



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/31

May/June 2023

1 hour 15 minutes

No additional materials are needed.

- 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.

- 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. Any blank pages are indicated.

- 1 (a) Fig. 1.1 shows the parts of an insect-pollinated flower.

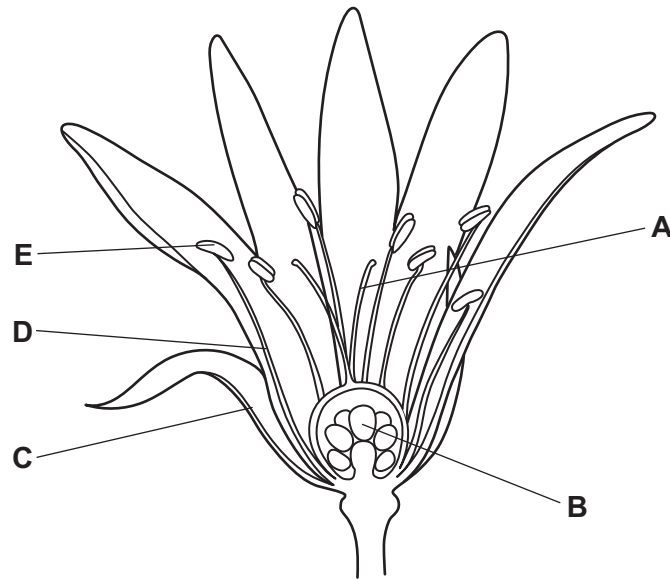


Fig. 1.1

- (i) State the letter in Fig. 1.1 that identifies the:
 sepal
 part where fertilisation occurs.
- (ii) State the **two** letters in Fig. 1.1 that identify the parts of the stamen.
 and

[2]

[1]

- (b) Table 1.1 shows some information about the germination of seeds from different plants.

Table 1.1

plant seed	temperature range for germination / °C	number of days seeds take to germinate
bean	16 – 30	6 – 8
lettuce	2 – 21	3 – 5
onion	10 – 35	6 – 8
pea	4 – 24	6 – 8
pumpkin	21 – 32	4 – 6

- (i) State the **minimum** number of days it takes for **all** of the seeds in Table 1.1 to germinate.

..... [1]

- (ii) All the seeds are planted at a temperature of 18 °C.
After 10 days one type of plant seed did **not** germinate.

Use Table 1.1 to identify the type of plant seed that did not germinate.
Give a reason for your answer.

plant seed

reason

..... [2]

- (iii) A suitable temperature is one environmental condition required for germination.

State one **other** environmental condition required for germination.

..... [1]

- (c) When seeds germinate, the roots show gravitropism.

Complete the sentence to define gravitropism.

Gravitropism is a response in which plants grow towards or away from [1]

[Total: 8]

- 2 A student measures the melting point of some salty water and some pure water.

The results are shown in Table 2.1.

Table 2.1

	melting point /°C
salty water	–5
pure water	0

- (a) (i) State the name of **one** piece of apparatus that is used to measure temperature.

..... [1]

- (ii) State whether melting is a chemical change or a physical change.

Give a reason for your answer.

change

reason

..... [1]

- (iii) The student also measures the boiling point of the two liquids.

State whether melting and boiling are endothermic or exothermic changes.

melting

boiling

[1]

- (b) Salty water contains salt dissolved in water.

State the method used to obtain pure water from salty water.

Explain your answer.

method

explanation

.....

.....

[2]

- (c) Pure water exists as a solid, as a liquid or as water vapour (a gas).

Complete Table 2.2 to describe the structure of solid water, liquid water and water vapour.

Table 2.2

	particle arrangement	particle separation	particle motion
solid water		close together	
liquid water			moving around
water vapour	random		

[3]

- (d) (i) Salt is a compound that is formed when atoms of sodium lose electrons and atoms of chlorine gain electrons.

State the name of the type of chemical bonding in sodium chloride.

..... [1]

- (ii) Water is a compound that is formed when hydrogen and oxygen, both non-metals, share electrons.

State the type of chemical bonding in water.

..... [1]

[Total: 10]

- 3 Fig. 3.1 shows a group of people keeping warm by a campfire and playing musical instruments.



Fig. 3.1

- (a) State the process that causes the hot smoke to move upwards from the fire.

..... [1]

- (b) A kettle filled with water is heated on the fire until it boils.

State the temperature of pure water when it is boiling.

temperature °C [1]

- (c) The air around the people is very cold.

- (i) State the process by which energy from the fire warms the people.

..... [1]

- (ii) State the part of the electromagnetic spectrum that transfers this energy.

..... [1]

- (d) The people play musical instruments.

Table 3.1 shows the frequency ranges of the instruments they play.

Table 3.1

instrument	frequency range / Hz
clarinet	164 – 1567
flute	261 – 3349
French horn	110 – 880
guitar	82 – 880
trombone	85 – 493
trumpet	164 – 987
violin	196 – 3136

- (i) Identify the instrument that can produce:

the note with the lowest pitch

the widest range of frequencies.

[2]

- (ii) A bat flies past the campfire. The hearing range of the bat is from 2 kHz to 110 kHz.

State which **two** musical instruments can be heard by the bat.

..... and [1]

- (e) A person at the campfire makes a mobile phone (cell phone) call.

State the part of the electromagnetic spectrum used to transmit the call using a mobile phone.

..... [1]

[Total: 8]

- 4 (a) Fig. 4.1 shows a model of the human gas exchange system.

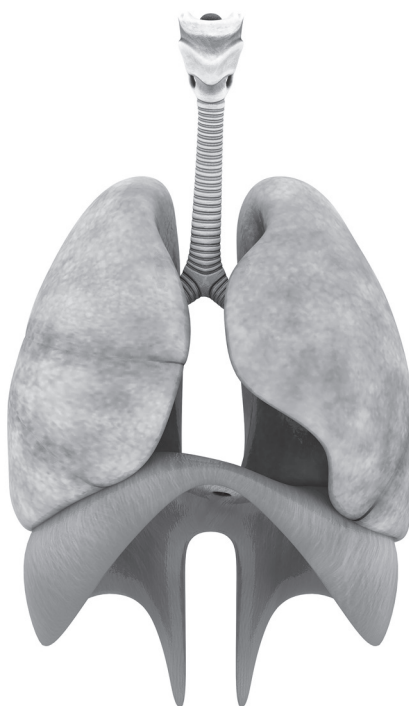


Fig. 4.1

Draw a label line and the letter **D** to identify the diaphragm on Fig. 4.1. [1]

- (b) A student investigates the composition of expired air.

The student blows expired air into a test-tube containing limewater. The limewater turns cloudy.

State the name of the gas that turns the limewater cloudy.

..... [1]

- (c) The gas exchange system is required for aerobic respiration.

State the word equation for aerobic respiration.

..... [2]

(d) The gas taken in by the lungs is transported around the body by the circulatory system.

(i) Complete the sentences about the circulatory system.

Use words from the list.

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

artery	capillary	platelets
red blood cells	white blood cells	vein

Blood is transported from the lungs to the heart in the pulmonary

The blood then leaves the heart in the main called the aorta.

Oxygen from the lungs is transported in the of the blood.
[3]

(ii) State **two** ways the structure of a capillary is different from a vein.

1

2
[2]

[Total: 9]

- 5 (a) Ethane, C_2H_6 , is an alkane. It is one of the saturated hydrocarbons present in refinery gas obtained from petroleum, as shown in Fig. 5.1.

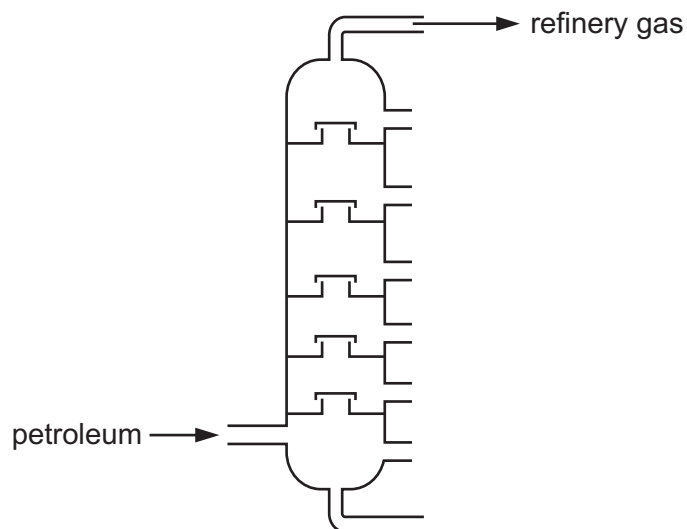


Fig. 5.1

- (i) State **one** use of refinery gas.

..... [1]

- (ii) Explain what is meant by hydrocarbon and saturated.

hydrocarbon

.....

saturated

.....

[2]

(b) Ethene, C_2H_4 , is an unsaturated hydrocarbon.

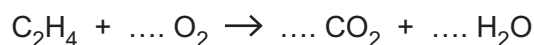
(i) State the process that produces unsaturated hydrocarbons from petroleum fractions.

..... [1]

(ii) Describe the change in colour of aqueous bromine when it is added to ethene.

from to [1]

(iii) Complete the balanced equation for the complete combustion of ethene.



[2]

(iv) State the name of the substance that is formed when many ethene monomer units join together.

..... [1]

[Total: 8]

- 6 Figure 6.1 shows a moving conveyor belt carrying a box from the ground up to an aircraft. The box weighs 500 N.

NOT TO
SCALE

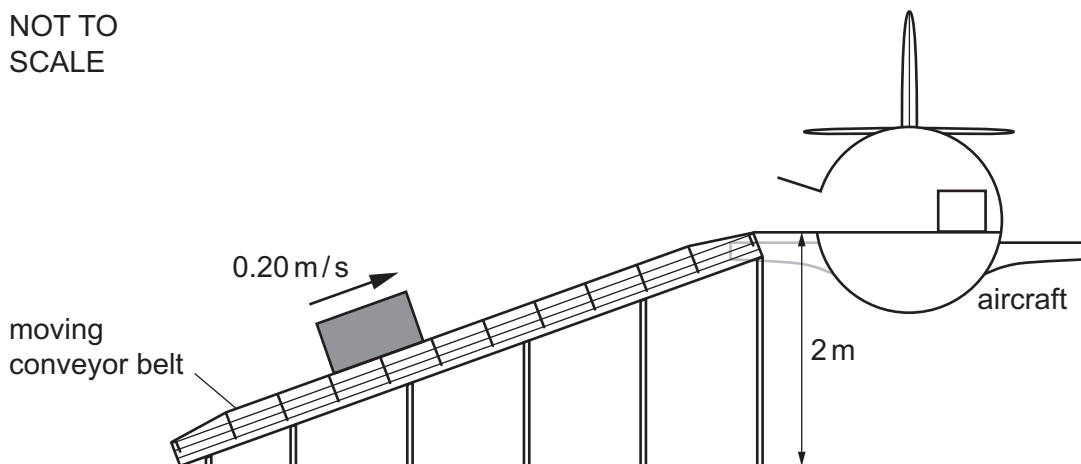


Fig. 6.1

- (a) (i) On Fig. 6.1, draw a force arrow to show the weight of the box. The arrow must be in contact with the box. [1]

- (ii) Complete the sentence.

