Cambridge Assessment International Education

# Cambridge IGCSE™

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*7065608674*

**CO-ORDINATED SCIENCES** **0654/32**

Paper 3 Theory (Core) **February/March 2024**

**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.

**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.

**1** **(a)** Fig. 1.1 is a diagram of a plant cell.

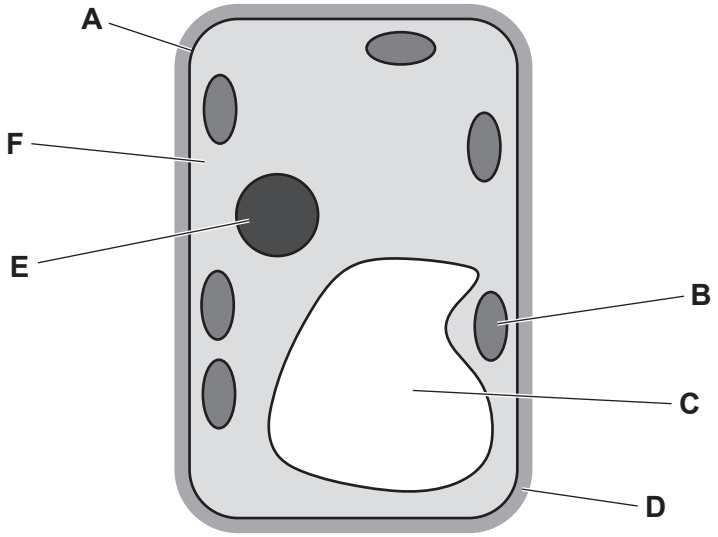



**Fig. 1.1**

**(i)** State the letter in Fig. 1.1 that identifies the part:

that strengthens the cell .....

where photosynthesis occurs .....

where genetic material is stored. .....

[3]

**(ii)** State **two** letters that identify cell structures in Fig. 1.1 that are present in **both** animal and plant cells.

..... and .....

[2]

**(b)** Fig. 1.2 is a photomicrograph of a plant cell.

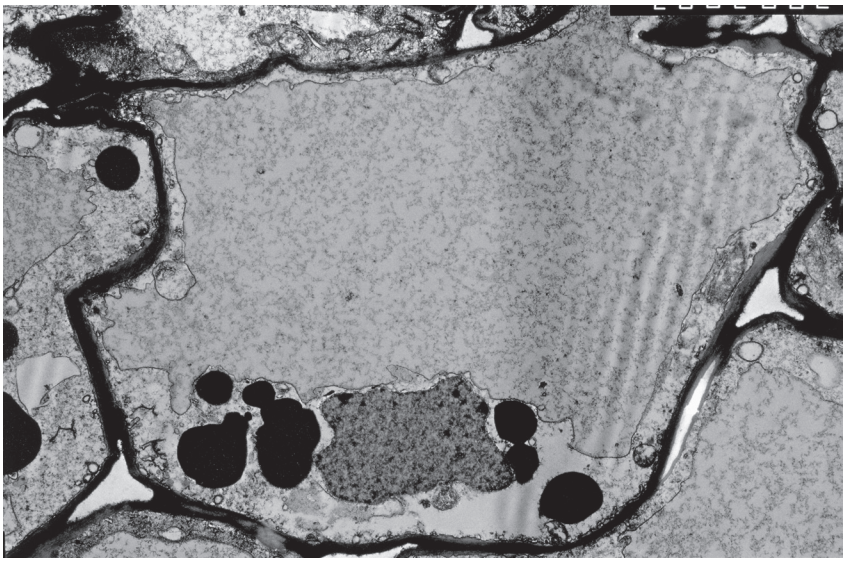


**Fig. 1.2**

**(i)** State the **two** values you need to be able to calculate the actual size of the plant cell.

1 .....

2 .....

[2]

**(ii)** Complete the sentences to describe the effect of immersion in pure water on the plant cell in Fig. 1.2.

Use words or phrases from the list.

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

**amino acids** **assimilation** **glucose**

**osmosis** **partially permeable** **respiration**

**vacuole** **water**

There is an increase in the size of the plant cell ..... .

