Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

3366141539

CO-ORDINATED SCIENCES **0654/42**

Paper 4 (Extended) **October/November 2018**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 36.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **33** printed pages and **3** blank pages.

CAMBRIDGE International Examinations

1 Fig. 1.1 shows a diagram of the distribution of tissues in a cross-section of a root.

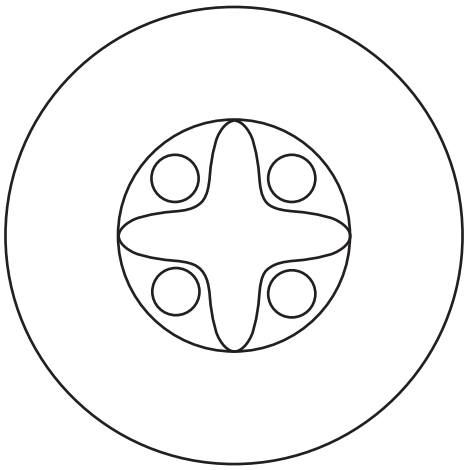

Fig. 1.1

(a) On Fig. 1.1, use label lines to label an area of:

- phloem tissue
- xylem tissue. [2]

(b) Explain, in detail, the mechanism of water movement up the stem of a plant.

.....

.....

.....

.....[3]

(c) Water enters the plant at the root.

(i) Describe how the root is adapted for the absorption of water.

.....

.....

.....[2]

(ii) State **one other** function of the root.

.....[1]

2 **(a)** State the percentage of nitrogen in clean air.

..... % [1]

(b) Fig. 2.1 shows the separation of nitrogen and oxygen from liquid air.

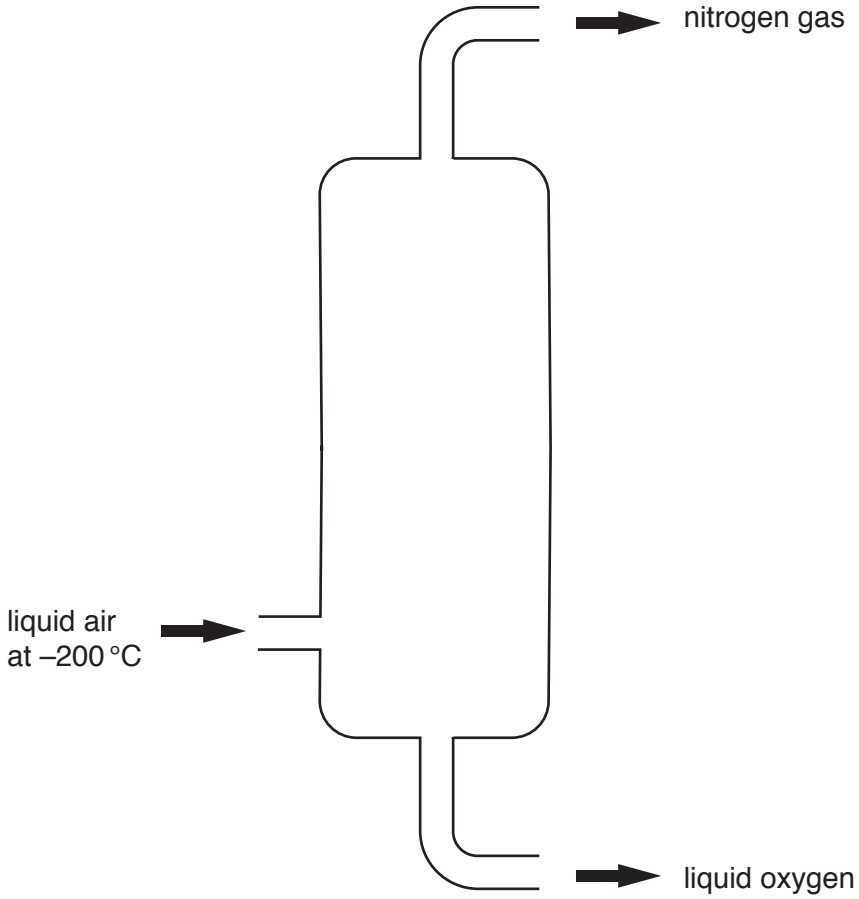

Fig. 2.1

The boiling point of liquid nitrogen is –196 °C.

The boiling point of liquid oxygen is –183 °C.

Suggest a suitable temperature that produces nitrogen gas and liquid oxygen from liquid air.

Explain your answer.

temperature ..... °C

explanation .....

.....

.....

[2]

(c) (i) Nitrogen from the air is used to make ammonium nitrate.

There are three steps in this process.

Table 2.1 shows these steps. They are **not** in the correct order.

Complete Table 2.1, using the numbers **1**, **2** and **3**, to show the correct order of these steps.

Table 2.1

step	order
A neutralisation reaction is used to produce ammonium nitrate.	
Nitrogen is used to produce ammonia in the Haber process.	
Nitrogen is separated from air.	

[1]

(ii) Name the element that combines with nitrogen to form ammonia in the Haber process.

.....[1]

(d) (i) Complete Fig. 2.2 to show the dot-and-cross diagram of all the outer shell electrons in a nitrogen molecule.

