Cambridge Assessment International Education

# Cambridge IGCSE™

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**CO-ORDINATED SCIENCES** **0654/33**

Paper 3 Theory (Core) **May/June 2025**

**2 hours**

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 120.
- 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 **28** pages. Any blank pages are indicated.

DC (IP) 355318


[Turn over

**1** Fig. 1.1 is a diagram of a bacterial cell.

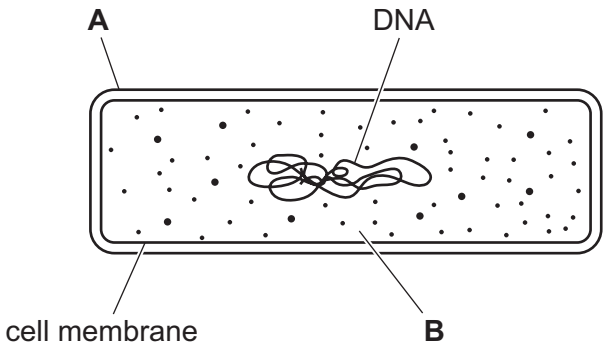



**Fig. 1.1**

**(a)** Name the part of the cell labelled **A** in Fig. 1.1.

..... [1]

**(b)** Describe the function of the cell membrane.

.....

..... [1]

**(c)** Some bacteria are pathogens.

State what is meant by a pathogen.

.....

..... [1]

**(d)** Pathogens are transmitted by direct contact or indirectly from one human to another.

Table 1.1 shows some methods of transmission.

Place ticks (✓) in Table 1.1 to show if each method of transmission is direct contact or indirect.

**Table 1.1**

| method of transmission | direct contact | indirect |
|---|---|---|
| dirty surfaces | | |
| contaminated air | | |
| blood in a cut | | |

[1]

**(e)** The body defends itself against pathogens.

On Fig. 1.2, draw **one** straight line from each defence to how it stops pathogens.

| **defence** | **how it stops pathogens** |
|---|---|
| mucus | acts as chemical barrier, destroying pathogens in food |
| skin | acts as physical barrier, stopping entry of pathogens |
| stomach acid | produces antibodies |
| white blood cells | traps pathogens before they enter lungs |

**Fig. 1.2**

[3]

**(f)** State the type of drug used as a treatment for bacterial infections.

..... [1]

[Total: 8]

**2** Pea plants produce seeds.

The seeds are either green or yellow.

**(a)** Complete the sentences about pea plants.

Use words from the list.

**asexual** **continuous** **discontinuous**

**genotypes** **mutations** **phenotypes**

The colour of pea seeds is an example of ..... variation.

This is because there are only two ..... with no intermediates.

[2]

**(b)** Fig. 2.1 is a diagram of a flower from a pea plant.

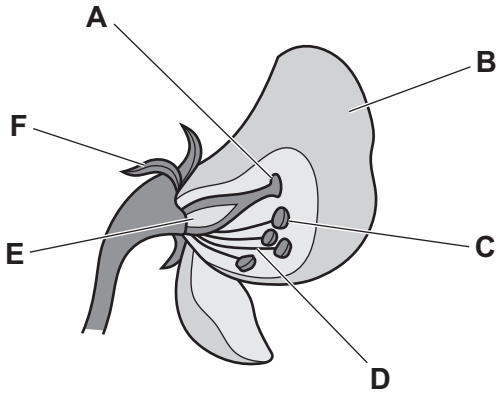



**Fig. 2.1**

**(i)** Using letters **A–F** in Fig. 2.1, identify the:

ovary .....

sepal. .....

[2]

**(ii)** Using letters **A–F** in Fig. 2.1, identify the parts of the flower where pollen grains are transferred during pollination.

from ..... to .....

[2]

**(c)** A scientist investigates the inheritance of colour in pea seeds.

The inheritance of colour is controlled by a single gene.

- The allele for yellow pea seeds is **Y**.
- The allele for green pea seeds is **y**.

All of the scientist's peas are yellow.

**(i)** Table 2.1 shows the different possible combinations of alleles, a description of the combination and the colour of the pea seeds.

Complete Table 2.1.

