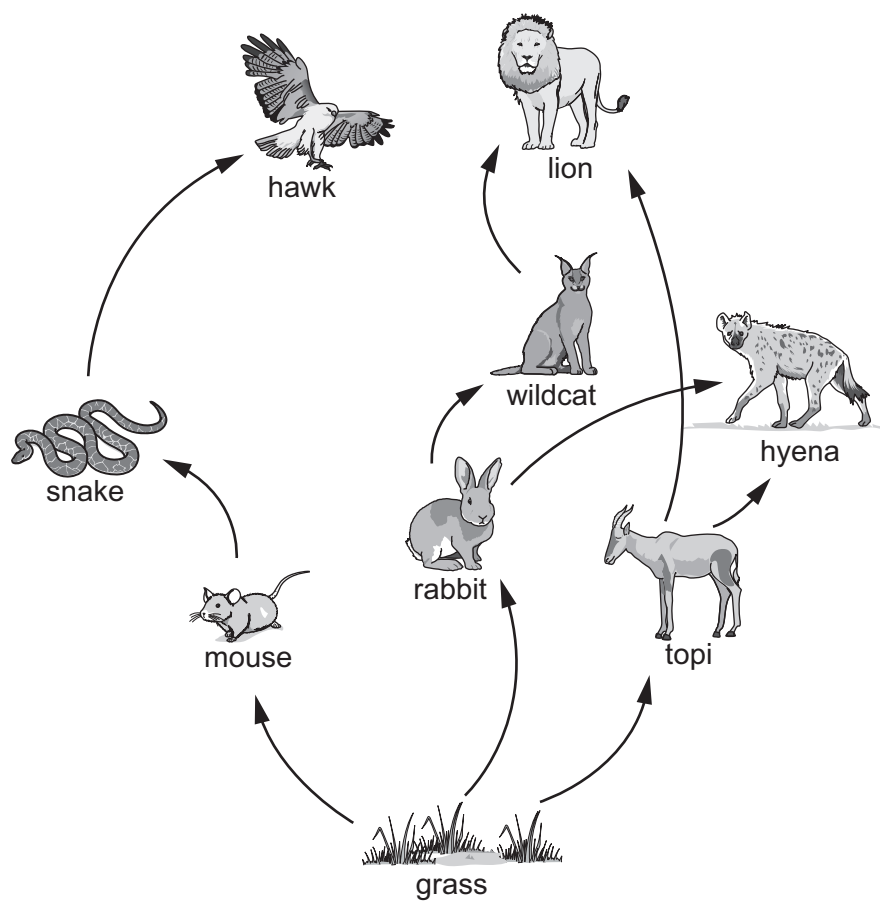


Fig. 3.1

(a) The food web in Fig. 3.1 is **not** complete.

The hawk also eats the mouse and the rabbit.

(i) Complete the food web in Fig. 3.1.

[1]

(ii) Identify **one** herbivore in Fig. 3.1.

..... [1]



- (b) People living near the grassland habitat burn areas of grassland to clear the ground for growing crops.

Replacing grassland with crops is causing the lions in the area to become endangered.

- (i) Use information from Fig. 3.1 to explain why the lions are becoming endangered.

.....

.....

.....

..... [2]

- (ii) Captive breeding programmes are one method of conserving endangered species.

State what is meant by a captive breeding programme.

.....

.....

.....

..... [2]

[Total: 6]



- 4 (a) A student investigates the reaction between aqueous sodium hydroxide, NaOH, and dilute hydrochloric acid, HCl.

The apparatus is shown in Fig. 4.1.

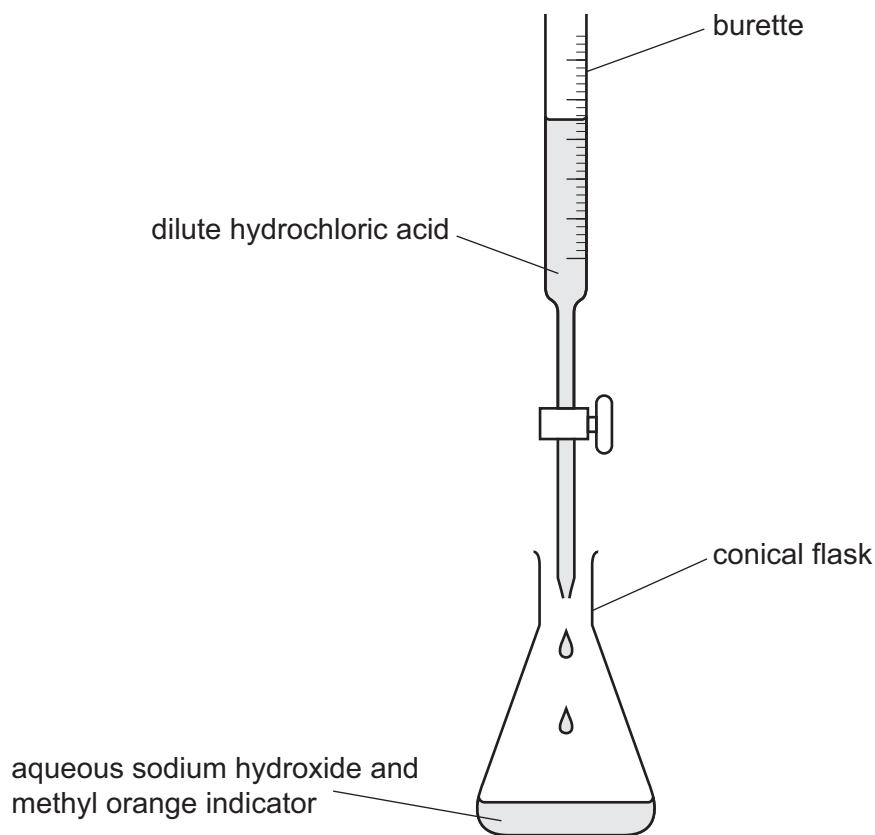


Fig. 4.1

- (i) Write the balanced symbol equation for the reaction shown in Fig. 4.1.

