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

Paper 3 Theory (Core)

**February/March 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 =  $9.8 \text{ m/s}^2$ ).

**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.

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

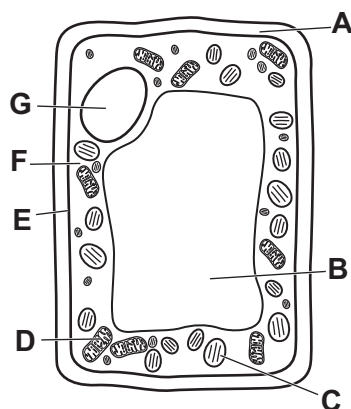


Fig. 1.1

(i) Using letters **A–G** in Fig. 1.1, identify:

the part where aerobic respiration takes place .....

the part that supports the cell .....

**all** the parts that are also found in animal cells.

..... [3]

(ii) State **two** ways a bacterial cell is different to the plant cell in Fig. 1.1.

1 .....

2 ..... [2]

(iii) State the name of the part labelled **C** in Fig. 1.1.

..... [1]





- (b) (i) The plant cell contains a green pigment used in photosynthesis.

State the name of this green pigment.

..... [1]

- (ii) State the word equation for photosynthesis.

..... + ..... → ..... + ..... [2]

- (iii) Complete the sentence about photosynthesis.

Photosynthesis is the process by which plants synthesise

carbohydrates from raw materials using ..... energy. [1]

- (c) Nutrition is one of the characteristics of living things.

State **two other** characteristics of living things.

1 .....

2 .....

[2]

[Total: 12]



- 2 (a) The boxes on the left show different processes that occur in the human body.

The boxes on the right show the descriptions of some of the processes.

Draw **one** line from each **process** to its correct **description**.

process	description
	the uptake and use of nutrients by cells
egestion	the taking of substances, e.g. food and drink, into the body
ingestion	the removal of undigested food from the body as faeces
digestion	the movement of nutrients from the intestine into the blood
assimilation	the breakdown of food

[4]

- (b) (i) Large biological molecules are made from smaller molecules.

Complete the sentences about different biological molecules.

Large protein molecules are made from smaller molecules called

..... .

The elements in protein molecules are carbon, .....,

oxygen and .....

Glycogen is a large molecule made from smaller molecules

called .....

[3]





(ii) Reducing sugars are small biological molecules.

State the name of the reagent used to test for reducing sugars. Give the observation for a positive result.

reagent .....

observation for a positive result .....

.....

[2]

[Total: 9]



- 3 (a) (i) Complete the sentences using words from the list.

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

**chromosomes**

**cilia**

**codes**

**ribosomes**

**secretes**

**targets**

**walls**

A gene is a length of DNA that ..... for a protein.

Proteins are made in the cell by structures called .....

Genes are found on ..... in the cell's nucleus.

[3]

- (ii) Fig. 3.1 shows a person with dimples in their cheeks. Dimples are inherited.



**Fig. 3.1**

Dimples are produced when a person has the dominant allele in their genotype.

The **dominant** allele for dimples is **D**.

The allele for not having dimples is **d**.

Two people with dimples have a child without dimples.

They are expecting a second child.





Predict the probability of the second child **having** dimples.

Complete the genetic diagram to explain your answer.


probability = .....

[3]

(b) Fig. 3.2 shows some Columbia sheep.

Columbia sheep are a type of sheep that are selectively bred to have very thick wool.

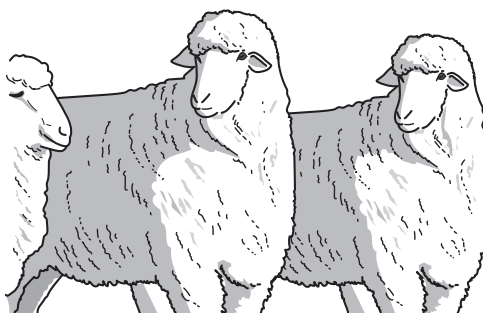


Fig. 3.2

Describe the process of selective breeding by artificial selection to produce Columbia sheep with very thick wool.

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]





4 (a) (i) State the word that describes a disease-causing organism.

..... [1]

(ii) HIV is a transmissible disease that may lead to another condition.

State the name of this condition.

..... [1]

(iii) Describe **two** ways that HIV is transmitted.

1 .....

.....

2 .....

..... [2]

(b) (i) Fig. 4.1 is a diagram of three types of blood vessels.

