Cambridge Assessment International Education

# Cambridge IGCSE™

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | | | | | | CANDIDATE NUMBER | | | | |

*7812176590*

**COMBINED SCIENCE** **0653/41**

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

**1** **(a)** Fig. 1.1 shows the human alimentary canal and some associated organs.

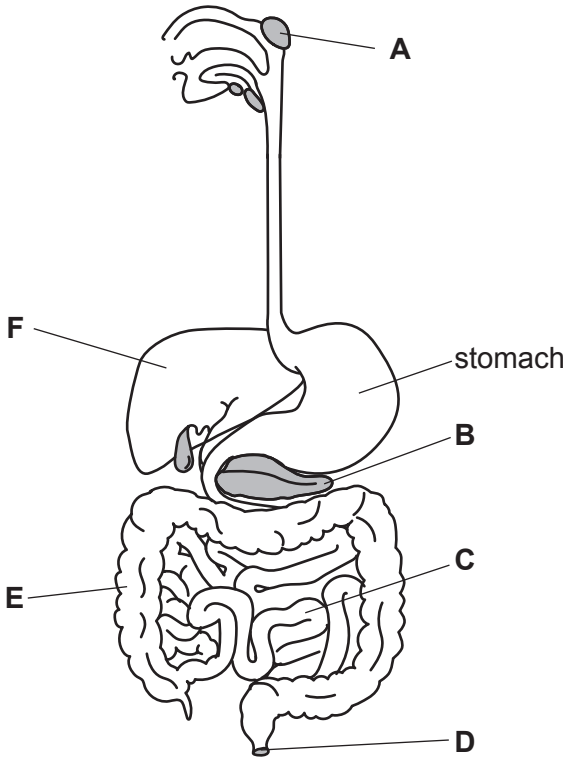


**Fig. 1.1**

**(i)** Table 1.1 shows some of the letters, names and functions of some of the parts in Fig. 1.1.

Complete Table 1.1.

**Table 1.1**

| letter in Fig.1.1 | name | function |
|---|---|---|
| ..... | salivary gland | secretes amylase |
| **B** | ..... | secretes amylase, protease and lipase |
| **D** | ..... | ..... |

[3]

**(ii)** Mechanical digestion takes place in the stomach.

Define mechanical digestion.

.....

.....

..... [2]

**(b)** Fig. 1.2 shows the effect of pH on the activity of two different enzymes, **Q** and **R**.

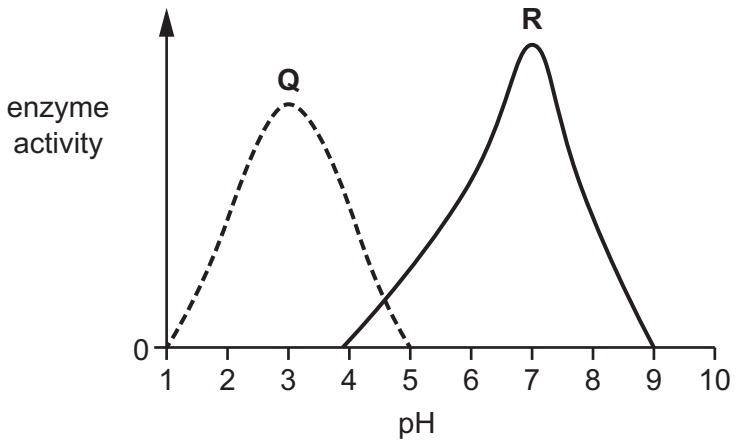


**Fig. 1.2**

**(i)** Identify the pH range over which **both** enzymes shown in Fig. 1.2 are active.

Tick (✓) the correct answer.

pH 3–4 ☐

pH 4–5 ☐

pH 5–6 ☐

pH 6–8 ☐

[1]

**(ii)** Enzyme **R** digests food in the mouth.

Explain why enzyme **R** is **not** active in the stomach.

.....

.....

.....

