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CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

COMBINED SCIENCE **0653/33**

Paper 3 Theory (Core) **May/June 2023**

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

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1 **(a)** The boxes on the left show different characteristics of living organisms.

The boxes on the right show descriptions of the characteristics.

Draw **one** straight line from each characteristic to its description.

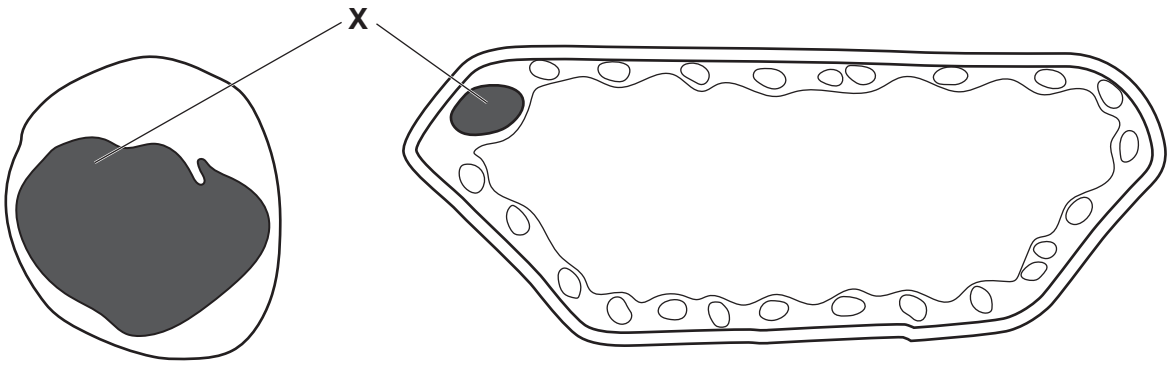
characteristic	**description**
growth	action that causes a change in position
movement	detect and respond to changes in the environment
nutrition	permanent increase in size
	taking in materials for energy

[3]

(b) Living organisms are made up of small basic units surrounded by membranes.

Fig. 1.1 represents photomicrographs of two of these small basic units.

A is found in human blood. **B** is found in a plant.



basic unit **A**

basic unit **B**

NOT TO SCALE

Fig. 1.1

(i) Circle the **one** word that is the name for the basic units of a living organism.

cells **organs** **proteins** **stomata** [1]

(ii) Identify the structure labelled **X** in Fig. 1.1.

..... [1]

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(iii) Basic unit **B** is from the leaf of a plant.

Identify **two** structures that show basic unit **B** is from a plant.

1 .....

2 .....
[2]

(c) A student investigates the effect of immersing potato tissue in sugar solutions of different concentrations.

The student:

- measures the mass of potato tissue at the start
- measures the mass of potato tissue after 1 hour in sugar solution.

Table 1.1 shows some of the results.

Table 1.1

sugar solution	mass of potato tissue at start /g	mass of potato tissue after 1 hour /g	change in mass /g
A	1.9	2.0	0.1
B	1.8	1.8	0.0
C	1.9	1.7	–0.2
D	1.8	1.5	–0.3
E	1.8	1.3	–0.5

(i) Suggest which solution **A**, **B**, **C**, **D** or **E** has the greatest concentration of sugar.
Give a reason for your answer.

solution .....

reason .....
[2]

(ii) Suggest why the potato in solution **B** does **not** change in mass.

.....

..... [1]

(iii) The potato tissue changes mass because a substance moves across the cell membrane.

State the name of this substance.

..... [1]

[Total: 11]

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[Turn over

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2 A student investigates the combustion of natural gas, as shown in Fig. 2.1.