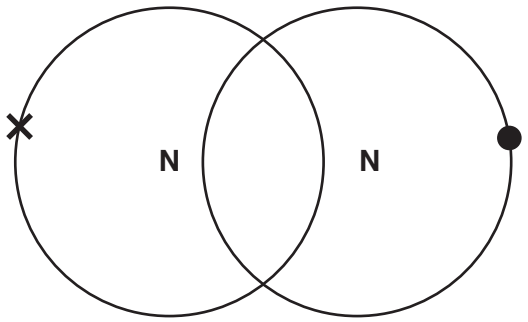

Fig. 2.2

[2]

(ii) During thunderstorms, lightning causes nitrogen and oxygen to combine to form nitrogen dioxide, NO_2.

Suggest why a large amount of energy is needed for this reaction.

.....

.....

.....[2]

(iii) Predict the effect that nitrogen dioxide has, if any, on the pH of rainwater.

Explain your answer.

effect on pH .....

explanation .....

.....

[2]

3 Fig. 3.1 shows a boat pulling a water skier across a lake.

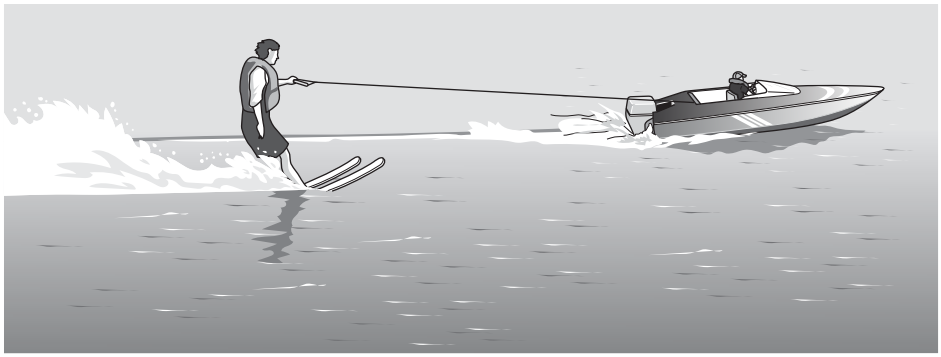

Fig. 3.1

(a) The boat accelerates at a constant rate.

The speed of the water skier increases from 5.0 m/s to 15.0 m/s in 8.0 seconds.

(i) On the grid in Fig. 3.2, draw the speed-time graph to show this motion.

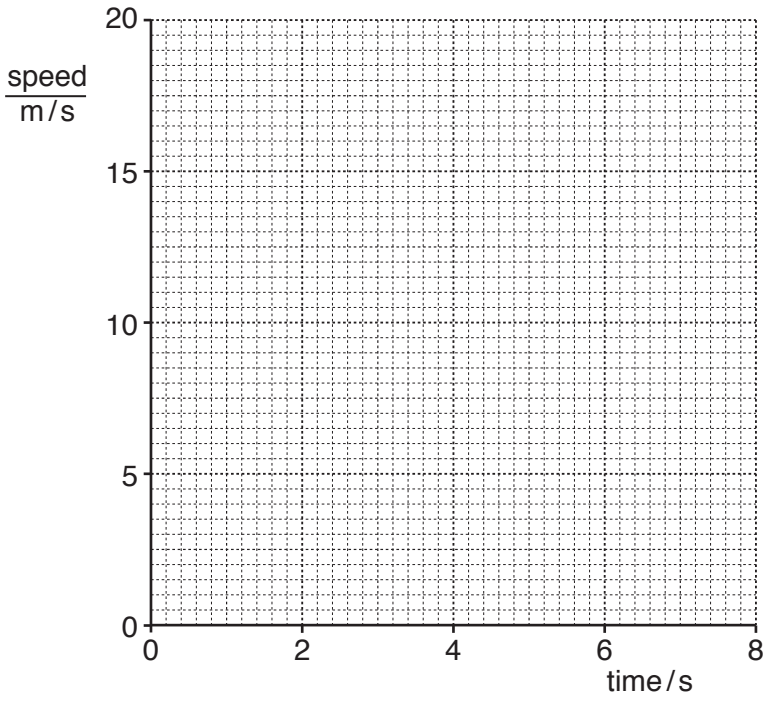

Fig. 3.2

[1]

(ii) Show that the acceleration of the water skier is 1.25 m/s^2.

[1]

(iii) The water skier has a mass of 60 kg.

Calculate the resultant force acting on the water skier as he accelerates.

State the formula you use and show your working.

formula

working

force = ... N [2]

(iv) Calculate the kinetic energy of the water skier when he is moving at 15.0 m/s.

State the formula you use and show your working.

formula

working

kinetic energy = ... J [2]

(b) The water skier produces water waves on the lake.

Fig. 3.3 shows some water waves.

