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Cambridge Assessment International Education

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CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6196234396

COMBINED SCIENCE **0653/41**

Paper 4 Theory (Extended) **October/November 2022**

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.

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 **24** pages. Any blank pages are indicated.

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1 **(a)** Fig. 1.1 shows the structure of a human heart.

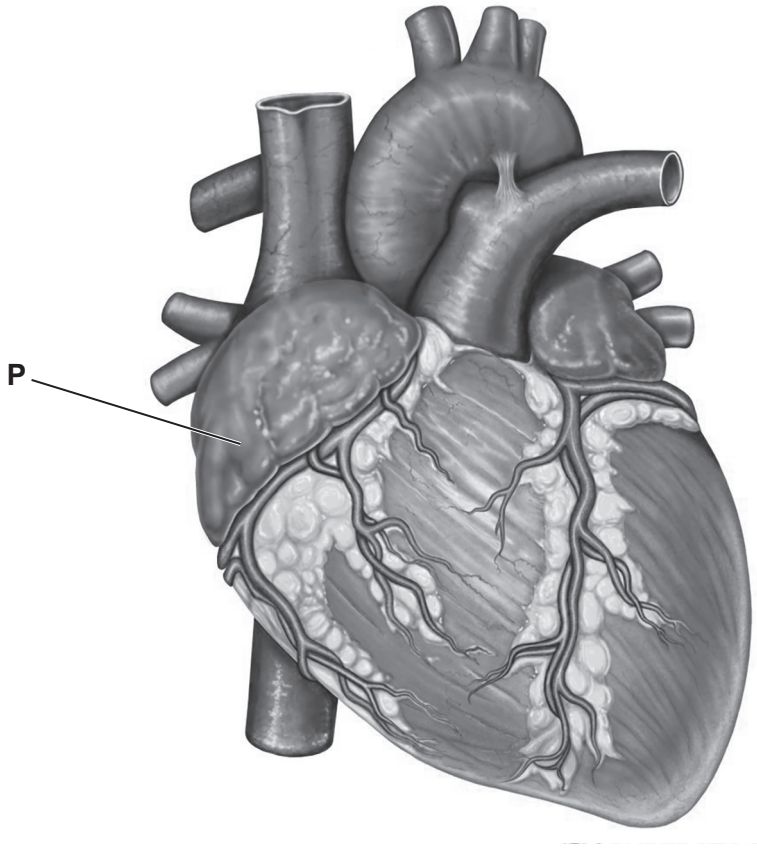


Fig. 1.1

(i) State the name of the part labelled **P** in Fig. 1.1.

..... [1]

(ii) State the name of the blood vessel that transports blood from the body to the heart.

..... [1]

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(iii) The human heart is part of a double circulation system.

Describe the double circulation system in humans.

.....

.....

.....

..... [2]

(b) The waist-to-hip ratio is used to determine whether a person is overweight.

The waist-to-hip ratio is calculated from two measurements using the equation shown.

$$\text{waist-to-hip ratio} = \frac{\text{waist measurement}}{\text{hip measurement}}$$

Fig. 1.2 shows where the measurements are taken.

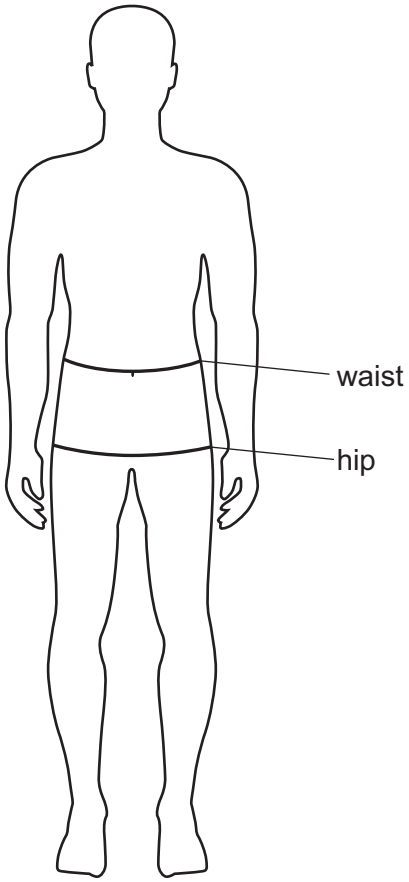


Fig. 1.2

(i) A person has a waist measurement of 80 cm and a hip measurement of 97 cm.