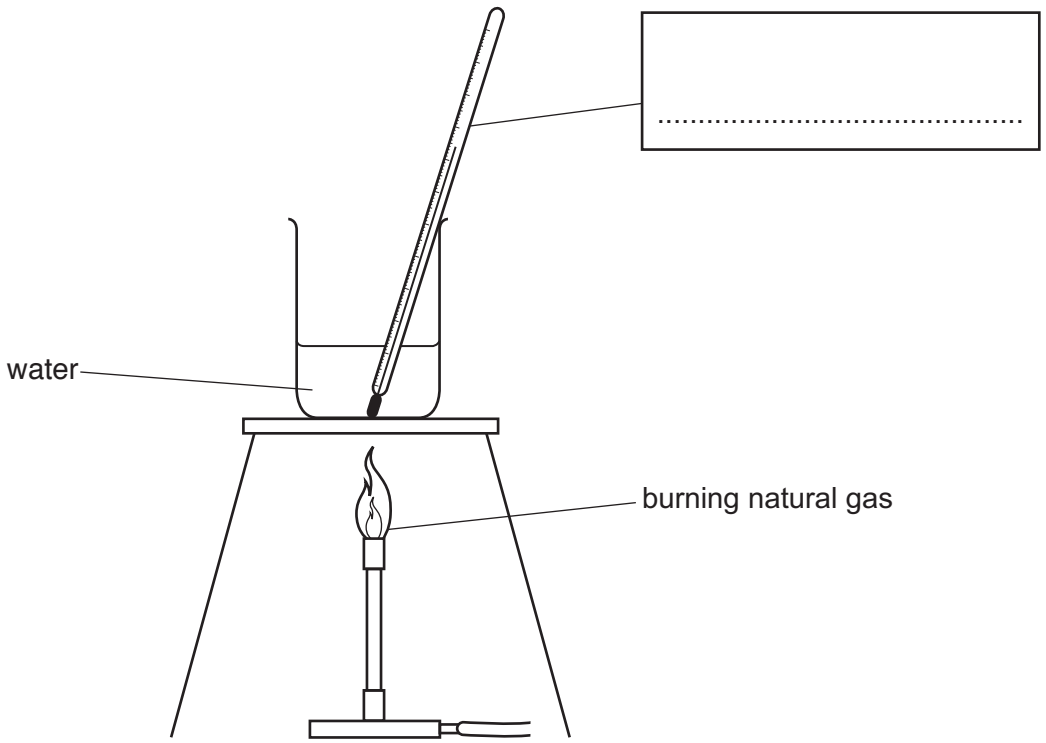

Fig. 2.1

(a) The student measures the temperature of the water as the natural gas burns.

(i) Complete Fig. 2.1 by labelling the apparatus that is used to measure temperature. [1]

(ii) State the name of the hydrocarbon that is the main constituent of natural gas.

..... [1]

(iii) State what is meant by hydrocarbon.

.....

..... [1]

(b) During this investigation, the combustion of natural gas causes the temperature of the water in the beaker to increase.

State the name of the type of chemical reaction that causes an increase in temperature.

..... [1]

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(c) One of the products of the combustion of natural gas is carbon dioxide, CO_2.

(i) Explain why this combustion reaction is a redox reaction.

.....

..... [1]

(ii) State the type of chemical bond formed in a molecule of carbon dioxide.

..... [1]

(iii) Describe a test for carbon dioxide and state the observation for a positive result.

test .....

.....

observation .....

[2]

[Total: 8]

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3 Fig. 3.1 shows a football player kicking a football.

Fig. 3.1

(a) Fig. 3.2 shows a speed–time graph for the horizontal motion of the ball after leaving the player's foot.