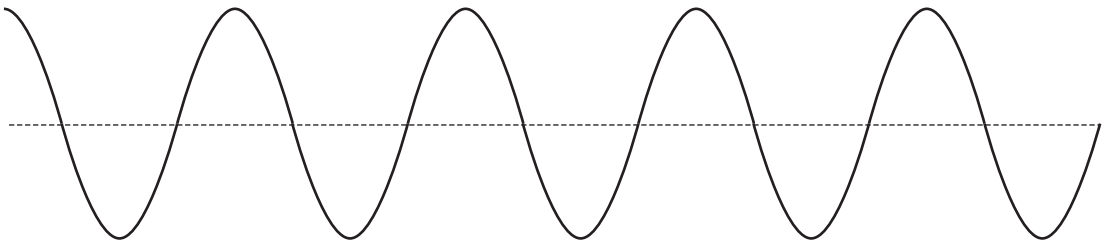

Fig. 3.3

On Fig. 3.3, draw a double headed arrow (⟷) to show the amplitude of the wave. [1]

(c) Fig. 3.4a shows the arrangement of particles in a sound wave.

Fig. 3.4b shows the arrangement of particles on the surface of a water wave.

The direction of movement of the two waves is also shown.

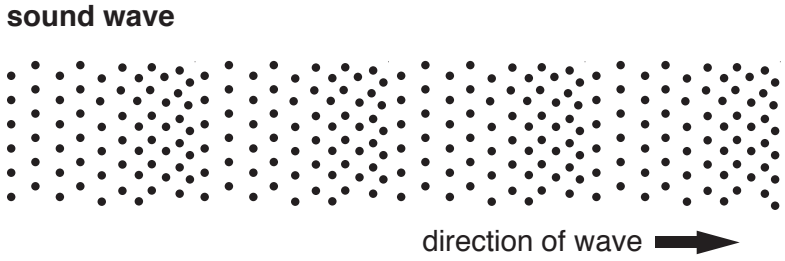

Fig. 3.4a

Fig. 3.4b

(i) On Fig. 3.4a, draw a double headed arrow (⟷) to show the direction of movement of particles in a sound wave. [1]

(ii) On Fig. 3.4b, draw a double headed arrow (⟷) to show the direction of movement of particles in a water wave. [1]

(iii) Sound waves pass through the air as a series of compressions and rarefactions.

State, in terms of compressions, what is meant by the frequency of a sound wave.

.....

.....[1]

4 **(a)** Fig. 4.1 shows the stages involved in the production of yoghurt.

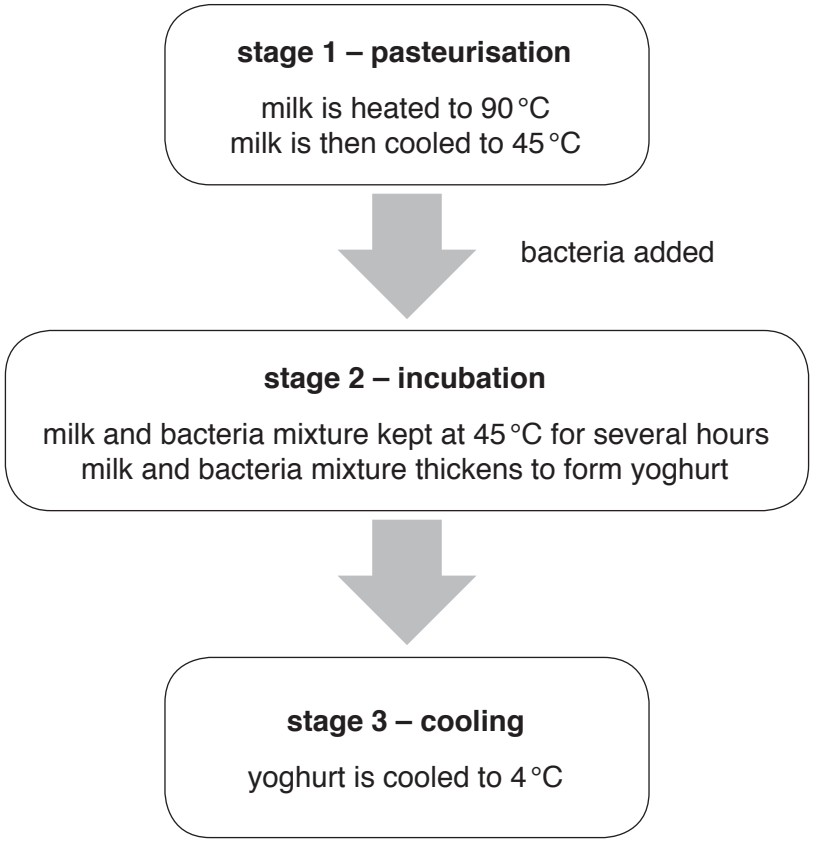

Fig. 4.1

(i) Suggest why the milk is pasteurised during **stage 1**.

.....

.....[1]

(ii) Explain why the acidity of the milk mixture increases during **stage 2**.

.....

.....

.....[2]

(iii) Explain why cooling to 4 °C stops the yoghurt production during **stage 3**.

.....

.....

.....[2]

[Turn over

(b) (i) Yoghurt contains some of the nutrients needed for a balanced diet.

The boxes on the left show some of the nutrients needed for a balanced diet.

The boxes on the right show good sources of these nutrients.

Draw four lines to link each nutrient with its good source.

nutrient	**good source**
carbohydrate	butter
fat	rice
protein	satsuma fruit
vitamin C	tuna fish

[3]

(ii) Name a deficiency disease that is caused by a lack of vitamin C.