Calculate the waist-to-hip ratio of this person.

Give your answer to **two** significant figures.

waist-to-hip ratio = ... [2]

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(ii) The people of one country are grouped into different categories according to waist-to-hip ratio.

The incidence of coronary heart disease in each group is recorded.

Fig. 1.3 shows the results.

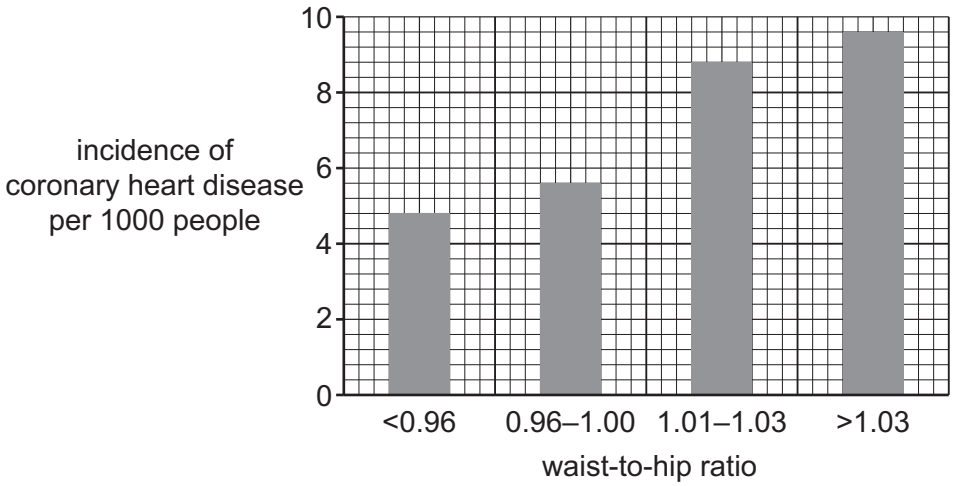


Fig. 1.3

Describe the relationship between incidence of coronary heart disease and waist-to-hip ratio shown in Fig. 1.3.

.....

..... [1]

(iii) Describe how malnutrition may cause coronary heart disease.

.....

.....

.....

..... [2]

[Total: 9]

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2 Concentrated aqueous sodium chloride is electrolysed using inert electrodes, as shown in Fig. 2.1.

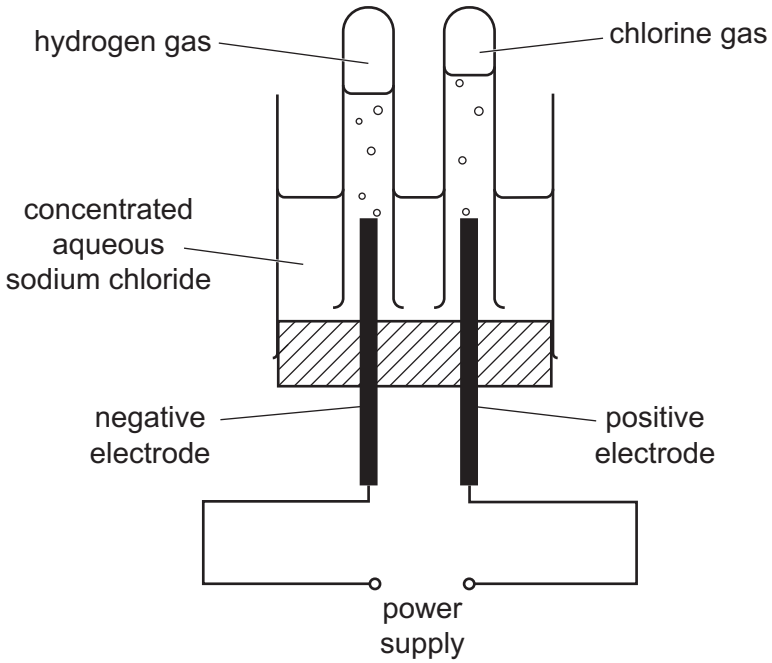


Fig. 2.1

(a) Describe the chemical tests for hydrogen and for chlorine.

