



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/41

October/November 2021

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.

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[Turn over

- 1 (a) The boxes on the left show the names of different types of cell.

The boxes on the right show the functions of these cells.

Draw one straight line from each cell to its function.

cell	function
ciliated cell	movement of mucus
palisade mesophyll cell	photosynthesis
sperm cell	reproduction

[2]

- (b) Fig. 1.1 is a photomicrograph of some cells in a plant root.

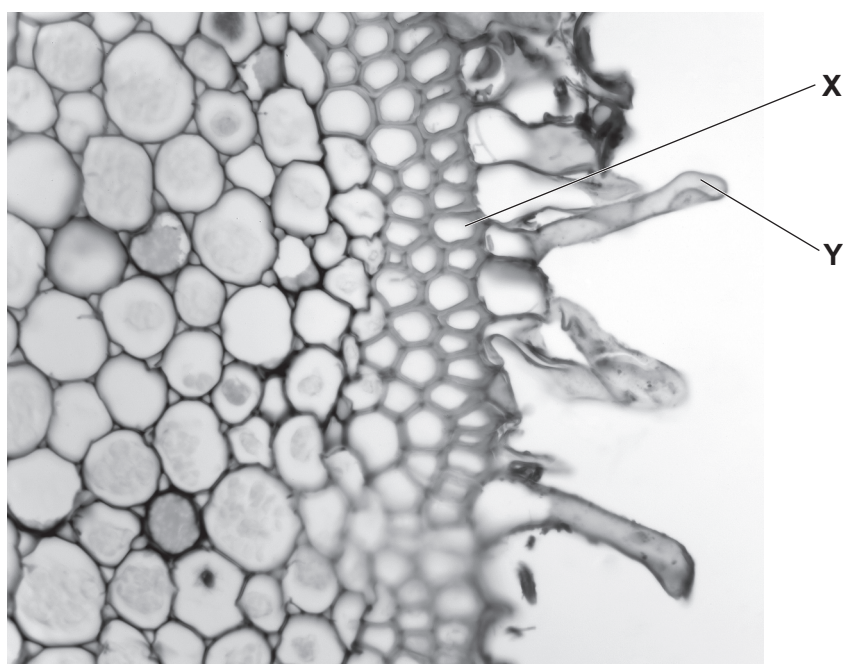


Fig. 1.1

- (i) State the name of **one** structure shown in Fig. 1.1 that identifies cell **X** as a plant cell.

..... [1]

- (ii) Identify the type of plant cell labelled **Y** in Fig. 1.1.

..... [1]

- (iii) The liquid inside cell **X** has a higher concentration of salts than the liquid inside cell **Y**.

Explain why water moves from cell **Y** to cell **X**.

Use ideas about water potential in your answer.

.....

.....

.....

.....

.....

..... [3]

- (c) Describe how water is lost from the leaves of a plant by transpiration.

.....

.....

..... [2]

- (d) The roots of a plant absorb magnesium ions.

Explain the effect of a deficiency of magnesium on the **colour** of plant leaves.

.....

.....

..... [2]

[Total: 11]

- 2 Fig. 2.1 shows the energy and state changes for water when it is heated from -10°C to 120°C .

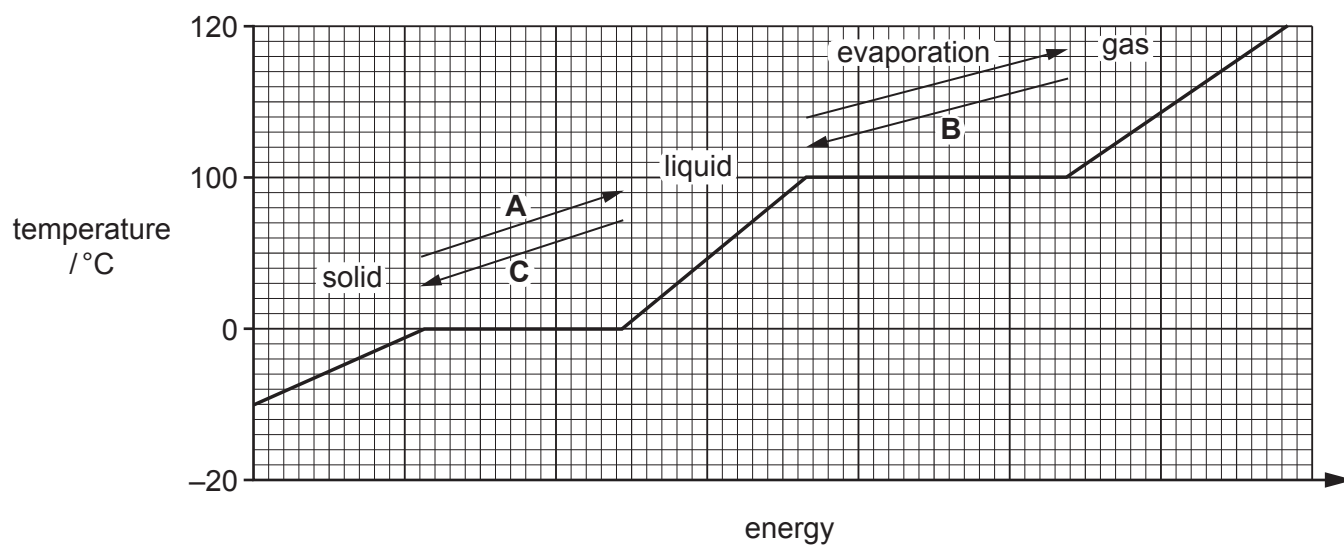


Fig. 2.1

- (a) State the names of processes **A**, **B** and **C**.

A

B

C

[3]

- (b) Describe the differences between the energy, the arrangement and the movement of the particles in the water at -10°C and at 120°C .

energy

.....

arrangement

.....

movement

.....

[3]

- (c) The melting point of sodium chloride is 800°C .

The boiling point of sodium chloride is 1465°C .

Explain why the melting point and boiling point of sodium chloride are higher than those shown for water in Fig. 2.1.

Use ideas about bonds in your answer.

.....

.....

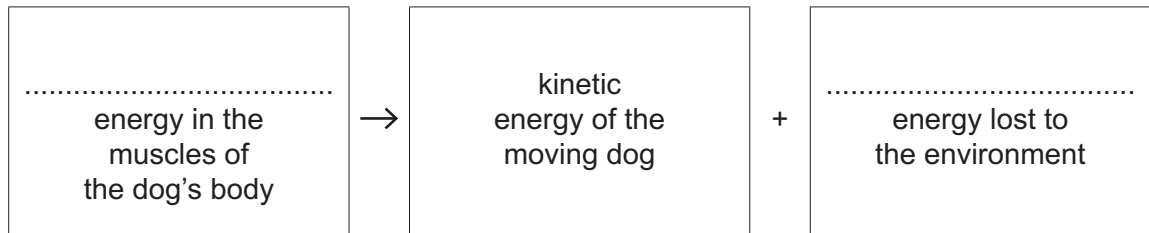
.....

..... [3]

[Total: 9]

3 A dog accelerates from rest to a maximum constant speed.

(a) Complete the boxes to show the energy changes for the dog as it is running.



[2]

(b) Fig. 3.1 shows a speed-time graph for the dog.

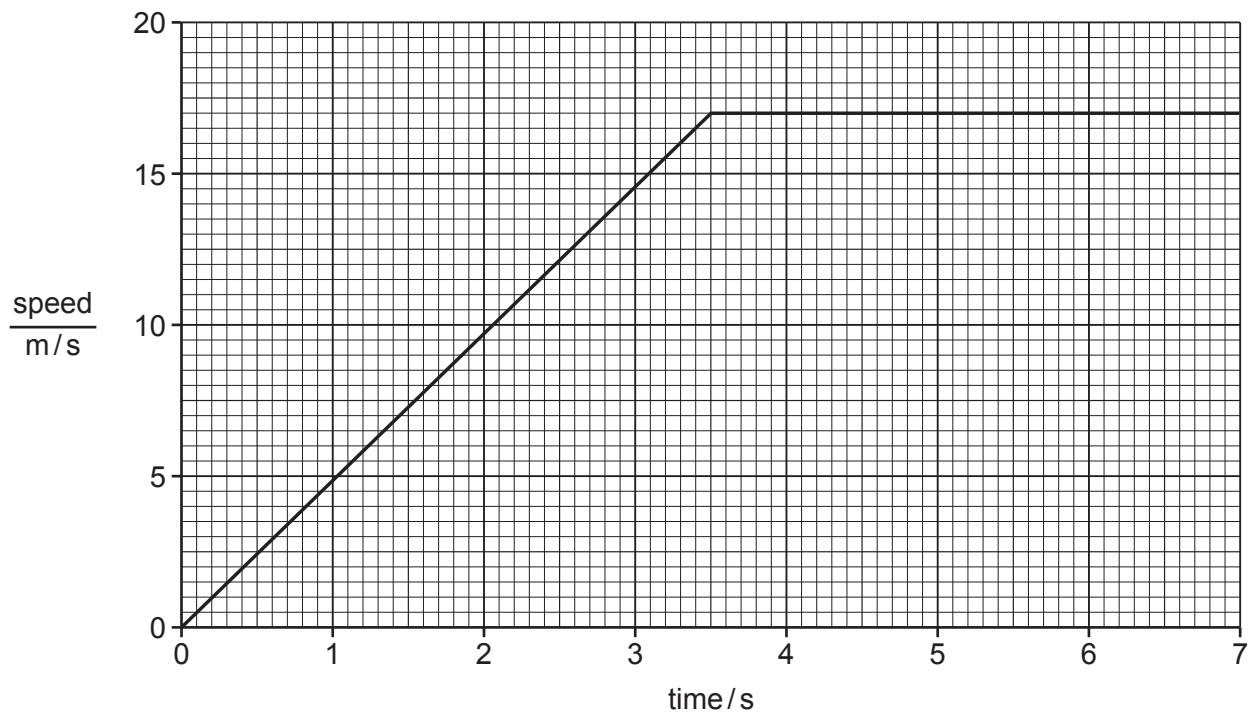


Fig. 3.1

(i) Use Fig. 3.1 to calculate the acceleration of the dog.

acceleration = ... m/s^2 [2]

(ii) Use Fig. 3.1 to calculate the distance travelled by the dog while accelerating.

distance = ... m [2]

- (iii) The dog has a mass of 32 kg.