**Table 2.1**

| combination of alleles | description of combination | colour of pea seeds |
|---|---|---|
| ..... | homozygous dominant | yellow |
| **Yy** | ..... | yellow |

[2]

**(ii)** The scientist uses plants with **yellow** pea seeds to produce plants with **green** pea seeds.

Complete the Punnett square in Fig. 2.2 to show how plants with **yellow** pea seeds produce plants with **green** pea seeds.

| | | parental gametes 1 | |
|---|---|---|---|
| | | **Y** | **y** |
| parental gametes 2 | ..... | ..... | ..... |
| | ..... | ..... | ..... |

**Fig. 2.2**

[2]

**(iii)** State the expected ratio of seed colours from this cross.

yellow pea seeds ..... : green pea seeds ..... [1]

[Total: 11]

**3** Humans are able to detect and respond to changes in their internal and external environment.

**(a)** The ability to detect and respond to changes in the environment is one of the characteristics of living organisms.

Circle this characteristic of living organisms.

**excretion** **growth** **movement** **nutrition** **sensitivity**

[1]

**(b)** Fig. 3.1 is a diagram of some of the organs involved in detecting and responding to changes in the environment.

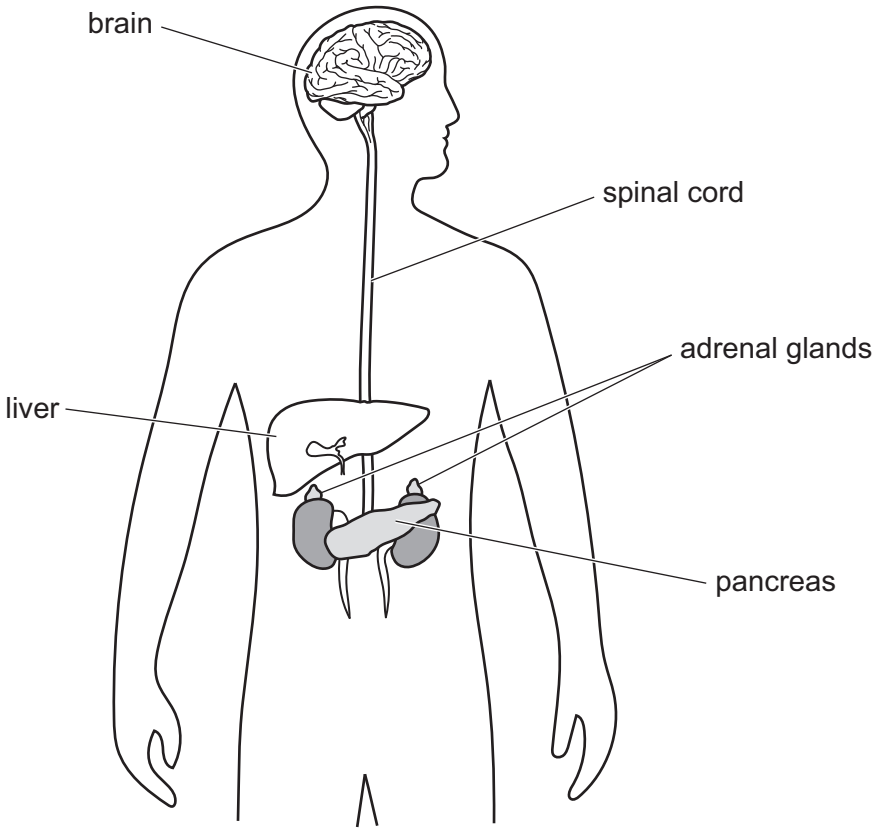



**Fig. 3.1**

**(i)** Identify the organs from Fig. 3.1 that are part of the central nervous system (CNS).

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

**(ii)** Identify the organ from Fig. 3.1 that secretes insulin.

..... [1]

**(iii)** Some of the organs shown in Fig. 3.1 conduct electrical impulses through specialised cells.

Name the specialised cells that conduct electrical impulses.

..... [1]

**(iv)** Some of the organs shown in Fig. 3.1 secrete hormones.

Complete the sentences about hormones.

Hormones are described as ..... substances.

They are produced by ..... and are carried by the

..... plasma.