.....[1]

5 **(a)** A student reacts iron with dilute sulfuric acid as shown in Fig. 5.1.

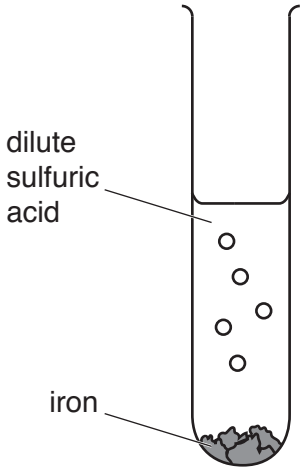

Fig. 5.1

During this reaction, aqueous iron(II) sulfate is formed.

A gas is also formed.

(i) State **one** property of iron(II) sulfate that is typical of a compound of a transition metal.

.....[1]

(ii) State the name of the gas produced when iron reacts with dilute sulfuric acid.

.....[1]

(iii) Describe what the student observes when she tests aqueous iron(II) sulfate with sodium hydroxide solution.

.....[1]

(b) The student then investigates another compound of a transition metal.

The student mixes copper oxide, CuO, with powdered carbon.

When the mixture is heated strongly, carbon reduces copper oxide to copper, and carbon is oxidised to carbon dioxide.

(i) Suggest, in terms of reactivity, why carbon is able to reduce copper oxide.

.....[1]

(ii) Construct the **balanced symbol** equation for this reaction.

.....[2]

(c) Impure copper can be purified by electrolysis as shown in Fig. 5.2.

In industry, impure copper is refined (made pure) using electrolysis.

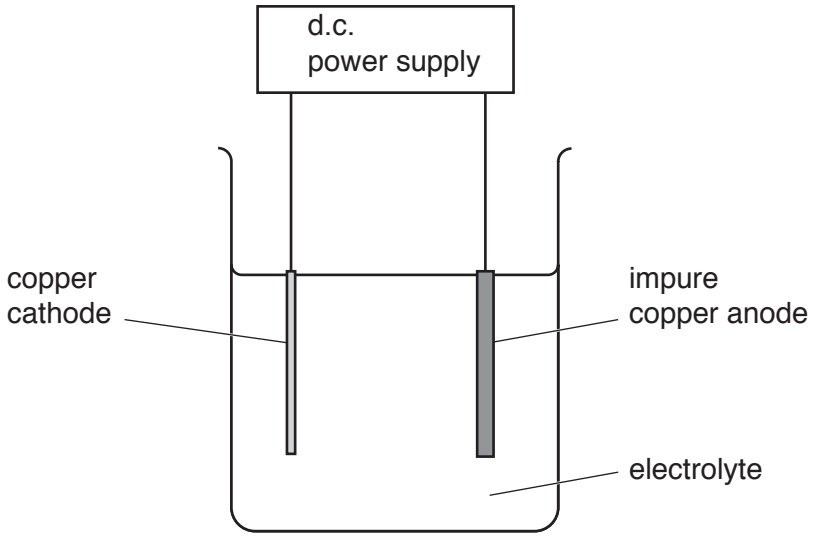

Fig. 5.2

During this process, the anode dissolves and the mass of the cathode increases.

(i) Suggest a suitable aqueous electrolyte for this process.

.....[1]

(ii) Explain, in terms of the movement of ions and electrons, why the mass of the cathode increases.

.....

.....

.....

.....[2]

6 **(a)** A fire engine communicates with the fire station using radio waves.

The fire engine uses a blue flashing light and a siren to warn people.

(i) Radio waves and visible light are both parts of the electromagnetic spectrum.

Fig. 6.1 shows an incomplete electromagnetic spectrum.

On Fig. 6.1 place radio waves **and** visible light in their correct places.

	X-rays				microwaves	

Fig. 6.1

[1]

(ii) Blue light waves have a frequency of 665 THz (1 THz = 10^{12} Hz).

Blue light waves have a wavelength of 450 nm (1 nm = 10^{-9} m).

Calculate the speed of blue light waves in m/s.

State the formula you use and show your working.

Give your answer to 3 significant figures.

formula

working

speed = ... m/s [2]

(b) A motorcyclist hears the siren from the fire engine.

The motorcyclist looks in his rear-view mirror to see the fire engine.

Fig. 6.2 shows the path of a ray of light from the fire engine to the eye of the motorcyclist.

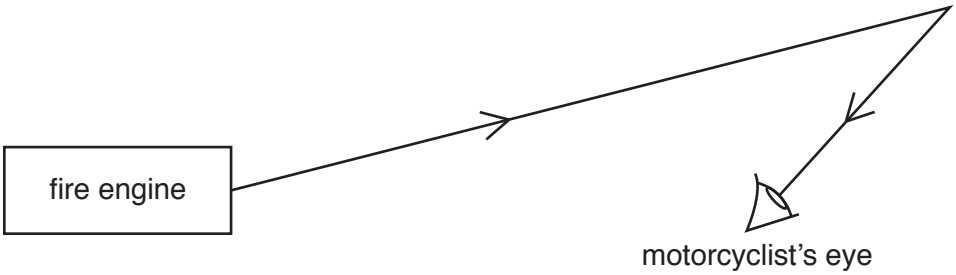

Fig. 6.2

(i) On Fig. 6.2, draw the rear-view mirror in its correct position. [2]

(ii) On Fig. 6.2, mark **and** label the angle of incidence with the letter ***i***. [1]

(iii) The angle of incidence is 30°.