State the positive result for each test.

hydrogen test .....

positive result .....

chlorine test .....

positive result .....

[2]

(b) The equation for the electrolysis of concentrated aqueous sodium chloride is shown.

$$2NaCl(.....) + 2H_2O(.....) \rightarrow H_2(g) + Cl_2(g) + 2NaOH(.....)$$

(i) Complete the equation by adding the missing state symbols. [1]

(ii) State the name of the product that has the formula NaOH.

..... [1]

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(c) Four statements about the electrolysis of concentrated aqueous sodium chloride are shown in Table 2.1.

Put a tick (✓) in **one** box in each row to show whether each statement is true or false.

Table 2.1

statement	true	false
OH^- ions are attracted to the cathode.		
H^+ ions gain electrons at the negative electrode.		
H^+ ions come from the water in the solution.		
Hydrogen gas is made when OH^- ions lose electrons.		

[2]

(d) A solution of hydrochloric acid is mixed with universal indicator solution.

State the colour and pH of this mixture.

colour .....

pH .....

[2]

[Total: 8]

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3 Fig. 3.1 shows forces **P**, **Q**, **R** and **S** acting on an airplane moving forward along a runway.

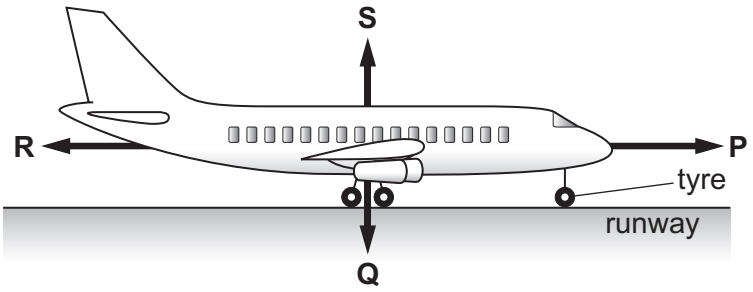


Fig. 3.1

(a) Use Fig. 3.1 to complete the sentences.

Write **P**, **Q**, **R** or **S** in each gap.

The weight of the airplane, ... , is balanced by force ..... acting in the opposite direction.

When force ..... is greater than force ..... , the airplane accelerates along the runway.

[2]

(b) The mass of the airplane is 120 000 kg.

(i) Calculate the weight of the airplane.

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

weight = ... N [1]

(ii) The total area of all the airplane tyres in contact with the ground is 0.125 m^2.

Use your answer to **(b)(i)** to calculate the pressure exerted by the airplane on the ground.

Give the units of your answer.

pressure = ... units ..... [3]

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(iii) The engines of the airplane provide a driving force of 1.2×10^6 N.

The airplane moves a distance of 1500 m along the runway.

Calculate the work done by the engines on the airplane.

work done = ... J [2]

(iv) The airplane takes off at a speed of 80 m / s.

Calculate the kinetic energy of the airplane as it takes off.

kinetic energy = ... J [2]

(v) Suggest a reason for the difference between your answers to **(b)(iii)** and **(b)(iv)**.

.....

..... [1]

[Total: 11]

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4 **(a)** Starch is broken down by amylase into smaller molecules.

(i) State the type of carbohydrate molecules produced when amylase breaks down starch.

..... [1]

(ii) Fig. 4.1 shows the effect of temperature on amylase activity.