The weight of the box is due to the force acting on the box. [1]

- (b) The conveyor belt carries the box at 0.20 m/s from the ground to the top in 25 s.

Calculate the length of the conveyor belt from the ground to the top.

length = ... m [2]

- (c) An electric motor drives the conveyor belt. Complete the sentences to describe the useful energy transfers.

The energy input to move the conveyor belt is energy.

This is transferred to energy of the moving conveyor belt and the box.

When the box stops at the top, it has gained energy. [3]

- (d) The conveyor belt stops for a short time when the box is only half-way to the top. The box stays at rest on the conveyor belt.

Explain in terms of the forces acting on the box, why the box stays at rest.

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

- (e) When the box reaches the top, the box is stationary in the aircraft.

As a result of the work done, the box gains a total of 2.5 kJ of energy.

The total energy input to the electric motor doing this work is 90 kJ.

Explain the difference between these figures.

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

[Total: 9]

- 7 (a) The leaves of some plants have green and white areas. Only the green areas of the leaf contain chlorophyll.

Fig. 7.1 shows a green and white leaf.

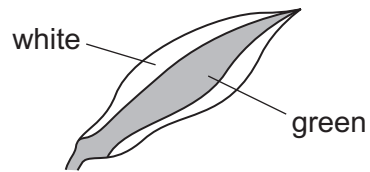


Fig. 7.1

Glucose from photosynthesis is stored as starch where it is made.

The leaf in Fig. 7.1 is tested for the presence of starch using iodine solution.

Fig. 7.2 shows some possible results.

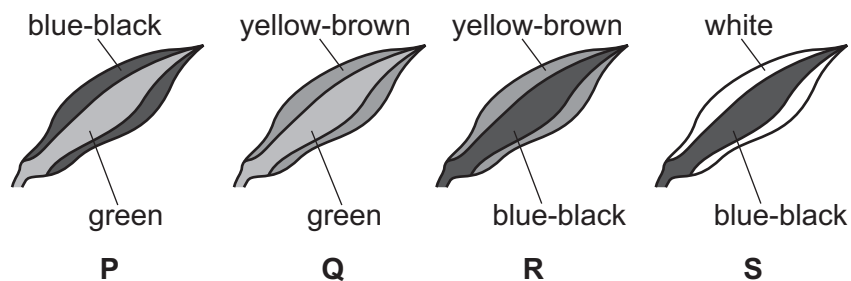


Fig. 7.2

- (i) Identify the letter of the correct result of the starch test in Fig. 7.2.

Give a reason for your answer.

letter

reason

.....

.....

[2]

- (ii) State the mineral ion needed by plants to keep leaves green.

..... [1]

(b) Transpiration involves the loss of water from leaves.

Tick (✓) **two** correct statements about transpiration.

Water evaporates from the surface of mesophyll cells.	
Water evaporates from the surface of cortex cells.	
Water evaporates from the surface of stomata.	
Water vapour diffuses through mesophyll cells.	
Water vapour diffuses through cortex cells.	
Water vapour diffuses through stomata.	

[2]

(c) The information in Fig. 7.3 describes some feeding relationships of living organisms in a habitat.

- | |
|---|
| <ul style="list-style-type: none"> • caterpillars eat flowers • owls eat snakes • frogs eat caterpillars • snakes eat frogs |
|---|

Fig. 7.3

(i) Draw a food chain using **all** the living organisms in Fig. 7.3.

..... [2]

(ii) Identify the **tertiary** consumer in Fig. 7.3.

..... [1]

(d) Two characteristics of living organisms are nutrition and respiration.

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

1

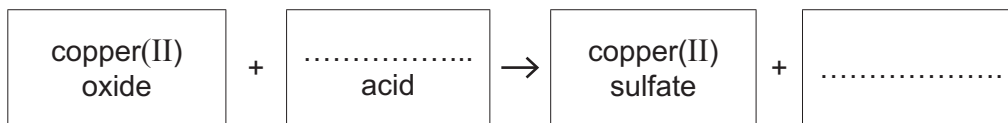
2

[2]

[Total: 10]

8 Copper(II) sulfate, CuSO_4 , can be made by reacting copper(II) oxide, CuO , with a dilute acid.

(a) (i) Complete the word equation for the formation of copper(II) sulfate from copper(II) oxide.



[1]

(ii) State **two** ways of increasing the rate of this reaction.

1

2

[2]

(b) (i) State the colour observed in the flame test of copper(II) ions, Cu^{2+} .

..... [1]

(ii) State the test for sulfate ions and the observation for a positive result.

test

.....

observation

[2]

(c) Copper atoms can have different numbers of neutrons.

One atom of copper is represented as shown.



Deduce the number of electrons and neutrons in this atom.

electrons

neutrons

[2]

[Total: 8]

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- 9 Fig. 9.1 shows a student using a laptop computer. There is a lamp beside the student.



Fig. 9.1

- (a) The student sees the light from the lamp reflected in the computer screen.
Fig. 9.2 is a diagram of the student, lamp and computer from the same viewpoint as Fig. 9.1.

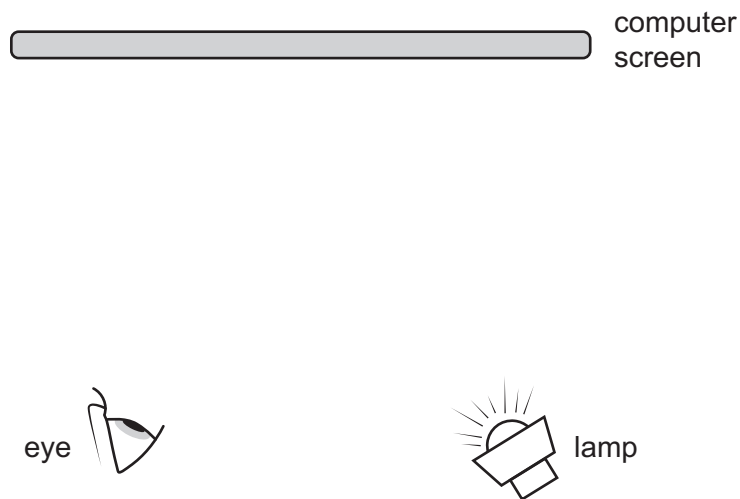


Fig. 9.2

On Fig. 9.2,

- Draw a ray from the lamp to the screen and the reflected ray to the student's eye.
- Draw and label the normal at the point of reflection.
- The ray you draw should follow the law of reflection at the screen.

[3]

- (b) The lamp is connected to the laptop computer by a cable with a switch. This supplies power to the lamp circuit at 5.0V.
The total resistance of the lamp circuit is 250 Ω .

- (i) Calculate the current in the lamp circuit. Include the unit in your answer.

current = ... unit [3]

- (ii) The lamp circuit consists of a $70\ \Omega$ resistor and an LED (light-emitting diode) in series with the power supply.

Calculate the resistance of the LED.

resistance = ... Ω [2]

- (c) Use information from (b) to complete the circuit diagram for the lamp circuit. Draw the correct circuit symbols on Fig. 9.3.

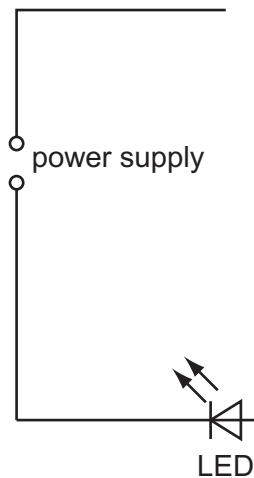


Fig. 9.3

[2]

[Total: 10]

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The Periodic Table of Elements

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3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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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 dm³ at room temperature and pressure (r.t.p.).



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0653/32

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[Turn over

- 1 (a) Fig. 1.1 is a diagram of a human heart.

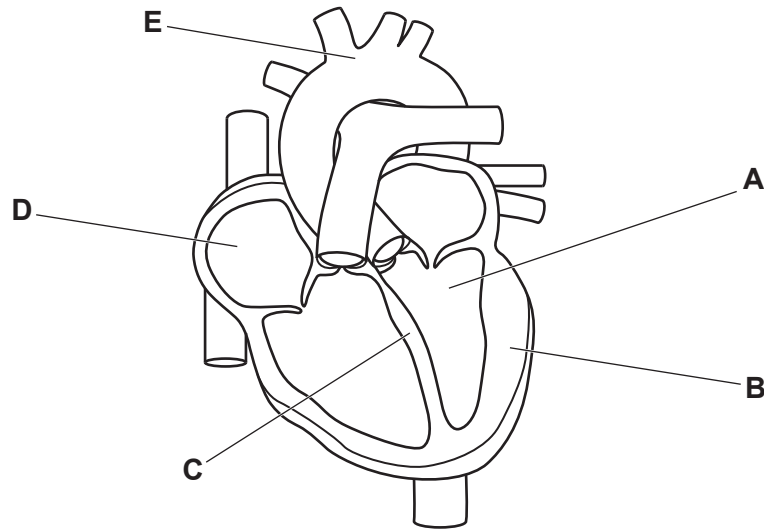


Fig. 1.1

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

right atrium

septum

[2]

- (ii) Part **E** in Fig. 1.1 transports blood to the body.

Circle the name of part **E**.

aorta

coronary artery

pulmonary artery

vena cava

[1]

- (b) A student investigates how their pulse rate changes during different types of physical activity. The pulse rate is measured in beats per minute (bpm).

Fig. 1.2 is a bar chart showing the results.

