Cambridge Assessment International Education

# Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER



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

Paper 4 Theory (Extended) **May/June 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 **24** pages. Any blank pages are indicated.




[Turn over

1 **(a)** Fats are broken down in the small intestine by chemical digestion.

**(i)** State the name of the enzyme that breaks down fats.

..... [1]

**(ii)** (Circle) **one** product of fat digestion.

**amino acid** **cellulose** **glycerol** **glycogen**

[1]

**(b)** One risk factor for coronary heart disease is a diet high in fats.

The graph in Fig. 1.1 shows the number of deaths from heart disease for one country between 1920 and 2020.

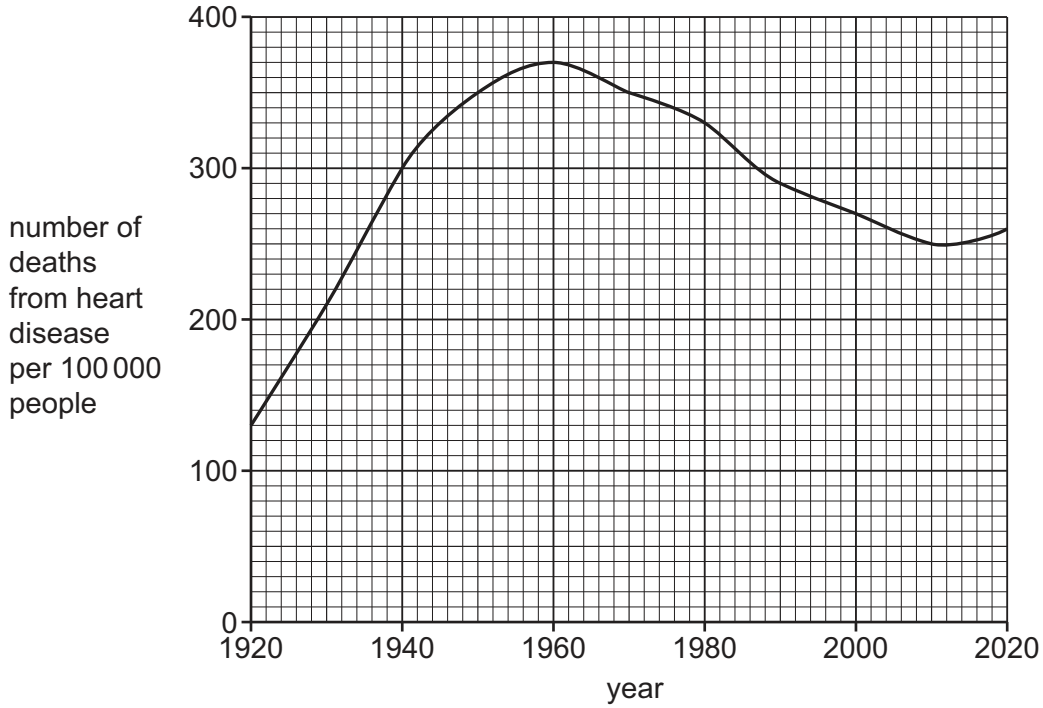


**Fig. 1.1**

**(i)** Describe the trend in the number of deaths from heart disease between 1920 and 1960 shown in Fig. 1.1.

..... [1]

**(ii)** Calculate the percentage increase between the lowest number of deaths and the highest number of deaths shown in Fig. 1.1.

lowest number of deaths = .....

highest number of deaths = .....

percentage increase = .....
[3]

**(c)** Digested food molecules are absorbed into the blood from the small intestine by active transport and diffusion.

Compare active transport and diffusion of molecules.

.....

.....

.....