[3]

**(c)** Adrenaline is a hormone.

Describe when adrenaline is secreted and the effects of adrenaline on the body.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

**4** Fig. 4.1 is a picture of a rhino.

**Fig. 4.1**

**(a)** Rhinos only eat plants.

Tick (✓) **two** boxes that describe rhinos.

| | |
|---|---|
| carnivore | ☐ |
| decomposer | ☐ |
| herbivore | ☐ |
| primary consumer | ☐ |
| producer | ☐ |
| secondary consumer | ☐ |

[2]

**(b)** There are different species of rhino.

Describe what is meant by the term species.

.....

.....

..... [2]

**(c)** Some of the rhino species are endangered.

One reason the rhinos are endangered is because their habitat has been destroyed.

**(i)** Suggest **two** other reasons why rhinos are endangered.

1 .....

2 .....

[2]

**(ii)** Describe **one** reason why habitats are destroyed.

.....

..... [1]

**(d)** Scientists are working to conserve all the rhino species.

They use different conservation methods for different species of rhino.

The method they use depends on how many rhinos are still alive in the wild.

Fig. 4.2 is a graph showing the population of each rhino species in 2023.

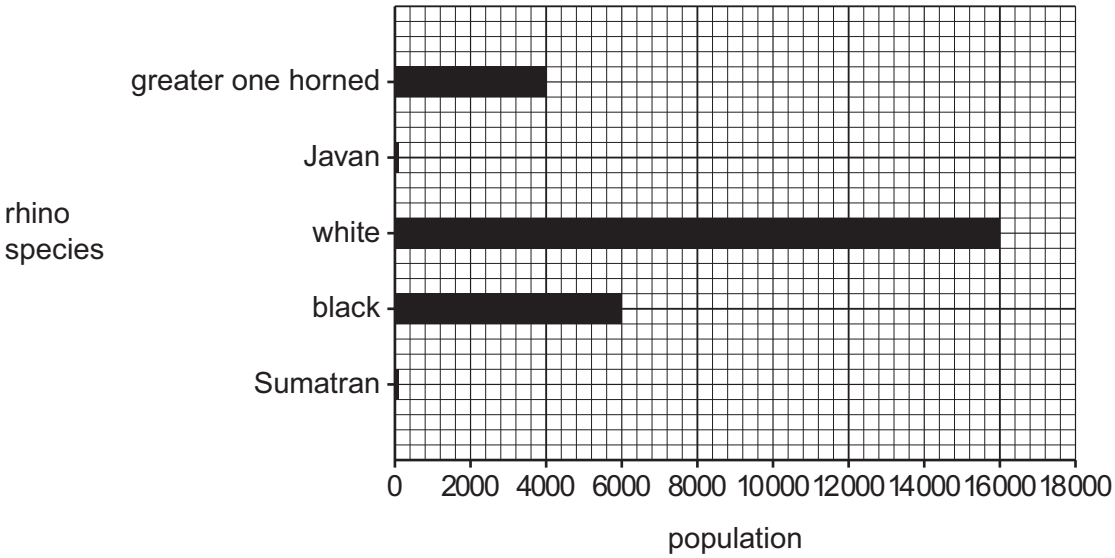



**Fig. 4.2**

**(i)** Identify the rhino species in Fig. 4.2 with the **highest** population.

..... [1]

**(ii)** Use Fig. 4.2 to calculate how many times bigger the population of white rhino is compared to the population of black rhino.

..... [2]

**(iii)** Black rhinos and white rhinos are kept in protected reserves where they can be monitored 24 hours a day.

Suggest **one** different conservation method that can be used for the Sumatran and Javan rhinos.

.....

..... [1]

[Total: 11]

**5** **(a)** Fig. 5.1 lists five chemical processes and the descriptions of these processes.

On Fig. 5.1, draw **one** straight line from each process to the correct description.

| chemical process | description |
|---|---|
| | loss of oxygen |
| chlorination | |
| | the decomposition of an ionic compound, when molten or in aqueous solution, by the passage of an electric current |
| chromatography | |
| | the result of the constant random motion of particles |
| diffusion | |
| | used in water treatment |
| electrolysis | |
| | used to separate mixtures of soluble coloured substances |
| reduction | |

**Fig. 5.1**

[4]

**(b)** Chlorine exists as two isotopes, $^{35}_{17}Cl$ and $^{37}_{17}Cl$.

**(i)** State what is meant by the term isotope.

.....

.....