This is because ..... enters the plant cell through the

..... membrane.

This process is called ..... .

[4]

[Total: 11]

**2** **(a)** A list of processes is shown.

**chromatography**
**combustion**
**cracking**
**electroplating**
**fermentation**
**filtration**
**oxidation**
**polymerisation**
**rusting**

Identify, from the list, the process that is used to:

**(i)** break down large hydrocarbon alkane molecules into smaller alkene and smaller alkane molecules.

..... [1]

**(ii)** make ethanol from glucose.

..... [1]

**(iii)** make long chain molecules from small monomer units.

..... [1]

**(iv)** separate a mixture of dyes.

..... [1]

**(v)** cover a metal with a layer of copper.

..... [1]

**(b)** Sodium chloride is made by reacting an acid with a base.

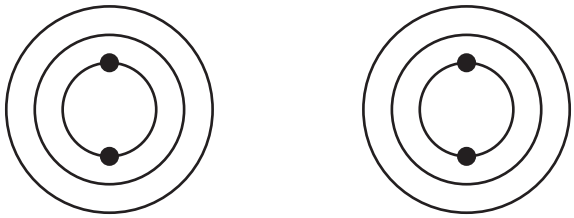
State the name of the acid and the base that are used.

acid .....

base .....
[2]

**(c)** An atom of sodium has 11 electrons. A sodium ion has the symbol $Na^+$.

Complete Fig. 2.1 to show the electronic structures of a sodium atom and a sodium ion. The first electron shell has been completed for you.



sodium atom sodium ion

**Fig. 2.1**

[2]

**(d)** Sodium and chlorine are both in Period 3 of the Periodic Table.

Use words from the list to complete the sentence to describe the changes in metallic nature across a period in the Periodic Table.

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

**left** **metallic** **non-metallic** **right**

Going from ..... to ....., the elements change from

..... to ..... .

[1]

[Total: 10]

**3** A student investigates the properties of five materials:

**copper** **ice** **iron** **plastic** **wood**

Each material is a block with the dimensions shown in Fig. 3.1.

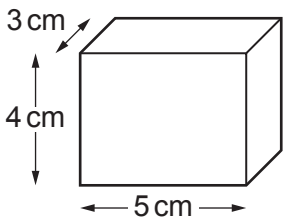



**Fig. 3.1**

**(a) (i)** State the **two** materials that are good thermal conductors.

1 .....

2 .....
[1]

**(ii)** State the **two** materials that are good electrical conductors.

1 .....

2 .....
[1]

**(iii)** State the material that a magnet attracts.

..... [1]

**(b)** The mass of the block of wood is 39 g.

Use information from Fig. 3.1 to calculate the density of the block of wood.

State the units of your answer.

density = ..... units ..... [4]

**(c)** The block of ice melts and turns to water.
Fig. 3.2 shows the arrangement of particles in ice and in water.

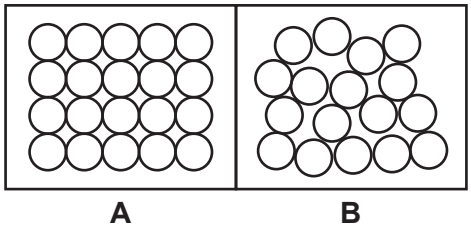



**Fig. 3.2**

Explain, in terms of the arrangement of particles, why diagram **A** represents ice and diagram **B** represents water.

.....

.....

..... [1]

**(d)** When the plastic block is rubbed with a cloth an electrostatic charge is produced.

State the particles that are transferred when the block is rubbed with the cloth.

..... [1]

[Total: 9]

**4** Fig. 4.1 shows the pathway and the structures involved in a reflex action when you touch a hot object.

When a very hot object is touched you immediately remove your hand.