..... [2]

[Total: 8]

**2** **(a)** Fig. 2.1 is a photograph of a wind-pollinated flower.

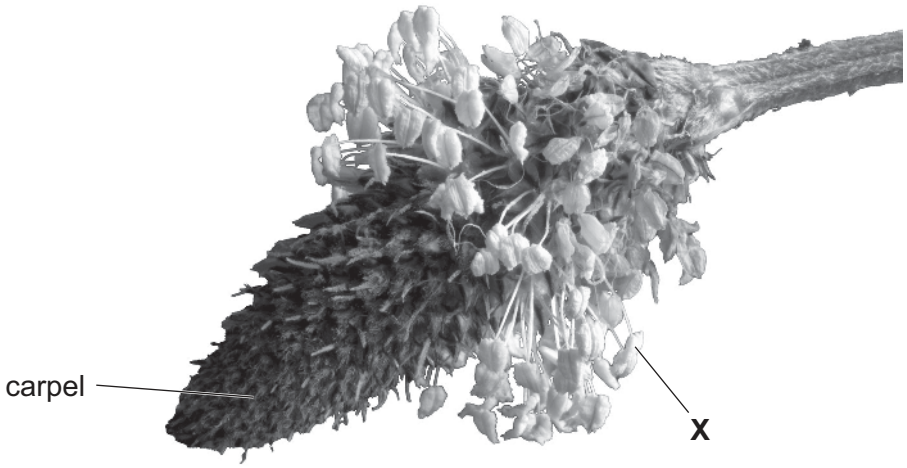


**Fig. 2.1**

**(i)** Identify the part labelled **X** on Fig. 2.1.

..... [1]

**(ii)** Describe how the flower in Fig. 2.1 is pollinated by the wind.

.....

.....

..... [2]

**(b)** Flowers produce seeds. Germination of seeds uses enzymes.

The graph in Fig. 2.2 shows the effect of pH on an enzyme.

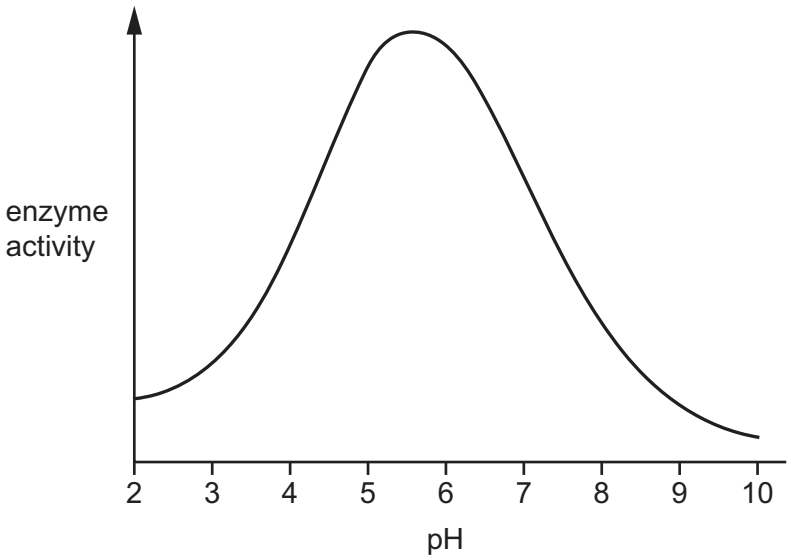


**Fig. 2.2**

Explain the effect of pH 10 on the enzyme in Fig. 2.2.

.....

.....

.....

.....

..... [3]

**(c)** A student investigates the germination of seeds.
Seeds produce carbon dioxide when they germinate.

Hydrogencarbonate indicator is a red solution in atmospheric carbon dioxide concentrations. In higher concentrations of carbon dioxide, the indicator turns yellow.

The student prepares the three test-tubes shown in Fig. 2.3.