..... [2]

**(ii)** State why the relative atomic mass, $A_r$, of chlorine is 35.5.

.....

..... [1]

**(iii)** Chlorine reacts with sodium to make sodium chloride.

During the violent reaction, thermal energy and light are released.

Explain why this reaction is **not** described as endothermic.

.....

..... [1]

**(iv)** Sodium chloride is also made by reacting an acid with an alkali.

State the acid and the alkali that is used.

acid .....

alkali .....

[2]

**(v)** Chlorine is a halogen.

The halogens are found in Group VII of the Periodic Table and have similar chemical properties.

Explain why the halogens have similar chemical properties.

.....

..... [1]

[Total: 11]

**6** **(a)** Ethanol has the formula $C_2H_5OH$.

**(i)** Explain why ethanol is **not** a hydrocarbon.

.....

..... [1]

**(ii)** Ethanol is used in alcoholic drinks.

State **one** other use of ethanol.

..... [1]

**(iii)** Draw the displayed formula of ethanol.

[2]

**(iv)** Determine the relative molecular mass, $M_r$, of ethanol.

[$A_r$: C, 12; H, 1; O, 16]

relative molecular mass = ..... [1]

**(b)** Carbon dioxide and water are made during the complete combustion of ethanol.

**(i)** State **one** adverse effect of higher levels of carbon dioxide in the atmosphere.

.....

..... [1]

**(ii)** Describe a chemical test for water.

State the colour change observed.

test .....

colour change from ..... to .....

[2]

**(iii)** Complete the dot-and-cross diagram in Fig. 6.1 to show the arrangement of electrons in a molecule of water.

Draw the outer-shell electrons only.

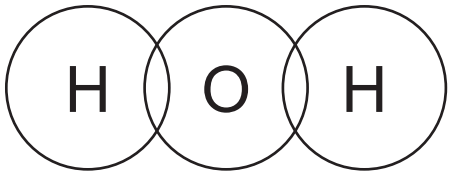



**Fig. 6.1**

[2]

[Total: 10]

**7** **(a)** An atom of copper is represented by $^{64}_{29}Cu$.

**(i)** State what the number 29 represents.

..... [1]

**(ii)** Deduce the number of neutrons in this atom.

number of neutrons = ..... [1]

**(b)** Copper is a transition element.

Tick (✓) the **three** correct statements about copper.

copper acts as a catalyst ☐

copper forms coloured compounds ☐

copper has a low melting point ☐

copper has a low density ☐

copper is ductile ☐

[3]

**(c)** Copper reacts slowly with oxygen in the air.

**(i)** Balance the equation for this reaction.

$$.....Cu\ (s) + O_2\ (g) \rightarrow .....CuO\ (s)$$

[1]

**(ii)** State what (g) means in the equation in **(c)(i)**.

..... [1]

**(d)** Brass is an alloy of copper and zinc.

**(i)** State what is meant by an alloy.

.....

..... [1]

**(ii)** Fig. 7.1 shows four structures **W**, **X**, **Y** and **Z**.

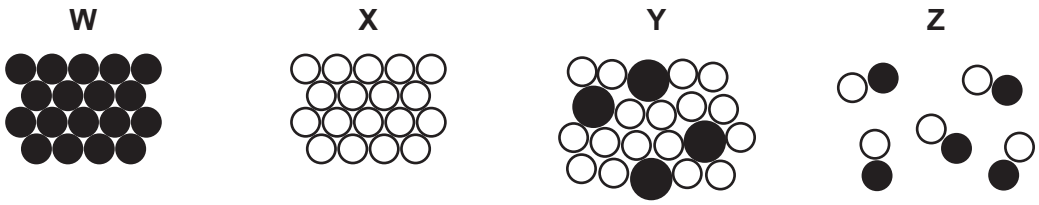



**Fig. 7.1**

State which structure best represents an alloy.

structure ..... [1]

**(iii)** Stainless steel is another alloy.

State why stainless steel is used in cutlery.

.....

..... [1]

[Total: 10]

**8** **(a)** Calcium carbonate has the formula $CaCO_3$.

**(i)** State the number of different elements shown in this formula.

..... [1]

**(ii)** State the total number of atoms shown in this formula.

..... [1]

**(b)** A student investigates the rate of reaction between dilute hydrochloric acid and excess calcium carbonate.

The word equation for the reaction is shown.

calcium carbonate + hydrochloric acid → calcium chloride + carbon dioxide + water

Fig. 8.1 shows some of the apparatus the student uses.