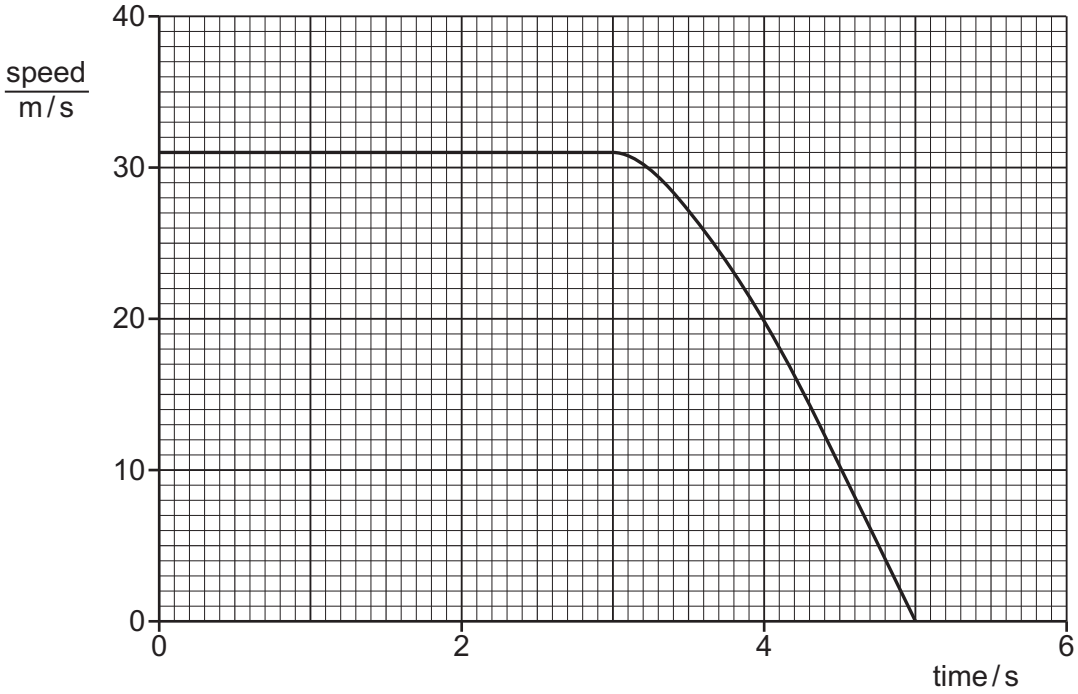

Fig. 3.2

(i) State the horizontal speed of the ball as it leaves the player's foot.

speed = ... m / s [1]

(ii) The ball hits the ground and rolls forwards before it stops. On Fig. 3.2, mark with an **X** a time when the ball is decelerating. [1]

(iii) Explain why the horizontal speed of the ball does **not** increase after leaving the player's foot.

.....

..... [1]

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(b) Fig. 3.3 shows the player holding the football on his hand without the ball moving.

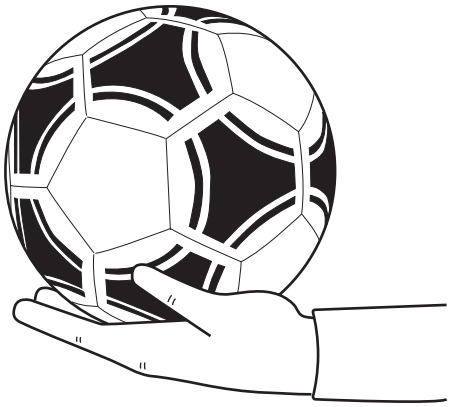

Fig. 3.3

The player uses an upward force of 4.0 N to hold the ball stationary.

Calculate the mass of the ball.

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

mass = ... kg [2]

(c) The mass of another ball is 150 g. The ball has a volume of 180 cm^3.

Calculate the density of the ball. Give the units of your answer.

density = ... units ..... [3]

[Total: 8]

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4 **(a)** Fig. 4.1 is a diagram of the alimentary canal and associated organs.