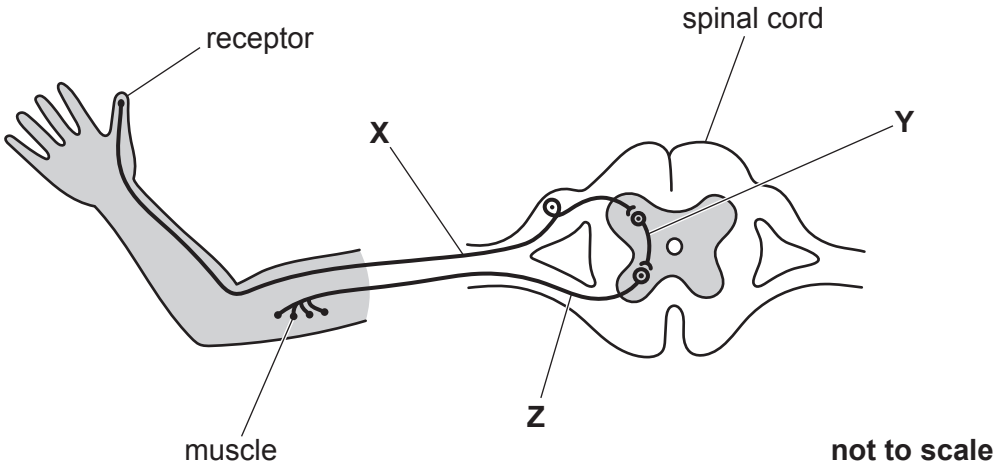



**Fig. 4.1**

**(a) (i)** Identify the part labelled **Y** in Fig. 4.1.

**Y** ..... [1]

**(ii)** Identify the direction of impulses in parts **X** and **Z** by drawing two arrows on Fig. 4.1. [1]

**(iii)** State the names of the stimulus and effector in this reflex action.

**stimulus** .....

**effector** .....
[2]

**(iv)** State **two** characteristics of living things that are involved in **this** reflex action.

1 .....

2 .....
[2]

**(b)** The spinal cord is part of the central nervous system.

**(i)** State the name of the **other** part of the central nervous system.

..... [1]

**(ii)** State the name of the **other** nervous system in humans.

..... [1]

[Total: 8]

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**5** **(a)** A sample of clean air contains nitrogen and other gases.

State the percentage of nitrogen in the sample of clean air.

.....% [1]

**(b)** Argon is one of the other gases found in clean air.
Fig. 5.1 shows the electronic structure of an atom of argon.

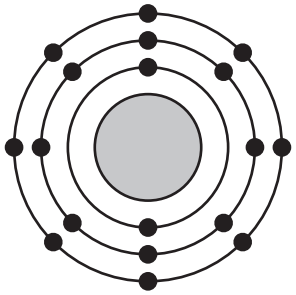

**Fig. 5.1**

**(i)** Use Fig. 5.1 to explain why argon is unreactive.

.....

..... [1]

**(ii)** State **one** use for argon gas.

..... [1]

**(c)** Sulfur dioxide is a pollutant in the air.

**(i)** State **one** source of sulfur dioxide.

..... [1]

**(ii)** Name **one** other oxide that is a pollutant in the air.

..... [1]

**(d)** Sulfur dioxide contributes to acid rain.

**(i)** Acid rain reacts slowly with limestone.

Suggest one reason for this slow rate of reaction.

.....

..... [1]

**(ii)** Acid rain also causes acidic soil.

Name the chemical substance used by farmers to treat acidic soil.

..... [1]

**(iii)** State the name of the type of reaction that occurs when the substance you have named in **(d)(ii)** is added to acidic soil.

..... [1]

**(e)** Scientists are concerned about the increase in the amount of greenhouse gases in the Earth's atmosphere.

Name **one** greenhouse gas.

..... [1]

[Total: 9]

**6** **(a)** Five different energy sources are shown in the list.

**coal** **geothermal** **hydroelectric** **nuclear** **solar**

**(i)** Circle the energy source in the list that produces carbon dioxide when it is used to generate electricity in a power station. [1]

**(ii)** State the name of one renewable energy source **not** shown in the list.

..... [1]

**(iii)** State the form of energy stored in coal.

..... [1]

**(iv)** Suggest one advantage and one disadvantage of solar power compared to nuclear power.

advantage .....