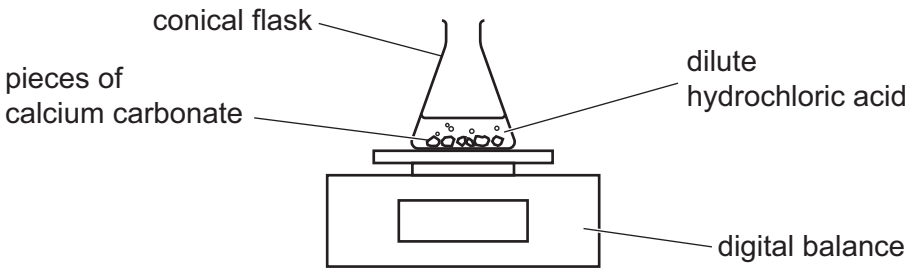



**Fig. 8.1**

**(i)** Name **one** other piece of apparatus needed to investigate the rate of this reaction.

..... [1]

**(ii)** The mass of the conical flask and contents decreases during the experiment.

Explain why the mass decreases.

.....

..... [1]

**(iii)** At the end of the experiment, the student separates the unreacted solid calcium carbonate from the calcium chloride solution.

State the method of separation that the student uses.

..... [1]

**(iv)** State **two** changes to the reaction conditions that will increase the rate of reaction.

1 .....

2 .....

[2]

**(c)** Calcium carbonate is a solid.

Carbon dioxide is a gas.

Fig. 8.2 shows diagrams of a solid, liquid and gas.

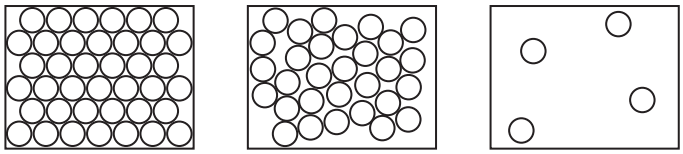



**Fig. 8.2**

Explain, in terms of particle separation and particle arrangement, why **A** represents solid calcium carbonate and **C** represents carbon dioxide gas.

**A** represents solid calcium carbonate because .....

.....

**C** represents carbon dioxide gas because .....

.....

[2]

[Total: 9]

**9** **(a)** Fig. 9.1 shows the speed–time graph for a short car journey.

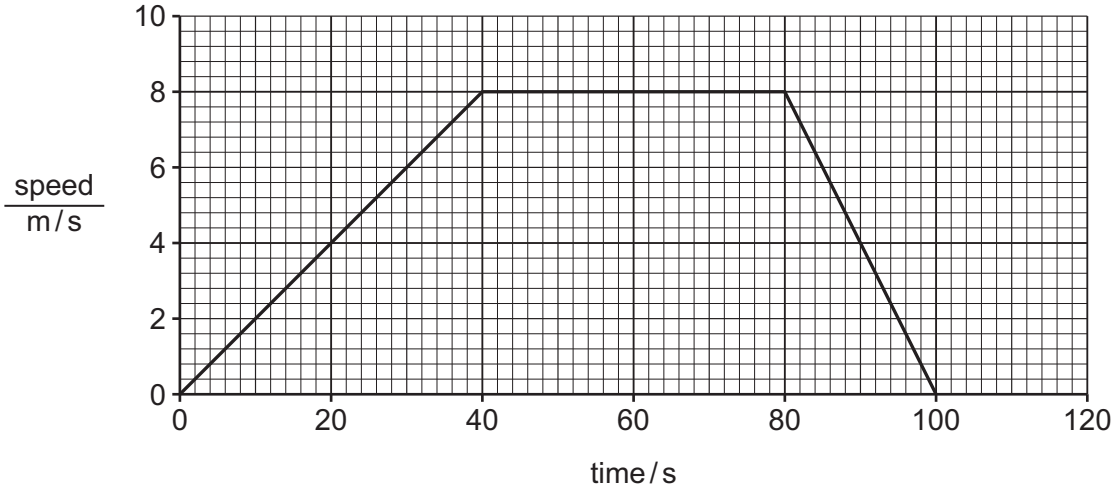



**Fig. 9.1**

**(i)** State a time when the car is accelerating.

time = ..... s [1]

**(ii)** Calculate the total distance travelled on this journey.

total distance = ..... m [3]

**(b)** The temperature of the air in the tyres increases during the journey.

State what happens to the motion of the air particles as the air warms up.