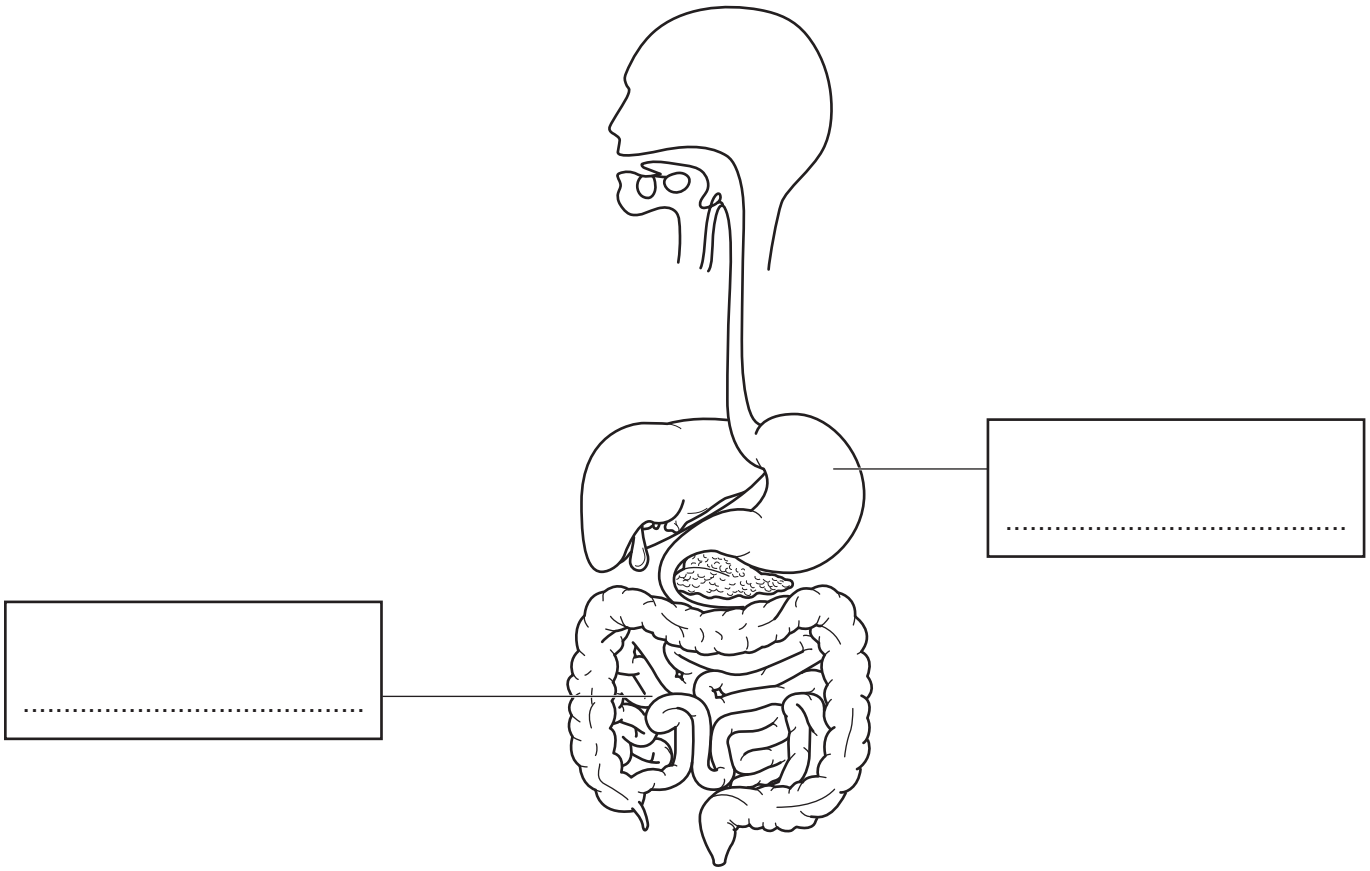

Fig. 4.1

(i) Complete the labels in Fig. 4.1 with the names of the parts shown. [2]

(ii) Draw a label line and the letter **G** to identify the gall bladder on Fig. 4.1. [1]

(b) Blood transports digested food away from the alimentary canal.

(i) State the name of the component of blood that transports the digested food.

..... [1]

(ii) State the name of the main blood vessel that transports blood back to the heart from all the organs in the body.

..... [1]

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(c) Males and females have different reproductive systems.

(i) The urethra and penis are part of the male reproductive system in humans.

State the names of two **other** parts of the male reproductive system in humans.

1 .....

2 .....

[2]

(ii) The uterus is one part of the female reproductive system in humans.

Describe what happens to the lining of the uterus between day 0 and day 5 of the menstrual cycle.

..... [1]

[Total: 8]

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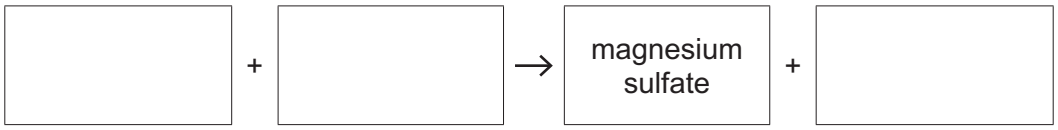
5 Magnesium sulfate is produced by reacting excess magnesium oxide with dilute sulfuric acid.

(a) Complete the word equation for this reaction.



[2]

(b) A coloured aqueous solution is used to measure the pH of dilute sulfuric acid.

(i) State the name of the coloured aqueous solution that is used to measure the pH of acids and alkalis.

..... [1]

(ii) Suggest the pH value of dilute sulfuric acid.

..... [1]

(c) Complete the sentences about the preparation of salt crystals.

Use words from the list.

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

acid **filtering** **heating** **magnesium**

distillation **magnesium sulfate** **shaking** **solid**

Excess magnesium oxide is added to dilute sulfuric acid and stirred until no more

..... dissolves.