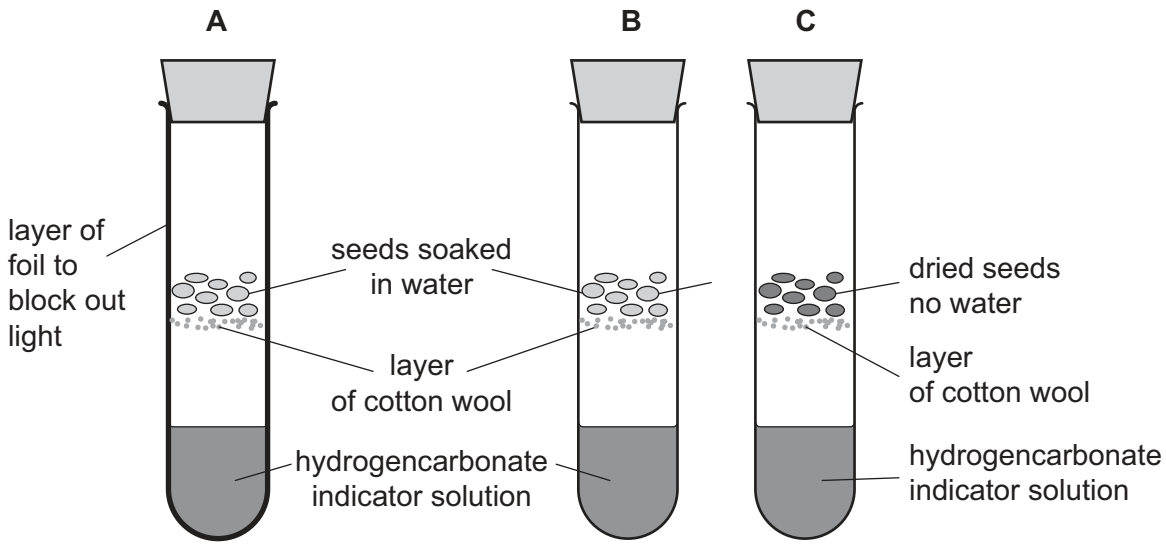


**Fig. 2.3**

After 24 hours, the student records the colour of the hydrogencarbonate indicator solution in each test-tube.

Table 2.1 shows the results.

**Table 2.1**

| test-tube | conditions | colour of hydrogencarbonate indicator solution | |
|---|---|---|---|
| | | at start | after 24 hours |
| **A** | dark and water | red | yellow |
| **B** | light and water | red | yellow |
| **C** | light and **no** water | red | red |

**(i)** Explain the results for test-tube **A** and test-tube **C**.

test-tube **A** .....

.....

test-tube **C** .....

.....

[2]

**(ii)** During germination, energy is released from stored carbohydrates in the seeds.

Complete the sentences about this process.

Energy is released from the carbohydrates by the process of aerobic

…… .

This is a chemical reaction in cells that uses …….. gas to break down glucose.

The chemical formula for glucose is …… .

[3]

[Total: 11]

**3** **(a)** Fig. 3.1 is a diagram showing a cross-section of a bacterial cell.

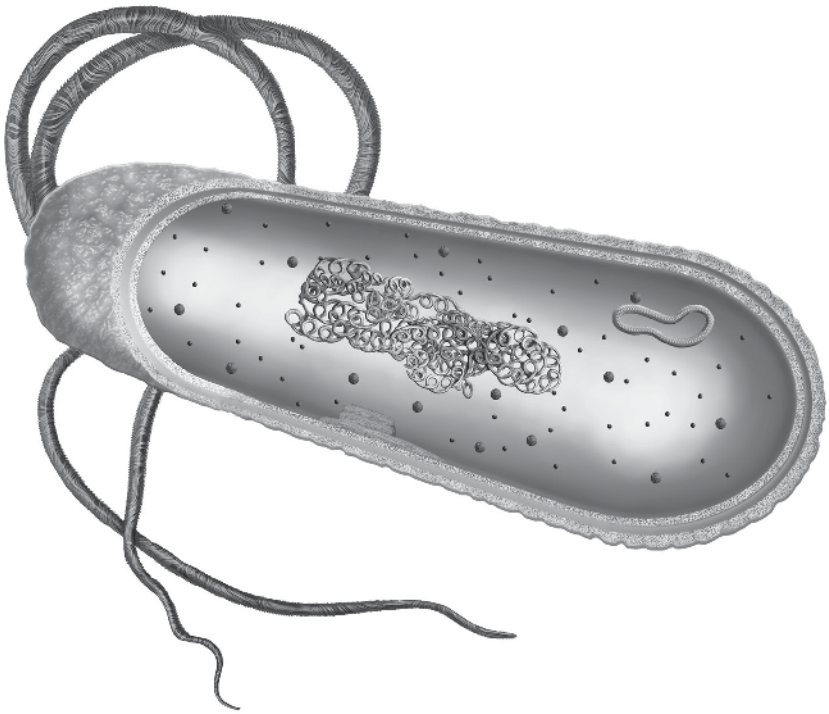

**Fig. 3.1**

**(i)** Draw a label line and the letter **P** to identify a plasmid in Fig. 3.1. [1]

**(ii)** Plasmids are one structure found in bacterial cells that are **not** found in plant cells.

Identify **two** structures visible in Fig. 3.1 that **are also** found in plant cells.