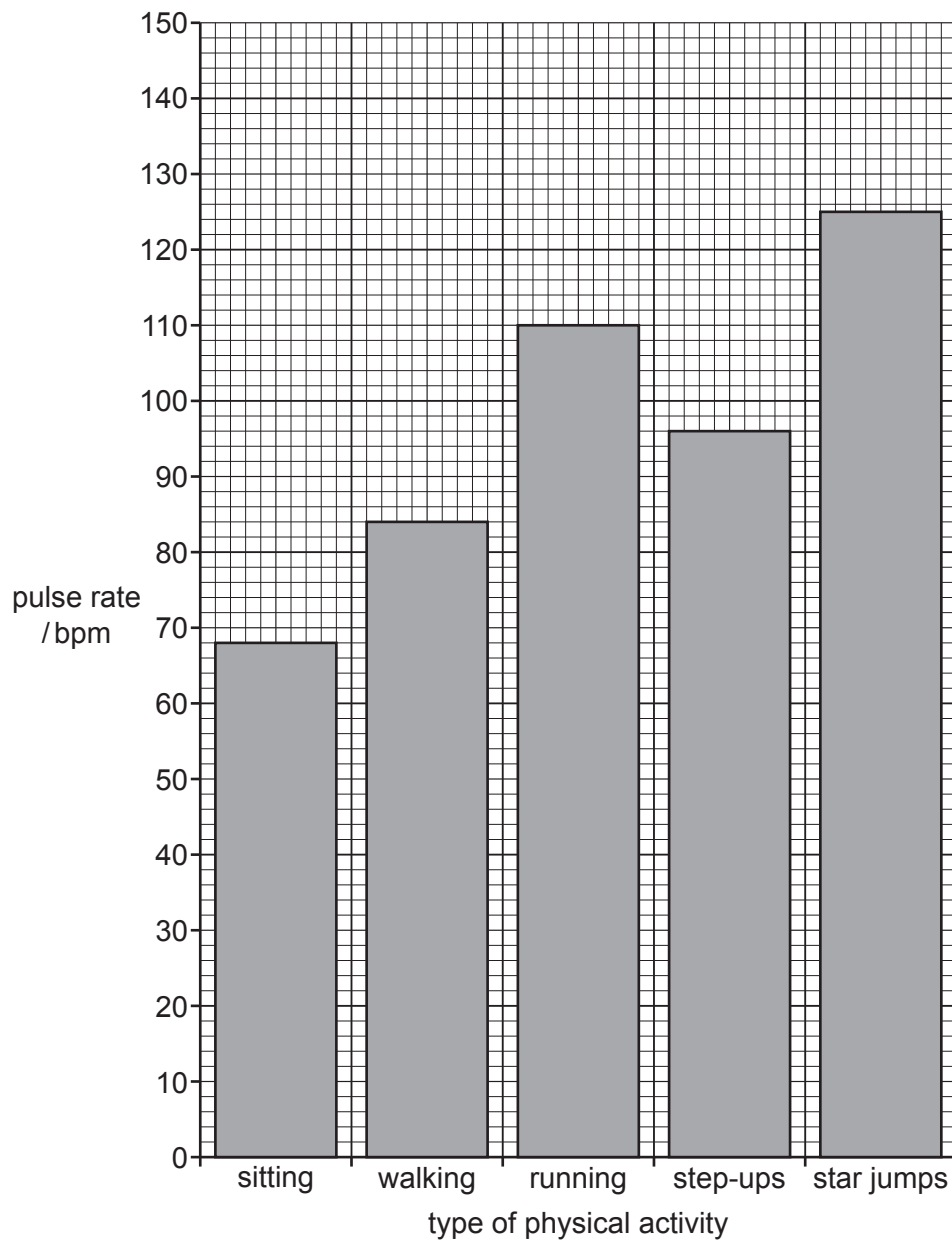


Fig. 1.2

- (i) Identify the type of physical activity in Fig. 1.2 where the pulse rate is the highest.

..... [1]

(ii) Calculate the difference in pulse rate between running and step-ups.

pulse rate during running bpm

pulse rate during step-ups bpm

difference = ... bpm
[2]

(c) Fig. 1.3 shows a photomicrograph of blood.

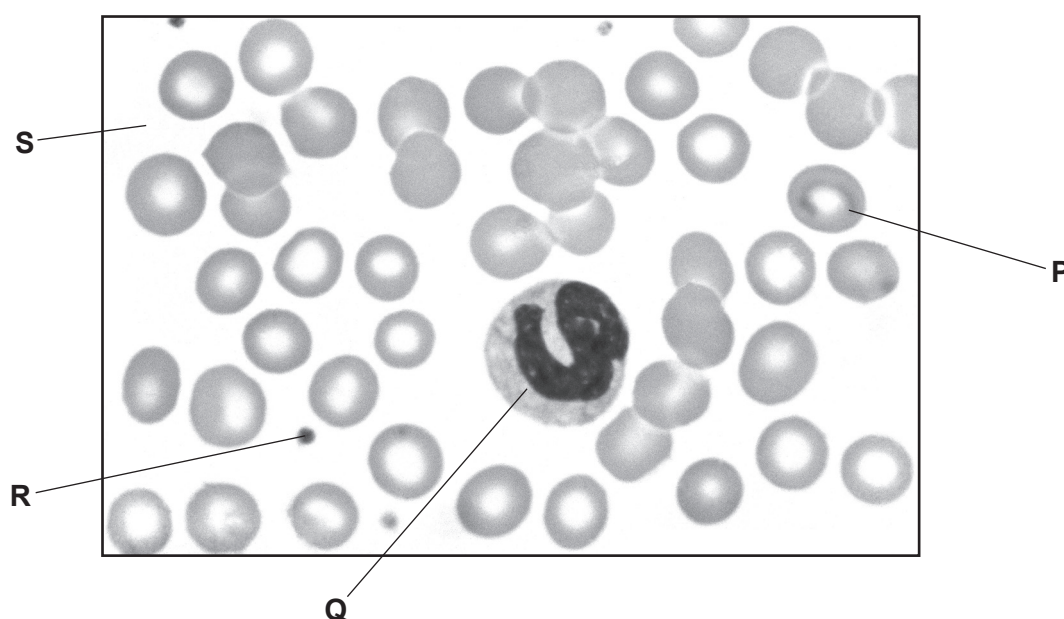


Fig. 1.3

Table 1.1 shows the names and functions of some parts of the blood labelled **P**, **Q**, **R** and **S** in Fig. 1.3.

Complete Table 1.1.

Table 1.1

name of part	letter in Fig. 1.3	function
red blood cell		transport of oxygen
	S	transport of hormones
white blood cell		

[3]

[Total: 9]

2 A student investigates sodium chloride, NaCl .

- (a) The student uses solid sodium chloride to make a concentrated aqueous solution of sodium chloride. The student then uses the apparatus shown in Fig. 2.1 to electrolyse this solution.

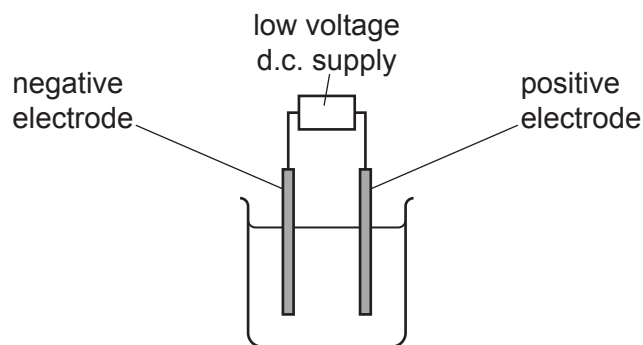


Fig. 2.1

- (i) State what is meant by concentrated and aqueous.

concentrated

.....

aqueous

.....

[2]

- (ii) State the name of the product formed at the positive electrode.

..... [1]

- (iii) State the name of the type of chemical bonding found in compounds that can be electrolysed.

..... [1]

- (b) The student adds aqueous silver nitrate to aqueous sodium chloride under acidic conditions.

State the observation when these two solutions are mixed.

..... [1]

- (c) Aqueous sodium chloride is made when dilute hydrochloric acid is neutralised by aqueous solution **X**, as shown in Fig. 2.2.

The reading on the thermometer increases during the reaction.

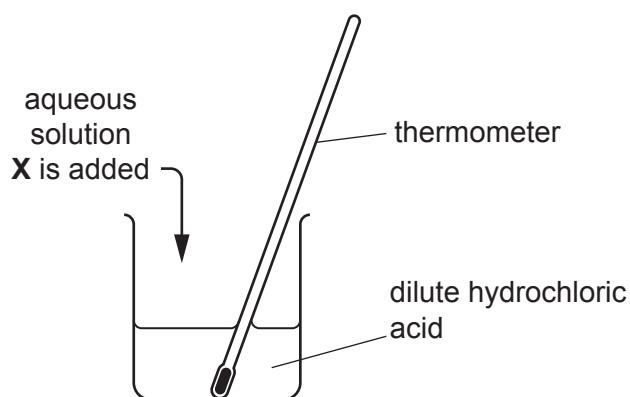


Fig. 2.2

- (i) Suggest the identity of **X**.

..... [1]

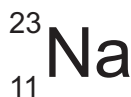
- (ii) State what happens to the pH of the mixture when **X** is added.

..... [1]

- (iii) State the type of chemical reaction that causes the reading on the thermometer to increase.

..... [1]

- (d) An atom of sodium is represented as shown.



Deduce the number of electrons and neutrons in this atom.

number of electrons = ...

number of neutrons = ...

[2]

[Total: 10]

- 3 Fig. 3.1 shows a speed–time graph for a car on part of a journey along a road.