Pure aqueous magnesium sulfate is separated by ..... .

Some water is removed by gentle ..... .

The solution is then left to form pure dry crystals of the salt called

..... .

[4]

(d) Magnesium sulfate contains magnesium ions, Mg^{2+}.

Describe how magnesium ions are formed from magnesium atoms.

..... [1]

(e) Aqueous magnesium sulfate is broken down by an electric current.

State the name of this process.

..... [1]

[Total: 10]

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6 Fig. 6.1 shows a car battery connected to an electric heater used in a caravan.
The heater has two identical heating elements connected as shown.

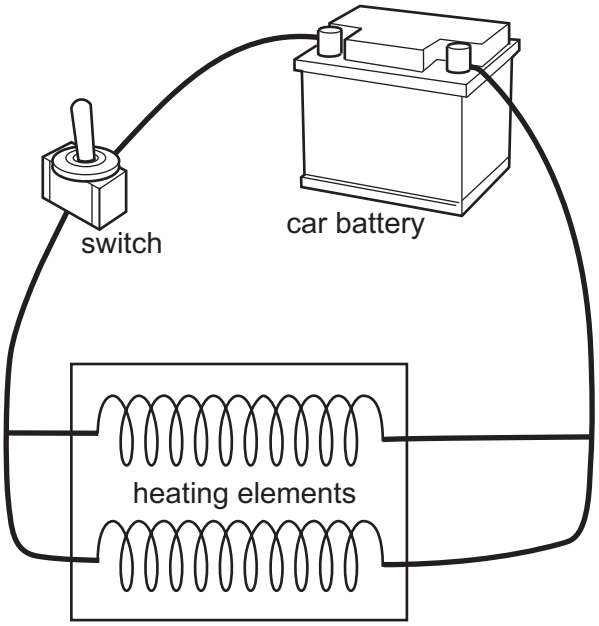


Fig. 6.1

(a) State the type of circuit connection for the heating elements.

..... [1]

(b) The two heating elements get hot. A hand held 20 cm in front of the heater feels warm. A hand held 20 cm above the heater feels hot from heated air rising.

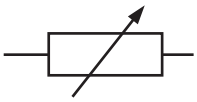
State **two** methods of thermal energy transfer from the heater that keep the people in the caravan warm.

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

(c) State the form of energy stored in the car battery.

..... [1]

(d) State the name of the circuit component with the symbol:



..... [1]

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(e) The switch shown in Fig. 6.1 turns both heating elements on and off.

Another switch is used to turn only one of the heating elements on and off. There is also a fuse to protect the complete circuit.

Fig. 6.2 shows an incomplete circuit diagram for the heater circuit.

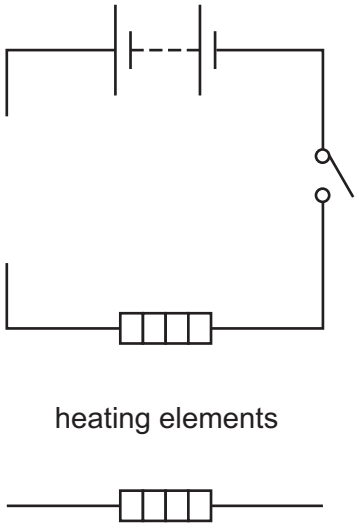

Fig. 6.2

On Fig. 6.2, complete the circuit diagram by including the fuse, the second switch and all connecting wires. [3]

(f) The battery provides a potential difference of 12 V across **one** heating element.

The current in the heating element is 8.0 A.

(i) Show that the resistance of the heating element is 1.5 Ω.

[1]

(ii) Explain why the current in the main circuit is larger than 8.0 A when both heaters are switched on.

.....

..... [1]

[Total: 10]

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7 **(a)** Fig. 7.1 shows part of a food web.