Use Fig. 3.1 to calculate the kinetic energy of the dog at maximum constant speed.

kinetic energy = ... J [2]

- (iv) Use your answer to **(b)(iii)** to calculate the power of the dog as it accelerates from rest to maximum constant speed.

State the unit of your answer.

power = ... unit [3]

[Total: 11]

- 4 (a) Complete the sentence to define an ecosystem.

An ecosystem is a unit containing all the organisms and their ,
interacting together, in a given [2]

- (b) Fig. 4.1 shows a food web from the Arctic ecosystem.

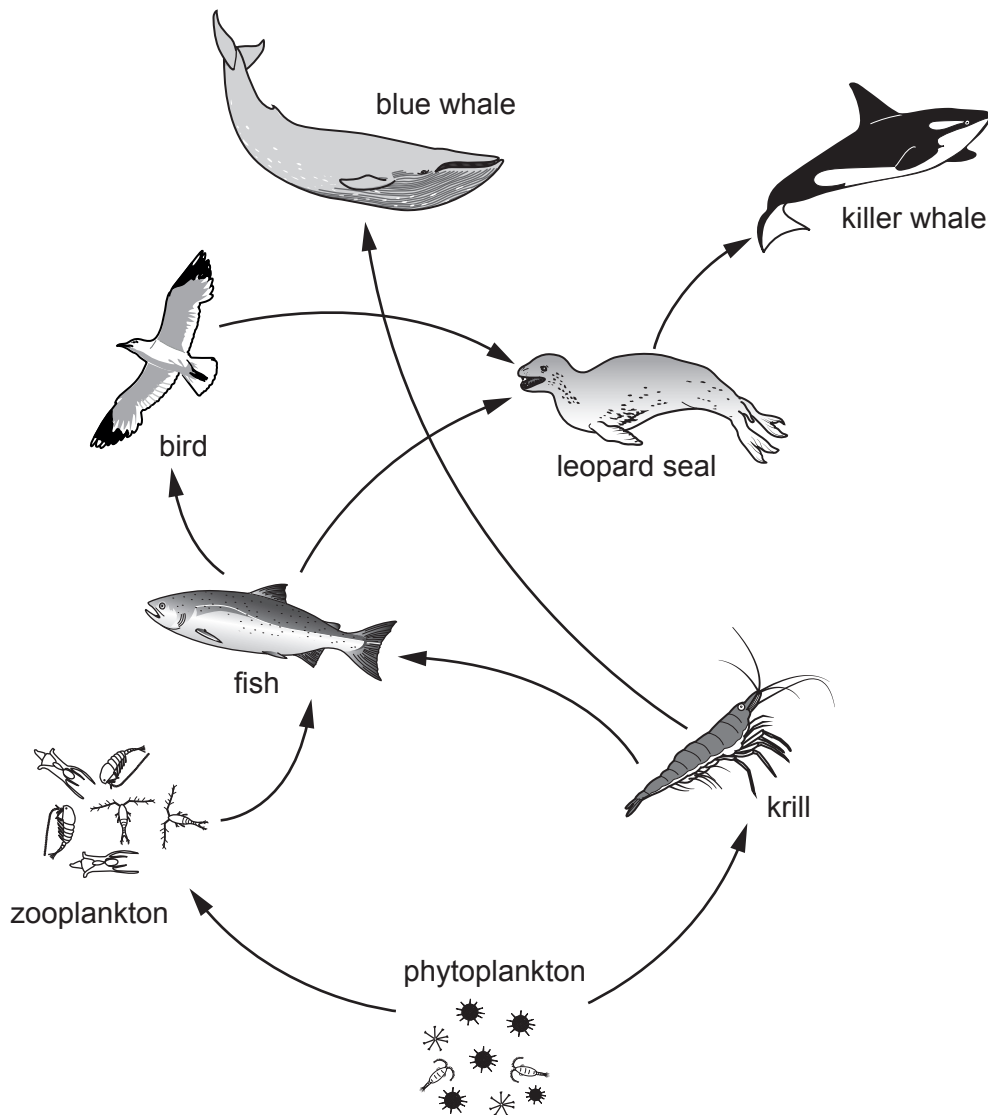


Fig. 4.1

- (i) Use Fig. 4.1 to identify **one** organism in the food web that is on the third trophic level.

..... [1]

- (ii) Describe how energy is transferred from the zooplankton to the bird.

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

(c) Fig. 4.2 is a diagram showing stages in the process of eutrophication.

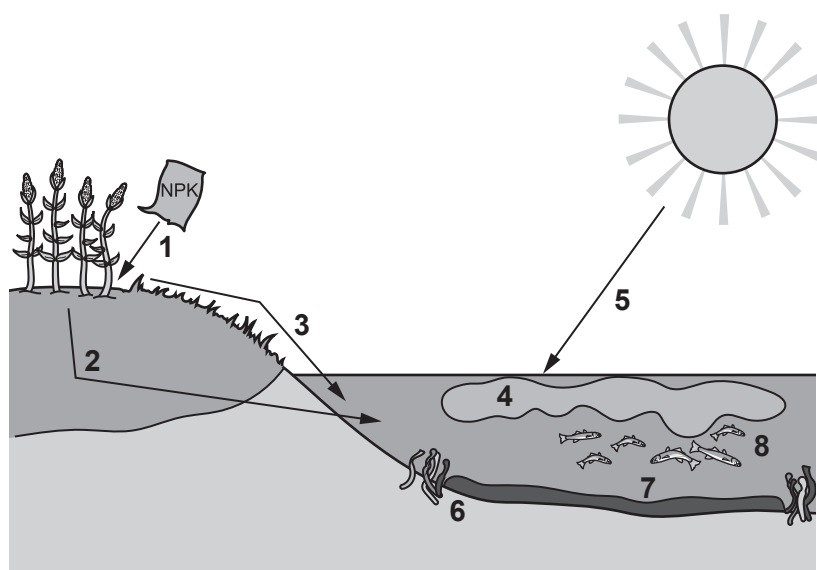


Fig. 4.2

Table 4.1 describes these stages in the process of eutrophication.

Use the information in Fig. 4.2. to complete Table 4.1.

Table 4.1

stage in Fig. 4.2	description of stage
1	Fertiliser is added to the soil.
2	Nitrate ions from the fertiliser leach from the soil into the water in the lake.
3	Fertiliser runs off the land into the water in the lake.
4	Increased availability of nitrate ions causes
5	Light is blocked from reaching the plants on the bottom of the lake.
6	Plants on the bottom of the lake die.
7	Increased aerobic respiration by
8	Death of fish due to

[3]

[Total: 8]

- 5 (a) Table 5.1 shows some names and some formulae of four metal oxides.

Complete Table 5.1.

Table 5.1

name	formula
iron(II) oxide	FeO
	Fe ₂ O ₃
copper(II) oxide	
lead(II) oxide	PbO

[2]

- (b) Lead can be extracted from lead(II) oxide by heating with carbon.

The equation for this reaction is shown.



State the name of the reducing agent in this reaction.

Explain your answer.

reducing agent

explanation

.....

[2]

- (c) When lead is heated with copper(II) oxide, copper metal forms.

When lead is heated with iron(II) oxide, there is no reaction.

- (i) Use this information to deduce the order of reactivity of these three metals.

Explain your answer.

most reactive	
↓	
least reactive	

explanation

..... [2]

- (ii) Zinc is heated with iron(II) oxide.

State whether a reaction occurs.

Give a reason for your answer.

..... [1]

- (d) A piece of lead is placed into aqueous copper nitrate and a reaction occurs.

Before the reaction, the lead has a silver colour and the aqueous copper nitrate is blue.

State **two** observations that are seen during this reaction.

1

.....

2

..... [2]

[Total: 9]

- 6 (a) Fig. 6.1 shows the compressions and rarefactions of a sound wave in air.

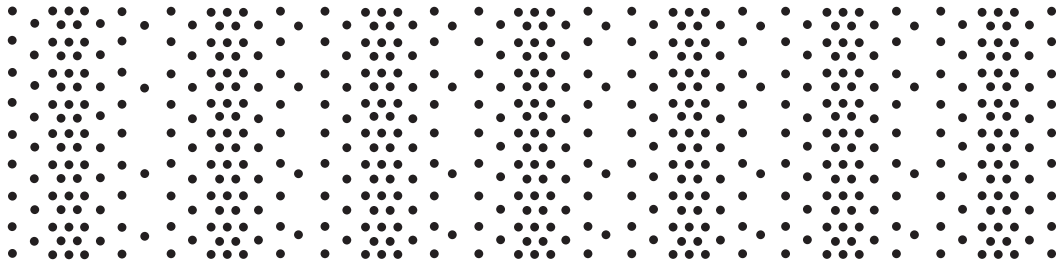


Fig. 6.1

- (i) On Fig. 6.1, draw a double-headed arrow ($\leftrightarrow$) to show one wavelength. [1]
- (ii) Compare the separation of the particles in the air in compressions and in rarefactions.

..... [1]

- (b) Table 6.1 shows the frequency range of sounds that different animals can hear.