.....

disadvantage .....

.....

[2]

**(b)** In a nuclear power station, there are radioactive materials. Emissions from these materials include $\alpha$-particles, $\beta$-particles and $\gamma$-rays.

**(i)** State the emission which is part of the electromagnetic spectrum.

..... [1]

**(ii)** Write the name of this emission in the correct position in the incomplete electromagnetic spectrum in Fig. 6.1.

| ← increasing frequency | | | | | | |
|---|---|---|---|---|---|---|
| | X-rays | | visible light | infrared | | |

**Fig. 6.1**

[1]

**(iii)** Place $\alpha$-particles, $\beta$-particles and $\gamma$-rays in order of their penetrating abilities.

greatest penetration .....

.....

least penetration .....

[1]

**(iv)** Describe the nature of an $\alpha$-particle.

.....

..... [1]

**(c)** The nuclear fuel used in some power stations is plutonium-239.

Plutonium-239 decays by $\alpha$-particle emission to produce uranium-235.
Plutonium-239 has a half-life of 24 000 years.

**(i)** 100 g of plutonium-239 is sealed in a lead container and left for 96 000 years.

Calculate the mass of plutonium-239 remaining after 96 000 years.

mass = ..... g [2]

**(ii)** Complete the word equation to show the decay of a nucleus of plutonium-239.

plutonium-239 $\rightarrow$ ..... + ..... [1]

[Total: 12]

**7** Pea colour and shape are inherited characteristics that are controlled by a single gene.

**(a)** Define the term gene.

.....

.....

..... [2]