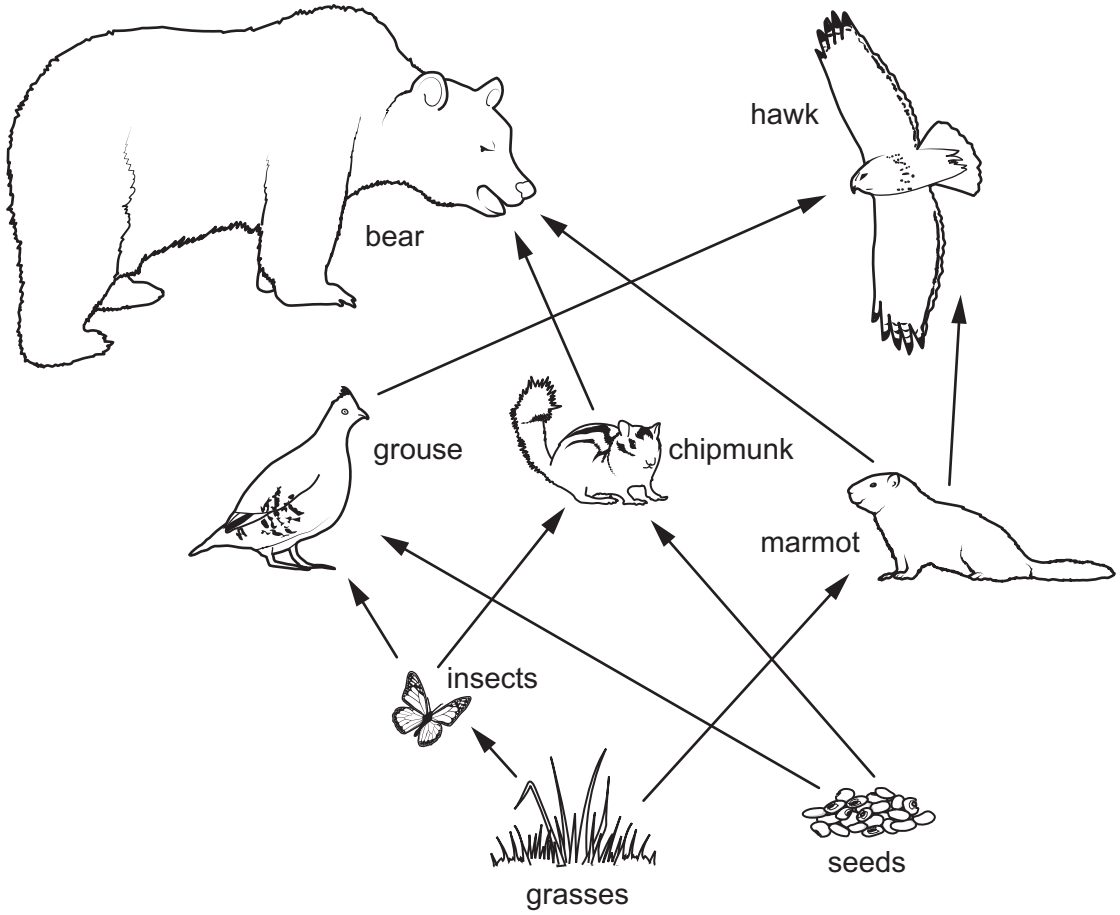

Fig. 7.1

(i) Identify the **two** herbivores in Fig. 7.1.

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

(ii) Identify **one** tertiary consumer in Fig. 7.1.

..... [1]

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(b) Complete the sentences about producers.

Use words from the list.

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

carbon dioxide	**magnesium**	**nitrate**	**oxygen**
photosynthesis	**respiration**	**iodine**	**transpiration**

Producers make their own organic nutrients using the process of ..... .

The raw materials needed for this process are water and ..... .

The products of this process are glucose and ..... .

Plants also need ..... ions for making amino acids.

[4]

(c) Food webs are affected by deforestation.

Fig. 7.2 is a bar chart showing the area of deforestation each year for one country.