Table 6.1

animal	frequency range/Hz
bat	10 000 – 39 000
canary bird	250 – 8 000
dog	64 – 44 000
elephant	17 – 10 000
horse	14 – 25 000

- (i) Identify **two** animals in Table 6.1 that can hear sounds above the normal range of human hearing.

..... [1]

- (ii) Humans emit sounds between 85 Hz and 255 Hz when talking.

Identify which animals in Table 6.1 **cannot** hear **all** the sounds of humans talking.

..... [1]

- (c) An elephant emits a sound at a frequency of 170 Hz. A second elephant hears the sound.

There is a distance of 60 wavelengths between the two elephants.

Calculate the distance in metres.

The speed of sound in air is 340 m/s.

distance = ... m [3]

- (d) Fig. 6.2 shows a drawing of an elephant.

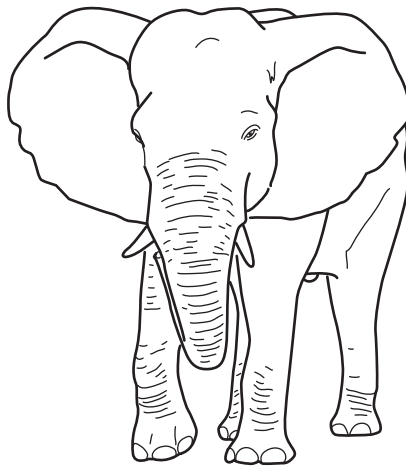


Fig. 6.2

Elephants use their ears to transfer thermal energy to the environment. This helps to control their body temperature.

Suggest how an elephant's ears are adapted to transfer thermal energy to the environment.

Use ideas about conduction, convection or radiation in your answer.

.....

.....

.....

[2]

[Total: 9]

- 7 (a) Fig. 7.1 is a diagram of the gas exchange system in humans.

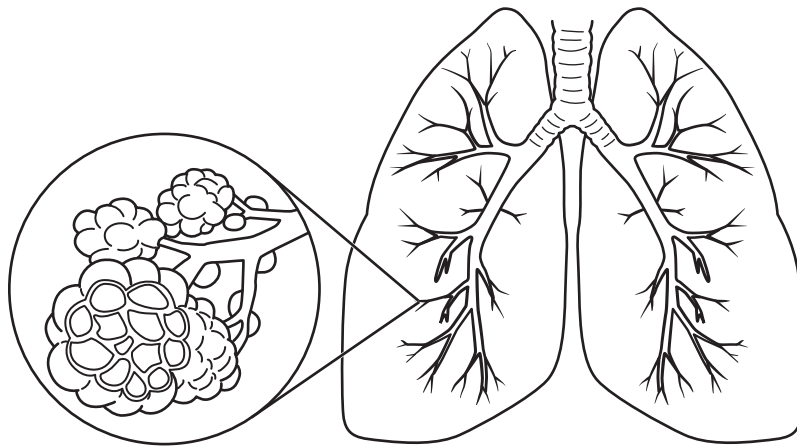


Fig. 7.1

- (i) On Fig. 7.1 draw a label line and the letter **B** to identify a bronchus. [1]

- (ii) State **two** features of the alveoli that make them an efficient gas exchange surface.

1

.....

2

.....

[2]

- (b) The pulse rate and breathing rate of two people are measured before and after activity.

Fig. 7.2 shows a bar chart of the results.

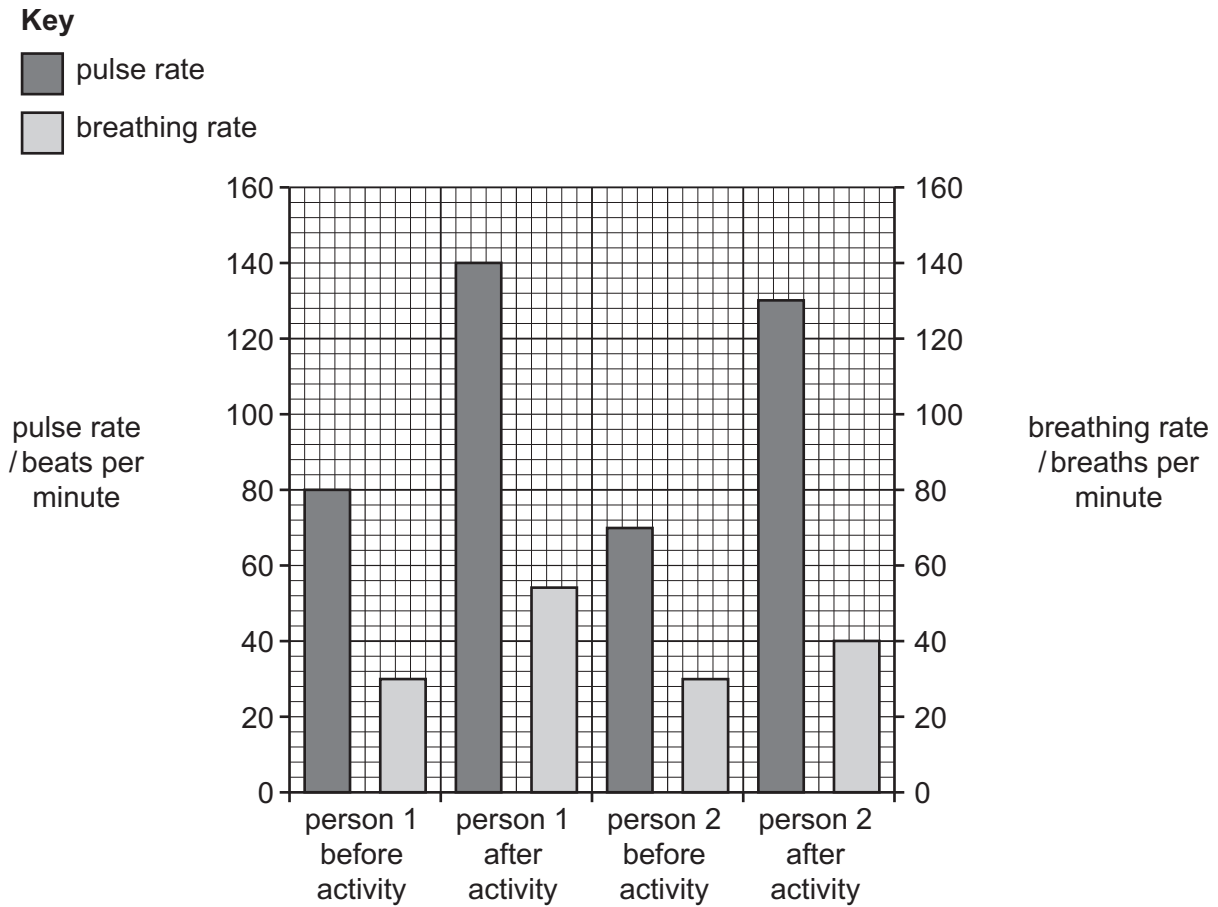


Fig. 7.2

- (i) Compare the increase in breathing rates of the two people.

.....
 [1]

- (ii) Table 7.1 shows the pulse rate data and percentage increase in pulse rate for person 1.

Complete Table 7.1 to show the pulse rate data and percentage increase in pulse rate for person 2.

Table 7.1

person	pulse rate before activity /beats per minute	pulse rate after activity /beats per minute	change in pulse rate /beats per minute	percentage increase in pulse rate
1	80	140	60	75
2				

[2]

- (c) One reason why breathing rate increases during activity is the need for more oxygen.

Explain **one** other reason why breathing rate increases during activity.

.....

.....

.....

..... [2]

[Total: 8]

8 A scientist uses three processes to treat a sample of sea water to make it safe to drink and store.

(a) The sample of sea water contains some solid plastic waste.

The scientist uses a filter to remove the solid plastic waste from the sea water.

Explain how this filter works.

.....

.....

..... [2]

(b) The sea water contains large amounts of dissolved salt.

After filtering, the scientist uses a separation method to obtain pure water from the sea water.

State the name of this separation method and explain how this method works.

separation method

explanation

.....

..... [4]

(c) Next, the scientist adds a chemical to the pure water to make it safe to drink and store.

State the name of this chemical and explain how it makes the pure water safe to drink and store.

chemical

explanation

..... [2]

[Total: 8]

- 9 A student connects a heater and four identical lamps to a battery.

Fig. 9.1 shows the circuit.

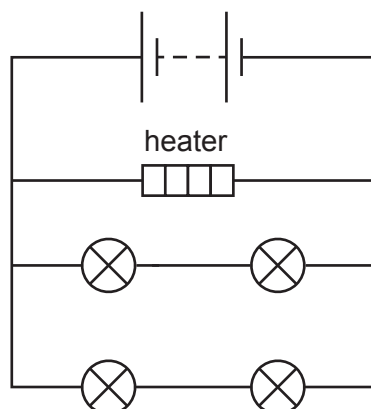


Fig. 9.1

- (a) There is a current of 8.5A in the heater.

There is a current of 1.5A in each lamp.

Calculate the total current in the battery.

total current = ... A [2]

- (b) State the name of the instrument used to measure current.

..... [1]

(c) A student has two switches, **S1** and **S2**, and a fuse.

The student changes the circuit so that:

- switch **S1** controls the heater but does **not** control the lamps
- switch **S2** controls all four lamps but does **not** control the heater
- the fuse protects the whole circuit.

On Fig. 9.2, complete the circuit diagram to show how the student connects the circuit.