Include state symbols.

..... [2]

- (ii) State the colour change of the methyl orange indicator during this reaction.

from to [2]



(iii) Tick (✓) **all** the statements that are true for aqueous sodium hydroxide.

It is a covalent substance.

☐

It turns universal indicator purple.

☐

It reacts with dilute sulfuric acid to form sodium sulfate.

☐

It is a base but **not** an alkali.

☐

[2]

(b) The reaction between aqueous sodium hydroxide and dilute hydrochloric acid transfers thermal energy to the surroundings.

(i) Give **one** conclusion about the energy involved in bond breaking and bond making in this reaction.

.....
 [1]

(ii) Complete Fig. 4.2 to show the reaction pathway diagram for this reaction.

Label:

- the reactants and products
- the overall energy change using an arrow.



Fig. 4.2

[3]

[Total: 10]



- 5 (a) Iron is extracted from hematite in the blast furnace.

During the extraction, carbon monoxide is formed.

- (i) Describe how carbon monoxide is formed in the blast furnace.

.....

.....

.....

.....

.....

..... [3]

- (ii) The carbon monoxide reacts with iron(III) oxide to form iron and carbon dioxide.

Write the balanced symbol equation for this reaction.

..... [2]

- (b) (i) Complete the dot-and-cross diagram in Fig. 5.1 to show the bonding in a carbon dioxide molecule.

Show **only** the outer-shell electrons.

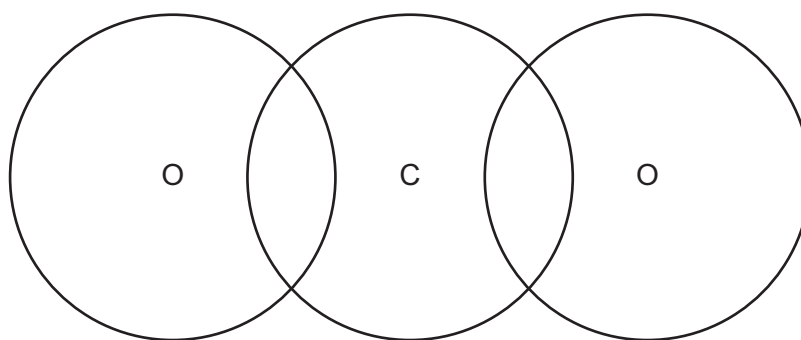


Fig. 5.1

[2]



(ii) Carbon dioxide is a greenhouse gas that contributes to climate change.

State **two** strategies to reduce the effects of climate change.

1

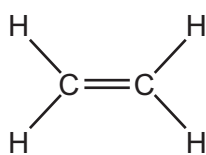
2

[2]

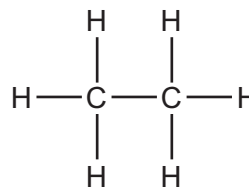
[Total: 9]



6 (a) Fig. 6.1 shows the structures of ethene and ethane.



ethene



ethane

Fig. 6.1

- (i) Organic compounds in the same homologous series as ethene have the general formula C_nH_{2n} .

Deduce the general formula for the homologous series to which **ethane** belongs.

..... [1]

- (ii) Name the homologous series to which ethene belongs and to which ethane belongs.

ethene

ethane

[1]

- (b) Complete the sentences about a reaction of ethene.

Ethene reacts with to form ethane.

This reaction is an reaction.

The reaction happens in the presence of a catalyst.

[3]



(c) Fig. 6.2 shows the structure of butane.

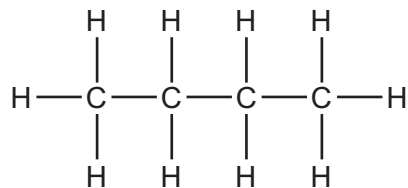


Fig. 6.2

Butane and ethane are in the same homologous series.

The boiling point of ethane is -88°C .

Predict the boiling point of butane.

Give a reason for your answer.

boiling point $^{\circ}\text{C}$

reason

..... [2]

[Total: 7]



- 7 A toy car contains a battery and an electric motor.

(a) Fig. 7.1 shows the speed–time graph for the toy car moving along a level surface.

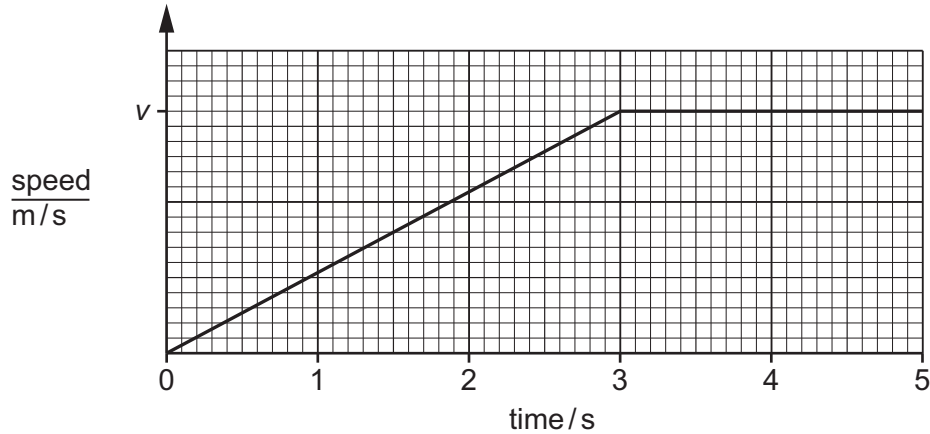


Fig. 7.1

- (i) Identify **one** energy store of the toy car that decreases between 0 and 3 s.
 [1]
- (ii) Use Fig. 7.1 to identify **one** energy store of the toy car that increases between 0 and 3 s.
 [1]
- (iii) State which feature of the speed–time graph represents the acceleration of the toy car.
 Explain your answer.
 feature
 explanation
 [2]
- (iv) The toy car travels a total distance of 5.6 m in a time of 5.0 s.
 Determine the maximum speed v of the toy car.