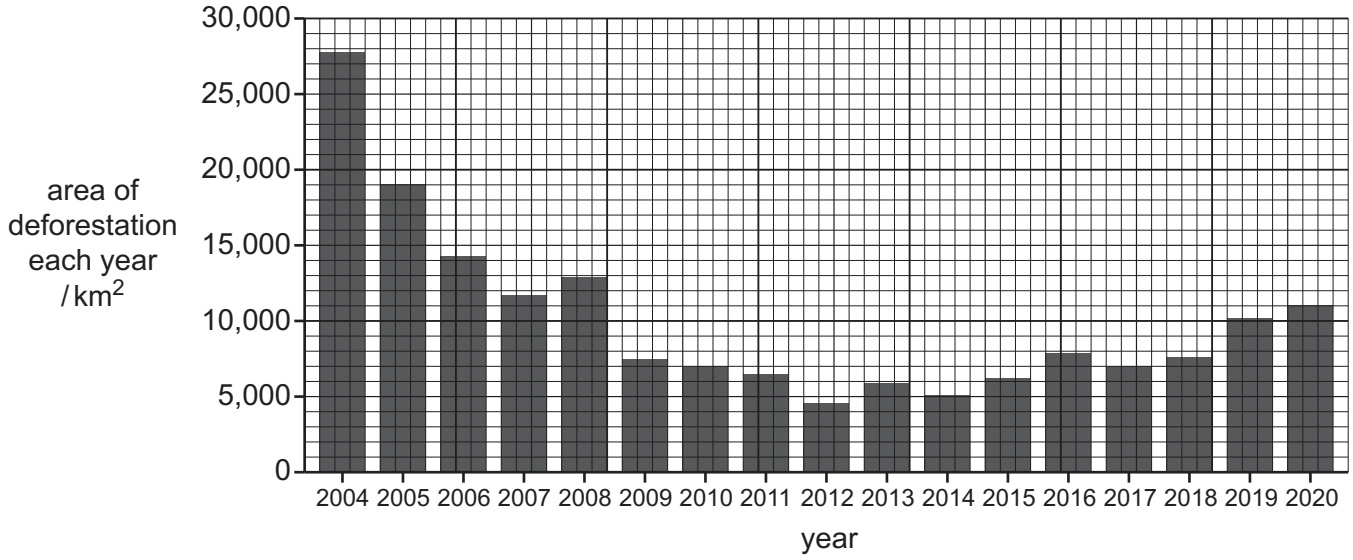

Fig. 7.2

Describe the trends shown in Fig. 7.2.

.....

.....

..... [2]

[Total: 8]

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[Turn over

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8 The Periodic Table contains groups and collections of different elements.

(a) Fig. 8.1 lists some of the elements in Group I.

3 Li lithium 7
11 Na sodium 23
19 K potassium 39

Fig. 8.1

The elements in Group I react with water to produce a gas.

(i) State the name of this gas.

..... [1]

(ii) State the trend in the reactivity of the elements down Group I.

..... [1]

(b) Fig. 8.2 lists some of the elements in Group VII.

17 C*l* chlorine 35.5
35 Br bromine 80
53 I iodine 127

Fig. 8.2

The elements in Group VII exist as diatomic molecules.

(i) State what is meant by diatomic.

..... [1]

(ii) State the trend in the colour of the elements down Group VII.

..... [1]

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(c) Iron and copper are part of a collection of metals which have high densities.

(i) State the name of this collection of metals.

..... [1]

(ii) Iron and copper and their compounds act as catalysts.

State one **other** property of these metals that is **not** a property of Group I metals.

..... [1]

(d) Argon and helium are noble gases.

Argon is used in lamps, and helium is used in balloons, as shown in Fig. 8.3.

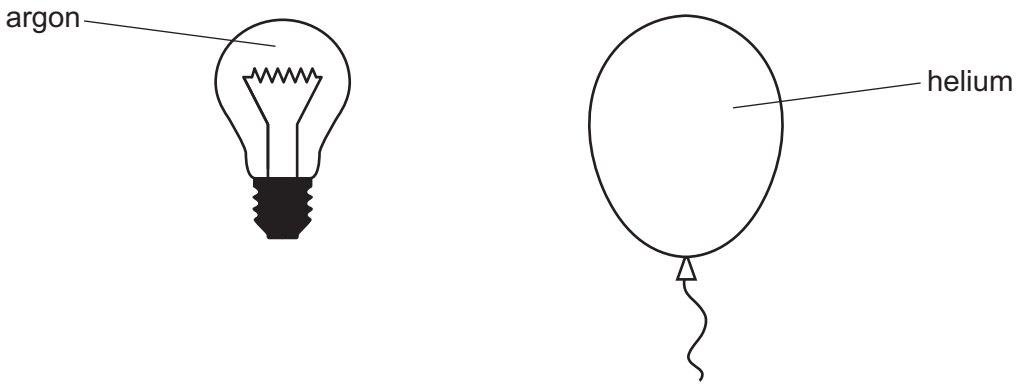

Fig. 8.3

Identify **one** property of each element that makes it suitable for the use shown in Fig. 8.3.

argon .....

helium .....
[2]

[Total: 8]

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9 **(a)** A person's voice emits sound in the form of longitudinal waves. The sound waves can be represented by wave graphs which plot displacement against time.