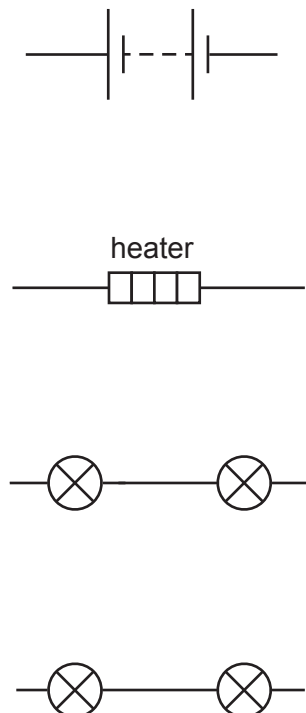


Fig. 9.2

[4]

[Total: 7]

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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															
11 Na sodium 23	12 Mg magnesium 24																
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 58	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 —	114 Pb lead 207	116 Lv livermorium —	116 Lv livermorium —	—	—

actinoids

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	euporium	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	—



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0653/42

October/November 2021

1 hour 15 minutes

No additional materials are needed.

- Answer **all** questions.
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- The Periodic Table is printed in the question paper.

This document has **24** pages. Any blank pages are indicated.

- 1 (a) Fig. 1.1 is a diagram of a fetus inside the uterus.

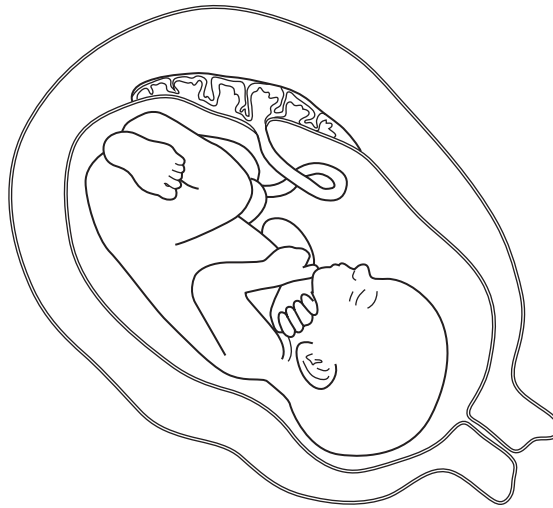


Fig. 1.1

On Fig. 1.1, draw a label line and the letter **C** to identify the cervix.

[1]

- (b) The fetus requires energy and amino acids for growth.

(i) State the name of the process in cells that releases energy.

..... [1]

(ii) Describe how the fetus obtains amino acids.

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

- (c) A pregnant female takes iron tablets to supplement her diet.

Explain why iron tablets may be needed **during pregnancy**.

.....

.....

..... [2]

- (d) Table 1.1 shows the names and functions of some organs associated with the alimentary canal of an adult human body.

Complete Table 1.1.

Table 1.1

organ	function
.....	uses teeth to break down food into smaller pieces
large intestine	
.....	egestion

[3]

[Total: 9]

- 2 (a) A student uses inert electrodes for the electrolysis of **dilute** aqueous sodium chloride and **concentrated** aqueous sodium chloride solutions.

(i) State what is meant by *inert*.

.....
 [1]

(ii) For each solution, the products formed at the positive and negative electrodes are gases.

The student tests the gases.

Table 2.1 shows the observations.

Table 2.1

solution	gas formed at positive electrode	gas formed at negative electrode
dilute aqueous sodium chloride	relights glowing splint	'pops' with a lighted splint
concentrated aqueous sodium chloride	bleaches damp litmus paper	'pops' with a lighted splint

Use the observations in Table 2.1 to identify the gases formed at the positive and negative electrodes for each solution.

Complete Table 2.2 with the names of these gases.

Table 2.2

solution	name of gas formed at positive electrode	name of gas formed at negative electrode
dilute aqueous sodium chloride		
concentrated aqueous sodium chloride		

[3]

(iii) State the names of the positive and negative electrodes.

positive electrode

negative electrode

[1]

(b) **Molten** sodium chloride is electrolysed using inert electrodes.

Describe how sodium is formed from sodium ions during this electrolysis.

.....

.....

.....

..... [3]

(c) During the electrolysis of **molten** sodium chloride, sodium **is** formed.

During the electrolysis of **aqueous** sodium chloride, sodium is **not** formed.

Explain this difference.

.....

.....

..... [2]

[Total: 10]

- 3 Two beach balls are floating in the sea.

Fig. 3.1 shows waves moving across the sea underneath the beach balls.

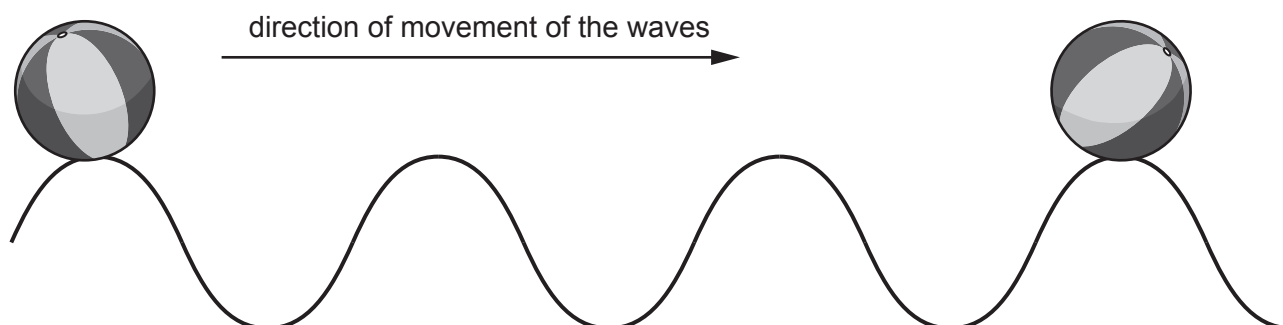


Fig. 3.1

- (a) (i) State the number of wavelengths between the two beach balls.

..... [1]

- (ii) On Fig. 3.1, draw a double-headed arrow ($\leftrightarrow$ or $\updownarrow$) to show the amplitude of a wave. [1]

- (b) Six waves pass under one beach ball in 40 seconds.

- (i) Calculate the frequency of the waves.

State the unit of your answer.

frequency = ... unit [3]

- (ii) The wavelength of the waves is 18 m.

Use your answer to (b)(i) to calculate the speed of the waves across the sea.

speed = ... m/s [2]

(c) A sound wave takes 0.22 s to travel 72 m in **air**.

Circle the time taken for the same sound wave to travel 72 m in **water**.

Give a reason for your answer.

0.055 s

0.22 s

0.88 s

reason

.....
[1]

[Total: 8]

- 4 (a) Fig. 4.1 is a diagram of the gas exchange system in a human.

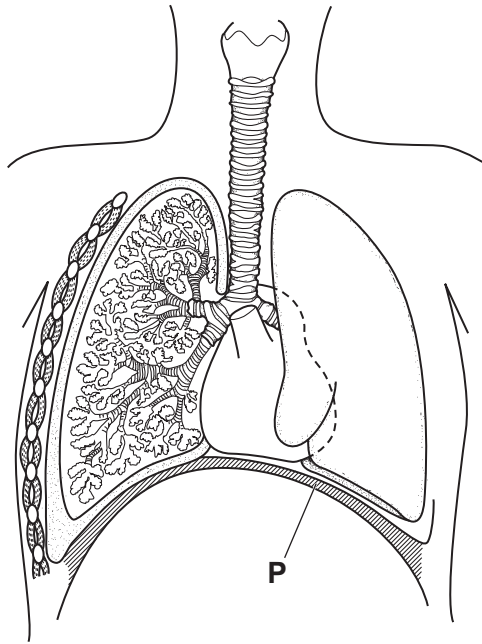


Fig. 4.1

- (i) Identify the part labelled **P** in Fig. 4.1.

..... [1]

- (ii) On Fig. 4.1, draw a label line and the letter **L** to identify the larynx.

[1]

- (b) Expired air contains a different percentage of carbon dioxide to inspired air.

State and explain this difference.

difference

.....

explanation

.....

[2]

(c) Fig. 4.2 shows cells that line the airways of a non-smoker and a smoker.

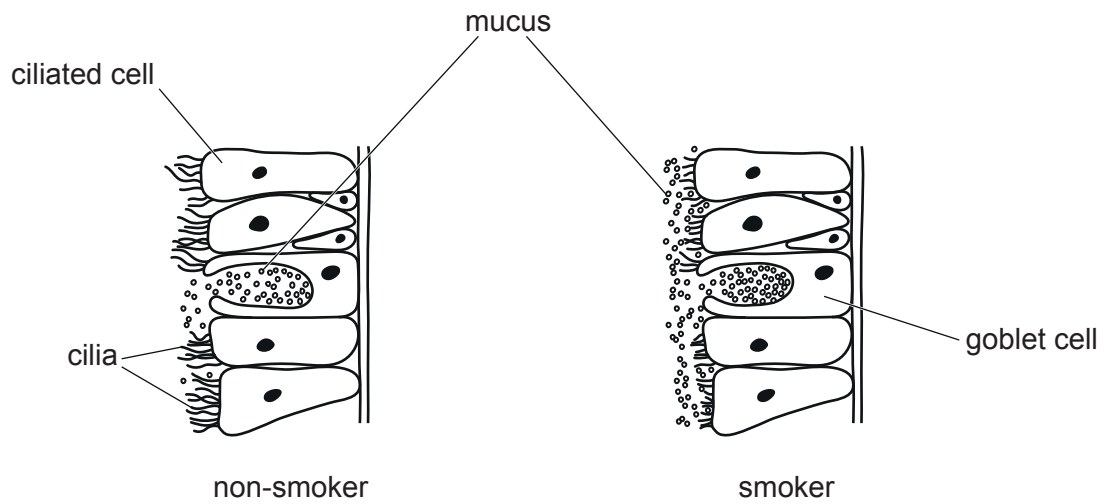


Fig. 4.2

Explain how smoking tobacco affects the function of the cells shown in Fig. 4.2.