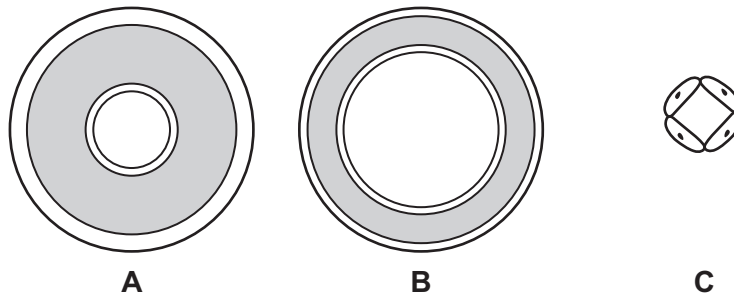


Fig. 4.1

Identify which of the blood vessels **A**, **B** or **C** transports deoxygenated blood from the body to the heart.

Choose from **A**, **B** or **C** and give **two** pieces of evidence from Fig. 4.1 to explain your answer.

blood vessel .....

evidence 1 .....

.....

evidence 2 .....

..... [2]







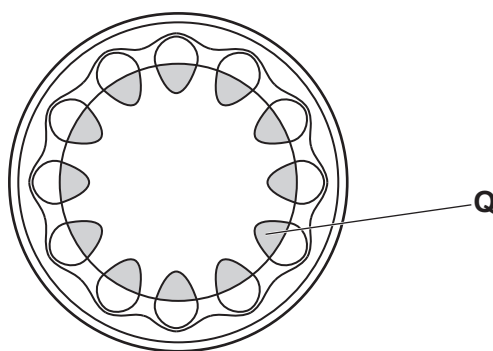
- (ii) The diameter of blood vessel **C** shown in Fig. 4.1 is 10 mm.

The actual diameter of blood vessel **C** is 0.008 mm.

Calculate the magnification of the image of blood vessel **C** in Fig. 4.1.

magnification = ..... [2]

- (c) Fig. 4.2 is a diagram of a section of a plant stem.



**Fig. 4.2**

State **two** functions of the part labelled **Q**.

1 .....

2 .....

[2]

[Total: 10]





5 (a) The list shows six metals.

aluminium  
calcium  
iron  
magnesium  
platinum  
sodium

Identify the metal from the list that is:

(i) extracted from bauxite

..... [1]

(ii) an alkali metal

..... [1]

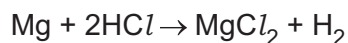
(iii) the main element in steel

..... [1]

(iv) used as inert electrodes in electrolysis.

..... [1]

(b) A student investigates the reaction between dilute hydrochloric acid and magnesium.  
The symbol equation for this reaction is



(i) Name one product from this reaction.

..... [1]

(ii) The concentration of the dilute hydrochloric acid used is  $36.5 \text{ g/dm}^3$ .  
The experiment is repeated using acid with a concentration of  $73.0 \text{ g/dm}^3$ .

State the effect on the rate of reaction.

Explain your answer.

effect on rate of reaction .....

explanation .....

..... [2]

(iii) Name a metal in the reactivity series that is more reactive than magnesium.

..... [1]

[Total: 8]





6 (a) Ethene,  $C_2H_4$ , is a hydrocarbon.

(i) Explain why ethene is described as a hydrocarbon.

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

(ii) Complete Fig. 6.1 to show the displayed formula of ethene.



Fig. 6.1

[2]

(b) (i) State the colour change observed when ethene gas is reacted with aqueous bromine.

from ..... to ..... [2]

(ii) Complete the sentences to describe another reaction of ethene.

The polymer ..... is a large molecule built up from many smaller ethene molecules called .....

This is an example of ..... polymerisation. [3]

[Total: 9]





- 7 (a) Gasoline/petrol reacts with oxygen in car engines making exhaust gases. This is an example of oxidation.

(i) State the meaning of oxidation.

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

(ii) Table 7.1 shows the composition of clean dry air and of exhaust gases.

**Table 7.1**

gases	percentage by volume in clean dry air / %	percentage by volume in exhaust gases / %
carbon dioxide and other gases	1	13
nitrogen	.....	67
oxygen	.....	9
water	0	11

Complete Table 7.1. [2]

(iii) Use Table 7.1 to state the two products of the oxidation of gasoline/petrol.

1 .....  
 2 ..... [2]

(iv) Describe a chemical test for the presence of water in a sample of exhaust gases and state the observations for a positive result.

test .....  
 .....  
 positive result .....  
 ..... [2]





- (b) Neon is another gas found in clean dry air.