..... [3]

[Total: 9]

**2** A student uses inert electrodes to investigate the electrolysis of lead(II) bromide, as shown in Fig. 2.1.

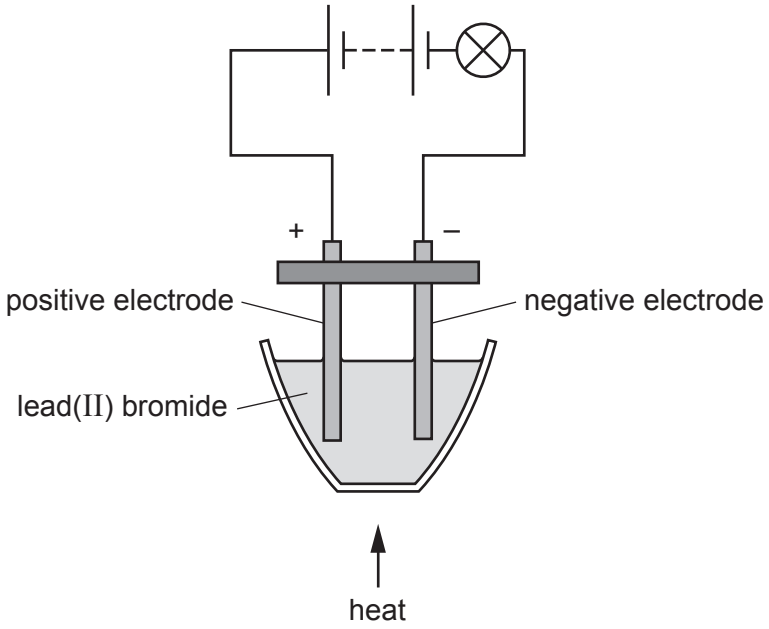


**Fig. 2.1**

**(a)** State the meaning of the term inert.

.....

..... [1]

**(b)** The lead(II) bromide is heated, and its temperature is recorded.

Table 2.1 shows some of the observations made as the temperature increases.

**Table 2.1**

| temperature / °C | observations |
|---|---|
| 20 | no change |
| 100 | no change |
| 200 | no change |
| 300 | no change |
| 400 | 1. lamp lights up<br>2. orange vapour seen at positive electrode<br>3. grey shiny liquid collects below negative electrode |

**(i)** Suggest why no change is observed at the first four temperatures recorded in Table 2.1.

.....

..... [1]

**(ii)** Explain the **three** observations made at 400 °C.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

**(c)** The student repeats the investigation using lead(II) chloride instead of lead(II) bromide.

**(i)** Two products are formed in the electrolysis of lead(II) chloride.

Write the name and formula of each product.

product 1

name ..... formula .....

product 2

name ..... formula .....

[2]

**(ii)** Suggest **one** difference in the observations made when lead(II) chloride is electrolysed instead of lead(II) bromide.

.....

..... [1]

[Total: 8]

**3** Fig. 3.1 shows the names of the forces acting on an aircraft flying at a constant speed and at a constant height above the ground.

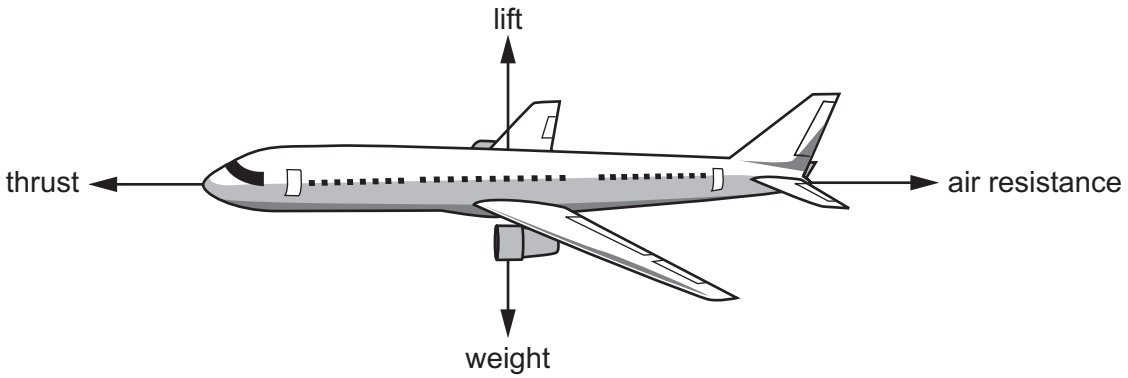


**Fig. 3.1**

**(a) (i)** State the name of the force in Fig. 3.1 caused by friction.

..... [1]

**(ii)** Use the names of the forces in Fig. 3.1 to complete the sentence.

The aircraft is flying at a constant speed and at a constant height, so the thrust must be equal to the ..... , and the ..... must be equal to the ..... .

[1]

**(b)** The aircraft travels a distance of 2170 km at an average speed of 620 km / h.

Calculate the time in hours for this journey.

time = ..... h [2]

**(c)** The aircraft has a mass of 190 000 kg.

The maximum speed of the aircraft is 720 km / h.