$v = \dots\dots\dots \text{ m/s}$ [2]



(b) The toy car now moves from the top to the bottom of the slope shown in Fig. 7.2.

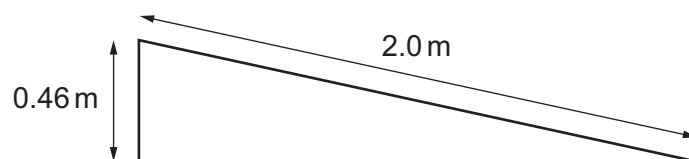


Fig. 7.2

The slope has a length of 2.0 m and a vertical height of 0.46 m.

The mass of the toy car is 72 g.

Calculate the change in the gravitational potential energy of the toy car.

change in gravitational potential energy = ... J [3]

[Total: 9]



- 8 (a) A student uses the apparatus shown in Fig. 8.1 to investigate the transfer of thermal energy by radiation.

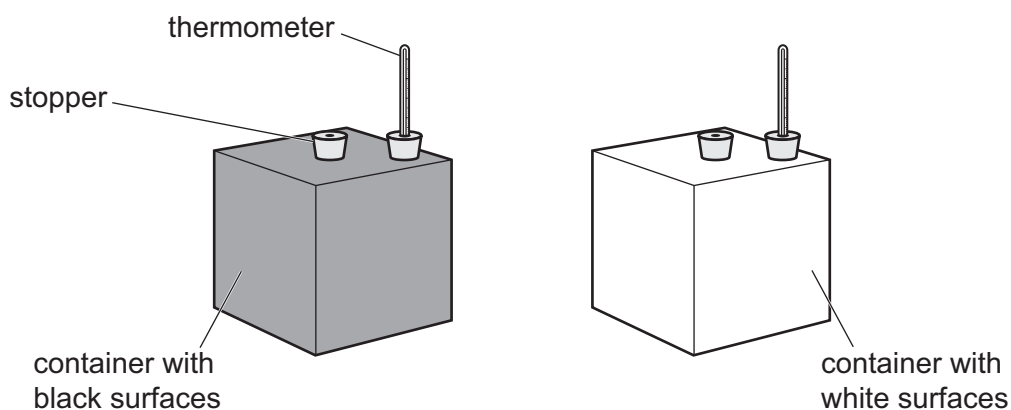


Fig. 8.1

The two containers are identical in size and made from the same material.

One container has only black surfaces, and the other container has only white surfaces.

The student has access to hot water.

Describe how the student uses this apparatus to determine whether a black surface or a white surface is a better emitter of thermal radiation.

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]



- (b) (i) Explain why energy is transferred through space from the Sun to the Earth by radiation but **not** by conduction or convection.

.....

.....

..... [2]

- (ii) Complete Fig. 8.2 to show the stages in the life cycle of a small mass star like the Sun.

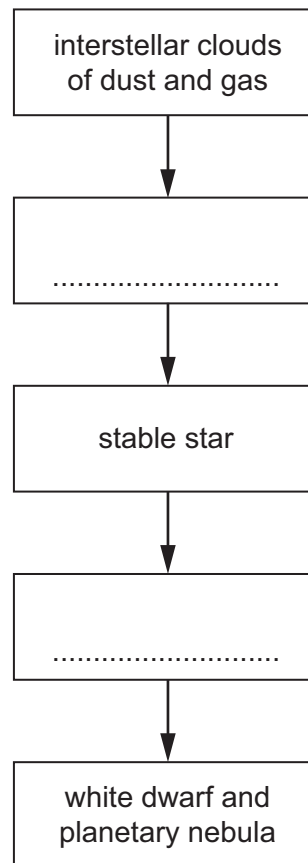


Fig. 8.2

[2]

- (iii) A supernova is part of the life cycle of a large mass star.

State what may form from the nebula after a supernova.

..... [1]

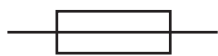
[Total: 8]



- 9 (a) State the names of the electrical components with the symbols shown.



.....



.....

[2]

- (b) A student assembles the circuit shown in Fig. 9.1.

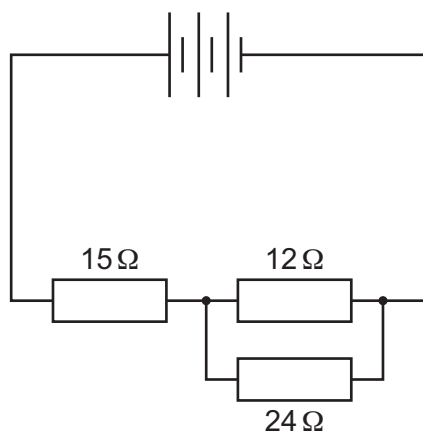


Fig. 9.1

The battery has an electromotive force (e.m.f.) of 9.0 V.

- (i) Define e.m.f.

.....

.....

..... [2]

- (ii) Calculate the combined resistance of the three resistors in the circuit.

resistance = ... Ω [3]



(c) A student stands in front of a vertical plane mirror of length 40 cm, as shown in Fig. 9.2.