..... [1]

**(c)** The driver in the car brakes by using the brake pedal.

Fig. 9.2 shows the force exerted by the driver's foot on the brake pedal.

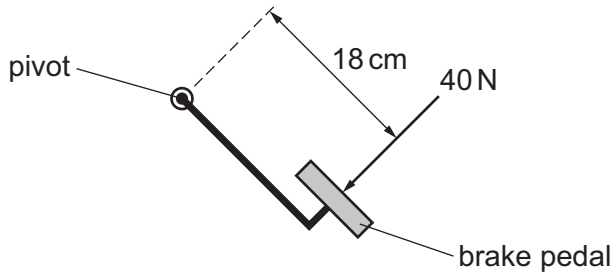



**Fig. 9.2**

Calculate the moment of the force from the driver's foot about the pivot.

moment = ..... N cm [2]

**(d)** As the car moves, electrostatic charges transfer to the car.

**(i)** State what causes the transfer of electrostatic charges.

..... [1]

**(ii)** State the name of the charged particles which move during this transfer of charge.

..... [1]

**(iii)** State the relative charge on the particles identified in **(d)(ii)**.

..... [1]

[Total: 10]

**10 (a)** A scientist is studying a polar bear.

**(i)** State the minimum frequency audible to humans.

minimum frequency = .....Hz [1]

**(ii)** The scientist hears a loud sound of frequency 25 Hz.

The sound has a wavelength of 14 m.

Calculate the speed of this sound in air.

speed = ..... m/s [2]

**(iii)** The polar bear jumps into a pool of water and makes water waves.

Fig. 10.1 shows a wave.

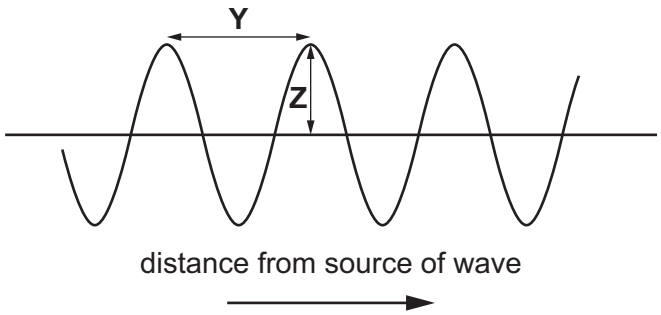



**Fig. 10.1**

Choose words from the list to identify **Y** and **Z** by completing the **two** sentences.

**amplitude** **frequency** **pitch**

**trough** **wave speed** **wavelength**

**Y** shows the ..... of the wave.

**Z** shows the ..... of the wave.

[2]

**(iv)** The scientist uses thermal imaging cameras to detect polar bears travelling on the ice.

State the region of the electromagnetic spectrum detected in thermal imaging cameras.

..... [1]

**(v)** The scientist sees the polar bear under the water.

On Fig. 10.2, draw a ray of light to show how the light travels from the polar bear's head to the scientist's eye.

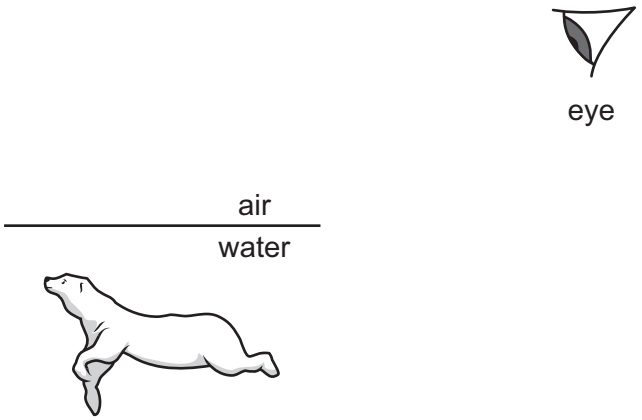



**Fig. 10.2**

[2]

**(b)** In the Arctic, harmful ionising radiation reaches the Earth's surface.

**(i)** State **one** danger to humans of ionising radiation.

.....