Calculate the kinetic energy of the aircraft at maximum speed.

kinetic energy = ..... J [3]

[Total: 7]

**4** **(a)** Fig. 4.1 shows part of the breathing system in humans.

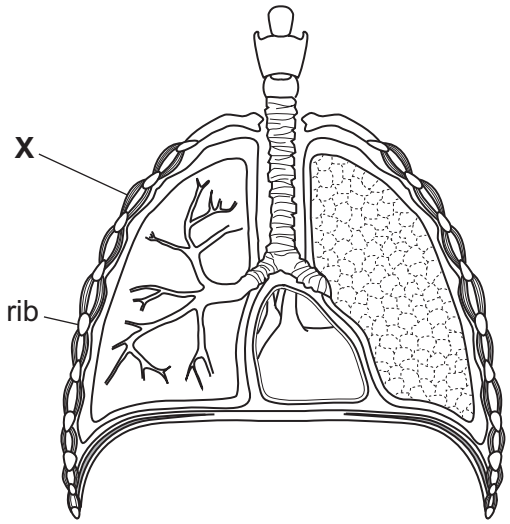


**Fig. 4.1**

State the name of the part labelled **X** in Fig. 4.1.

..... [1]

**(b)** Alveoli are the gas exchange surface in humans.

State **one** feature of the gas exchange surface in humans.

..... [1]

**(c)** Complete the sentences about the differences in composition between expired and inspired air.

Expired air contains more carbon dioxide than inspired air. This is because

carbon dioxide is made in cells by the process of ..... .

Expired air also contains more ..... than inspired air.

[2]

**(d)** Fig. 4.2 shows cells that line the bronchi.

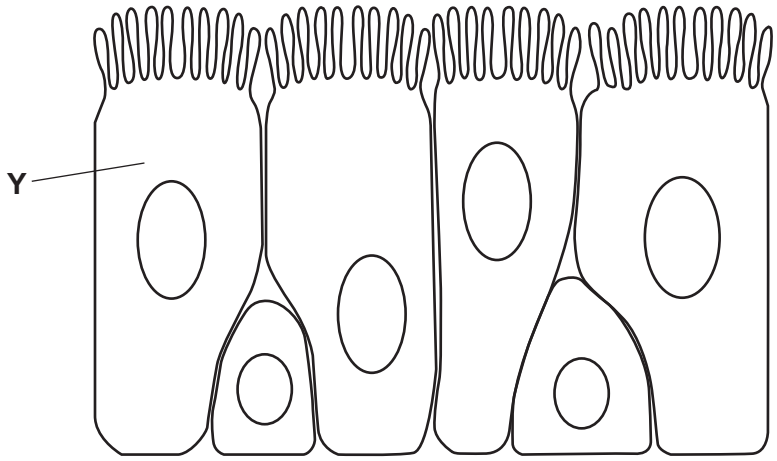


**Fig. 4.2**

Describe how cell **Y** is adapted to its function.

.....

.....

..... [2]

**(e)** Tobacco smoking affects the body.

The boxes on the left show different components of tobacco smoke.

The boxes on the right show the effects of these components on the body.

Draw **one** straight line from each component to its effect.

| **component** | **effect** |
|---|---|
| carbon monoxide | addiction |
| nicotine | lung cancer |
| tar | reduced oxygen transport by red blood cells |

[1]

[Total: 7]

**5** A student does five experiments to investigate the reaction between zinc granules and dilute hydrochloric acid.

In each experiment, the student measures the volume of gas produced during the first 10 s of the reaction, using the apparatus shown in Fig. 5.1.