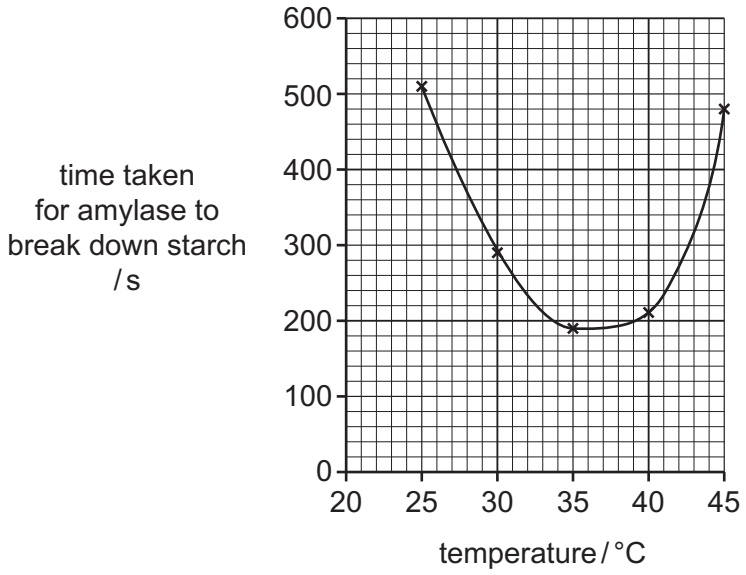


Fig. 4.1

Explain the effect of temperature on amylase activity between 25 °C and 35 °C.

.....

.....

.....

.....

..... [3]

(iii) Explain why amylase does **not** break down protein molecules.

.....

.....

..... [2]

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(b) Starch is used for storage in plants. Carbon in starch is returned to the atmosphere as part of the carbon cycle.

(i) State **two** processes in the carbon cycle that return carbon to the atmosphere.

1 .....

2 .....
[2]

(ii) State the process in the carbon cycle that traps carbon for millions of years.

..... [1]

(c) Plants are the producers in a food web.

Fig. 4.2 shows a food web.

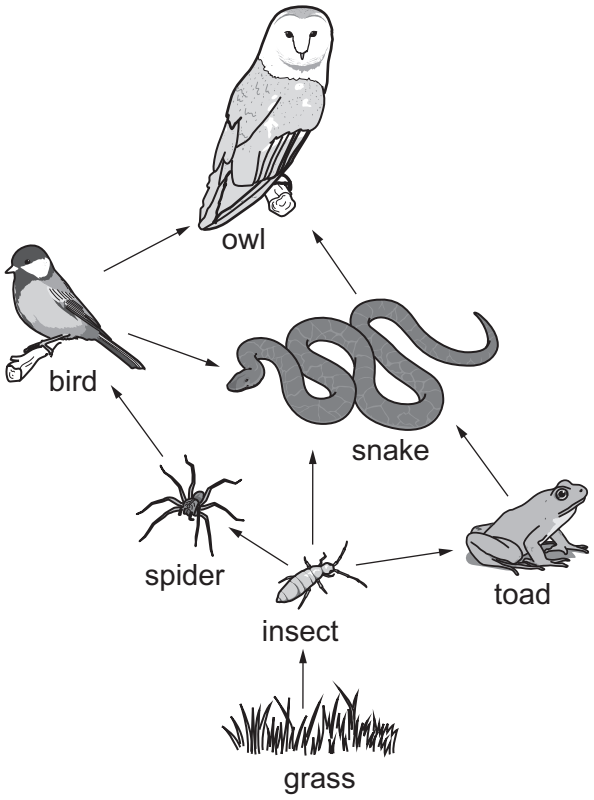


Fig. 4.2

Use Fig. 4.2 to explain why the snake is both a secondary and a tertiary consumer.

.....

.....

..... [2]

[Total: 11]

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5 The energy level diagram for the combustion of hydrogen is shown in Fig. 5.1.