State the angle of reflection.

Explain your answer.

angle of reflection = ...°

explanation .....

.....

[1]

7 **(a)** Fig. 7.1 shows the blood glucose concentration of a person during a period of exercise and recovery.

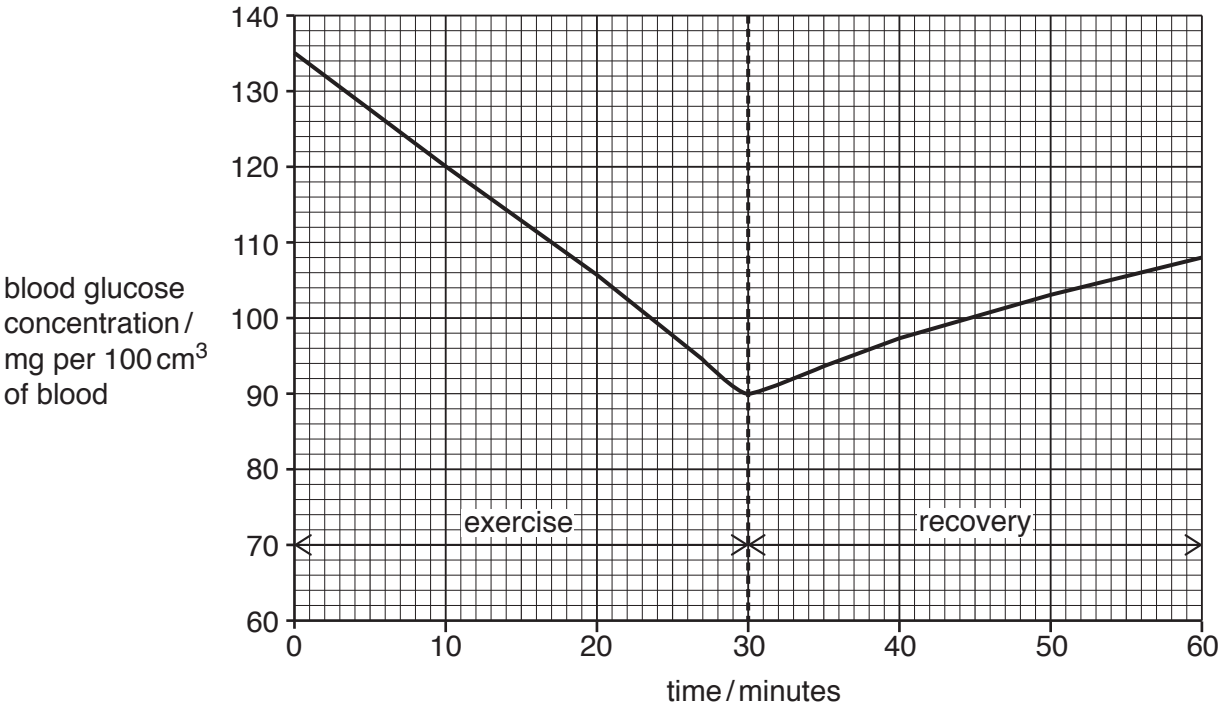

Fig. 7.1

(i) Explain why blood glucose concentration decreases during the period of exercise.

.....

.....

.....[2]

(ii) Explain why blood glucose concentration increases during the period of recovery.

.....

.....

.....

.....[3]

(b) (i) Explain why the control of blood glucose concentration is an example of negative feedback.

.....

.....

.....

.....[2]

(ii) State one **other** example of negative feedback in the human body.

.....[1]

Please turn over for Question 8.

8 **(a)** Limestone is a useful material obtained from the Earth's crust.

The main compound in limestone is calcium carbonate.

State **two** uses of limestone.

1 .....

2 .....
[2]

(b) Fig. 8.1 shows apparatus a student uses to investigate the rate of reaction between calcium carbonate and excess dilute hydrochloric acid.

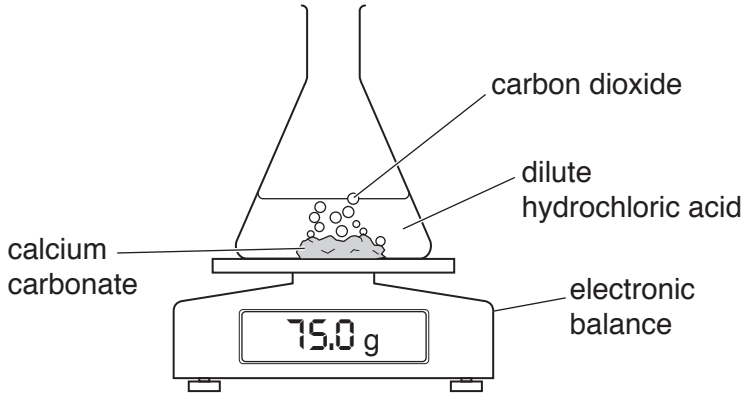

Fig. 8.1

The student records the balance reading every minute for 18 minutes.