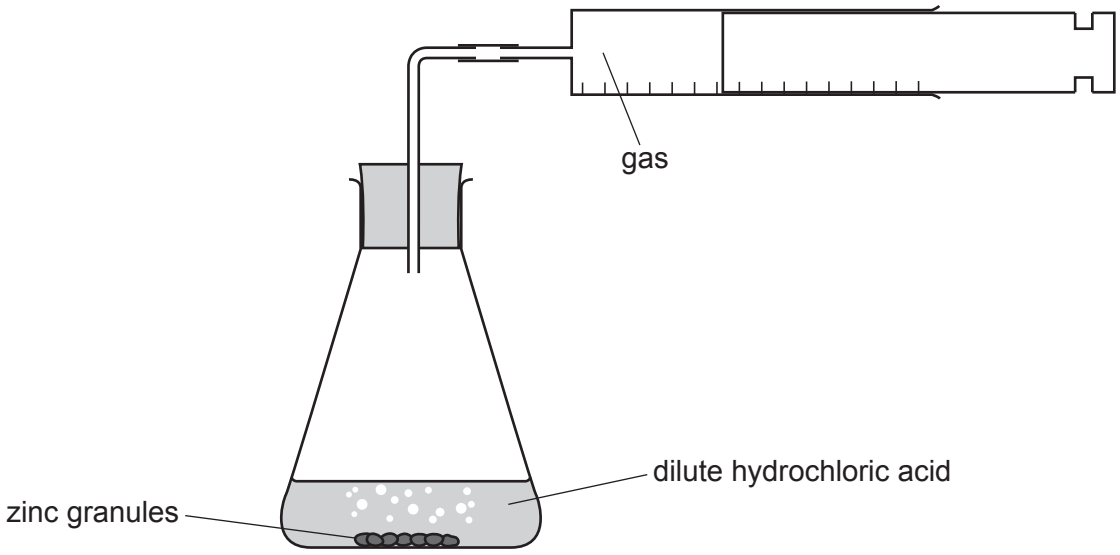


**Fig. 5.1**

The student uses the same mass of zinc granules and the same volume of dilute hydrochloric acid in each experiment.

The student uses different temperatures and different concentrations of dilute hydrochloric acid.

Table 5.1 shows the results.

**Table 5.1**

| experiment | temperature of acid / °C | concentration of acid mol / $dm^3$ | volume of gas produced / $cm^3$ |
|---|---|---|---|
| 1 | 20 | 1.0 | 25 |
| 2 | 20 | 1.5 | 38 |
| 3 | 30 | 1.0 | 45 |
| 4 | | 1.0 | 15 |
| 5 | 20 | | 9 |

**(a)** Suggest a value for:

- the temperature of acid used in experiment 4 ..... °C
- the concentration of acid used in experiment 5. ..... mol / $dm^3$

[2]

**(b)** Explain why the results for experiments 1 and 2 are different.

Use ideas about reacting particles in your answer.

.....

.....

..... [2]

**(c)** State which experiment listed in Table 5.1 contains the most colliding particles that have the minimum energy (activation energy) to react.

Give a reason for your answer.

experiment .....

reason .....

.....

[2]

**(d)** The student repeats experiment 1 using different metals.

Table 5.2 shows the results.

**Table 5.2**

| metal | volume of gas produced / $cm^3$ |
|---|---|
| zinc | 25 |
| iron | 14 |
| magnesium | 34 |

**(i)** Explain the differences in the results.

.....

.....

..... [2]

**(ii)** Suggest what is observed when copper is used instead of zinc.

Give a reason for your answer.

observation .....

reason .....

[1]

[Total: 9]

**6** **(a)** Fig. 6.1 shows an incomplete circuit diagram for the heater, two headlamps and two rear lamps in a car.

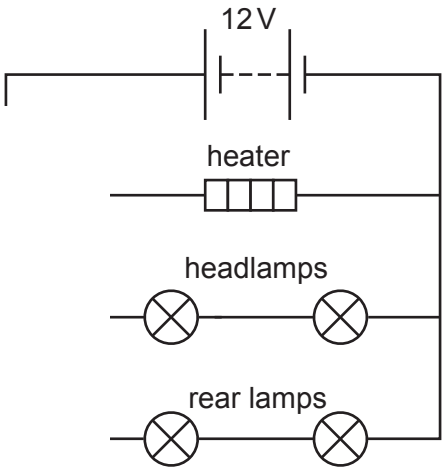


**Fig. 6.1**

**(i)** The headlamps and rear lamps are switched on at the same time by one switch, **S1**.

The heater is switched on separately by switch **S2**.

Complete and label the circuit diagram in Fig. 6.1 to show the positions of switches **S1** and **S2**. [3]

**(ii)** Fig. 6.2 shows the four lamps connected together.

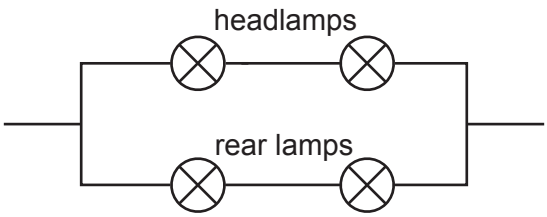


**Fig. 6.2**

Each headlamp has a resistance of 7.0 Ω.

Each rear lamp has a resistance of 3.5 Ω.