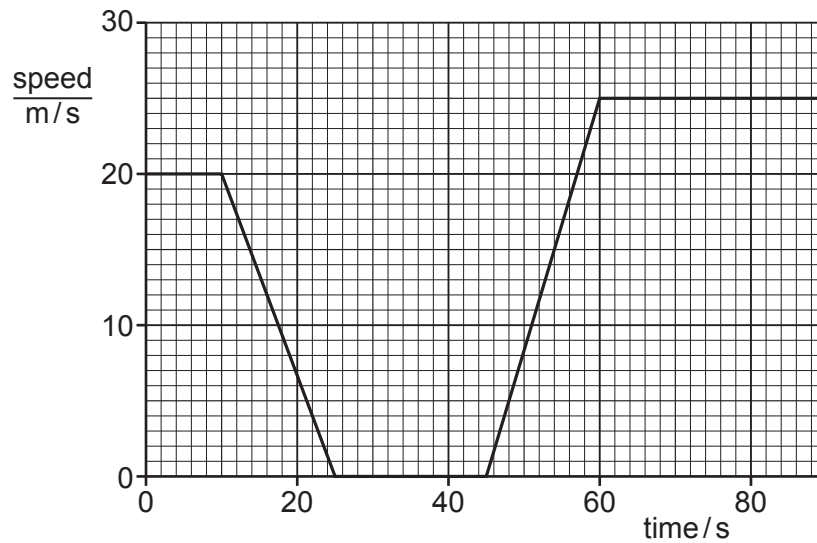


Fig. 3.1

- (a) (i) Deduce the time interval for which the car is moving at a constant speed of 20 m/s.

time interval = ... s [1]

- (ii) During the journey the car stops at traffic lights.

Deduce the time interval for which the car stops at the traffic lights.

time interval = ... s [1]

- (iii) On Fig. 3.1, mark with an **X** a point at which the car is decelerating. [1]

- (b) For part of the journey the car is travelling at 25 m/s.

Calculate the speed of the car in km/h.

speed = ... km/h [1]

- (c) In another part of the journey the car travels at a constant speed of 30 m/s for 65 s.

Calculate the distance the car travels in this time interval.

distance = ... m [2]

- (d) At the traffic lights the driver sees a red light. The light contains a lamp and lens.

Fig. 3.2 shows the arrangement of the lamp and the lens. The lamp is at the principal focus of the lens.

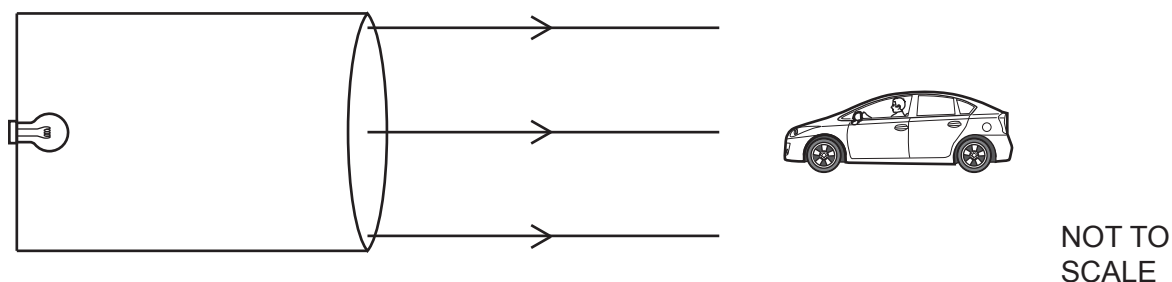


Fig. 3.2

- (i) Complete the sentence.

When light waves pass from air into glass, they can undergo due to a change in the of the waves.

[2]

- (ii) On Fig. 3.2, complete the **three** rays emitted by the traffic light to show how they reach the lens from the lamp. [1]

[Total: 9]

4 (a) A student investigates photosynthesis.

The student:

- adds an indicator solution to three test-tubes, **A**, **B** and **C**
- puts one leaf into test-tube **B** and one leaf into test-tube **C**
- puts a bung into the top of each test-tube
- wraps test-tube **C** with dark card
- places the test-tubes in a warm room with plenty of light for 24 hours.

Fig. 4.1 is a diagram of the test-tubes after 24 hours.

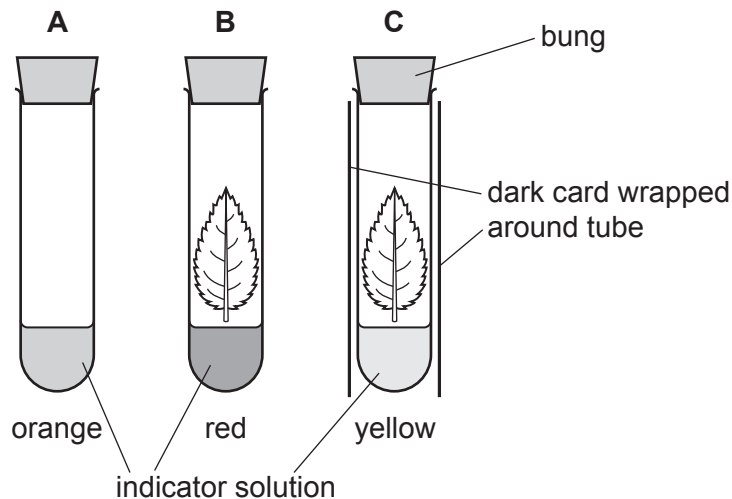


Fig. 4.1

The colour of the indicator solution shows the concentration of carbon dioxide in the test-tube.

- red = low carbon dioxide concentration
- orange = medium carbon dioxide concentration
- yellow = high carbon dioxide concentration

Explain the results for test-tubes **B** and **C**.

Use the words photosynthesis and respiration in your answer.

test-tube **B**

.....

.....

test-tube **C**

.....

.....

.....

[3]

(b) Fig. 4.2 shows a photomicrograph of cells in the lower epidermis of a leaf.

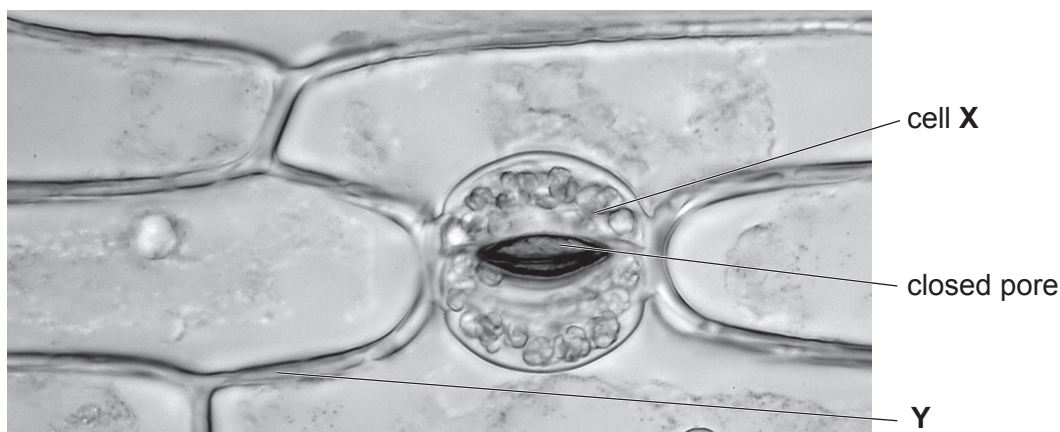


Fig. 4.2

(i) State the function of the structure labelled **Y** in Fig. 4.2.

..... [1]

(ii) Complete the sentences about Fig. 4.2.

Use words from the list.

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

air	guard	mesophyll	liquid
minerals	palisade	stomata	water

Cell **X** is called a cell.

Cell **X** changes shape to control the size of the pore.

The pores in leaves are called

The pores open to allow to diffuse out during transpiration. [3]

(iii) State one change to the environmental conditions that would **increase** the rate of transpiration.

..... [1]

(iv) State the name of the vessels that transport water from the roots to the leaf.

..... [1]

[Total: 9]

5 Copper is a transition element.

(a) (i) State **one** physical property and **one** chemical property of copper.

physical property

chemical property

[2]

(ii) Suggest why some coins are made of copper alloy rather than pure copper.

.....

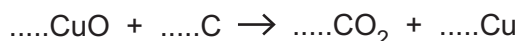
..... [1]

(b) Copper is extracted from copper oxide by heating with carbon.

Aluminium is extracted from aluminium oxide by electrolysis.

Argon, a noble gas, does not react with copper or aluminium.

(i) Complete the balanced equation for the extraction of copper.



[1]

(ii) State whether carbon is oxidised or reduced during the extraction of copper.

Give a reason for your answer.

carbon is

reason

.....

[1]

(iii) State why aluminium cannot be extracted from aluminium oxide by heating with carbon.

.....

..... [1]

(iv) Explain why argon and other noble gases do **not** react with either copper or aluminium.

Use ideas about noble gas electronic structures in your answer.

.....

.....

..... [2]

[Total: 8]

- 6 (a) Moving water has kinetic energy.

State **two** energy resources which supply useful energy from moving water.

1

2

[2]

- (b) Fig. 6.1 shows a borehole drilled into the Earth to obtain energy. This energy is then used to generate electricity.

The temperature of the rock at the top of the borehole and at the bottom of the borehole is shown.

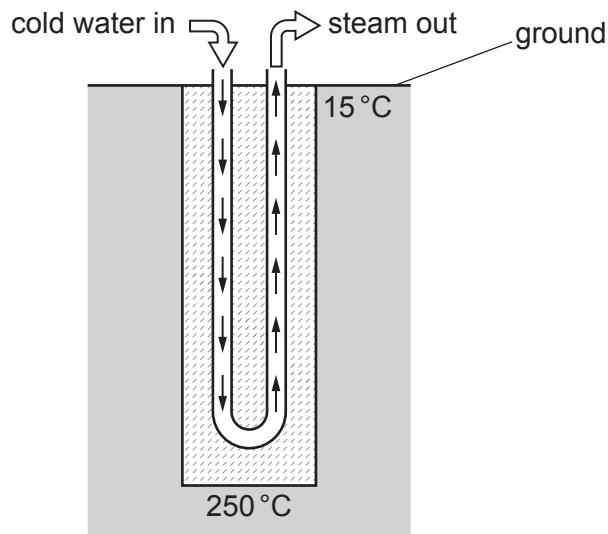


Fig. 6.1

- (i) Calculate the temperature difference between the top and the bottom of the borehole.

temperature difference = ... °C [1]

- (ii) This is an energy resource that uses energy stored in hot rocks below the ground.

State the name of this type of energy resource.

..... [1]

- (iii) Use Fig. 6.1 to describe how the energy is extracted from the borehole and used to generate electrical energy.

.....

.....

.....

.....

..... [3]

(c) Energy is stored in batteries.

(i) State the form of energy stored in a battery.

..... [1]

(ii) Two electric motors do work using energy from batteries.

One of the electric motors does work by lifting a load to a high shelf.

The second electric motor has a lower power output but does the same task.

Complete the sentences.

As the load moves upwards, it has kinetic energy and gains
energy.

The second motor takes to complete the same task.