Fig. 7.1 shows the electronic configuration of an atom of neon.

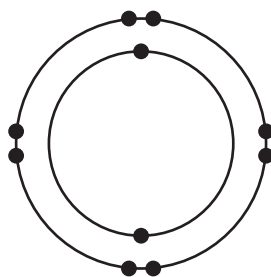


Fig. 7.1

- (i) Use Fig. 7.1 to explain why neon is found in Group VIII and Period 2 of the Periodic Table.

Group VIII .....

.....

.....

Period 2 .....

.....

[2]

- (ii) Use Fig. 7.1 to explain why neon is unreactive.

.....

..... [1]

- (c) Water at room temperature is a liquid.  
Water vapour in the air is a gas.

Name the change of state that occurs when:

liquid water changes into water vapour

.....

water vapour changes into liquid water.

.....

[2]

[Total: 12]



- 8 (a) Chlorine is an element in Group VII of the Periodic Table.

Chlorine molecules are diatomic.

- (i) State the type of chemical bonding in a chlorine molecule.

..... [1]

- (ii) Astatine, At, is also a diatomic molecule.

State the formula for a molecule of astatine.

..... [1]

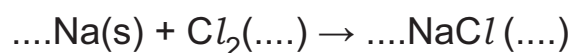
- (b) When chlorine gas reacts with solid sodium, an orange flame is seen and the sodium melts.

Solid sodium chloride is formed.

- (i) Explain how these observations show that the reaction is exothermic.

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

- (ii) Complete the balanced equation for the reaction between chlorine and sodium.  
 Include state symbols.



[2]

- (c) Fig. 8.1 shows the electronic configuration of a sodium atom and a chlorine atom.

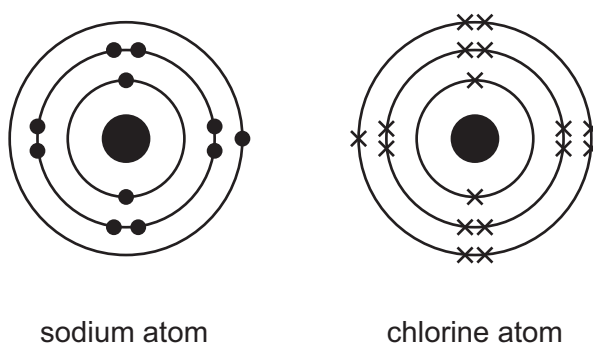


Fig. 8.1

A sodium ion and a chloride ion are formed when a sodium atom reacts with a chlorine atom.



Complete the dot-and-cross diagrams in Fig. 8.2 to show the electronic configurations of a sodium ion and a chloride ion.

Include the charges on the ions.

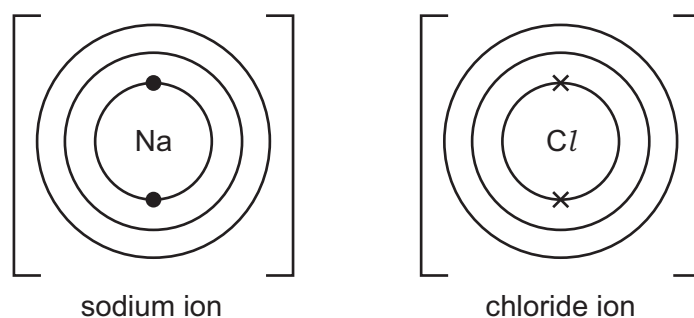


Fig. 8.2

[3]

- (d) Fig. 8.3 shows an experiment in which an electric current is passed through concentrated aqueous sodium chloride.

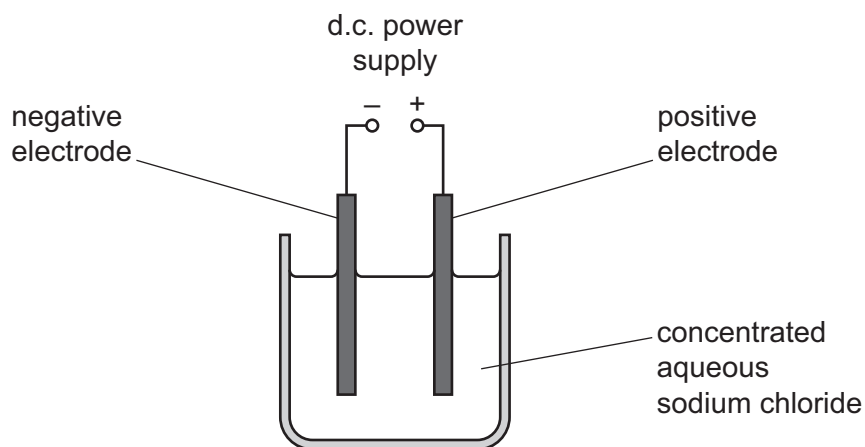


Fig. 8.3

- (i) State the names of the positive electrode and the negative electrode.

positive electrode .....

negative electrode .....