**(b)** A farmer recorded the colour and shape of a sample of 14 peas.
Fig. 7.1 shows a graph of the results.

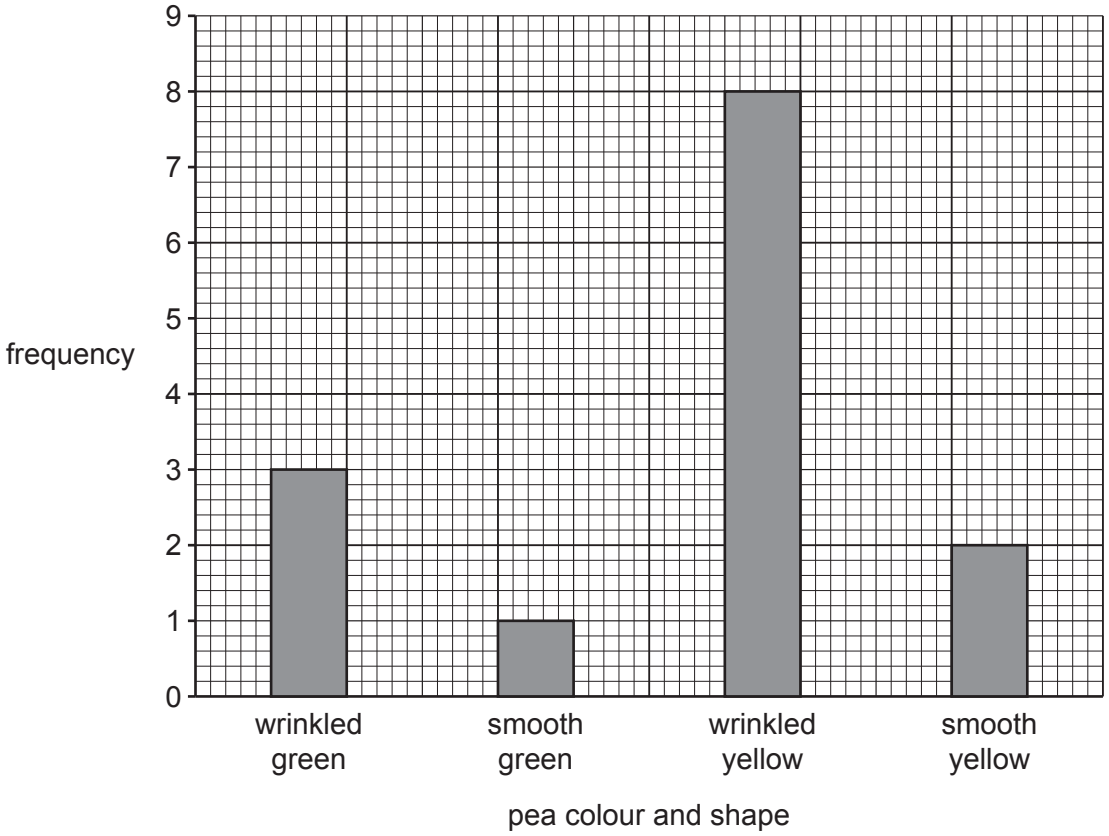


**Fig. 7.1**

**(i)** Identify the most frequent pea colour and shape in Fig. 7.1.

..... [1]

**(ii)** State the frequency of wrinkled green peas in Fig. 7.1.

..... [1]

**(iii)** Describe evidence from Fig. 7.1 that shows that pea colour and shape are examples of discontinuous variation.

.....

..... [1]

**(iv)** State one example of **continuous** variation in humans.

..... [1]

**(c)** The farmer found that smooth green peas were the most popular with food buyers.

Describe how the farmer uses selective breeding to increase the number of smooth green peas.

.....

.....

.....

.....

..... [3]

**(d)** Name the type of selection that results in species being adapted to the environment they live in.

..... [1]

[Total: 10]

**8** Methane, $CH_4$, is a hydrocarbon.

**(a)** **(i)** Methane is the main constituent of a fossil fuel.

State the name of this fossil fuel.

..... [1]

**(ii)** State the name of the type of bonding in a molecule of methane.

..... [1]

**(iii)** Complete the dot-and-cross diagram in Fig. 8.1 to show the bonding in a molecule of methane. You only need to show the outer-shell electrons.

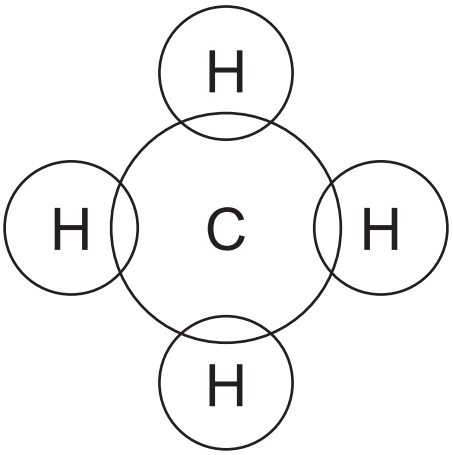


**Fig. 8.1**

[2]

**(b)** The complete combustion of methane makes carbon dioxide and water.

**(i)** Balance the symbol equation for the complete combustion of methane.

$$CH_4 + .....O_2 \rightarrow CO_2 + .....H_2O$$

[2]

**(ii)** Methane is oxidised in this reaction.

Explain how the symbol equation shows that methane is oxidised.

.....

..... [1]

**(iii)** During the incomplete combustion of methane carbon monoxide is made.

Describe **one** adverse effect of carbon monoxide on the health of humans.

.....

..... [1]

**(c)** Carbon is an element. Methane is a compound.

Describe the difference between an element and a compound by completing the sentences using only the words **elements** or **compounds**.

..... are pure substances consisting only of atoms, all of which have the same number of protons in their nuclei.

..... are chemical substances composed of two or more ..... held together by chemical bonds.

[1]

[Total: 9]