[2]

[Total: 10]

- 7 (a) Fig. 7.1 shows an incomplete food web.

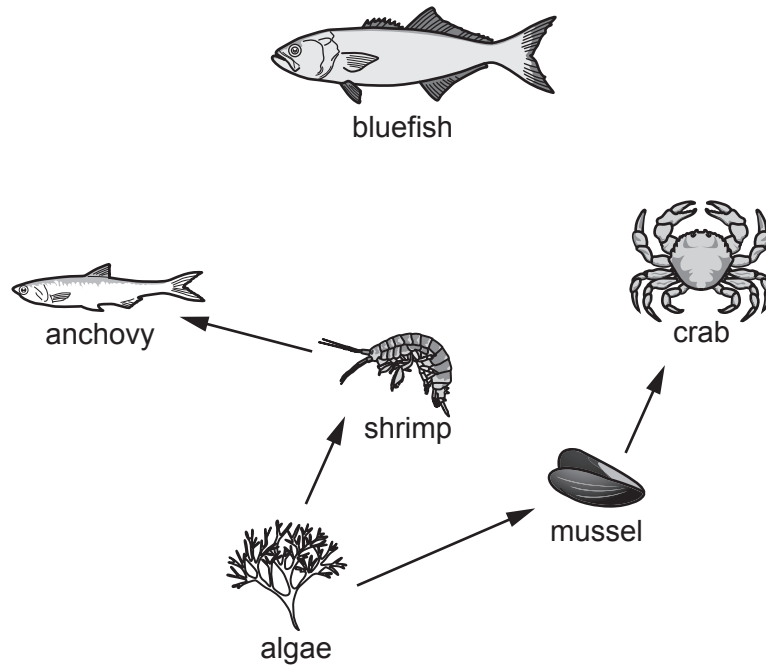


Fig. 7.1

- (i) The bluefish eats the anchovy **and** the shrimp.

Draw **two** arrows on Fig. 7.1 to show these feeding relationships.

[1]

- (ii) Identify **one** primary consumer shown in Fig. 7.1.

..... [1]

- (iii) State the principal source of energy in all food webs.

..... [1]

- (b) Algae reproduce both sexually and asexually.

State **two** ways asexual reproduction is different from sexual reproduction.

1

.....

2

.....

[2]

(c) Bluefish are eaten by humans. They are a source of fats.

(i) State the dietary importance of fats in humans.

..... [1]

(ii) Circle the name of the chemical used in the test for the presence of fats in food.

Benedict's solution

biuret solution

ethanol

iodine solution

[1]

(iii) Fats are digested in the alimentary canal.

Complete the sentences to describe the process of digestion.

Digestion is the breakdown of insoluble food molecules into

..... soluble molecules using mechanical and chemical processes.

Chemical digestion uses a type of protein that functions as a biological catalyst.

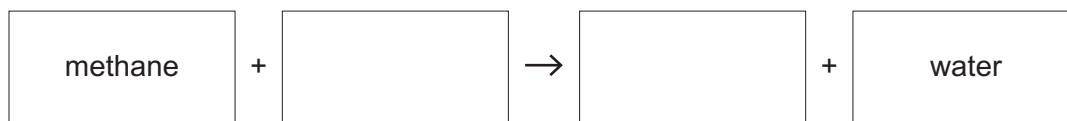
These proteins are called

[2]

[Total: 9]

8 (a) Methane, CH_4 , is the main constituent of natural gas.

(i) Complete the word equation for the complete combustion of methane.



[1]

(ii) Complete the dot-and-cross diagram in Fig. 8.1 to show the arrangement of electrons in a molecule of water.

Show only the outer shell electrons.

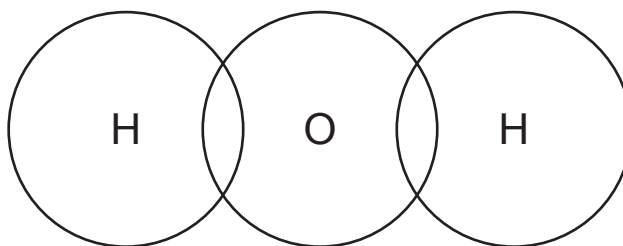


Fig. 8.1

[2]

(b) Ethene is an unsaturated hydrocarbon.

Aqueous **Y** is an orange solution that is decolourised by ethene. It is used as a test for ethene.

(i) State what is meant by unsaturated.

.....
 [1]

(ii) Identify **Y**.

..... [1]

(iii) State the type of polymerisation that produces poly(ethene) from ethene.

..... [1]

(c) At -120°C methane is a gas and ethene is a liquid.

Describe **two** differences between the particles in a gas and a liquid.

1

.....

2

.....

[2]

[Total: 8]

- 9 Fig. 9.1 shows an electrical circuit.

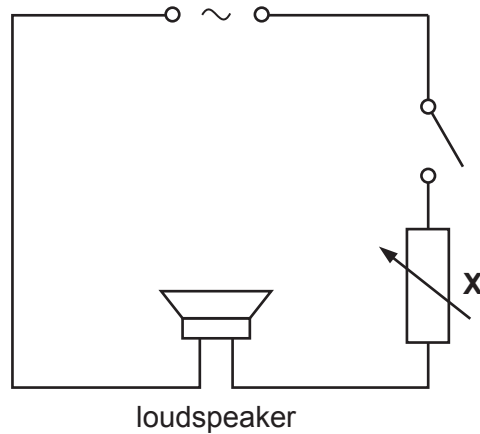


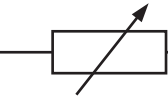
Fig. 9.1

- (a) The potential difference across the loudspeaker is 9 V.
The current in the loudspeaker is 1.5 A.

Calculate the resistance of the loudspeaker.

Give the unit of your answer.

resistance = ... unit [3]

- (b) (i) State the name of component **X** with the symbol . [1]

..... [1]

- (ii) Increasing the current in the loudspeaker increases the loudness.

Explain why increasing the resistance of component **X** decreases the loudness of the sound emitted.

..... [1]

- (iii) The loudness of the sound emitted decreases.

State the property of the sound waves that changes.

..... [1]

- (c) A lamp is added to the circuit in parallel with the loudspeaker to show when the loudspeaker is switched on.

The lamp is connected so that it is not affected by altering the resistance of component **X**.

On Fig. 9.2, add the lamp to the circuit diagram, using the circuit symbol for a lamp.

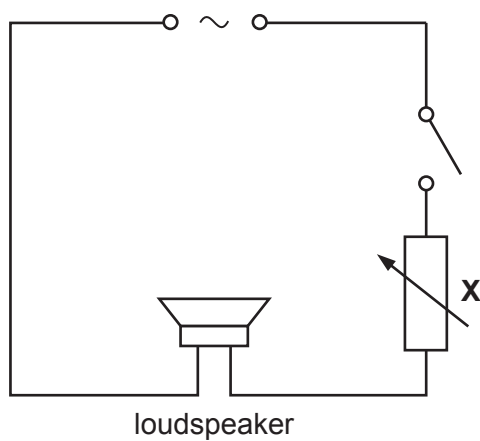


Fig. 9.2

[2]

[Total: 8]

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The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										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 —		

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 dm³ at room temperature and pressure (r.t.p.).

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COMBINED SCIENCE

0653/33

Paper 3 Theory (Core)

May/June 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. Any blank pages are indicated.

- 1 (a) The boxes on the left show different characteristics of living organisms.

The boxes on the right show descriptions of the characteristics.

Draw **one** straight line from each characteristic to its description.

characteristic	description
growth	action that causes a change in position
movement	detect and respond to changes in the environment
nutrition	permanent increase in size
	taking in materials for energy

[3]

- (b) Living organisms are made up of small basic units surrounded by membranes.

Fig. 1.1 represents photomicrographs of two of these small basic units.

A is found in human blood. **B** is found in a plant.

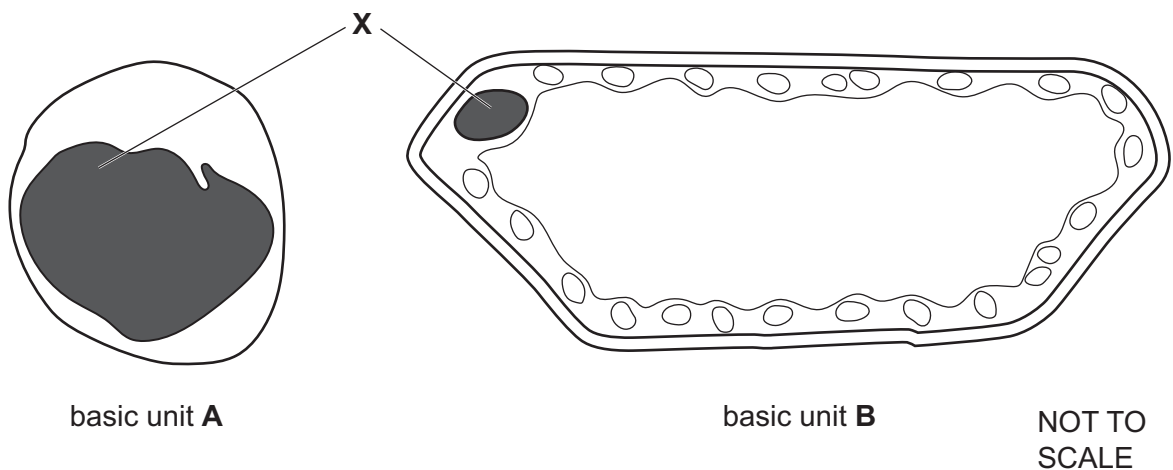


Fig. 1.1

- (i) Circle the **one** word that is the name for the basic units of a living organism.

cells organs proteins stomata

[1]

- (ii) Identify the structure labelled **X** in Fig. 1.1.

..... [1]

- (iii) Basic unit **B** is from the leaf of a plant.

Identify **two** structures that show basic unit **B** is from a plant.

1

2 [2]

- (c) A student investigates the effect of immersing potato tissue in sugar solutions of different concentrations.

The student:

- measures the mass of potato tissue at the start
- measures the mass of potato tissue after 1 hour in sugar solution.

Table 1.1 shows some of the results.