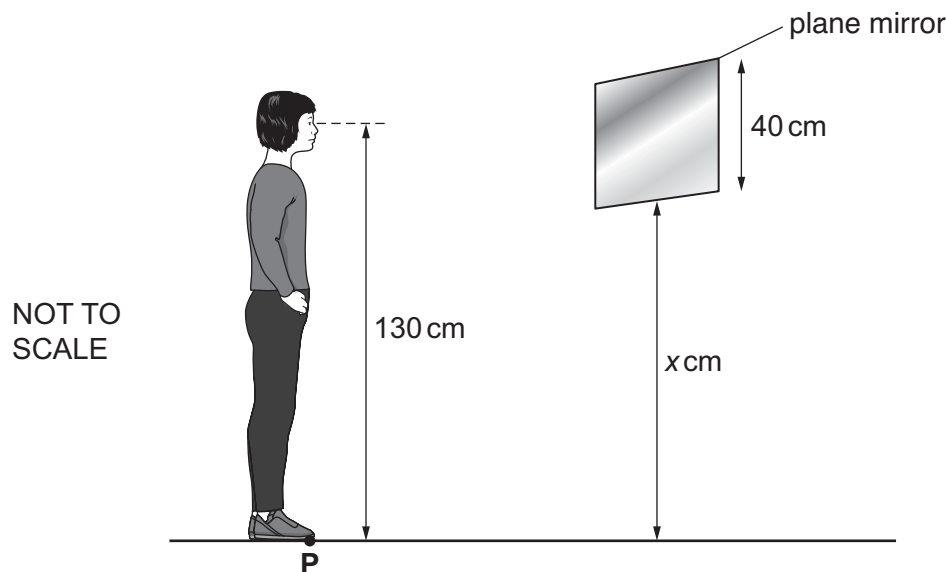


Fig. 9.2

The vertical position of the mirror can be adjusted.

- **P** is a point on the ground that is vertically below the student's eyes.
- The vertical distance between the student's eyes and point **P** is 130 cm.
- The vertical distance between the bottom of the mirror and the ground is x cm.

Determine the **smallest** value of x at which it is possible for the student to see point **P** in the mirror.

$x = \dots\dots\dots$ cm [3]

[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
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 —

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

0653/43

Paper 4 Theory (Extended)

October/November 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 shows part of the human alimentary canal and associated organs.

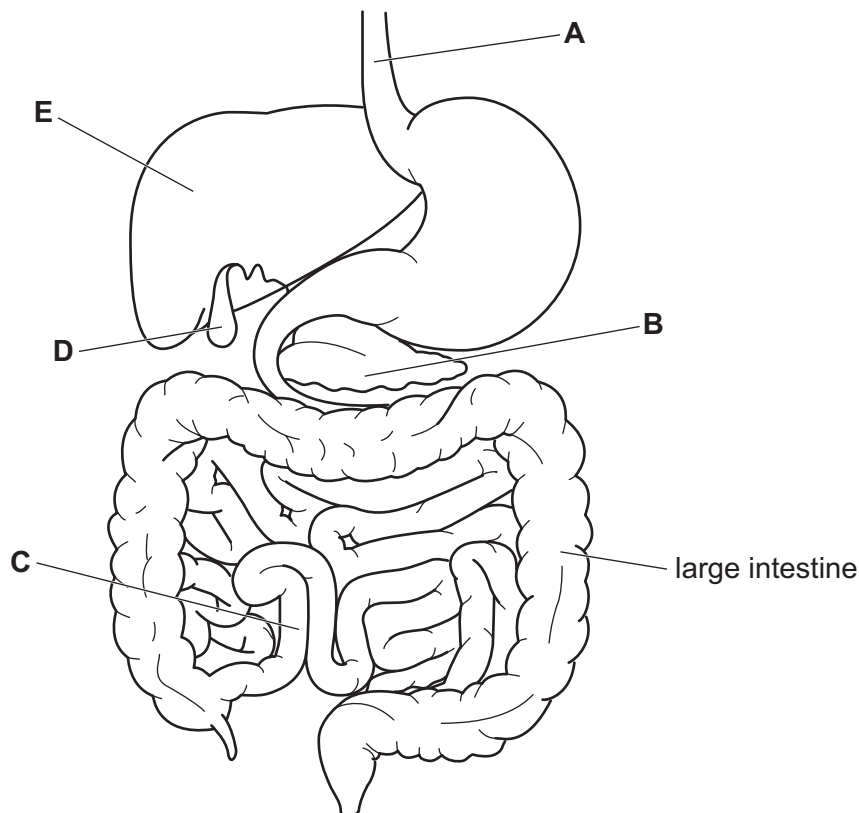


Fig. 1.1

- (i) Use the letters on Fig. 1.1 to identify the:

gall bladder

part where absorption takes place

part that secretes amylase.

[3]

- (ii) The large intestine has three different parts.

One part is called the anus.

Name the other **two** parts of the large intestine.

1

2

[2]



(b) The graph in Fig. 1.2 shows the effect of pH on four different enzymes, **P**, **Q**, **R** and **S**.