Use the information in Fig. 4.2 in your answer.

.....

.....

.....

.....

.....

..... [3]

[Total: 7]

- 5 The pH values of four aqueous salt solutions are listed in Table 5.1.

Table 5.1

aqueous salt solution	pH
copper sulfate	4
iron chloride	2
magnesium sulfate	6
sodium chloride	7

- (a) Describe how an aqueous salt solution can be tested to find its pH value.

.....

 [2]

- (b) (i) Identify the most acidic aqueous salt solution listed in Table 5.1.

Explain your choice.

solution
 explanation
 [1]

- (ii) State the names of the **two** aqueous salt solutions listed in Table 5.1 that react with zinc.

..... and [1]

- (c) A student reacts solid copper carbonate with dilute sulfuric acid in four different experiments.

The same mass of copper carbonate is used in each experiment.

Table 5.2 shows the conditions used.

Table 5.2

experiment	size of pieces of copper carbonate	temperature of acid / °C
1	large	20
2	large	40
3	small	20
4	small	40

State which experiment has the highest rate of reaction.

Explain your answer using ideas about colliding particles and activation energy.

experiment

explanation

.....

.....

.....

[4]

[Total: 8]

- 6** A meteorite is an object from space that travels through the Earth's atmosphere and hits the surface of the Earth.

(a) A meteorite in space is moving towards the Earth.

- (i)** Before it enters the Earth's atmosphere, the speed of the meteorite is increasing.

Explain why the speed of the meteorite increases as it moves closer to the Earth.

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

- (ii)** The meteorite has a mass of 45 000 kg.

Calculate the kinetic energy of the meteorite when it has a speed of 1.7×10^4 m/s.

kinetic energy = ... J [2]

- (b)** The meteorite decelerates as it travels through the Earth's atmosphere. The deceleration increases as the meteorite gets closer to the surface of the Earth.

- (i)** Explain why the meteorite decelerates.

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

- (ii)** Suggest why the deceleration increases.

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

- (c) A scientist wants to identify the type of meteorite.

Fig. 6.1 shows a piece of the meteorite.

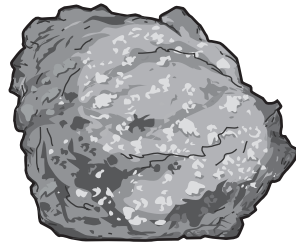


Fig. 6.1

- (i) The scientist puts the piece of meteorite in a large measuring cylinder containing 2500 cm^3 of water.

The water level on the measuring cylinder increases to 3480 cm^3 .

Calculate the volume of this piece of meteorite.

volume = ... cm^3 [1]

- (ii) Table 6.1 shows the density ranges for three types of meteorite.

Table 6.1

type of meteorite	<u>density range</u> kg/m^3
stony	2110 to 3550
stony-iron	4250 to 4760
iron	7000 to 8000

The piece of meteorite has a mass of 4.52 kg.

Use Table 6.1 and your answer to (c)(i) to identify the type of meteorite.

Show your working.

type of meteorite [4]

[Total: 10]

- 7 (a) A student investigates the effect of light intensity on the rate of photosynthesis of an aquatic plant submerged in a beaker of water.

During photosynthesis, the aquatic plant produces bubbles of gas.

The student shines a lamp on the aquatic plant from different distances and measures the volume of gas produced in 3 minutes.

Table 7.1 shows the results.

Table 7.1

distance of lamp from aquatic plant /cm	volume of gas produced in 3 minutes /cm ³	rate of gas produced /cm ³ per second
50	0.2	
40	0.8	0.004
30	1.6	0.009
20	2.2	0.012
10	2.2	0.012

- (i) Calculate the rate of gas produced when the lamp is 50 cm from the aquatic plant.

..... cm³ per second [2]

- (ii) Describe the effect of light intensity on the rate of photosynthesis shown by the results in Table 7.1.

.....

.....

.....

..... [2]

- (b) The student does a different experiment to investigate the effect of **temperature** on the rate of photosynthesis.

Fig. 7.1 shows a graph of the results.

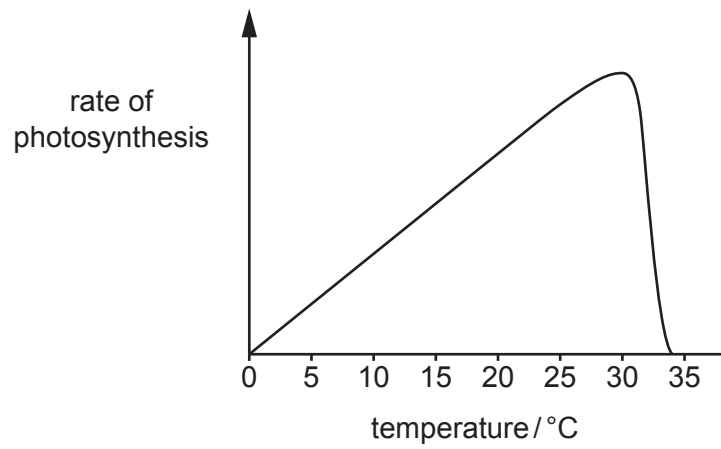


Fig. 7.1

The process of photosynthesis is controlled by enzymes.

Explain the shape of the graph seen in Fig. 7.1.

Use ideas about enzymes in your answer.

.....

.....

.....

.....

.....

..... [3]

- (c) Glucose is a product of photosynthesis.

Complete these sentences about the uses of glucose in a plant.

Choose words from the list.

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

glycogen

mesophyll

phloem

protein

starch

xylem

Glucose is converted to sucrose and transported to the roots in vessels.

In the roots, the sucrose is converted to for storage.

[2]

- (d) Plant shoots grow towards a light source.

- (i) State the name of this tropic response of plants to light.

..... [1]

- (ii) State the name of the chemical involved in this response.

..... [1]

[Total: 11]

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- 8 There has been a large increase in the concentration of carbon dioxide in the atmosphere over the last 50 years.

(a) (i) State the name of **one** natural process which produces carbon dioxide.

..... [1]

(ii) Suggest **one** reason for the large increase in carbon dioxide concentration over the last 50 years.

..... [1]

(b) Carbon dioxide is a greenhouse gas.

Suggest why many scientists are concerned about increased concentrations of greenhouse gases in the atmosphere.

.....

 [2]

(c) Some information about carbon dioxide and sea water is shown.

Sea water is made of water, dissolved salts and dissolved gases.

Carbon dioxide from the atmosphere dissolves in sea water.

The carbon dioxide then reacts with water to form carbonic acid.

(i) Use the information to identify a solvent, a solute and a solution.

solvent

solute

solution

[3]

(ii) Suggest why many scientists are concerned about increasing amounts of carbon dioxide dissolving in sea water.

.....
 [1]

[Total: 8]

9 Fig. 9.1 shows an electric kettle used to boil water.

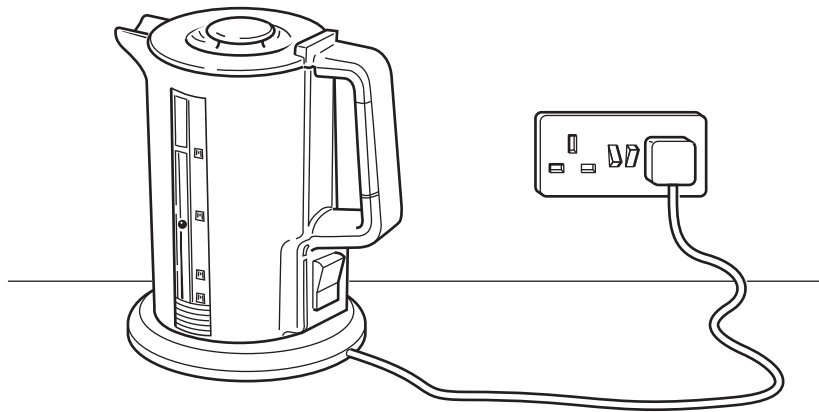


Fig. 9.1

(a) State the boiling point of water, including the correct unit.

..... [1]

(b) When the water in the kettle is boiling, a switch turns off the kettle.

The switch is made of a thin piece of steel joined to a thin piece of brass.

Fig. 9.2 shows the switch when it is cold (turned ON) and when it is hot (turned OFF).

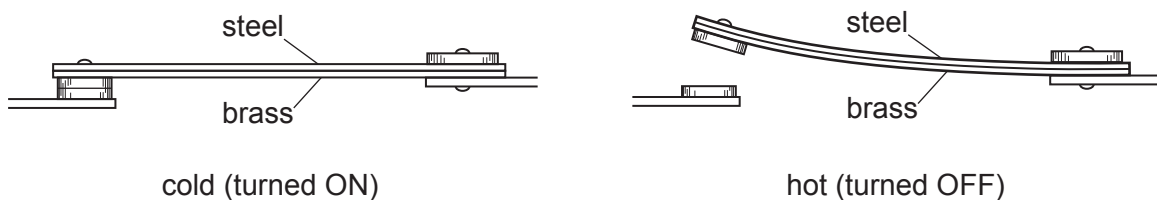


Fig. 9.2

Explain why the switch turns off when it is hot.

.....

.....

.....

..... [2]

(c) Fig. 9.3 shows a label on the kettle.

Model: X-12
Power: 2.4 kW
Voltage: 220 V
Frequency: 50 Hz

Fig. 9.3

(i) Calculate the current from the source when the kettle is turned on.

current = ... A [3]

(ii) The electric circuit in the kettle contains a heating element, a lamp and a switch.