**9** **(a)** Fig. 9.1 shows a speed-time graph for a penguin swimming in the sea.

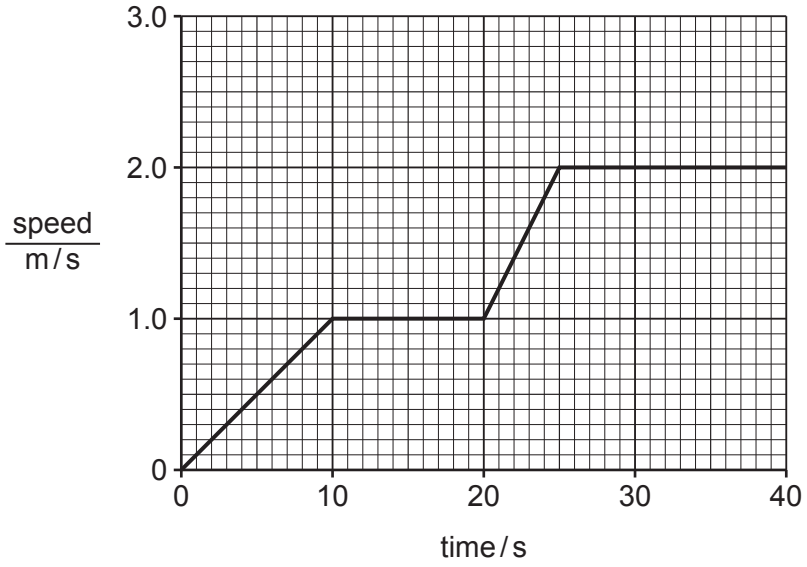


**Fig. 9.1**

**(i)** On Fig. 9.1 mark with the letter **A** a time when the penguin has **greatest** acceleration. [1]

**(ii)** On Fig. 9.1 mark with the letter **M** a time when the penguin is swimming at constant speed and state this speed.

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

**(b)** Fig. 9.2 shows a penguin walking on ice in Antarctica.

**Fig. 9.2**

A scientist is studying the penguin.

**(i)** State the **two** quantities that the scientist needs to know to calculate the pressure exerted by the penguin on the ice.

1 .....

2 .....
[2]

**(ii)** The scientist can detect the penguin moving on the ice using thermal imaging cameras. These use infrared radiation.

State **one** other use for infrared radiation.

..... [1]

**(c)** The penguin hears a sound of 400 Hz made by the scientist.
The audible frequency range for the penguin has a higher minimum frequency and a lower maximum frequency compared to a human.

Suggest the audible frequency range for the penguin.

minimum frequency = ..... Hz

maximum frequency = ..... Hz
[2]

**(d)** Describe how the scientist could measure the speed of sound.

Include the measurements that need to be taken.

.....

.....

.....

.....

..... [3]

[Total: 11]

**10 (a)** Fig. 10.1 is a diagram of the gas exchange system in humans.

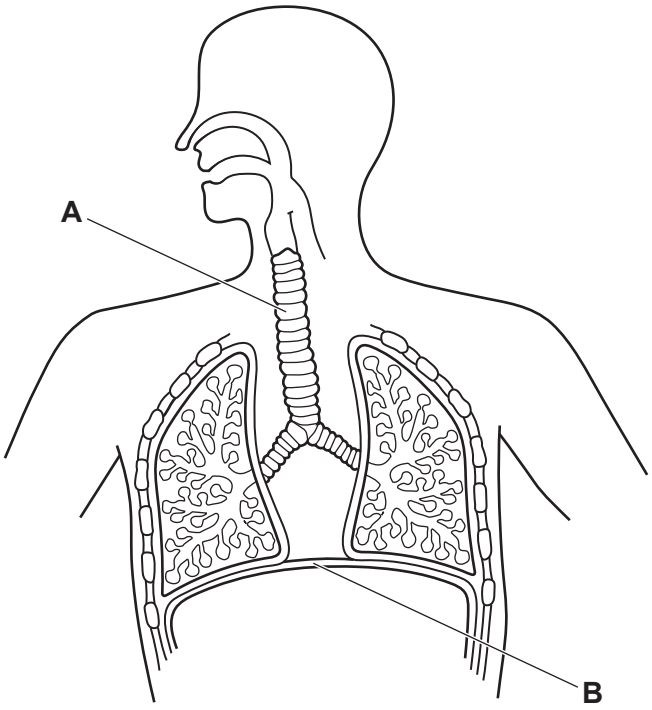


**Fig. 10.1**

State the name of the parts labelled **A** and **B** in Fig. 10.1.