Fig. 8.2 shows a graph of her results.

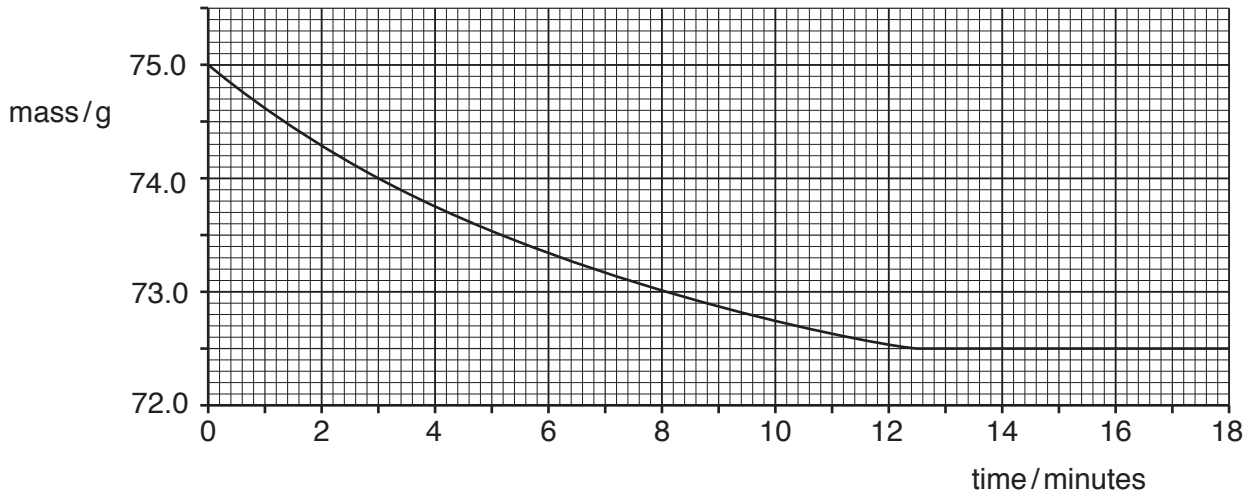

Fig. 8.2

(i) Use the graph to find the time taken for all of the calcium carbonate to react.

time = ... minutes [1]

(ii) Use the graph and your answer to **(b)(i)** to calculate the average loss of mass per minute until the reaction is complete.

average loss of mass per minute = ... g [1]

(iii) The student repeats the experiment, using acid at a higher temperature.

She does not change the other variables.

Predict **and** explain the effect of this temperature increase on the rate of this reaction.

Use ideas about collisions between particles in your explanation.

effect .....

explanation .....

.....

.....

[2]

(c) The balanced equation for the reaction in **(b)** is shown below.

$$2HCl(aq) + CaCO_3(s) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

(i) State the meanings of the state symbols (aq) and (l).

(aq) .....

(l) .....

[1]

(ii) Use **steps 1**, **2** and **3** to calculate the volume of carbon dioxide that is produced when 2.0 g of calcium carbonate reacts with excess dilute hydrochloric acid.

Show your working.

step 1
Calculate the number of moles of calcium carbonate contained in 2.0 g.
[A_r : Ca, 40; C, 12; O, 16]

number of moles of calcium carbonate = ...

step 2
State the number of moles of carbon dioxide that are produced.

number of moles of carbon dioxide = ...

step 3
Calculate the volume in dm^3 of carbon dioxide that is produced.
[molar gas volume = 24 dm^3]

volume = ... dm^3

[4]

Please turn over for Question 9.

9 A list of metals is shown.

aluminium **copper** **iron** **lead** **uranium**

(a) **(i)** Scientists wear protective aprons when handling radioactive materials.

State which metal from the list is used in the aprons to reduce the ionising radiation passing through.

.....[1]

(ii) An isotope of uranium has a nuclide notation $^{234}_{92}U$ and decays by alpha emission to produce an isotope of thorium.

Use the correct nuclide notation to write a symbol equation for this decay process.

$$^{234}_{92}U \longrightarrow {}^{\cdots\cdots}_{\cdots\cdots}Th + {}^{\cdots\cdots}_{\cdots\cdots}He$$

[2]

(b) Fig. 9.1 shows a simplified diagram of a transformer.

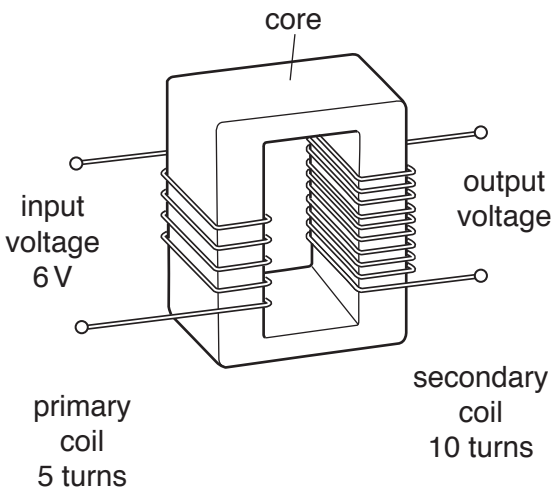

Fig. 9.1

(i) State which metal from the list is used in the core of a transformer.