1 .....

2 .....

[2]

**(b)** Some bacteria are pathogens that infect the human body.

**(i)** Bacterial infections are treated with antibiotics.

Explain why antibiotics should only be used when essential.

.....

.....

..... [2]

**(ii)** The body can develop active immunity after infection by some bacteria.

Describe what is meant by active immunity.

.....

.....

..... [1]

**(c)** Some bacteria gain energy from waste organic material in sewage.

**(i)** Name the type of organism that gains energy from waste organic material.

..... [1]

**(ii)** Sewage treatment is one way to control the spread of disease.

State **one** other way to control the spread of disease.

.....

..... [1]

[Total: 8]

**4** Iron is a metal.

**(a)** Fig. 4.1 shows the three physical states of iron.

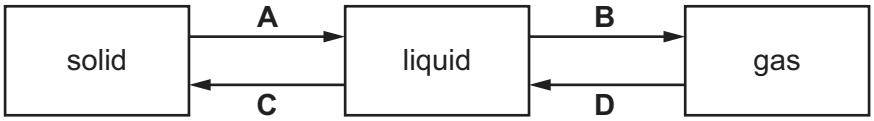


**Fig. 4.1**

Name the state changes shown by arrows **B** and **C**.

**B** .....

**C** .....

[2]

**(b)** Describe how the arrangement and movement of particles change when solid iron becomes a liquid.

Use ideas about kinetic particle theory in your answer.

.....

.....

.....

..... [2]

**(c)** Stainless steel is an alloy of iron.

**(i)** Name **one** of the other elements in stainless steel.

..... [1]

**(ii)** Explain in terms of structure why stainless steel is harder and stronger than iron.

.....

.....

.....

..... [2]

**(d)** Iron is extracted from iron(III) oxide in the blast furnace.

Iron(III) oxide reacts with carbon monoxide to form iron.

The equation for the reaction is shown.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

Explain how the equation shows the iron(III) oxide is reduced.

.....

..... [1]

[Total: 8]

**5** **(a)** Table 5.1 shows properties of some halogens at room temperature (25 °C) and pressure.

**Table 5.1**

| halogen | melting point / °C | state | colour |
|---|---|---|---|
| fluorine | –220 | gas | pale yellow |
| chlorine | –101 | gas | pale yellow-green |
| bromine | | liquid | |
| iodine | +114 | solid | grey-black |
| astatine | +302 | | black |

**(i)** State the colour of bromine at room temperature and pressure.

.....[1]

**(ii)** Predict the:

- melting point of bromine .....
- physical state of astatine at room temperature and pressure. .....

[2]

**(b)** **(i)** State the type of chemical reaction when chlorine reacts with aqueous potassium bromide.

..... [1]

**(ii)** Write the word equation for the reaction of chlorine with aqueous potassium bromide.

..... [1]

**(iii)** Explain why chlorine does **not** react with aqueous potassium fluoride.

.....

..... [1]

**(c)** Iodine reacts with iron to form iron(III) iodide, $FeI_3$.

Complete the balanced symbol equation for this reaction.

..... + ..... → ..... $FeI_3$

[1]

**(d)** Aqueous bromine is used to distinguish between saturated and unsaturated hydrocarbons.

**(i)** Circle the type of reaction when aqueous bromine reacts with an unsaturated hydrocarbon.

**addition** **combustion** **polymerisation** **sedimentation**

[1]

**(ii)** State the colour change when aqueous bromine is added to an **unsaturated** hydrocarbon.

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

[Total: 9]

**6** This question is about ionic compounds.

**(a)** Dilute nitric acid and solid copper oxide react to form copper nitrate.

Copper oxide is an insoluble base and copper nitrate is a soluble salt.

Describe how to produce pure, dry crystals of copper nitrate.

.....

.....

.....

.....

.....

.....

.....

..... [4]

**(b)** Sodium chloride is an ionic compound.

Complete the dot-and-cross diagram in Fig. 6.1 to show the outer-shell electrons for each ion in sodium chloride.