[1]

- (ii) Identify the gases produced at the positive electrode and at the negative electrode in this experiment.

gas at positive electrode .....

gas at negative electrode .....

[2]

[Total: 11]



- 9 (a) A student walks to school.

Fig. 9.1 shows a speed–time graph for part of the journey.

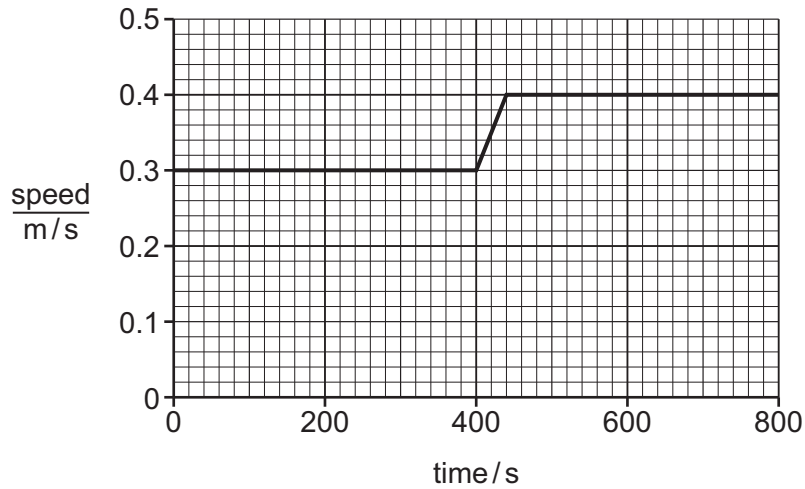


Fig. 9.1

- (i) Write the letter **C** on a part of the graph where the student is walking at constant speed. [1]

- (ii) State a time when the student accelerates.

time = ..... s [1]

- (iii) State the maximum speed of the student.

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

- (b) In the classroom, the student uses a laptop computer.

Fig. 9.2 shows the power cable from the mains supply to the laptop.

The power cable insulation is damaged.

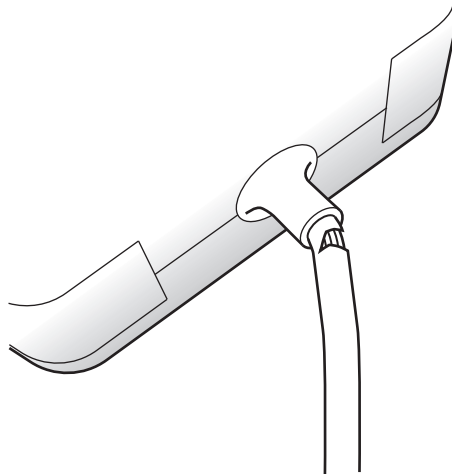


Fig. 9.2



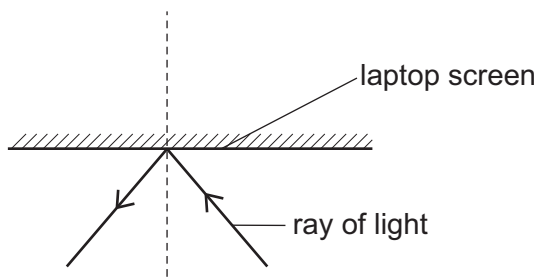


State one danger of using this laptop with damaged insulation.

.....

..... [1]

(c) Fig. 9.3 shows a ray of light reflecting off the laptop screen.



**Fig. 9.3**

(i) On Fig. 9.3, label the angle of incidence with the letter  $i$  and the angle of reflection with the letter  $r$ . [2]

(ii) State the relationship between the angle of incidence and the angle of reflection.

.....

..... [1]

(d) The student watches the teacher demonstrate an experiment using the isotope strontium-90.

Strontium-90 is radioactive and emits  $\beta$ -particles.

(i) State the charge on a  $\beta$ -particle.

..... [1]

(ii) State one method of storing safely a small quantity of strontium-90 in a school.

.....