Table 1.1

sugar solution	mass of potato tissue at start /g	mass of potato tissue after 1 hour /g	change in mass /g
A	1.9	2.0	0.1
B	1.8	1.8	0.0
C	1.9	1.7	-0.2
D	1.8	1.5	-0.3
E	1.8	1.3	-0.5

- (i) Suggest which solution **A**, **B**, **C**, **D** or **E** has the greatest concentration of sugar.
Give a reason for your answer.

solution

reason [2]

- (ii) Suggest why the potato in solution **B** does **not** change in mass.

.....

..... [1]

- (iii) The potato tissue changes mass because a substance moves across the cell membrane.

State the name of this substance.

..... [1]

[Total: 11]

- 2 A student investigates the combustion of natural gas, as shown in Fig. 2.1.

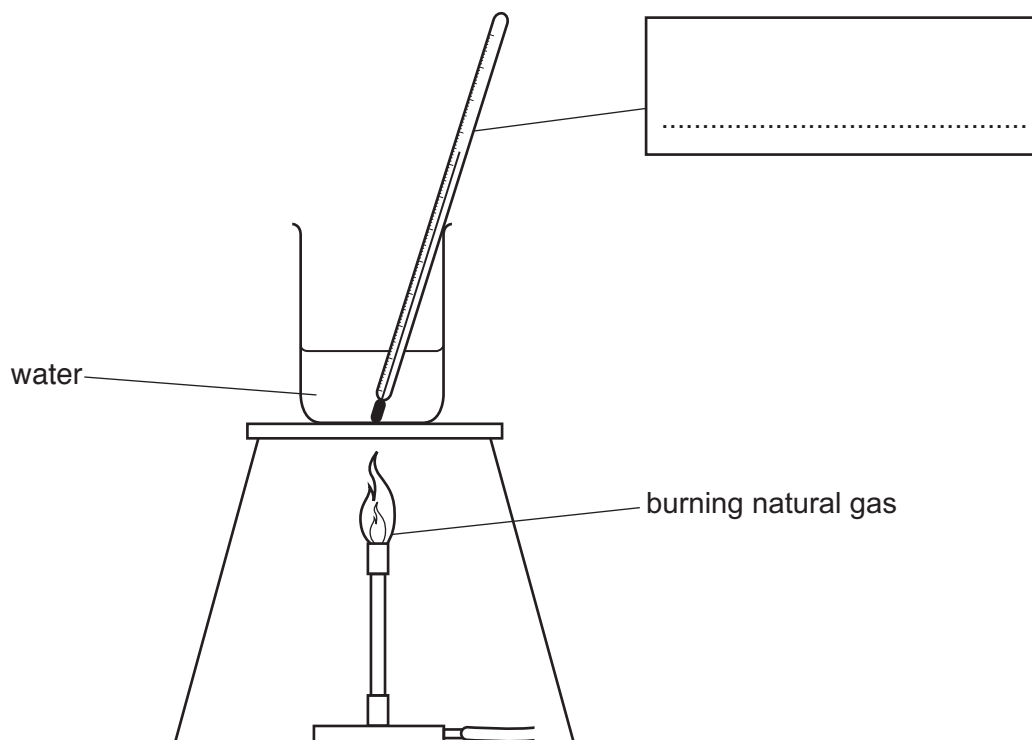


Fig. 2.1

- (a) The student measures the temperature of the water as the natural gas burns.
- (i) Complete Fig. 2.1 by labelling the apparatus that is used to measure temperature. [1]
- (ii) State the name of the hydrocarbon that is the main constituent of natural gas. [1]
-
- (iii) State what is meant by hydrocarbon. [1]
-
-
- (b) During this investigation, the combustion of natural gas causes the temperature of the water in the beaker to increase.
- State the name of the type of chemical reaction that causes an increase in temperature. [1]
-

(c) One of the products of the combustion of natural gas is carbon dioxide, CO_2 .

(i) Explain why this combustion reaction is a redox reaction.

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

(ii) State the type of chemical bond formed in a molecule of carbon dioxide.

..... [1]

(iii) Describe a test for carbon dioxide and state the observation for a positive result.

test

.....

observation [2]

[Total: 8]

3 Fig. 3.1 shows a football player kicking a football.



Fig. 3.1

(a) Fig. 3.2 shows a speed–time graph for the horizontal motion of the ball after leaving the player's foot.

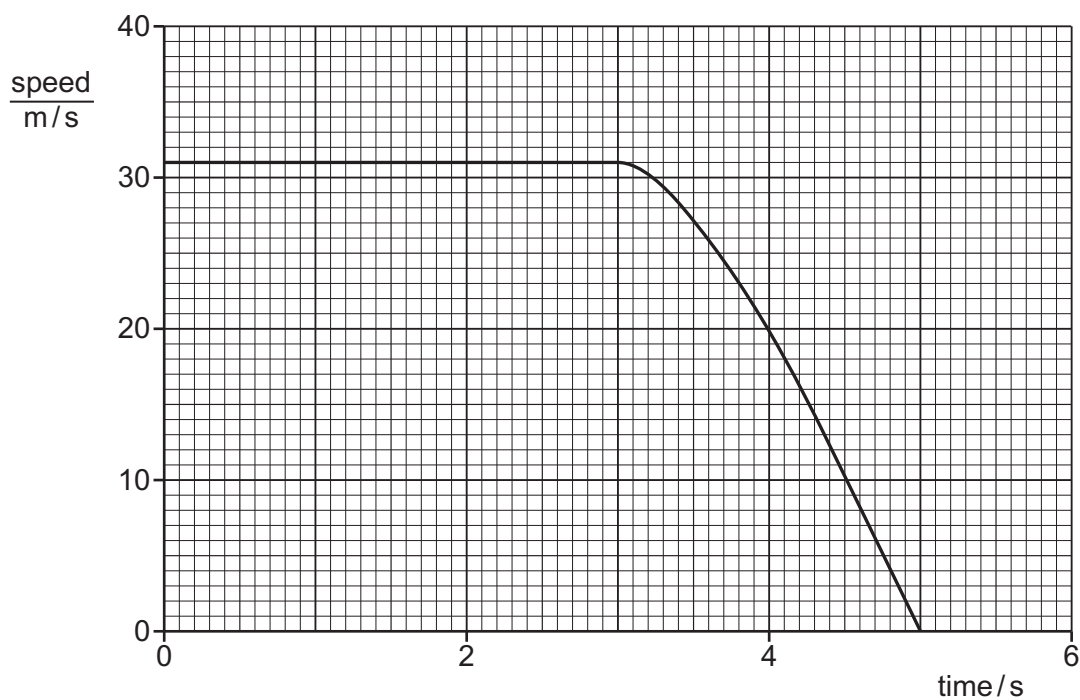


Fig. 3.2

(i) State the horizontal speed of the ball as it leaves the player's foot.

speed = ... m/s [1]

(ii) The ball hits the ground and rolls forwards before it stops. On Fig. 3.2, mark with an **X** a time when the ball is decelerating. [1]

(iii) Explain why the horizontal speed of the ball does **not** increase after leaving the player's foot.

.....
 [1]

- (b) Fig. 3.3 shows the player holding the football on his hand without the ball moving.

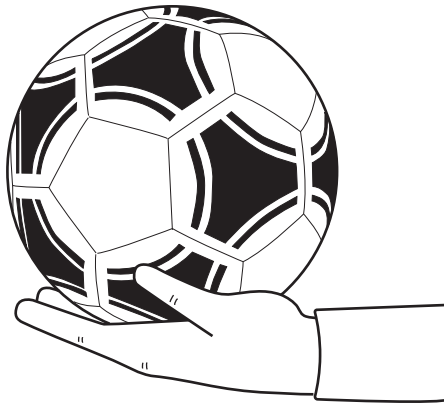


Fig. 3.3

The player uses an upward force of 4.0 N to hold the ball stationary.

Calculate the mass of the ball.

The gravitational force on unit mass is 10 N/kg .

mass = ... kg [2]

- (c) The mass of another ball is 150 g . The ball has a volume of 180 cm^3 .

Calculate the density of the ball. Give the units of your answer.

density = ... units [3]

[Total: 8]

- 4 (a) Fig. 4.1 is a diagram of the alimentary canal and associated organs.