.....[1]

(ii) State which metal from the list is used in the coils of a transformer.

.....[1]

(iii) Calculate the voltage induced in the secondary coil of the transformer shown in Fig. 9.1. State the formula you use and show your working.

formula

working

output voltage = ... V [2]

(c) (i) A block of aluminium has a density of 2700 kg / m^3.

State the two quantities needed to calculate the density of the block.

1 .....

2 .....
[1]

(ii) When aluminium melts, energy is required but the temperature remains the same.

Explain what is happening in terms of atoms.

Use the term *latent heat of fusion* in your answer.

.....

.....

.....

.....

.....[2]

(iii) Aluminium has a specific heat capacity of 913 J / (kg°C).

State what is meant by this quantity.

.....

.....

.....[1]

(iv) An aluminium cable of length 1 km has a resistance of 1.2 Ω. The cable has a cross-sectional area of 25 mm^2.

Determine the resistance of another aluminium cable of length 1 km that has a cross-sectional area of 50 mm^2.

resistance = ... Ω [1]

10 (a) Fig. 10.1 shows a diagram of an insect-pollinated flower.

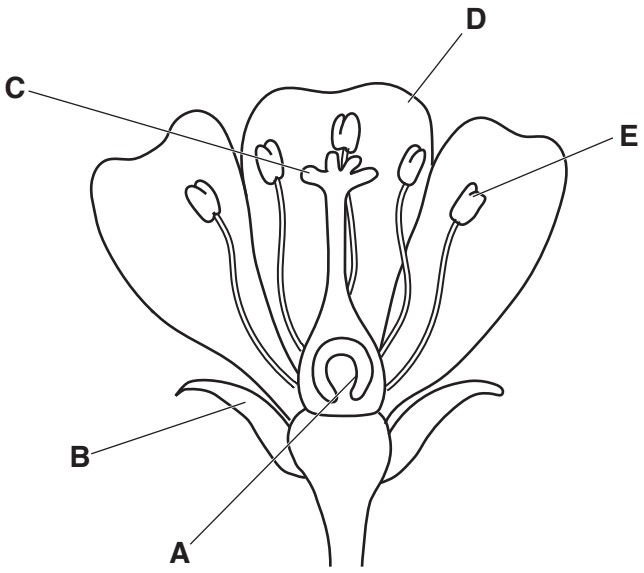

Fig. 10.1

(i) Table 10.1 shows information about some of the parts of the flower in Fig. 10.1.

Use Fig. 10.1 to complete Table 10.1.

Table 10.1

name of part	letter in Fig. 10.1	function
anther		
		produces the female gamete (ovule)
sepal		

[3]

(ii) Describe how the appearance of the part labelled **D** in Fig. 10.1 differs in a wind-pollinated plant.

.....

.....[1]

(b) Pollination often leads to fertilisation and the formation of seeds.

Seeds can be dispersed by wind or animals.

(i) Describe **two** ways in which animals can disperse seeds.

1 .....

.....

2 .....

.....

[2]

(ii) Suggest an advantage to seeds being dispersed in a new area.

.....

.....[1]

(c) Draw a circle around the name of the gas required by seeds for germination.

carbon dioxide **carbon monoxide** **hydrogen**

nitrogen **oxygen** **sulfur dioxide**

[1]

11 **(a)** Polymers form from monomer units.

State the type of polymerisation that forms:

poly(ethene) .....

nylon. .....

[2]

(b) Fig. 11.1 shows the structures of six hydrocarbon molecules **P**, **Q**, **R**, **S**, **T** and **U**.

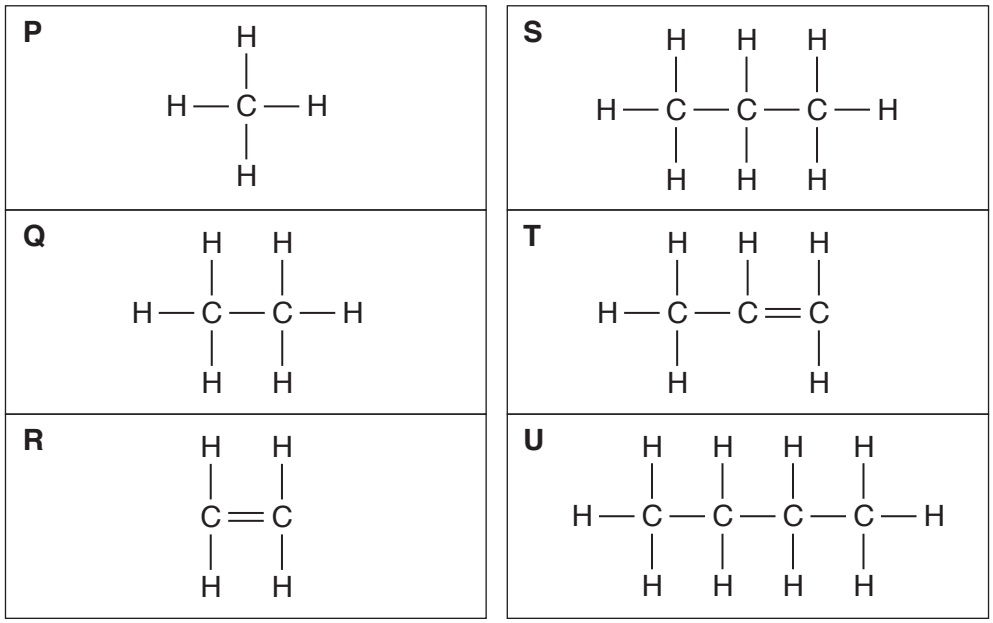

Fig. 11.1

State all the hydrocarbons from **P**, **Q**, **R**, **S**, **T** and **U** which:

are alkanes

.....

are alkenes

.....

react with steam to produce ethanol

.....

react with hydrogen to produce ethane

.....

produce carbon dioxide and water on complete combustion.