Include the charge on each ion.

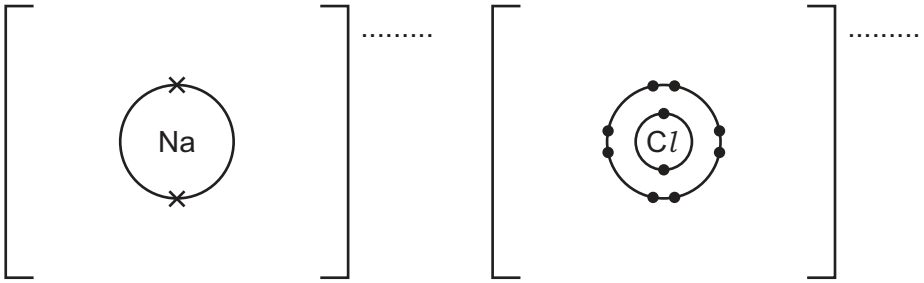


**Fig. 6.1**

[3]

**(c)** Describe the arrangement of ions in solid sodium chloride.

.....

.....

.....

..... [2]

[Total: 9]

**7** Fig. 7.1 shows an electric car.

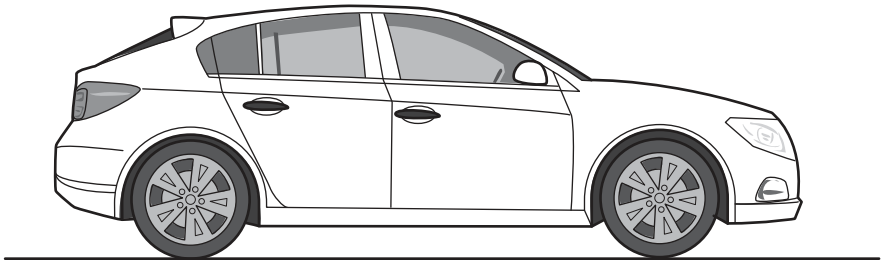

**Fig. 7.1**

The mass of the car is 2000 kg.

The speed of the car increases from 5.0 m / s to 23 m / s in a time of 4.0 s.

**(a) (i)** Complete Fig. 7.2 to show one energy transfer that occurs.

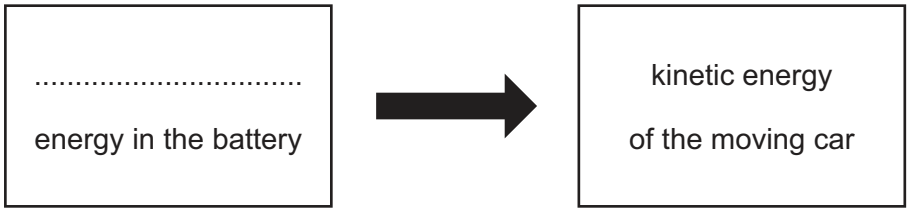


**Fig. 7.2**

[1]

**(ii)** State the equation used for calculating the efficiency of energy transfers.

..... [1]

**(b)** Show that the acceleration of the car is approximately 5 m / $s^2$.

[2]

**(c)** Calculate the resultant force acting on the car.

Include the unit in your answer.

force = ..... unit ..... [3]

**(d)** Calculate the increase in the kinetic energy of the car.

increase in kinetic energy = ..... J [2]

[Total: 9]

**8** Fig. 8.1 shows the two tyres of a motorcycle.

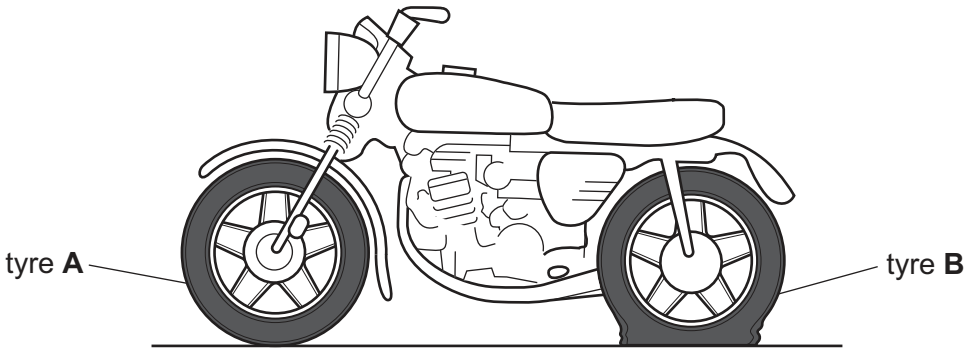


**Fig. 8.1**

Tyre **A** is full of air and is at the correct pressure.