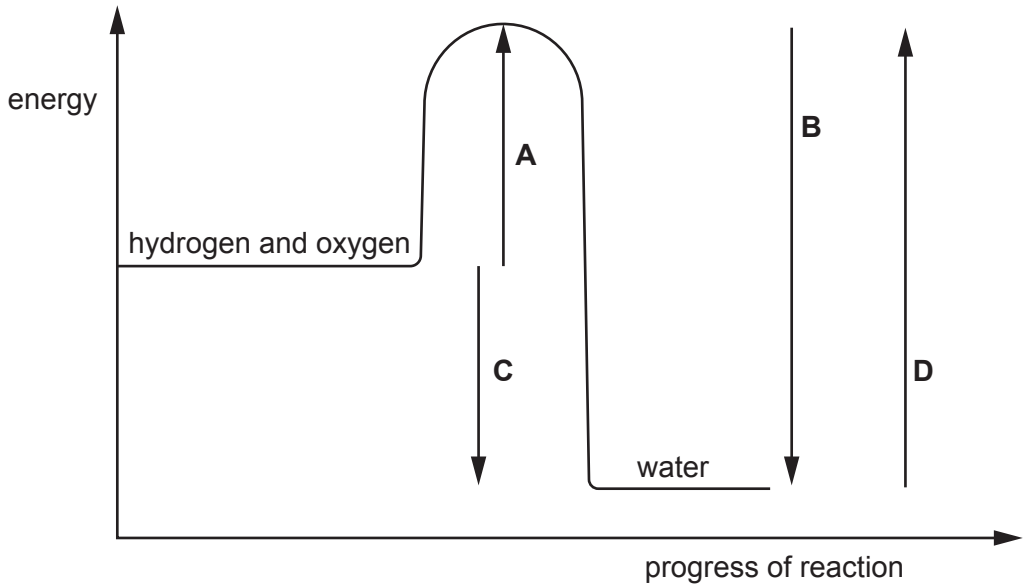


Fig. 5.1

(a) State which arrow, **A**, **B**, **C** or **D**, represents the overall energy change for the reaction.

..... [1]

(b) Complete Table 5.1 to describe the changes represented by arrow **A** and arrow **B**.

Place **two** ticks (✓) in each row.

Table 5.1

	bonds break	bonds form	energy is taken in	energy is given out
arrow **A**				
arrow **B**				

[2]

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(c) Some cars use hydrogen as a fuel.

Some cars use diesel oil as a fuel. Diesel contains mainly alkanes.

(i) Give **one** similarity and **one** difference between the products of the combustion of hydrogen and of the complete combustion of alkanes.

similarity .....

.....

difference .....

.....
[2]

(ii) Use your answer to **(c)(i)** to suggest why diesel cars are considered more harmful to the environment than hydrogen cars.

.....

..... [1]

(iii) Table 5.2 shows information about the melting points and boiling points of hydrogen and of diesel.

Table 5.2

	melting point / °C	boiling point / °C
hydrogen	–259	–253
diesel	less than 20	greater than 150

Use the information in Table 5.2 to suggest why hydrogen is more difficult to store than diesel at 20 °C.

.....

.....

.....

..... [2]

[Total: 8]

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6 **(a)** Fig. 6.1 shows a hairdryer.

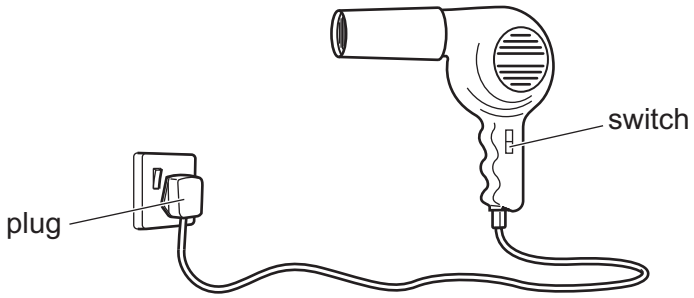


Fig. 6.1

The hairdryer contains an electric motor to blow air and a heater to heat the air.

The plug contains a fuse.

Fig. 6.2 shows the circuit diagram for the hairdryer.

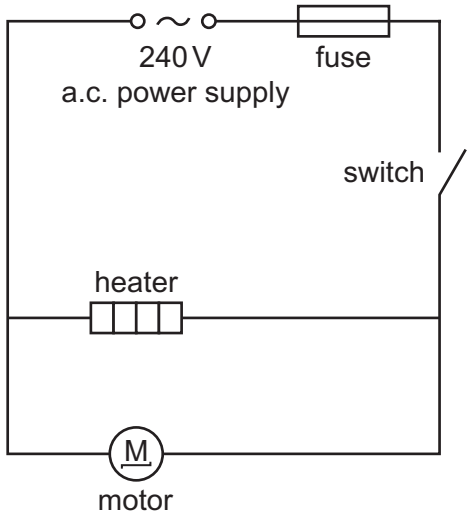


Fig. 6.2

(i) The electric motor has a power rating of 60 W.

The heater has a power rating of 2300 W.

Show that the current in the fuse is 9.8 A.

[3]

(ii) Discuss whether 10 A is an appropriate rating for the fuse.

.....

.....

..... [2]

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(b) Fig. 6.3 shows a different hairdryer with two switches.