..... [1]





(e) Fig. 9.4 shows the student sitting on a chair.



**Fig. 9.4**

Fig. 9.5 shows the student balancing on the chair which is tilted backwards.



**Fig. 9.5**

Explain why the student and chair fall over when the chair is tilted further backwards. Use ideas about centre of gravity and moments in your answer.

.....

.....

.....

.....

[2]

[Total: 11]







- 10 (a) (i) The Sun consists mostly of two elements.

State the names of these two elements.

1 .....

2 .....

[1]

- (ii) The Milky Way galaxy contains the Sun and many other stars.

State the approximate diameter of the Milky Way.

diameter = ..... light-years [1]

- (iii) Stars are extremely hot bodies. Energy is being transferred from the stars into space when they emit electromagnetic radiation.

Explain why stars can lose energy by radiation and **not** by conduction or convection.

..... [1]

- (iv) Visible light waves from a distant star change direction as they enter the Earth's atmosphere.

State the name of this effect.

..... [1]

- (b) (i) A frequency of infrared radiation emitted by the Sun is  $2.5 \times 10^{14}$  Hz.  
The speed of infrared radiation is  $3.0 \times 10^8$  m/s.

Calculate the wavelength of this infrared radiation.

wavelength = ..... m [2]

- (ii) Fig. 10.1 shows an incomplete electromagnetic spectrum.

Write infrared radiation in its correct position.

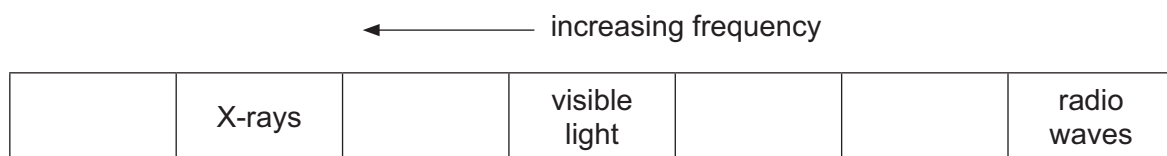


Fig. 10.1

[1]



(c) Fig. 10.2 shows a ray of white light from the Sun refracting through a prism.

The ray of light splits into the seven colours of the visible spectrum.  
The seven colours are shown as the numbers 1 to 7.

Red light refracts less than violet light.

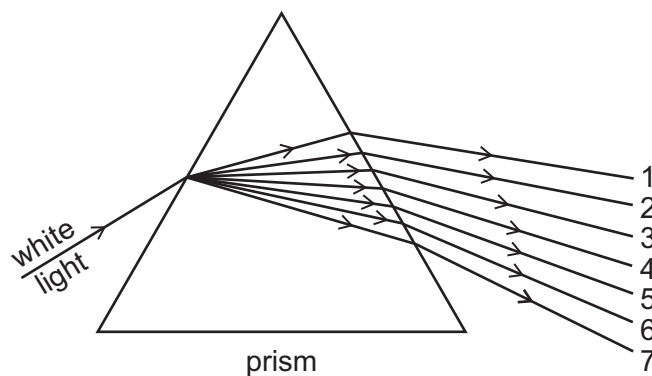


Fig. 10.2

Complete Table 10.1 to identify the seven colours.

Table 10.1

ray number	colour observed
1	
2	
3	
4	
5	
6	
7	

[2]





(d) Fig. 10.3 shows a spacecraft on a rocket about to be launched.

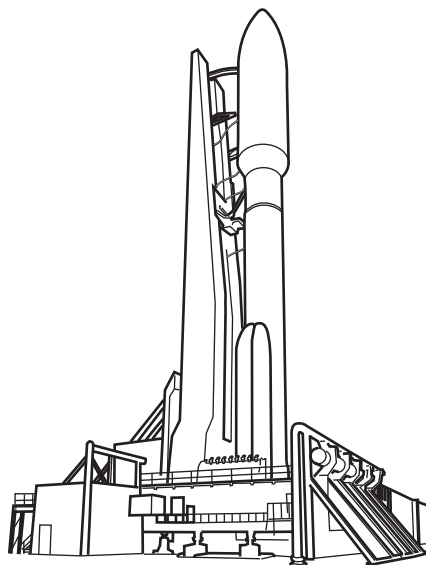


Fig. 10.3

- (i) The weight of the spacecraft and the rocket is 6 000 000 N.

When the rocket engines start to operate, the upward force exerted by the rocket engines is 9 000 000 N.