**A** .....

**B** .....
[2]

**(b)** Table 10.1 compares the composition of two gases in inspired air and expired air.

**Table 10.1**

| gas | percentage in inspired air | percentage in expired air |
|---|---|---|
| **X** | 21 | 16 |
| **Y** | 0.04 | 4 |

**(i)** Calculate the difference between the percentage of gas **X** in inspired air compared to expired air in Table 10.1.

.....% [1]

**(ii)** Describe the test for gas **Y and** state the positive result.

test .....

positive result .....
[2]

**(iii)** State the name of the chemical reaction that occurs in cells that requires gas **X**.

..... [1]

**(c)** The rate of breathing increases during physical activity.

State **one** other change to the pattern of breathing during physical activity.

..... [1]

**(d)** Pulse rate also increases during physical activity to supply more blood to the muscles. White blood cells are one of the major components of blood.

**(i)** State **two** other major components of blood.

1 .....

2 .....
[2]

**(ii)** State **two** functions of white blood cells.

1 .....

2 .....
[2]

[Total: 11]

**11** **(a)** Three metals are placed in three different test-tubes of dilute sulfuric acid as shown in Fig. 11.1.

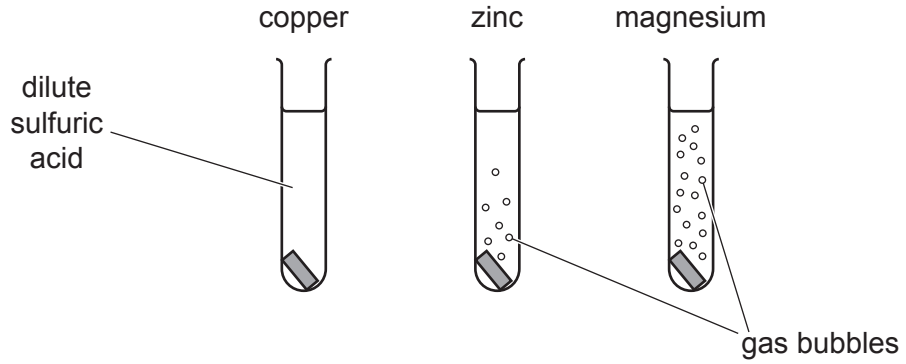


**Fig. 11.1**

**(i)** Suggest the pH number of the dilute sulfuric acid.

pH = ..... [1]

**(ii)** State which of the three metals in Fig. 11.1 reacts most quickly with dilute sulfuric acid.

..... [1]

**(iii)** When metals react with dilute sulfuric acid a gas is made.

State the name of this gas.

..... [1]

**(iv)** A sulfuric acid molecule contains two hydrogen atoms, one sulfur atom and four oxygen atoms.

State the formula of sulfuric acid.

..... [1]

**(b)** Brass is an alloy.

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

.....

..... [1]

**(ii)** A sample of brass has a mass of 250 g. The sample of brass has the composition shown in Table 11.1.

**Table 11.1**

| metal | % composition |
|---|---|
| lead | 2 |
| copper | 65 |
| zinc | 33 |

Calculate the mass of zinc contained in the sample of brass.

mass of zinc = ..... g [2]

**(c)** An isotope of zinc contains atoms which have a proton number of 30 and a nucleon number of 64.

**(i)** Complete the sentence to define the term isotope.

Isotopes are atoms of the same ..... which have the

same ..... number but a different ..... number.

[2]

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

number of electrons = ..... [1]

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

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

**(d)** Zinc ore is a finite resource.

State what is meant by a finite resource.

.....

..... [1]

[Total: 12]

**12 (a)** Complete the following sentences using the words shown.

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

**current** **ohms** **charge** **newtons**

**resistance** **volts**

A flow of electrons is called a ..... .

Electromotive force (e.m.f.) is measured in ..... .

To calculate the resistance of a component you divide the voltage by the ..... .
[3]

**(b)** Energy transfers occur when electrical energy is supplied to a lamp. Fig. 12.1 shows a lamp and the energy transfers.