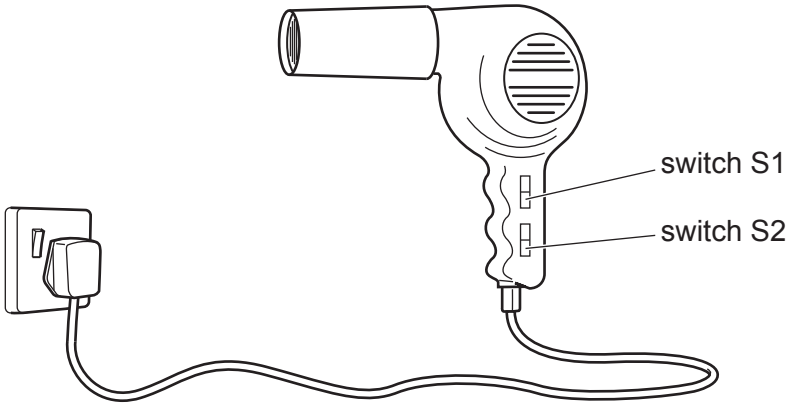


Fig. 6.3

When switch S1 is ON and switch S2 is ON, the hairdryer blows out **heated** air.

When switch S1 is ON and switch S2 is OFF, the hairdryer blows out **unheated** air.

When switch S1 is OFF, both the motor and the heater are switched OFF.

Fig. 6.4 shows an incomplete circuit diagram for the hairdryer.

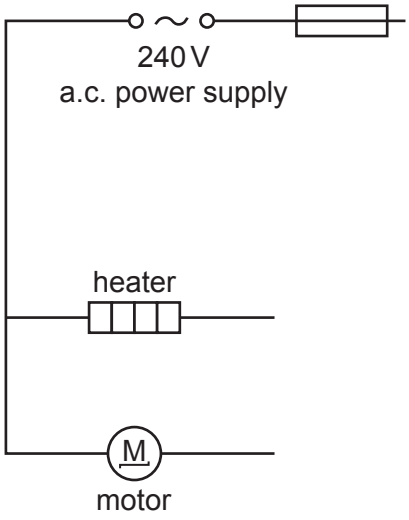


Fig. 6.4

On Fig. 6.4, complete the circuit diagram for the hairdryer by adding switch S1 and switch S2 in the correct positions.

Label the switches S1 and S2. [2]

[Total: 7]

7 **(a)** Fig. 7.1 is a diagram showing a fetus developing inside the female reproductive system.

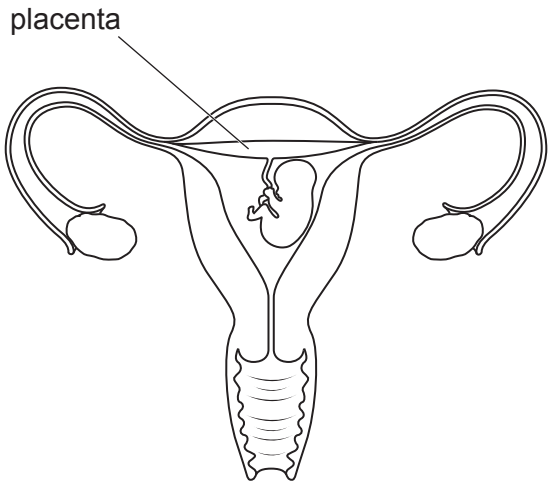


Fig. 7.1

(i) On Fig. 7.1, draw a label line and the letter **O** to identify one ovary. [1]

(ii) Complete the sentences about the placenta using one word from the list in each gap.

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

excretory	**insoluble**	**nutrients**
oxygen	**reproductive**	**toxins**

The placenta provides a barrier to prevent ..... reaching the fetus.

The placenta also allows ..... products to pass from the fetus to the mother.

[2]

(b) A pregnant female takes vitamin D to supplement her diet.

Explain why vitamin D is needed during **pregnancy**.

.....

.....

..... [2]

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(c) Pregnant females are advised **not** to smoke tobacco.

Tobacco smoke contains nicotine and tar.

Describe the effects of nicotine and tar on the body.

nicotine .....

.....

tar .....

.....