- The heating element has 220 V across it.
- The lamp has 220 V across it.
- The switch controls both the heating element and the lamp.

Fig. 9.4 shows an incomplete circuit diagram for the kettle.

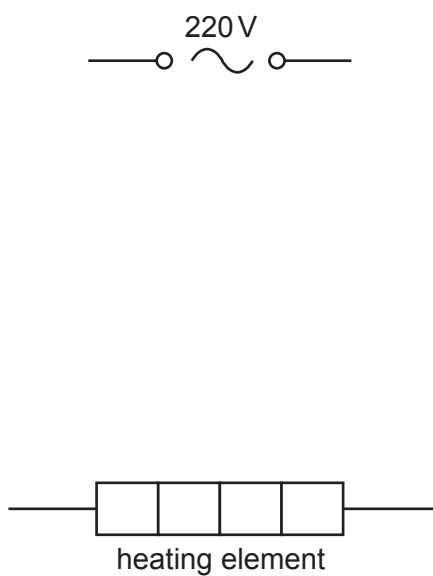


Fig. 9.4

On Fig. 9.4, complete the circuit diagram to include the switch and the lamp.

[3]

[Total: 9]

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The Periodic Table of Elements

Group																	
I	II							III	IV	V	VI	VII	VIII				
		1 H hydrogen 1															
		Key atomic number atomic symbol name relative atomic mass															
3 Li lithium 7	4 Be beryllium 9																
11 Na sodium 23	12 Mg magnesium 24																
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 —	117 Ts tennessine —	118 Og oganesson —	119 Nh nihonium —	120 Ds darmstadtium —



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/43

October/November 2021

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.

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[Turn over

- 1 (a) Fig. 1.1 is a diagram of a fetus inside the uterus.

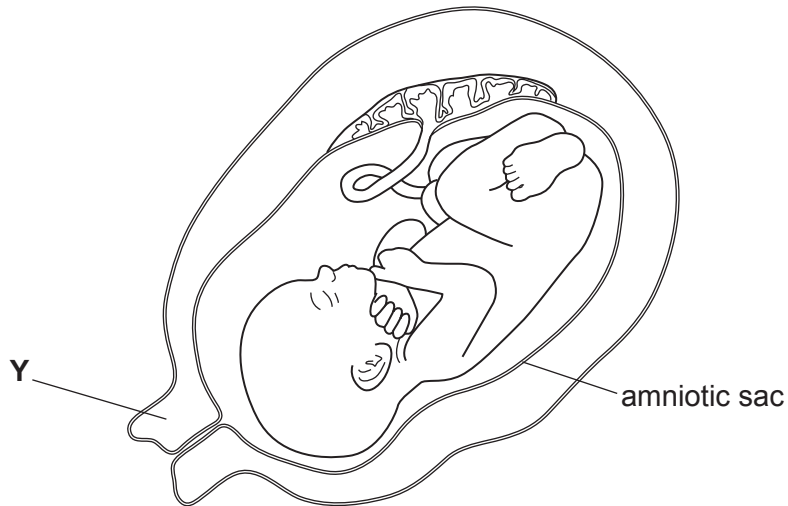


Fig. 1.1

- (i) Identify the part labelled **Y** in Fig. 1.1.

..... [1]

- (ii) State the function of the amniotic sac.

.....
 [1]

- (iii) Describe how carbon dioxide is removed from the blood of the fetus.

.....

 [3]

(b) Describe how the human heart works to pump blood around the body.

.....

.....

..... [2]

(c) Table 1.1 shows information about human male and female gametes.

Complete Table 1.1.

Table 1.1

	male gametes	female gametes
name		eggs
where they are produced		ovaries
number released at any one time	over 40 million	
adaptive feature		jelly coating

[4]

[Total: 11]

2 Fig. 2.1 shows the energy level diagrams for four different compounds dissolving in water.

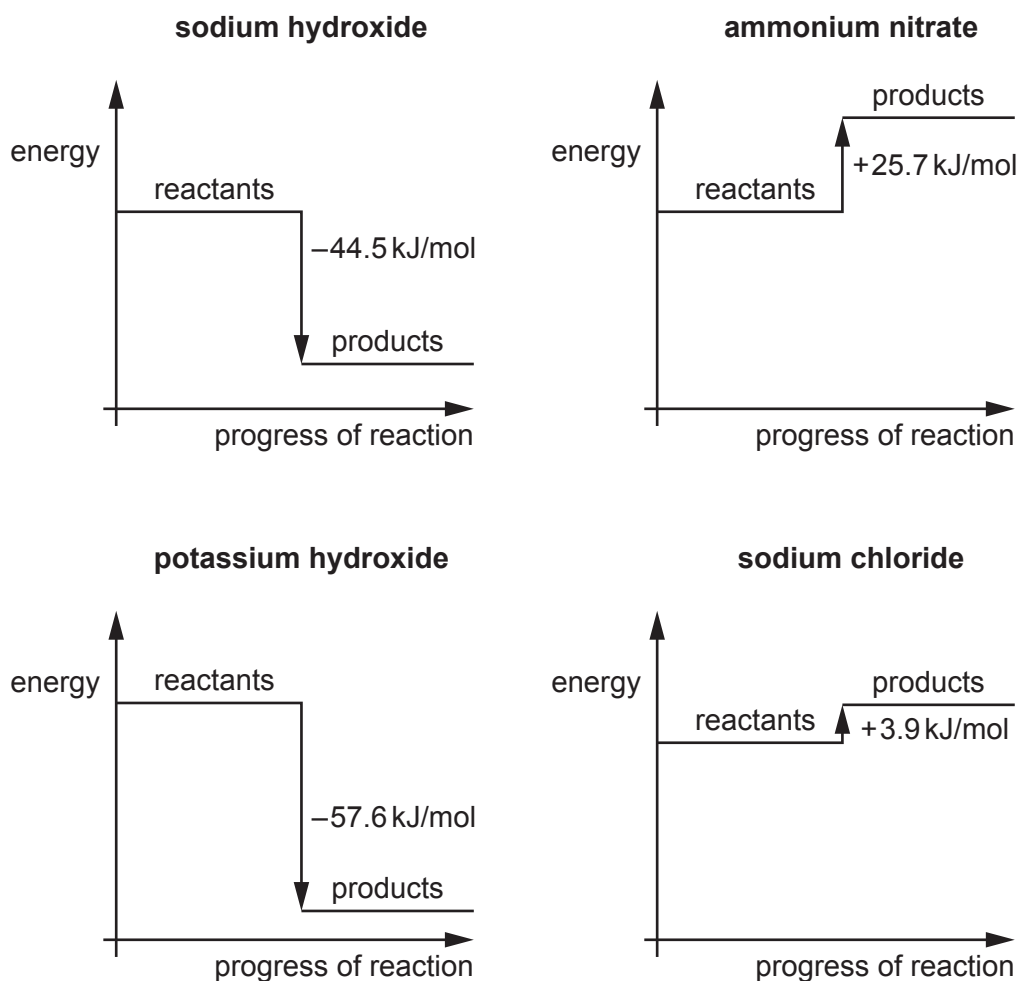


Fig. 2.1

(a) Dissolving in water is an endothermic reaction for **two** of these four compounds.

State the names of these two compounds.

Use the energy level diagrams to explain your answer.

compound 1

compound 2

explanation

.....

.....

[2]

- (b) A teacher dissolves some solid sodium hydroxide in water to make a solution.

The teacher records the initial temperature of the water before adding the sodium hydroxide.

The teacher records the temperature of the solution every 10 s after adding the sodium hydroxide.

Table 2.1 shows the results.

Table 2.1

initial temperature of water / °C	temperature of solution / °C					
	10 s	20 s	30 s	40 s	50 s	60 s
22.0	28.0	34.5	33.0	31.5	30.5	29.0

- (i) Name **two** pieces of equipment the teacher uses to collect the data in Table 2.1.

1

2

[2]

- (ii) Describe the changes in the temperature of the solution over the 60 s.

Explain why these changes occur.

changes in temperature

.....

explanation

.....

.....

[3]

- (iii) Calculate the maximum temperature change shown by the data in Table 2.1.

maximum temperature change = ... °C [1]

[Total: 8]

3 A laser is a device that emits a beam of electromagnetic radiation.

Some lasers emit visible light. Some lasers emit infrared radiation.

(a) (i) Fig. 3.1 shows an incomplete electromagnetic spectrum.

On Fig. 3.1, write *visible light* and *infrared* in their correct places.

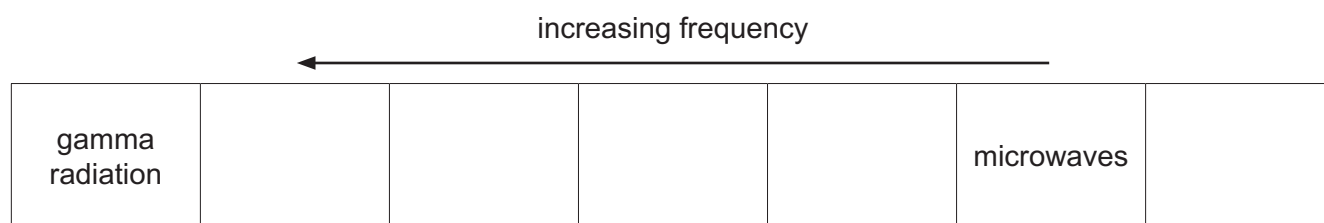


Fig. 3.1

[2]

(ii) The speed of visible light in a vacuum is 3×10^8 m/s.

State the speed of infrared radiation in a vacuum.

Explain your answer.

speed of infrared radiation m/s

explanation

.....

[1]

(b) A laser emits a beam of red visible light of wavelength 635×10^{-9} m.

Calculate the frequency of the red visible light emitted by the laser.