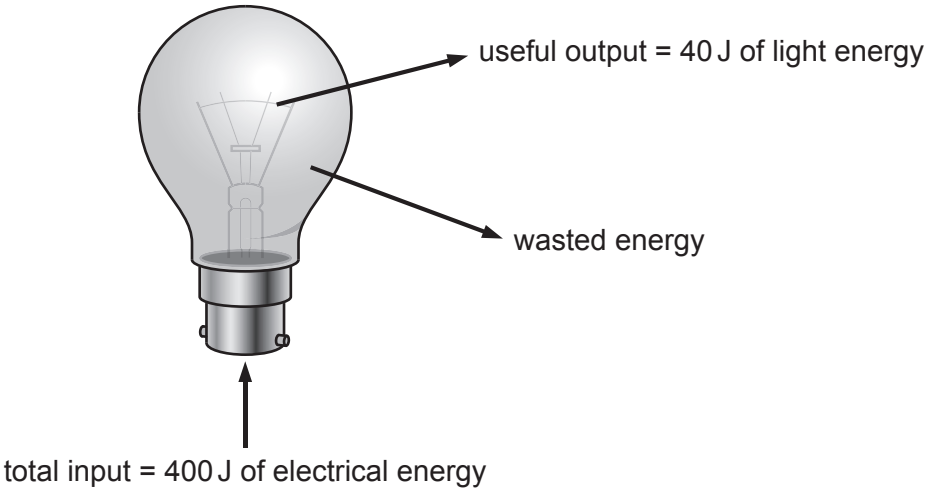


**Fig. 12.1**

Use information from Fig. 12.1 to calculate the wasted energy.

wasted energy = ..... J [1]

**(c)** Fig. 12.2 shows a ray of light from the lamp entering a glass block.

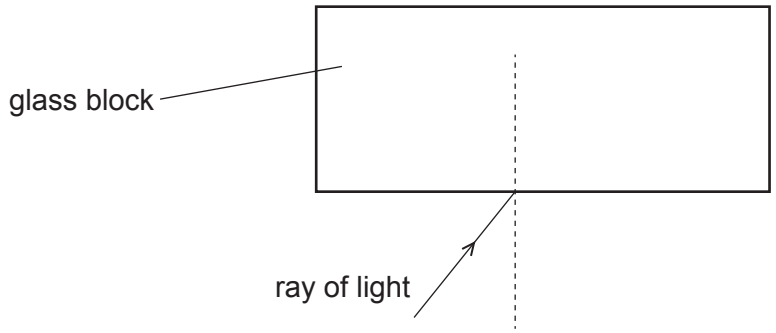


**Fig. 12.2**

**(i)** On Fig. 12.2 continue the path of the ray into the block as it is refracted. [1]

**(ii)** On Fig. 12.2 label the angle of incidence with an *i* and the angle of refraction with an *r*. [1]

**(d)** Fig. 12.3 represents a visible light wave.

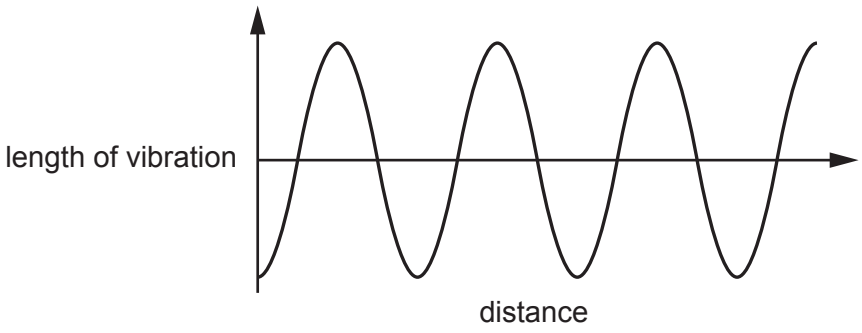


**Fig. 12.3**

**(i)** On Fig. 12.3 use a double-headed arrow (↔ or ↕) and the letter **W** to show one wavelength. [1]

**(ii)** On Fig. 12.3 use a double-headed arrow (↔ or ↕) and the letter **A** to show the amplitude of the wave. [1]

[Total: 8]

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## The Periodic Table of Elements

| Group | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | II | | | | | | | | | | | III | IV | V | VI | VII | 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.).