[2]

[Total: 7]

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8 Period 3 of the Periodic Table is shown in Fig. 8.1.

group	I	II	III	IV	V	VI	VII	VIII
element	Na sodium	Mg magnesium	A*l* aluminium	Si silicon	P phosphorus	S sulfur	C*l* chlorine	Ar argon

Fig. 8.1

(a) Identify **two** metals and **two** non-metals in Period 3.

metals: ..... and .....

non-metals: ..... and .....
[2]

(b) A sodium atom forms a sodium ion, Na^+.

A chlorine atom forms a chloride ion, Cl^-.

Explain why the ions formed by these atoms have different charges.

Use ideas about electron arrangements in your answer.

.....

.....

.....

..... [3]

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(c) Sodium and chlorine react together to form sodium chloride, an ionic solid.

Fig. 8.2 shows the arrangement of ions in solid sodium chloride. Two of the ions have been labelled.

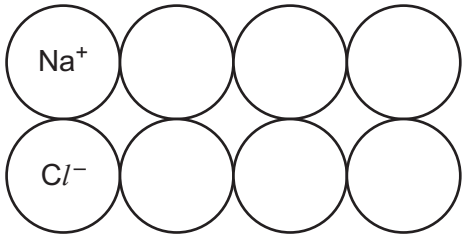


Fig. 8.2

(i) Complete Fig. 8.2 by labelling the other ions. [1]

(ii) Explain why ionic solids, such as sodium chloride, have high melting points.

.....

.....

..... [2]

(iii) State the name of an element in the same group of the Periodic Table as sodium that is more reactive than sodium.

..... [1]

(iv) State the name of an element in the same group of the Periodic Table as chlorine that is more reactive than chlorine.

..... [1]

[Total: 10]

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9 **(a)** A radar system in an airport uses microwaves to find and track an airplane in the sky.

(i) Fig. 9.1 shows an incomplete electromagnetic spectrum.

On Fig. 9.1, write microwaves in the correct place.

← increasing frequency						
	X-rays	ultraviolet				

Fig. 9.1

[1]

(ii) The radar system makes a regular beeping sound.

When the airplane gets close to the airport, the beeping sound increases in volume and pitch.

Fig. 9.2 shows the waveform of the beeping sound when the airplane is far from the airport and when the airplane is close to the airport.

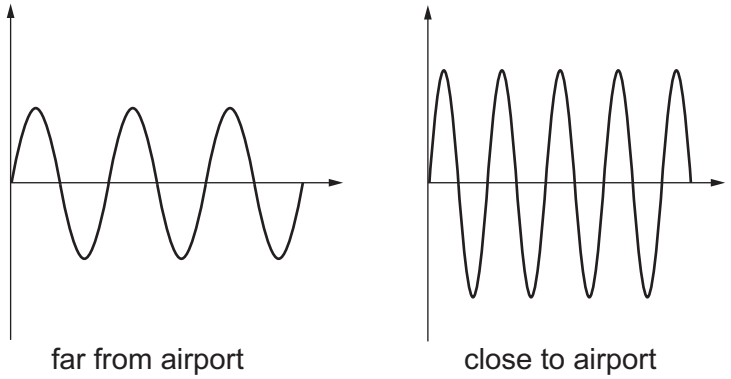


Fig. 9.2

Describe how Fig. 9.2 shows that the beeping sound increases in volume and pitch.

Use the words amplitude and frequency in your answer.

volume .....

.....

pitch .....

.....

[2]

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(b) Write **one** word in each gap to complete the sentences about waves.

For a ..... wave, the direction of vibration is at right angles to the direction of travel of the wave.

For a ..... wave, the direction of vibration is parallel to the direction of travel of the wave.

[2]

(c) An airplane is flying in bright sunlight.

It is warmed by electromagnetic radiation from the Sun.

(i) State the speed at which electromagnetic radiation travels from the Sun.

speed = ... m/s [1]

(ii) The distance of the airplane from the Sun is 1.5×10^{11} m.

Use your answer to **(c)(i)** to calculate the time taken for the electromagnetic radiation to reach the airplane from the Sun.

time = ... s [2]

(iii) Suggest how painting the airplane in shiny white paint helps to keep the airplane cool.

.....

..... [1]

[Total: 9]

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The Periodic Table of Elements

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

Key

atomic number
atomic symbol
name
relative atomic mass

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

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

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