.....

[5]

(c) Proteins are natural polymers that can be broken down into smaller molecules by enzymes and also by chemical reactions under acid or alkaline conditions.

(i) State the type of chemical reaction that occurs when protein molecules are broken down under acid or alkaline conditions.

.....[1]

(ii) State the type of small molecules that are produced when protein molecules are broken down.

.....[1]

12 (a) Fig. 12.1 shows a bicycle with a front lamp **A** and a rear lamp **B** powered by the same battery.

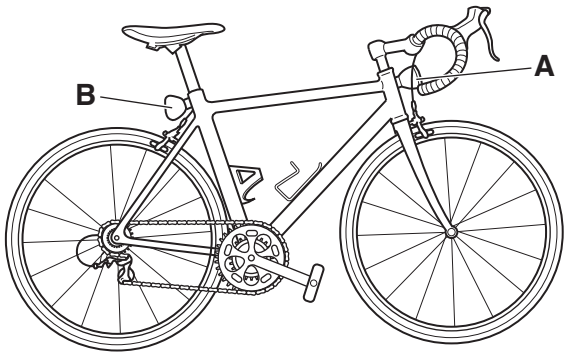

Fig. 12.1

Fig. 12.2 is a circuit diagram to show how the lamps are connected.

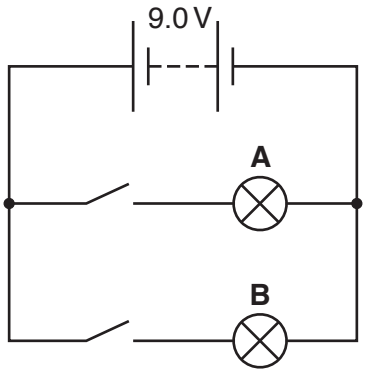

Fig. 12.2

(i) Lamp **A** has a resistance of 16.0 Ω and lamp **B** has a resistance of 8.0 Ω.

Calculate the combined resistance of the two lamps in this circuit when both switches are closed.

Show your working.

resistance = ... Ω [2]

(ii) Calculate the power of lamp **B**.

State any formula you use, show your working and give the unit of your answer.

formula

working

power = ... unit ..... [4]

(b) One of the lamps is shown in Fig. 12.3.

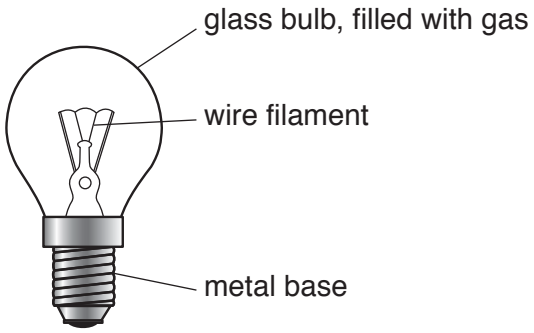

Fig. 12.3

The hot lamp transfers thermal energy.

(i) Name the process that transfers thermal energy through the metal base.

.....[1]

(ii) Name the **two** processes that transfer thermal energy between the hot wire filament and the glass bulb.

1 .....

2 .....
[1]

(c) The cyclist has a flat tyre. She pumps up the flat tyre with a volume of 3168 cm^3 of air at atmospheric pressure.

When the tyre is inflated, the volume of air in the tyre is 1441 cm^3. Assume that there was no air in the flat tyre.

The pressure of the air in the inflated tyre is 2.22×10^5 N/m^2.

The temperature of the air does not change.

(i) Write down the value of the inflated tyre pressure in pascals (Pa).

..... Pa [1]

(ii) Calculate the atmospheric pressure in N/m^2.

State the formula you use and show your working.

formula

working

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

13 (a) Mitosis and meiosis are two types of cell division.

(i) Use words from the list to complete the definition of the term *mitosis*.

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

alleles	**cells**	**chromosomes**
gamete	**genes**	**nuclear**

Mitosis is defined as ..... division giving rise to genetically identical ..... in which the chromosome number is maintained by the exact duplication of ..... . [3]

(ii) State **two** roles of mitosis in the body.

1 .....

2 .....[2]

(b) Table 13.1 shows some statements about sex cells.

Place a tick (✓) next to **all** of the statements that describe sperm cells.

Table 13.1

statement	tick (✓) if correct
always contain an **X** chromosome	
always contain a **Y** chromosome	
are diploid cells	
are gametes	
are haploid cells	
contain paired chromosomes	
contain unpaired chromosomes	

[2]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

Group

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

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

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