Calculate the total resistance of the four lamps connected together.

resistance = ..... Ω [3]

**(b)** Fig. 6.3 shows the circuit for the starter motor of the car.

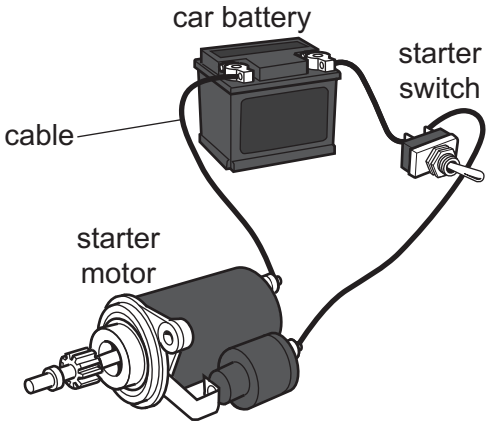


**Fig. 6.3**

**(i)** There is a current of 150 A in the starter motor.

Calculate the charge that flows through the starter motor in 30 s.

charge = ..... C [2]

**(ii)** The cables in the circuit contain very thick copper wires.

Suggest why the wires are very thick.

.....

.....

..... [2]

[Total: 10]



**[Turn over**

**7** **(a)** Fig. 7.1 shows an insect-pollinated flower.

**Fig. 7.1**

**(i)** Draw a label line and the letter **C** to identify a carpel in Fig. 7.1. [1]

**(ii)** State **two** pieces of evidence that show the flower in Fig. 7.1 is insect-pollinated.

1 .....

2 .....
[2]

**(b)** Complete the sentence about the role of chlorophyll in a plant.

Chlorophyll transfers ..... into .....

energy for the ..... of the carbohydrate glucose.
[2]

**(c)** In plants, glucose is converted into the sugar sucrose for transport. Glucose is also converted into a carbohydrate for storage.

**(i)** State the name of the structure in plants used to transport the sugar sucrose.

..... [1]

**(ii)** State the name of the carbohydrate used for storage.

..... [1]

**(d)** Fig. 7.2 shows cells from a plant before and after being immersed in a concentrated sugar solution.

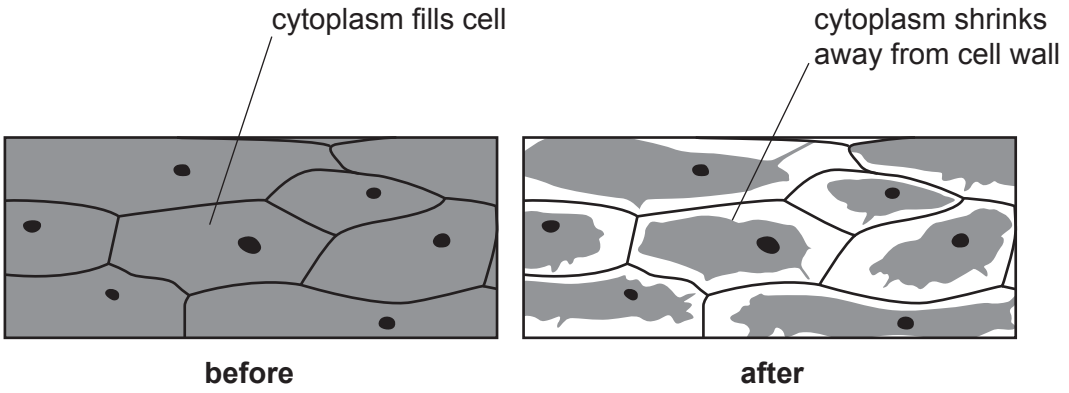


**Fig. 7.2**

The change seen in Fig. 7.2 is due to movement of water.

Explain the change in the cells shown in Fig. 7.2.

Use the term water potential in your answer.

.....

.....

.....

.....

..... [4]

[Total: 11]

**8** Table 8.1 gives information on the percentage composition of the atmosphere of the planet Mars.

**Table 8.1**

| gas | percentage of the atmosphere of Mars |
|---|---|
| carbon dioxide | 95.0 |
| nitrogen | 1.9 |
| argon | 1.9 |

**(a) (i)** State how Table 8.1 shows that the atmosphere of Mars contains gases that are **not** listed in Table 8.1.

.....

..... [1]

**(ii)** Describe how the percentage composition of the atmosphere of Earth is different from that of Mars.

.....

.....

.....