Fig. 9.1 shows the wave graph for sound wave **A** and the wave graph for sound wave **B** as they travel through the air.

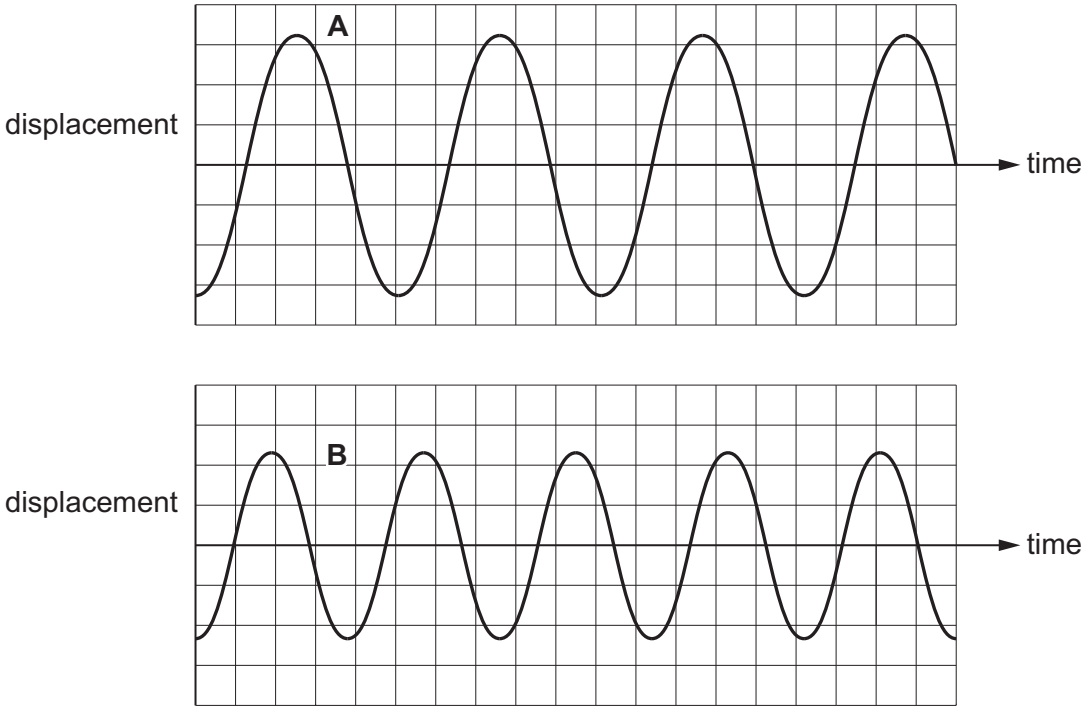

Fig. 9.1

Both wave graphs are plotted to the same time and displacement scales.

Complete the sentences about Fig. 9.1.

Use words from the list.

Each word may be used once or not at all.

amplitude **frequency** **speed** **wavelength**

Wave **A** has a lower ..... than wave **B**.

Wave **A** has a greater ..... than wave **B**.

[2]

(b) Many telephone calls are connected by electric currents in copper wires between the telephones.

Complete the sentences by filling in the blank space with the correct word.

A current in a copper wire is due to a ..... of electrons.

Electrons have a ..... charge.

[2]

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(c) Other ways of sending calls use electromagnetic waves.

(i) State the type of electromagnetic wave used to send calls between two mobile (cell) phones.

..... [1]

(ii) Fibre optic cables use infrared waves for telephone calls.

Fig. 9.2 shows part of the electromagnetic spectrum.

Write infrared waves in the correct position in the spectrum.

← increasing frequency						
gamma rays			visible light			radio waves

Fig. 9.2

[1]

(iii) Infrared waves travel along fibre optic cables at a speed of 2×10^8 m/s.

A telephone call between two people 12 000 km apart travels by fibre optic cable.

Calculate the time taken for the call to travel between the two people.

time = ... s [3]

[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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