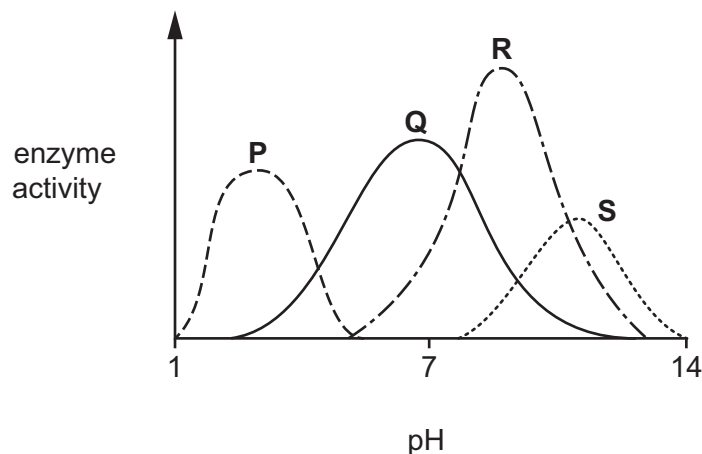


Fig. 1.2

(i) Identify the enzyme in Fig. 1.2 with optimum activity in the stomach.

..... [1]

(ii) Explain the effect of pH 7 on the activity of enzyme **S**.

.....

 [3]

(c) Lipase is an enzyme in the digestive system.

Complete the sentence about the function of lipase.

Lipase breaks down and into two types of smaller molecules called and [2]

[Total: 11]



2 (a) Fig. 2.1 shows a food web.

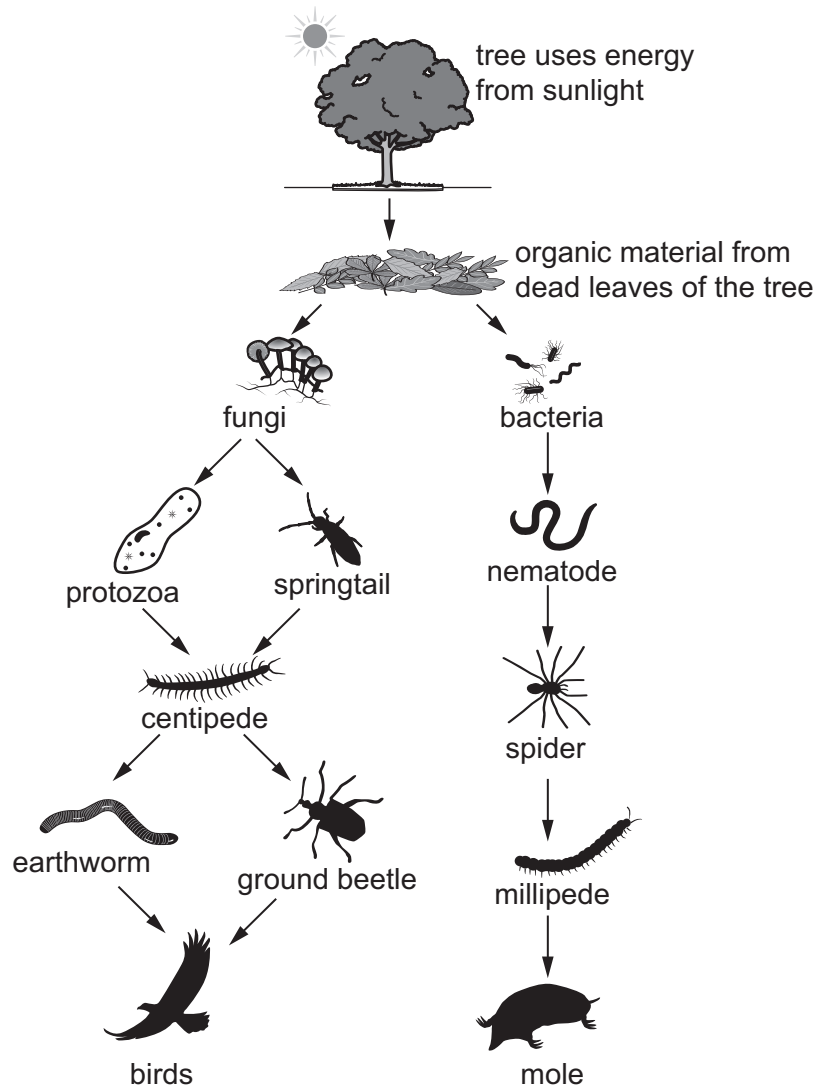


Fig. 2.1

(i) Circle the word that describes the tree in Fig. 2.1.

carnivore decomposer herbivore producer

[1]

(ii) Circle the word that describes the fungi in Fig. 2.1.

carnivore decomposer herbivore producer

[1]

(iii) Identify the animal in Fig. 2.1 that gets its energy from the spider.

..... [1]



(b) Transpiration takes place in plants.

(i) Describe transpiration in plants.

.....
 [1]

(ii) Describe the effect of variation of wind speed on transpiration rate.

.....
 [1]

(c) Fig. 2.2 shows plant cells before and after being immersed in a concentrated sugar solution.

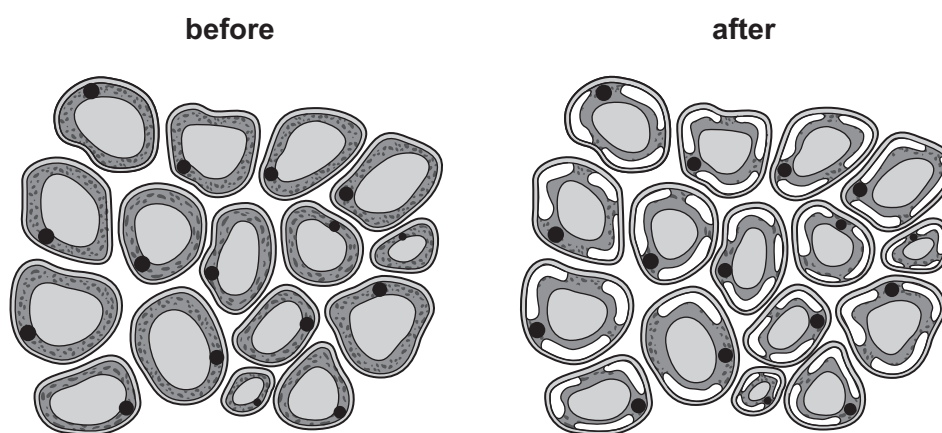


Fig. 2.2

Explain the effect of the concentrated sugar solution on the cells shown in Fig. 2.2.