..... [1]

**(ii)** $\alpha$-particles, $\beta$-particles and $\gamma$-radiation are all types of ionising radiation.

Place $\alpha$-particles, $\beta$-particles and $\gamma$-radiation in order of their ionising effect, from most ionising to least ionising.

most ionising .....

.....

least ionising .....

[1]

[Total: 10]

**11** **(a)** The Earth is a planet in our Solar System.

List the other seven planets in our Solar System in order from closest to the Sun.

Do **not** include Pluto in your list.

closest to the Sun .....

.....

Earth

.....

.....

.....

.....

furthest from the Sun .....

[2]

**(b)** Granite rock is found on the Earth.

Granite rock contains a radioactive isotope which decays by β-emission.

Complete the equation to show what happens to a neutron in the nucleus of an atom during β-emission.

neutron → ..... + .....

[1]

**(c)** Fig. 11.1 shows a block of granite.

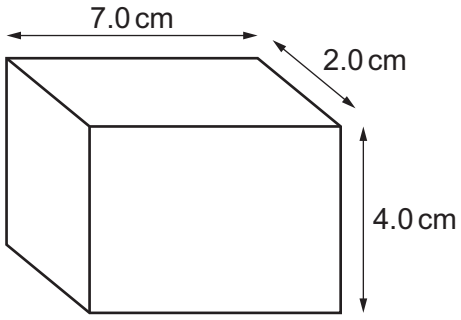



**Fig. 11.1**

**(i)** Calculate the volume of the block.

volume = .....$cm^3$ [1]

**(ii)** The block of granite weighs 1.47 N.

Show that the mass of the block is 150 g.

[3]

**(iii)** Calculate the density of the granite block.

density = ..... g / $cm^3$ [2]

**(d)** The block of granite is placed in a large bowl of water.

The block of granite sinks.

Explain why the block of granite sinks.

.....

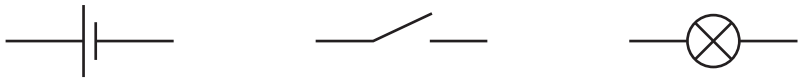
.....

..... [1]

[Total: 10]

**12** **(a)** Fig. 12.1 shows the circuit symbols for three electrical components, **X**, **Y** and **Z**, used in an electric torch (flashlight).

component **X** component **Y** component **Z**



**X** is ..... **Y** is ..... **Z** is .....

**Fig. 12.1**

**(i)** Complete Fig. 12.1 to identify each component. [2]

**(ii)** Using the symbols in Fig. 12.1, draw the circuit diagram for the torch.

[1]

**(iii)** The current in component **Z** is 0.50 A.

The voltage supplied by component **X** is 1.5 V.

Calculate the resistance of component **Z**.

resistance = ..... Ω [2]

**(b)** Fig. 12.2 shows a single ray of light from the torch reflected by a mirror.

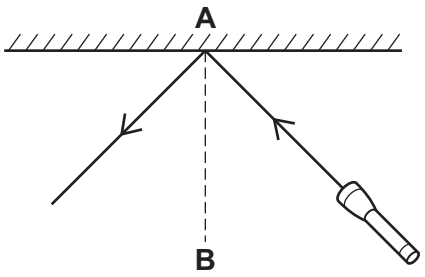



**Fig. 12.2**

**(i)** State the name of the dotted line **AB**.

..... [1]

**(ii)** On Fig. 12.2, label the angle of incidence with the letter *i*. [1]

**(iii)** The angle of incidence is 40°.

State the angle of reflection.

angle of reflection = .....° [1]

**(c)** Fig. 12.3 shows a single ray of **white** light from the torch passing into a glass prism.

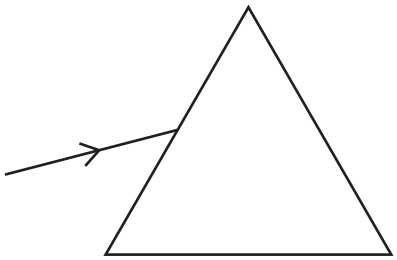


**Fig. 12.3**

Complete Fig. 12.3 to show what happens to the light as it passes through and out of the prism. [2]

[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.).