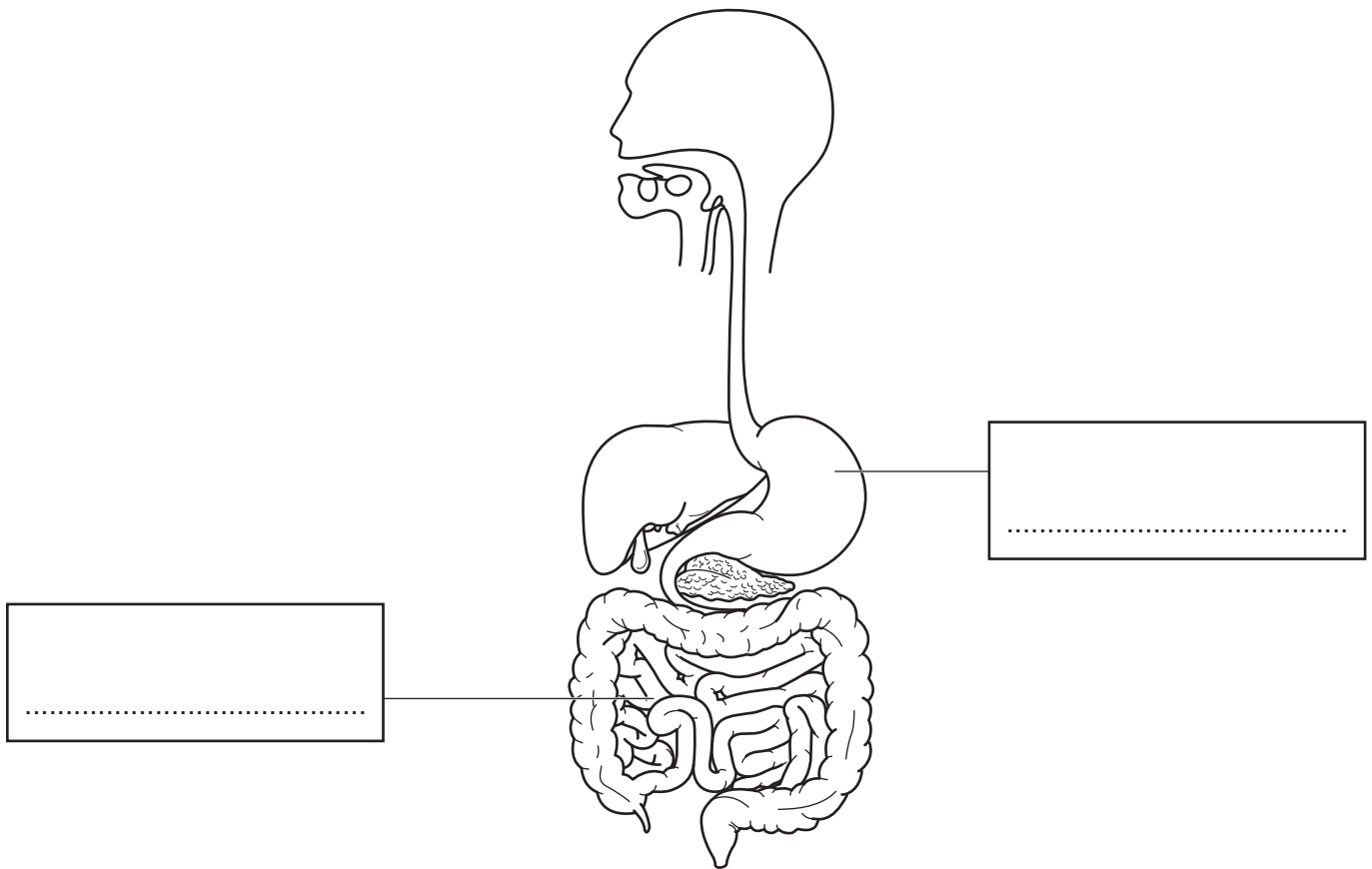


Fig. 4.1

- (i) Complete the labels in Fig. 4.1 with the names of the parts shown. [2]
- (ii) Draw a label line and the letter **G** to identify the gall bladder on Fig. 4.1. [1]
- (b) Blood transports digested food away from the alimentary canal.
- (i) State the name of the component of blood that transports the digested food.
 [1]
- (ii) State the name of the main blood vessel that transports blood back to the heart from all the organs in the body.
 [1]

(c) Males and females have different reproductive systems.

(i) The urethra and penis are part of the male reproductive system in humans.

State the names of two **other** parts of the male reproductive system in humans.

1

2

[2]

(ii) The uterus is one part of the female reproductive system in humans.

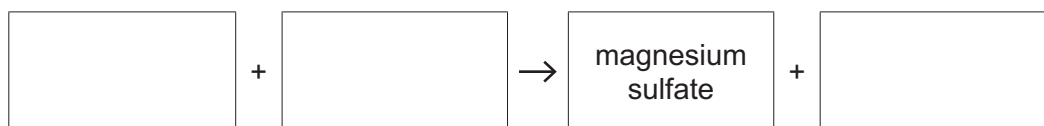
Describe what happens to the lining of the uterus between day 0 and day 5 of the menstrual cycle.

..... [1]

[Total: 8]

5 Magnesium sulfate is produced by reacting excess magnesium oxide with dilute sulfuric acid.

(a) Complete the word equation for this reaction.



[2]

(b) A coloured aqueous solution is used to measure the pH of dilute sulfuric acid.

(i) State the name of the coloured aqueous solution that is used to measure the pH of acids and alkalis.

..... [1]

(ii) Suggest the pH value of dilute sulfuric acid.

..... [1]

(c) Complete the sentences about the preparation of salt crystals.

Use words from the list.

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

acid	filtering	heating	magnesium
distillation	magnesium sulfate	shaking	solid

Excess magnesium oxide is added to dilute sulfuric acid and stirred until no more

..... dissolves.

Pure aqueous magnesium sulfate is separated by

Some water is removed by gentle

The solution is then left to form pure dry crystals of the salt called

.....

[4]

(d) Magnesium sulfate contains magnesium ions, Mg^{2+} .

Describe how magnesium ions are formed from magnesium atoms.

..... [1]

(e) Aqueous magnesium sulfate is broken down by an electric current.

State the name of this process.

..... [1]

[Total: 10]

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- 6 Fig. 6.1 shows a car battery connected to an electric heater used in a caravan. The heater has two identical heating elements connected as shown.

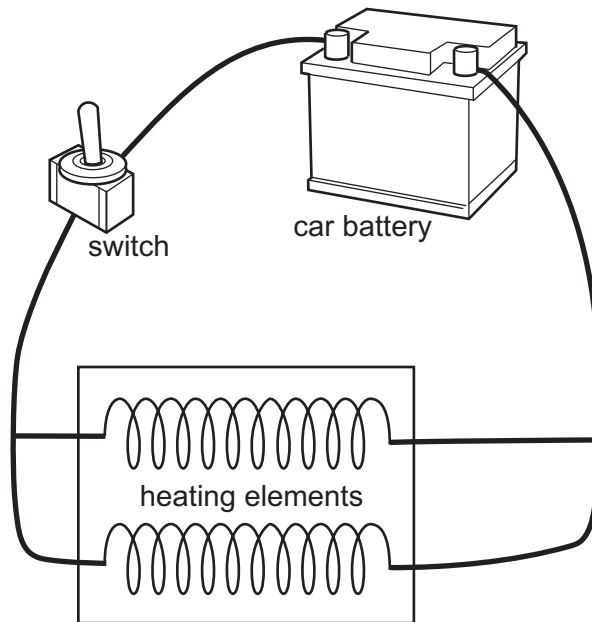


Fig. 6.1

- (a) State the type of circuit connection for the heating elements.

..... [1]

- (b) The two heating elements get hot. A hand held 20 cm in front of the heater feels warm. A hand held 20 cm above the heater feels hot from heated air rising.

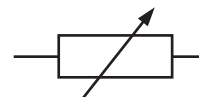
State **two** methods of thermal energy transfer from the heater that keep the people in the caravan warm.

..... and [2]

- (c) State the form of energy stored in the car battery.

..... [1]

- (d) State the name of the circuit component with the symbol:



..... [1]

- (e) The switch shown in Fig. 6.1 turns both heating elements on and off.

Another switch is used to turn only one of the heating elements on and off. There is also a fuse to protect the complete circuit.

Fig. 6.2 shows an incomplete circuit diagram for the heater circuit.

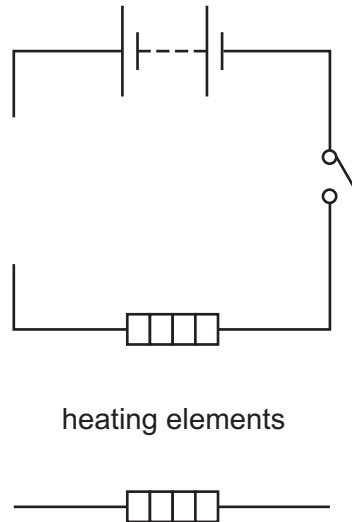


Fig. 6.2

On Fig. 6.2, complete the circuit diagram by including the fuse, the second switch and all connecting wires. [3]

- (f) The battery provides a potential difference of 12 V across **one** heating element.

The current in the heating element is 8.0 A.

- (i) Show that the resistance of the heating element is 1.5Ω .

[1]

- (ii) Explain why the current in the main circuit is larger than 8.0 A when both heaters are switched on.

..... [1]

[Total: 10]

7 (a) Fig. 7.1 shows part of a food web.

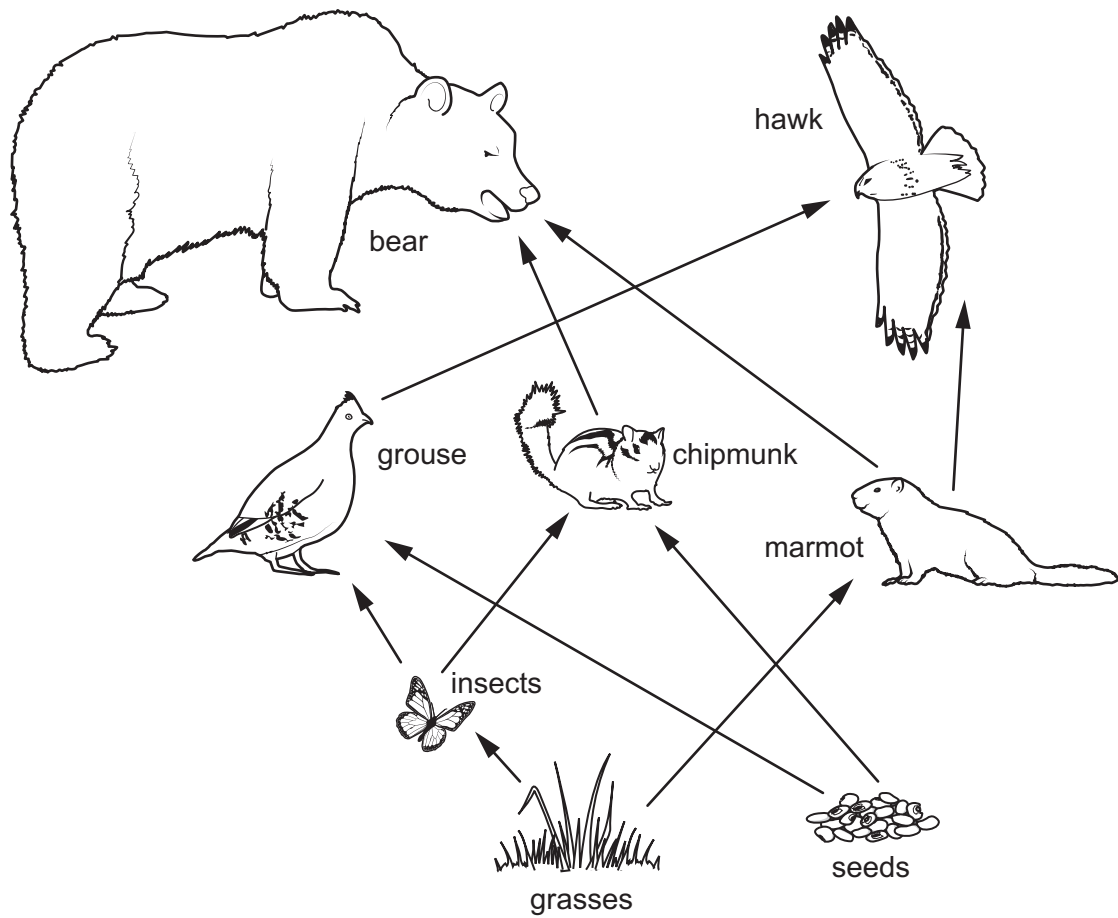


Fig. 7.1

(i) Identify the **two** herbivores in Fig. 7.1.