.....

 [4]

[Total: 9]



- 3 (a) Fig. 3.1 shows the structure of a virus and a bacterial cell.

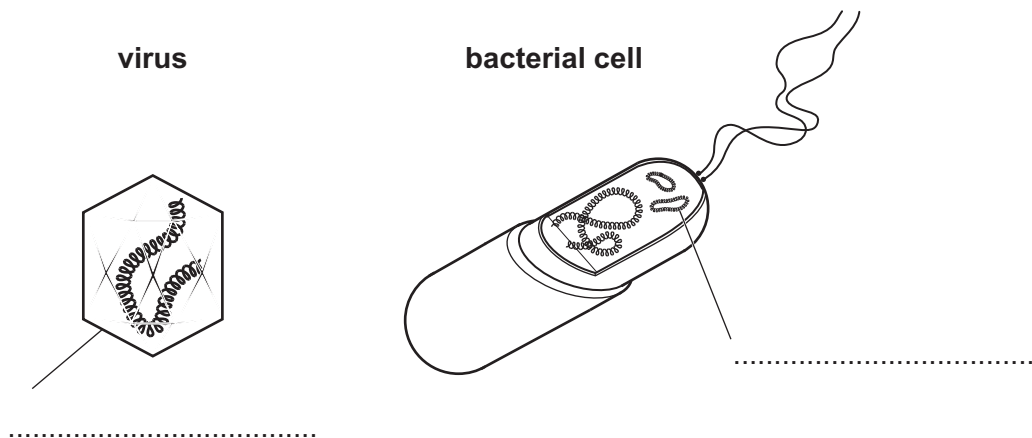


Fig. 3.1

Complete the labels on Fig. 3.1. Choose words from the list.

cell membrane

cell wall

cytoplasm

nucleus

plasmid

protein coat

[2]

- (b) Some viruses and bacteria are pathogens.

Platelets in blood help to defend against pathogens by clotting the blood.

State **two** other body defences against pathogens.

1

2

[2]

- (c) Antibiotics are drugs used to treat bacterial infections.

Describe what is meant by the term drug.

.....

..... [1]



(d) Vaccines are drugs used to help protect the body from bacterial infections.

Describe how vaccinations protect the body from bacterial infection.

.....

.....

.....

..... [2]

[Total: 7]



- 4 A student investigates the rate of reaction between large pieces of magnesium carbonate, MgCO_3 , and dilute hydrochloric acid, HCl , using the apparatus shown in Fig. 4.1.

The student records the time taken to produce 10 cm^3 of gas.

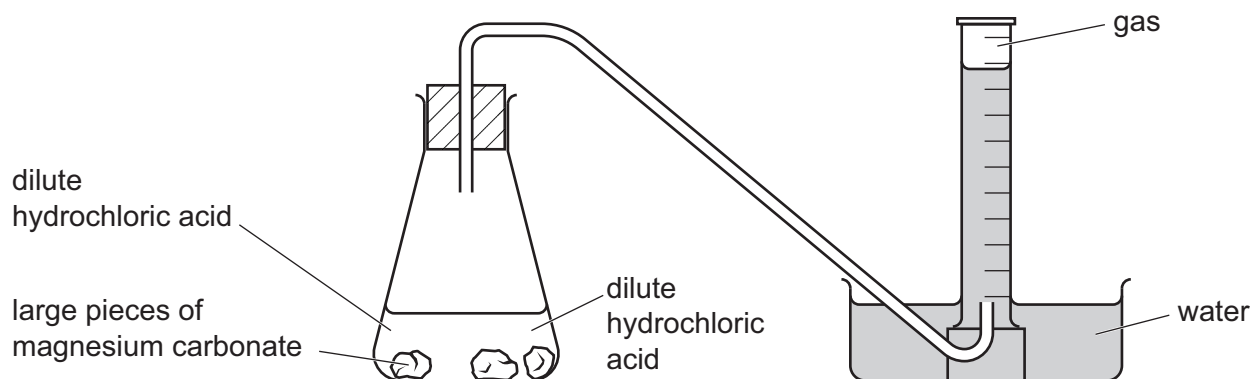


Fig. 4.1

- (a) Three products are formed in the reaction: magnesium chloride MgCl_2 , a gas and one other product.

Give the balanced symbol equation for this reaction.

..... [2]

- (b) The student repeats the experiment using:

- small pieces of magnesium carbonate
- magnesium carbonate powder.

All other conditions are kept constant.

Table 4.1 shows the time taken to produce 10 cm^3 of gas and the rate of reaction.

Table 4.1

magnesium carbonate	time taken to produce 10 cm^3 of gas in s	rate of reaction in cm^3 per s
large pieces	15.2	0.66
small pieces	8.3	1.2
powder	5.1	

- (i) Calculate the rate of reaction in cm^3 per s for magnesium carbonate powder.

Write your answer in Table 4.1.

[1]



- (ii) State and explain how the size of the magnesium carbonate pieces affects the rate of this reaction.

.....

.....

.....

.....

.....

..... [3]

- (c) Fig. 4.2 shows an atom of magnesium and an atom of chlorine.