State the unit of your answer.

frequency = ... unit [3]

- (c) Lasers can be used in hospitals to treat some types of cancer.

The cancer cells absorb radiation from the laser beam and increase in temperature.

The cancer cells are destroyed by high temperature.

- (i) Absorption of radiation transfers energy to the cancer cells.

Identify the type of energy transferred to the cancer cells.

..... [1]

- (ii) Laser treatment is more effective when the cancer cells are covered with a dull black carbon coating.

Suggest why the dull black carbon coating makes the treatment more effective.

.....
 [1]

- (d) Metal solids are good thermal conductors.

Describe **two** ways that thermal energy is conducted by a metal solid.

1

 2

 [2]

[Total: 10]

- 4 (a) Fig. 4.1 shows part of a food web.

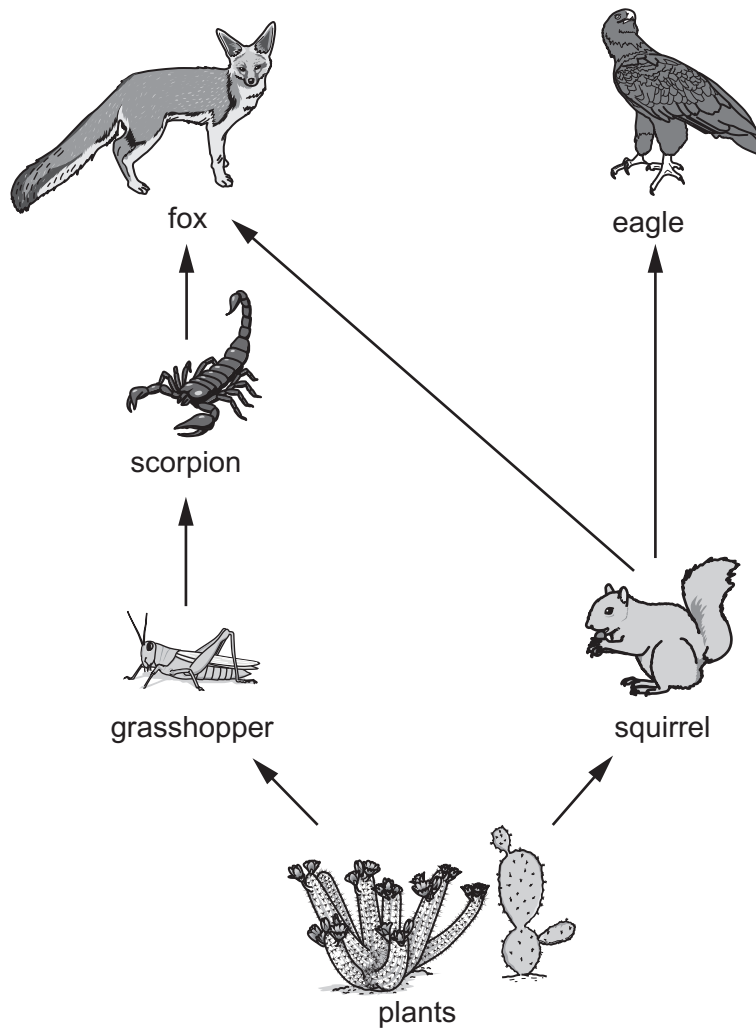


Fig. 4.1

- (i) The food web is **not** complete.

Eagles also eat grasshoppers.

On Fig. 4.1, draw **one** arrow to show this relationship between eagles and grasshoppers.

[1]

- (ii) Identify **one** primary consumer in the food web shown in Fig. 4.1.

..... [1]

- (iii) Explain why food chains usually have fewer than five trophic levels.

.....

.....

..... [2]

(b) The roots of plants take in water.

Explain how water moves from the soil into the root hair cells of a plant.

Use ideas about water potential in your answer.

.....

.....

.....

..... [3]

[Total: 7]

- 5 Fig. 5.1 shows how molten iron is used to join railway tracks together.

The molten iron is poured into the gap between the tracks.

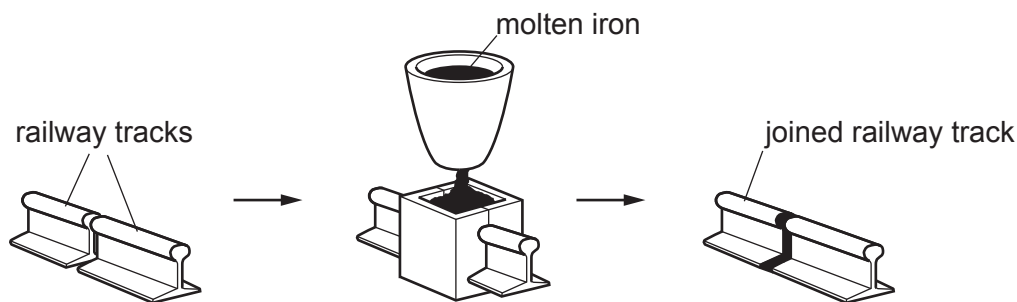
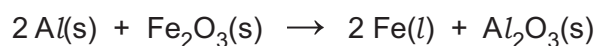


Fig. 5.1

The molten iron is produced in a reaction between aluminium and iron(III) oxide.

The reaction is exothermic and the temperature rises to about 2500 °C.

The equation for this reaction is shown.



- (a) Use the state symbols in the equation to suggest the melting point of iron and the melting point of aluminium oxide.

Explain your answers.

melting point of iron °C

melting point of aluminium oxide °C

explanation

..... [2]

- (b) Explain why iron is made in this reaction.

Use ideas about reactivity in your answer.

.....

 [2]

- (c) The reaction between aluminium and iron(III) oxide is a redox reaction.

Name the oxidising agent in this reaction.

Explain your answer.

oxidising agent

explanation

..... [2]

- (d) The names and formulae of two different oxides of iron are listed in Table 5.1.

Table 5.1

name of iron oxide	formula
iron(II) oxide	FeO
iron(III) oxide	Fe ₂ O ₃

Explain why the two different oxides of iron have these formulae.

Use ideas about the charges on the ions in your answer.

.....

 [2]

[Total: 8]

- 6 Fig. 6.1 shows a dinosaur called Tyrannosaurus Rex (T-Rex).

T-Rex lived about 66 million years ago.

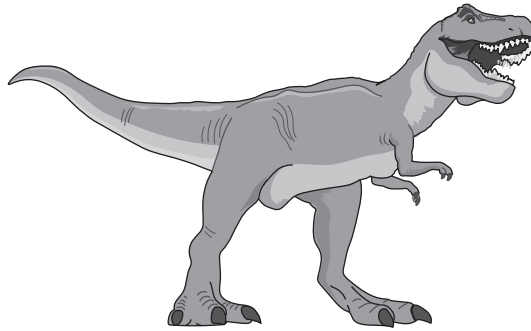


Fig. 6.1

- (a) The T-Rex in Fig. 6.1 has a mass of 8000 kg.

Each foot has an area of 0.28 m^2 in contact with the ground.

Earth's gravitational field strength is 10 N/kg .

Calculate the pressure exerted by T-Rex standing on **two** feet.

pressure = ... Pa [3]

(b) The T-Rex moves for 14 s.

Fig. 6.2 shows a speed-time graph of the motion of the T-Rex.

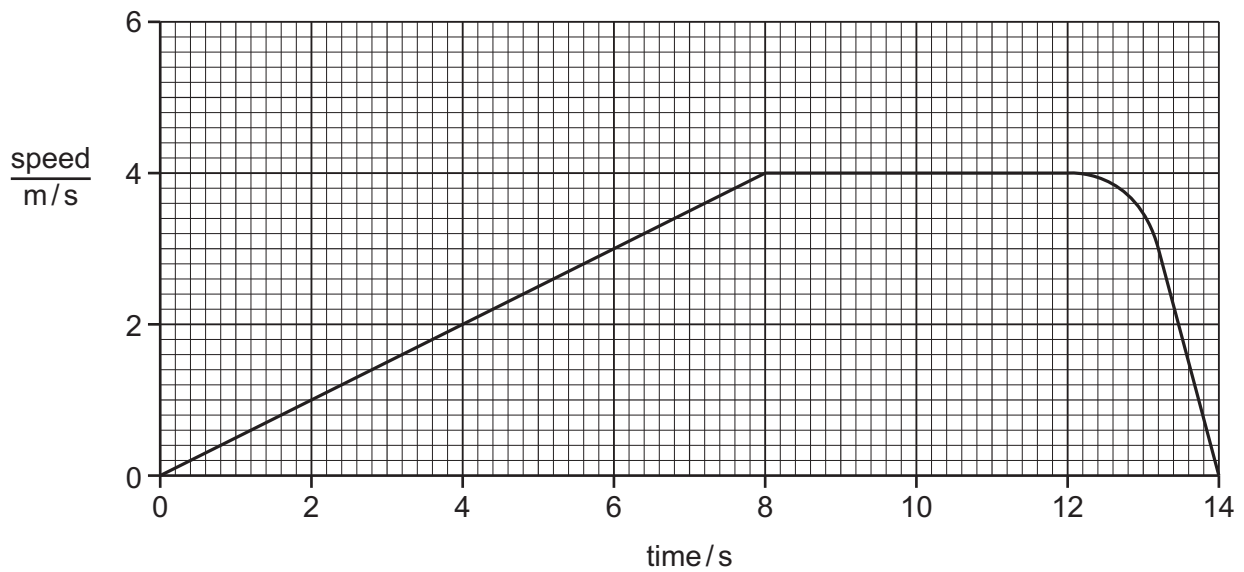


Fig. 6.2

(i) Calculate the acceleration of the T-Rex between 0 s and 8 s.

acceleration = ... m/s^2 [2]

(ii) Describe the motion of the T-Rex between 12 s and 14 s.