..... and [1]

(ii) Identify **one** tertiary consumer in Fig. 7.1.

..... [1]

(b) Complete the sentences about producers.

Use words from the list.

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

carbon dioxide	magnesium	nitrate	oxygen
photosynthesis	respiration	iodine	transpiration

Producers make their own organic nutrients using the process of

The raw materials needed for this process are water and

The products of this process are glucose and

Plants also need ions for making amino acids.

[4]

(c) Food webs are affected by deforestation.

Fig. 7.2 is a bar chart showing the area of deforestation each year for one country.

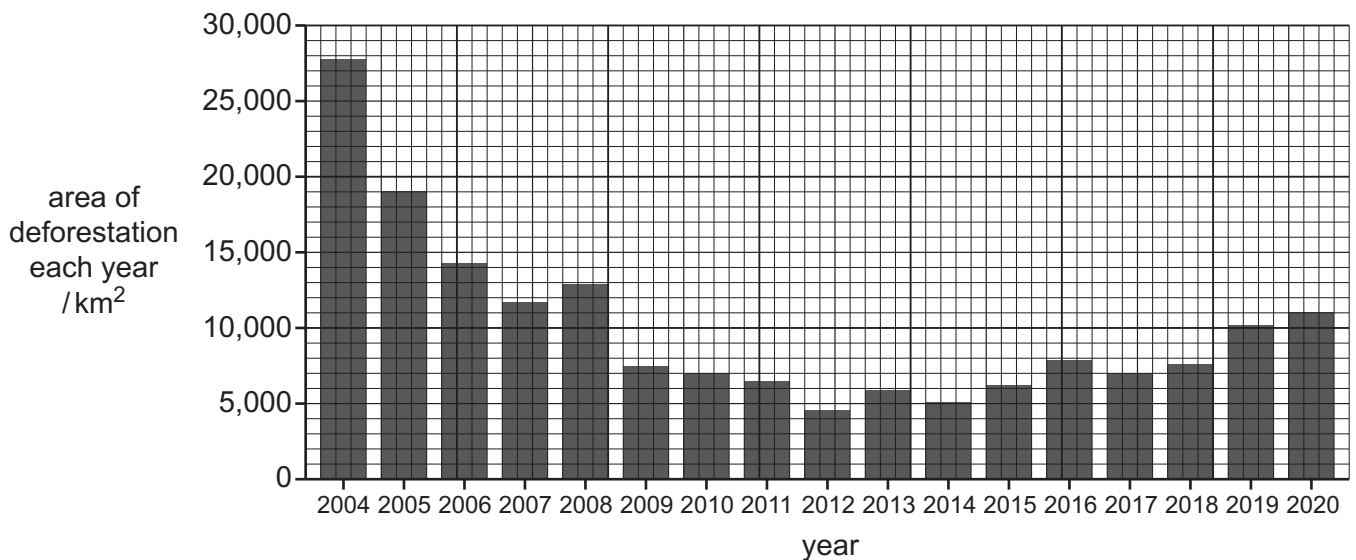


Fig. 7.2

Describe the trends shown in Fig. 7.2.

.....

.....

..... [2]

[Total: 8]

8 The Periodic Table contains groups and collections of different elements.

(a) Fig. 8.1 lists some of the elements in Group I.

3 Li lithium 7
11 Na sodium 23
19 K potassium 39

Fig. 8.1

The elements in Group I react with water to produce a gas.

(i) State the name of this gas.

..... [1]

(ii) State the trend in the reactivity of the elements down Group I.

..... [1]

(b) Fig. 8.2 lists some of the elements in Group VII.

17 Cl chlorine 35.5
35 Br bromine 80
53 I iodine 127

Fig. 8.2

The elements in Group VII exist as diatomic molecules.

(i) State what is meant by diatomic.

..... [1]

(ii) State the trend in the colour of the elements down Group VII.

..... [1]

(c) Iron and copper are part of a collection of metals which have high densities.

(i) State the name of this collection of metals.

..... [1]

(ii) Iron and copper and their compounds act as catalysts.

State one **other** property of these metals that is **not** a property of Group I metals.

..... [1]

(d) Argon and helium are noble gases.

Argon is used in lamps, and helium is used in balloons, as shown in Fig. 8.3.

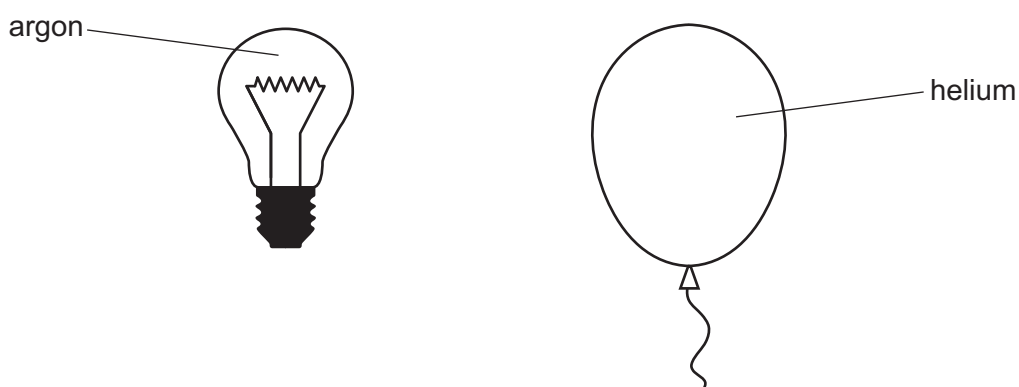


Fig. 8.3

Identify **one** property of each element that makes it suitable for the use shown in Fig. 8.3.

argon

helium

[2]

[Total: 8]

- 9 (a) A person's voice emits sound in the form of longitudinal waves. The sound waves can be represented by wave graphs which plot displacement against time.

Fig. 9.1 shows the wave graph for sound wave **A** and the wave graph for sound wave **B** as they travel through the air.

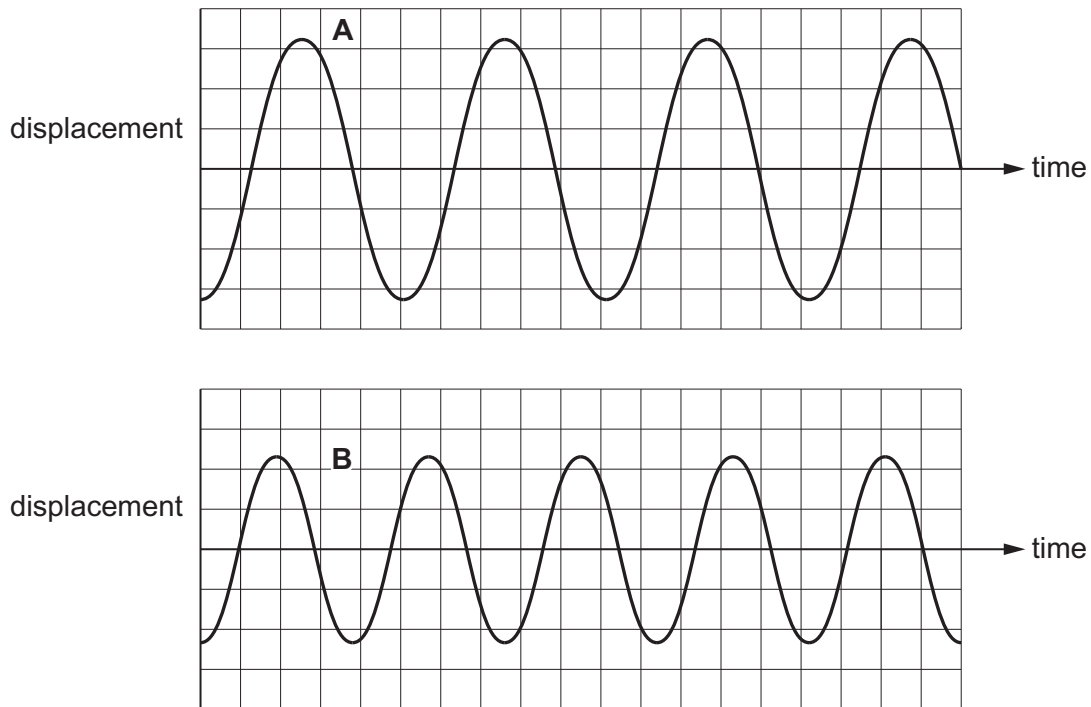


Fig. 9.1

Both wave graphs are plotted to the same time and displacement scales.

Complete the sentences about Fig. 9.1.

Use words from the list.

Each word may be used once or not at all.

amplitude frequency speed wavelength

Wave **A** has a lower than wave **B**.

Wave **A** has a greater than wave **B**.

[2]

- (b) Many telephone calls are connected by electric currents in copper wires between the telephones.

Complete the sentences by filling in the blank space with the correct word.

A current in a copper wire is due to a of electrons.

Electrons have a charge.

[2]

(c) Other ways of sending calls use electromagnetic waves.

- (i) State the type of electromagnetic wave used to send calls between two mobile (cell) phones.

..... [1]

- (ii) Fibre optic cables use infrared waves for telephone calls.

Fig. 9.2 shows part of the electromagnetic spectrum.

Write infrared waves in the correct position in the spectrum.

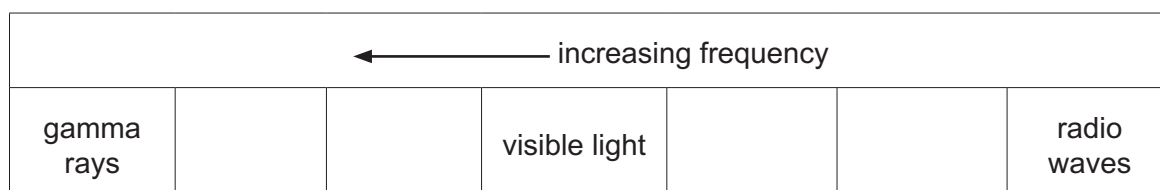


Fig. 9.2

[1]

- (iii) Infrared waves travel along fibre optic cables at a speed of 2×10^8 m/s.

A telephone call between two people 12 000 km apart travels by fibre optic cable.

Calculate the time taken for the call to travel between the two people.

time = ... s [3]

[Total: 9]

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The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										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 —		

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 dm³ at room temperature and pressure (r.t.p.).