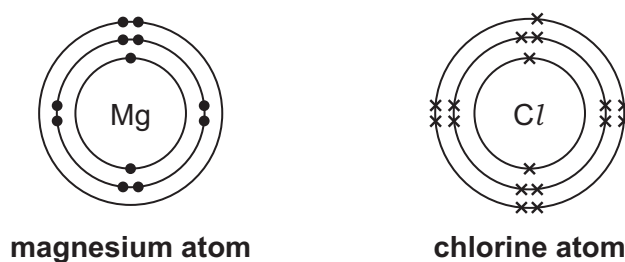


Fig. 4.2

Complete the dot-and-cross diagram in Fig. 4.3 to show the ionic bonding in magnesium chloride, MgCl_2 .

Show **only** the outer-shell electrons and include the charges on the ions.

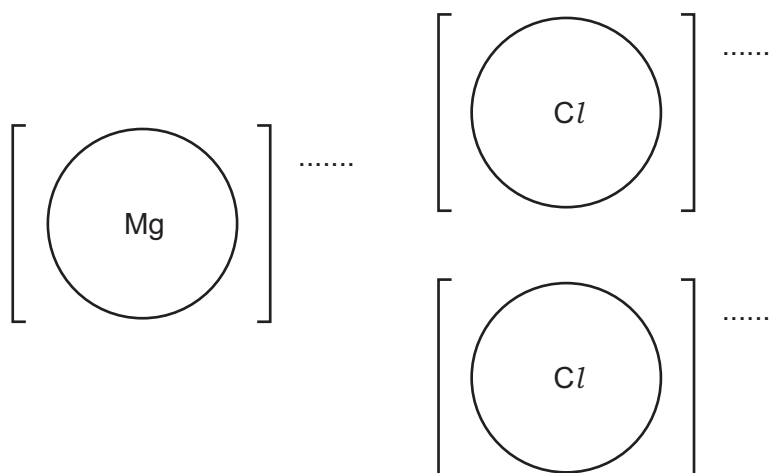


Fig. 4.3

[3]

[Total: 9]



5 Group VII elements are known as the halogens.

(a) (i) Halogens can be represented by the formula X_2 .

State the term used to describe molecules with the formula X_2 .

..... [1]

(ii) Complete Table 5.1:

- state the appearance of bromine at room temperature and pressure (r.t.p.)
- predict the appearance of astatine at r.t.p.

Table 5.1

halogen	appearance at r.t.p.
chlorine	pale yellow-green gas
bromine	
iodine	grey-black solid
astatine	

[2]

(b) Aqueous potassium iodide is colourless.

Aqueous chlorine is added to aqueous potassium iodide in a test-tube.

State the colour change observed.

Explain why this colour change occurs.

colour change

explanation

.....

.....

[3]

(c) (i) State why chlorine is used in the treatment of the domestic water supply.

..... [1]

(ii) State **one** other stage in the treatment of the domestic water supply.

..... [1]

[Total: 8]





6 Pentene is an alkene that contains one double carbon–carbon bond.

(a) Fig. 6.1 shows the structure of one form of pentene.

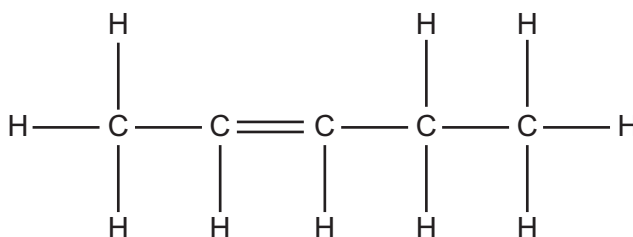


Fig. 6.1

(i) Use Fig. 6.1 to deduce the molecular formula of pentene.

..... [1]

(ii) The double carbon–carbon bond in pentene can be in different positions.

Complete Fig. 6.2 to show the structure of **one** other form of pentene.



Fig. 6.2

[1]

(iii) Pentene is a member of a homologous series.

State what is meant by a homologous series.

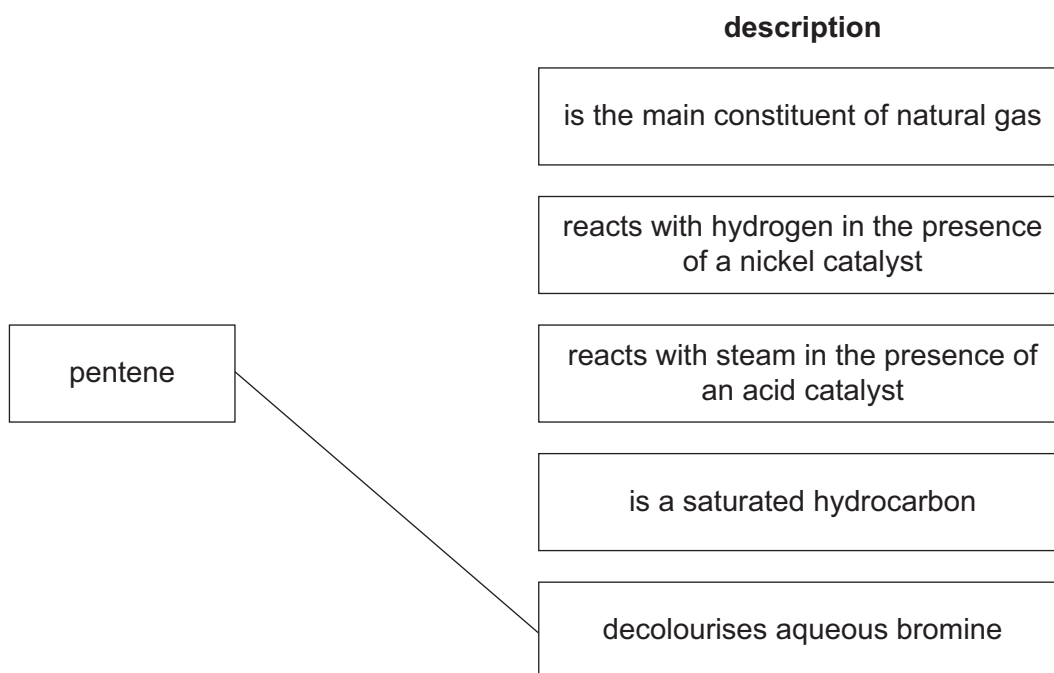
.....