.....
 [2]

(iii) Calculate the kinetic energy of the T-Rex when moving at its maximum speed.

kinetic energy = ... J [3]

[Total: 10]

- 7 (a) A student uses the apparatus in Fig. 7.1 to investigate the effect of temperature on the rate of photosynthesis of an aquatic plant.

During photosynthesis, the aquatic plant produces bubbles of gas.

The rate of bubbles produced shows the rate of photosynthesis.

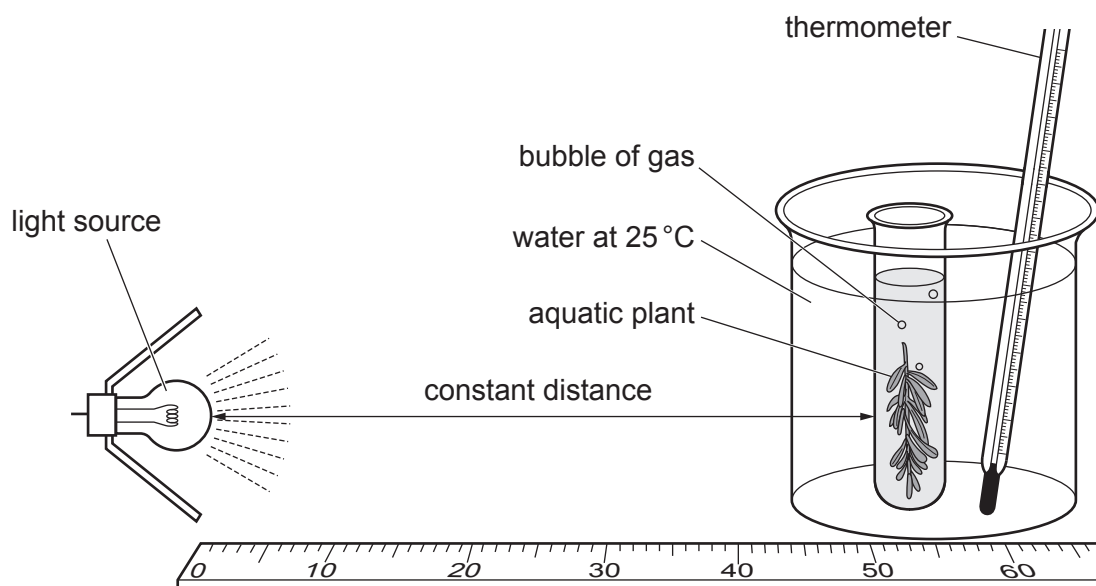


Fig. 7.1

The student counts the number of bubbles produced by the aquatic plant in 3 minutes.

The student does this two more times and calculates the average number of bubbles.

The student then repeats the investigation at different temperatures of water.

Table 7.1 shows the results.

Table 7.1

temperature of water / °C	number of bubbles produced in 3 minutes			
	experiment 1	experiment 2	experiment 3	average
25	56	64	59	60
30	75	78	83	79
35	98	93	97	96
40	78	81	76	78
45	20	21	19	20

- (i) Describe the effect of temperature on the rate of photosynthesis shown by the results in Table 7.1.

.....

.....

..... [2]

- (ii) The process of photosynthesis is controlled by enzymes.

Explain the result at 45 °C in Table 7.1.

Use ideas about enzymes in your answer.

.....

.....

..... [2]

(b) Fig. 7.2 shows a cross-section of a leaf of a plant.

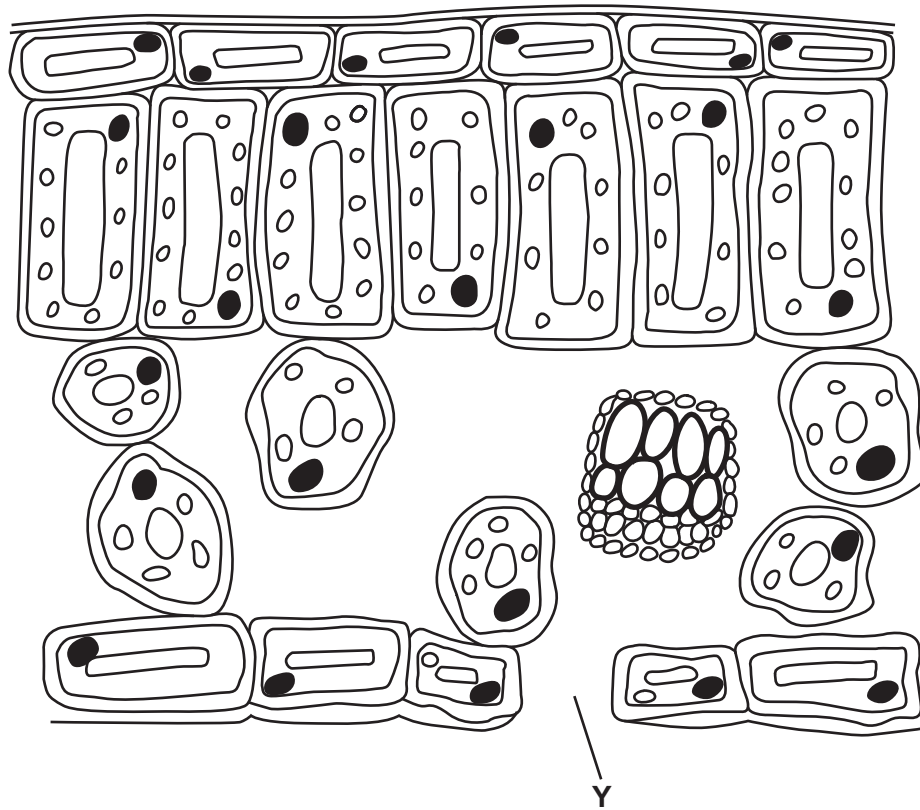


Fig. 7.2

- (i) On Fig. 7.2, draw a label line and the letter **X** to identify cells adapted to synthesise **most** of the carbohydrates made by the leaf. [1]
- (ii) State the function of the part labelled **Y** in Fig. 7.2. [1]
-
- (iii) Explain why a deficiency in magnesium ions results in a reduction in the synthesis of carbohydrates. [3]
-
-
-
-

[Total: 9]

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8 Table 8.1 shows some properties of three elements in Group VII of the Periodic Table.

(a) (i) Complete Table 8.1.

Table 8.1

element	state at room temperature and pressure	colour at room temperature and pressure	melting point /°C	boiling point /°C
chlorine	gas	pale green	−219	−188
bromine	liquid		−7	59
iodine		grey-black	114	184

[2]

(ii) Explain why chlorine, bromine and iodine are in the same group of the Periodic Table.

Use ideas about electrons in your answer.

.....

..... [1]

(b) Fluorine is another element in Group VII.

(i) Fluorine molecules have the formula F_2 . The atoms are held together by a single covalent bond.

Draw a dot-and-cross diagram for a fluorine molecule.

Show the outer electrons only.

[2]

- (ii) Fluorine is a diatomic element.

Explain what is meant by *diatomic element*.

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

- (c) The names of some elements in Group I are listed.

lithium
sodium
potassium
rubidium

- (i) State which Group I element in this list reacts most vigorously with chlorine.

Give a reason for your answer.

element

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

- (ii) State the formula of the compound formed when potassium reacts with chlorine.

Use the Periodic Table on page 24 to help you.

..... [1]

[Total: 10]

9 Fig. 9.1 shows some electrical components of a car.

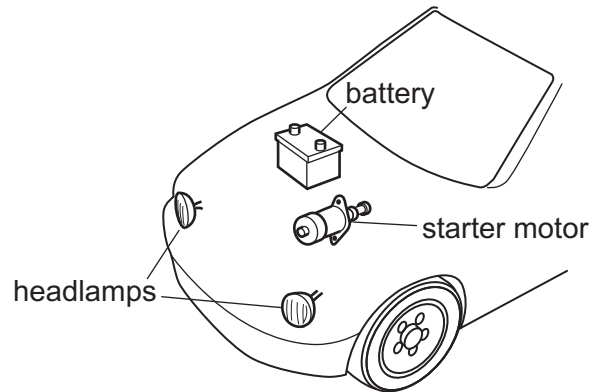


Fig. 9.1

Fig. 9.2 shows a circuit diagram for the components.

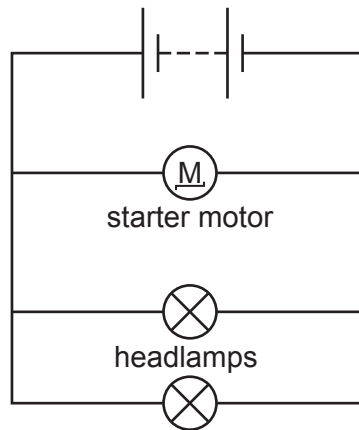


Fig. 9.2

(a) State **one** advantage of connecting the headlamps in parallel.

.....
 [1]

(b) One headlamp requires a current of 5A.

The headlamp is switched on for five hours.

Calculate the total charge that flows through the headlamp in this time.

charge = ... C [3]

(c) The circuit is changed to include two switches, **S1** and **S2**.

- Switch **S1** controls the starter motor but does **not** control the headlamps.
- Switch **S2** controls **both** the headlamps but does **not** control the starter motor.

On Fig. 9.3, complete the circuit diagram to include switches **S1** and **S2**.

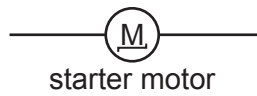
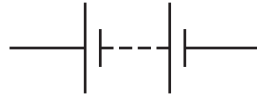


Fig. 9.3

[3]

[Total: 7]

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