Tyre **B** is flat and does **not** have enough air in it.

**(a)** The weight of the motorcycle is shared equally between the two tyres.

**(i)** Identify which tyre, **A** or **B**, exerts the greater pressure on the road.

Give a reason for your answer.

tyre ……..

reason .....

.....

[2]

**(ii)** Describe how the pressure inside tyre **A** is caused by the air particles inside the tyre.

.....

.....

..... [2]

**(b)** Each tyre has a pressure sensor that transmits an electromagnetic wave as a signal when the pressure is low.

Table 8.1 shows the approximate frequency ranges of the different regions of the electromagnetic spectrum.

**Table 8.1**

| gamma radiation | X-rays | ultraviolet | visible light | infrared | micro-waves | radio waves |
|---|---|---|---|---|---|---|
| more than $1 \times 10^{19}$ Hz | $1 \times 10^{16}$ Hz to $1 \times 10^{19}$ Hz | $8 \times 10^{14}$ Hz to $1 \times 10^{16}$ Hz | $4 \times 10^{14}$ Hz to $8 \times 10^{14}$ Hz | $1 \times 10^{11}$ Hz to $4 \times 10^{14}$ Hz | $1 \times 10^{9}$ Hz to $1 \times 10^{11}$ Hz | less than $1 \times 10^{9}$ Hz |

The frequency of the transmitted wave is $3.5 \times 10^{8}$ Hz.

**(i)** Use Table 8.1 to identify the region of the electromagnetic spectrum of this transmitted wave.

..... [1]

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

speed = ..... m/s [1]

**(iii)** Use your answer to **(b)(ii)** to calculate the wavelength of the transmitted wave.

wavelength = ..... m [2]

[Total: 8]

**9** Fig. 9.1 shows a circuit that contains an electric motor and a light-emitting diode (LED) connected to a direct current (d.c.) power supply.

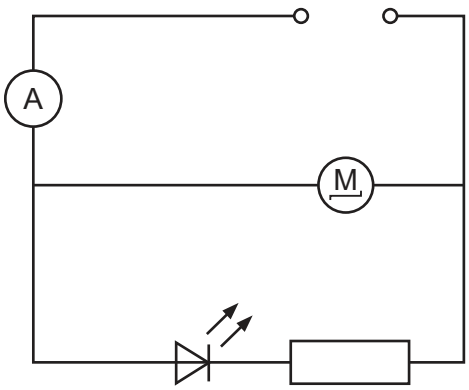


**Fig. 9.1**

**(a)** When the motor is switched on, the LED lights up.

**(i)** On Fig. 9.1, show the polarity of the terminals of the power supply using + and – signs.

Give a reason why the + and – signs must be the way you have shown.

.....

..... [1]

**(ii)** The power supply is 9.0 V.

The reading on the ammeter is 6.6 A.

The current in the LED is 0.30 A.

Calculate the resistance of the motor.

resistance = ..... Ω [3]

**(b)** **(i)** State the name of the component with the electrical symbol shown.


…… [1]

**(ii)** Complete the sentence to define electromotive force (e.m.f.).

Electromotive force is the electrical …… done by a source in

moving a unit …… around a complete circuit.

[2]

**(c)** The circuit in Fig. 9.1 is used in a satellite.

**(i)** The satellite orbits the Earth at a distance of 15 000 km from the centre of the Earth.

The orbital speed of the satellite is 17 km / s.

Calculate the orbital period *T* of the satellite.

*T* = ..... s [2]

**(ii)** The satellite is used to study the Universe.
State the approximate age of the Universe.

..... [1]

[Total: 10]

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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 – | 113 Nh nihonium – | 114 Fl flerovium – | 115 Mc moscovium – | 116 Lv livermorium – | 117 Ts tennessine – | 118 Og oganesson – |

**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.).