 [2]



(iv) Draw lines to show which descriptions are true for pentene.

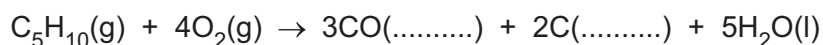
One has been drawn for you.



[2]

(b) Pentene combusts in a limited supply of oxygen to form two air pollutants: carbon monoxide and carbon particulates.

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



[1]

(ii) Name this type of combustion reaction.

..... [1]

(iii) State **one** adverse effect of carbon particulates on human health.

..... [1]

[Total: 9]



7 A student assembles the circuit in Fig. 7.1.

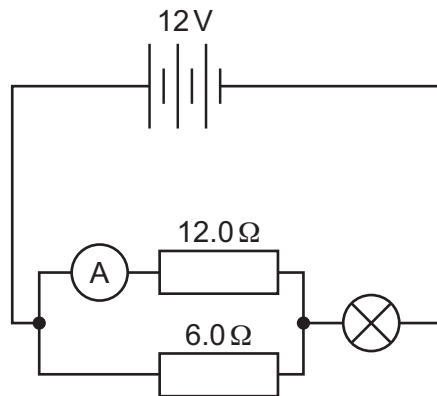


Fig. 7.1

The reading on the ammeter is 0.80 A .

The potential difference (p.d.) across the $12.0\ \Omega$ resistor is 9.6 V .

(a) Determine the p.d. across the lamp.

p.d. = ... V [1]

(b) Determine the current in the $6.0\ \Omega$ resistor.

current = ... A [2]





(c) Calculate the charge flowing through the **lamp** in 2.0 minutes.

State the unit of charge.

charge = ... unit [5]

[Total: 8]



8 Fig. 8.1 shows a motor and an object at rest on the ground.

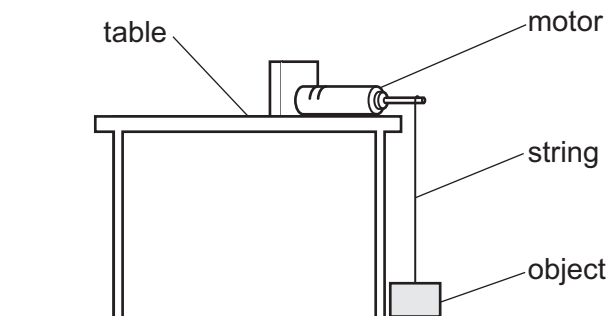


Fig. 8.1

The object has a mass of 2.9 kg.

Ignore any friction or air resistance.

(a) Calculate the weight of the object.

weight = ... N [2]

(b) The motor lifts the object with force L .

The object accelerates upwards from rest with a constant acceleration of 2.5 m/s^2 .

Calculate L .

$L = \dots\dots\dots$ N [3]



(c) The motor now lifts the object upwards at constant speed through vertical distance h .

(i) The total energy input to the motor is 150 J.

The motor has an efficiency of 66%.

Calculate the useful energy output of the motor.

useful energy output = ... J [2]

(ii) Use your answer in (c)(i) to calculate h .

h = ... m [2]

[Total: 9]



- 9 (a) Fig. 9.1 shows a convection heater in a closed room.

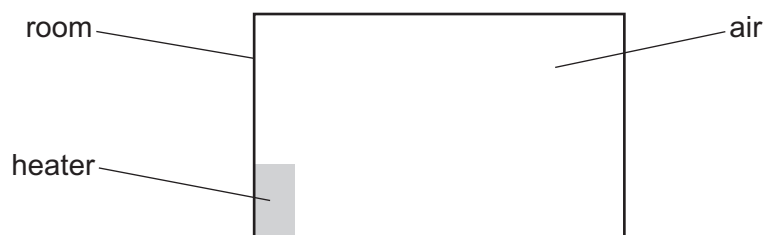


Fig. 9.1

The heater is on the floor on the left hand side of the room.

The heater warms the room by convection.

- (i) State **one** other method of thermal energy transfer.

..... [1]

- (ii) Explain how the heater warms the room by convection.

Use ideas about density in your answer.

You may draw on Fig. 9.1 if you wish.

.....

 [2]

- (iii) Explain why the air in the room exerts a greater pressure on the walls when the temperature of the air increases.

Use ideas about particles in your answer.

.....

 [3]





- (b) Complete Table 9.1 to describe the difference between a transverse wave and a longitudinal wave.

Use **one** word in each gap.

Table 9.1

wave	direction of compared to direction of propagation
transverse	at right angles
longitudinal	

[2]

- (c) The Big Bang Theory includes statements about the beginning of the Universe that are supported by astronomical observations.

Give **two** statements about the beginning of the Universe included in the Big Bang Theory.

1

.....

2

.....

[2]

[Total: 10]

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The Periodic Table of Elements

Group																			
I	II	Key										III	IV	V	VI	VII	VIII		
3 Li lithium 7	4 Be beryllium 9	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		
		1 H hydrogen 1																	
11 Na sodium 23	12 Mg magnesium 24	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	
87 Fr francium —	88 Ra radium —	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 La lanthanum 139	
89 Ac actinoids	90 Th thorium 232	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 —	119 Lu lutetium 175	120 Yb ytterbium 173

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