Calculate the resultant upward force on the spacecraft and the rocket.

resultant force = ..... N [1]

- (ii) The rocket accelerates as it leaves the ground.

State what is meant by accelerate.

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

- (iii) State **two** energy stores in which the energy stored is increasing as the rocket accelerates upwards.

1 .....

2 .....

[2]

[Total: 13]







- 11 (a) Fig. 11.1 shows an elephant pushing a tree trunk along at a constant speed. The elephant exerts a constant force of 1500 N to move the tree trunk 20 m in the direction of the force.

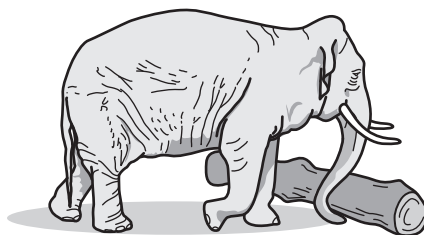


Fig. 11.1

- (i) Calculate the work done by the elephant when the tree trunk is moved 20 m.

work done = .....

unit ..... [3]

- (ii) The elephant stands with all four feet on the ground.  
The area of each foot in contact with the ground is  $0.070 \text{ m}^2$ .  
The weight of the elephant is 36 000 N.

Calculate the pressure exerted on the ground due to the elephant.

pressure = .....  $\text{N/m}^2$  [3]





- (b) Table 11.1 shows the highest- and lowest-frequency sounds that four animals are able to hear.

**Table 11.1**

animal	highest frequency / Hz	lowest frequency / Hz
bat	110 000	2000
dog	50 000	50
elephant	12 000	5
mouse	100 000	1000

- (i) State which animal in Table 11.1 has the smallest audible frequency range.

..... [1]

- (ii) State the approximate range of frequencies audible to humans.

from ..... Hz to ..... Hz [1]

[Total: 8]



12 Fig. 12.1 shows a refrigerator.

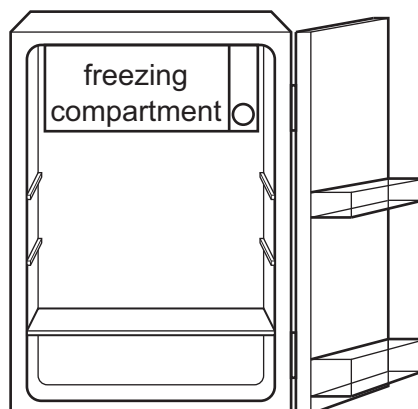


Fig. 12.1

- (a) The air inside the refrigerator is cooled by a freezing compartment.

On Fig. 12.1 draw **one** straight arrow to show the movement of the cooled air inside the refrigerator. [1]

- (b) Some ice is made from water in the freezing compartment.

- (i) State the freezing point of water.

freezing point = ..... °C [1]

- (ii) Complete the diagrams in Fig. 12.2 to show the arrangement of water molecules in liquid water and in solid ice.

One molecule has been drawn for you in each box.

Each box must contain at least 9 molecules.

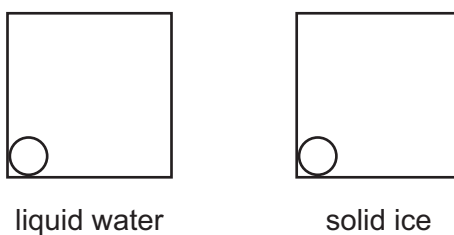


Fig. 12.2

[2]





(c) The refrigerator uses electricity to:

- power two lamps connected in series inside the refrigerator
- power an electric motor connected in parallel with the two lamps.

(i) Complete the circuit diagram in Fig. 12.3 for the refrigerator.

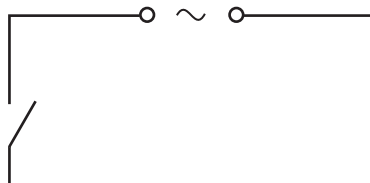


Fig. 12.3

[3]

(ii) One of the lamps has a resistance of  $6000\ \Omega$  and the other lamp has a resistance of  $3000\ \Omega$ .

Calculate the combined resistance of the two lamps connected in series.

combined resistance = .....  $\Omega$  [1]

[Total: 8]

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The Periodic Table of Elements

Group																							
I	II											III	IV	V	VI	VII	VIII						
		<div>Key</div> <div>atomic number atomic symbol name relative atomic mass</div>										<div>1 H hydrogen 1</div>											
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	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 —	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 —						

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
	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<sup>3</sup> at room temperature and pressure (r.t.p.).