..... [3]

**(b)** The bonding in carbon dioxide and nitrogen is represented in Fig. 8.1.

**carbon dioxide** **nitrogen**

**Fig. 8.1**

**(i)** State the number of electrons that are shared between atoms in one molecule of nitrogen.

..... [1]

**(ii)** Complete Fig. 8.2 to show the dot-and-cross diagram for carbon dioxide.

Show only the outer shell electrons.

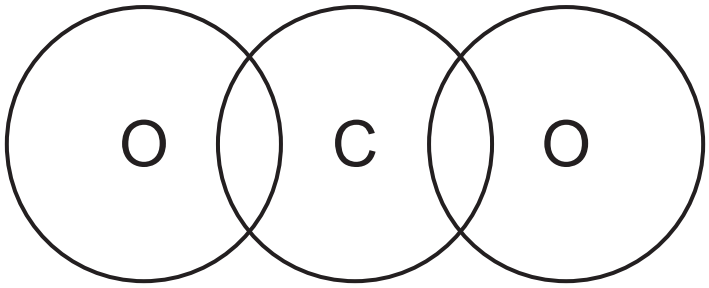


**Fig. 8.2**

[2]

**(iii)** The percentage of carbon dioxide in Earth's atmosphere is increasing.

State how this affects the environment.

.....

.....

..... [2]

[Total: 9]

**9** **(a)** Fig. 9.1 represents a sound wave in air.

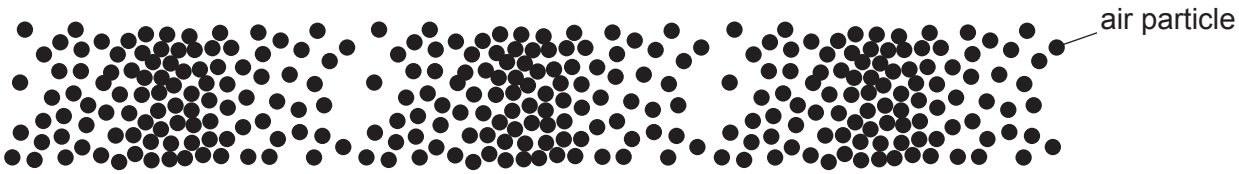


**Fig. 9.1**

**(i)** On Fig. 9.1, draw:

- a label line and the letter **C** to the centre of a compression
- a label line and the letter **R** to the centre of a rarefaction.

[1]

**(ii)** The speed of sound in air is 330 m / s.

Calculate the frequency of a sound wave with a wavelength of 1.5 m.

Give the unit of frequency.

frequency = ..... unit ..... [3]

**(b)** Fig. 9.2 shows the seven regions of the electromagnetic spectrum.

| ← increasing frequency | | | | | | |
|---|---|---|---|---|---|---|
| gamma radiation | X-rays | ultraviolet | visible light | infrared | microwaves | radio waves |

**Fig. 9.2**

**(i)** State which region of the electromagnetic spectrum has the greatest wavelength.

..... [1]

**(ii)** State the speed of electromagnetic waves in a vacuum.

..... [1]

**(iii)** Electromagnetic waves are transverse waves.

Sound waves are longitudinal waves.

Describe the difference between a transverse wave and a longitudinal wave.

.....

.....

.....

..... [2]

**(c)** Fig. 9.3 shows how rays from an object close to a thin converging lens are focused to form an image on the screen.

**F** represents the principal focus of the lens.

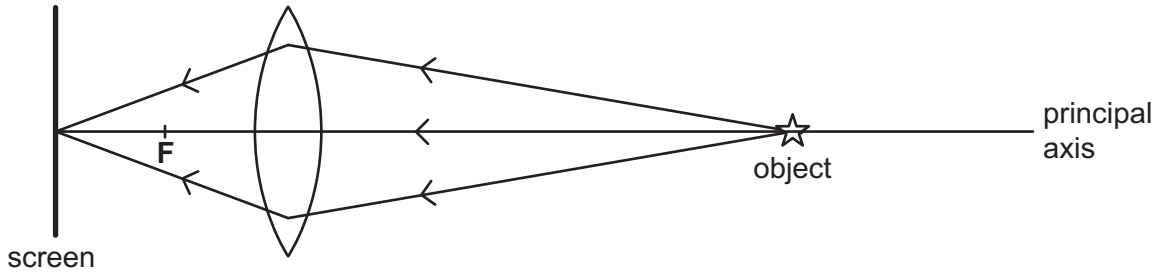


**Fig. 9.3**

The object is now moved very far away from the lens.

Explain why the lens must be moved closer to the screen to focus the image on the screen.

.....

.....

..... [2]

[Total: 10]

## 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.).