



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/41

October/November 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.

- 1 (a) Fig. 1.1 shows the human alimentary canal and some associated organs.

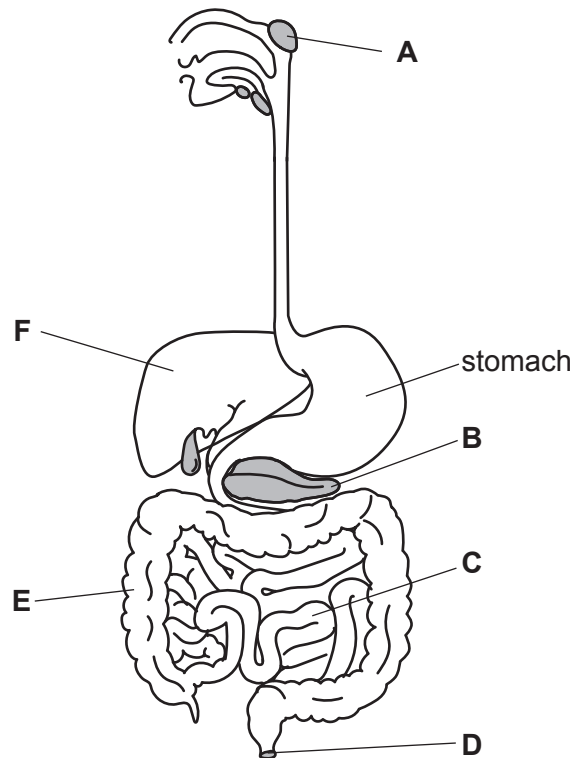


Fig. 1.1

- (i) Table 1.1 shows some of the letters, names and functions of some of the parts in Fig. 1.1.

Complete Table 1.1.

Table 1.1

letter in Fig.1.1	name	function
.....	salivary gland	secretes amylase
B		secretes amylase, protease and lipase
D		

[3]

- (ii) Mechanical digestion takes place in the stomach.

Define mechanical digestion.

.....

.....

..... [2]

(b) Fig. 1.2 shows the effect of pH on the activity of two different enzymes, **Q** and **R**.

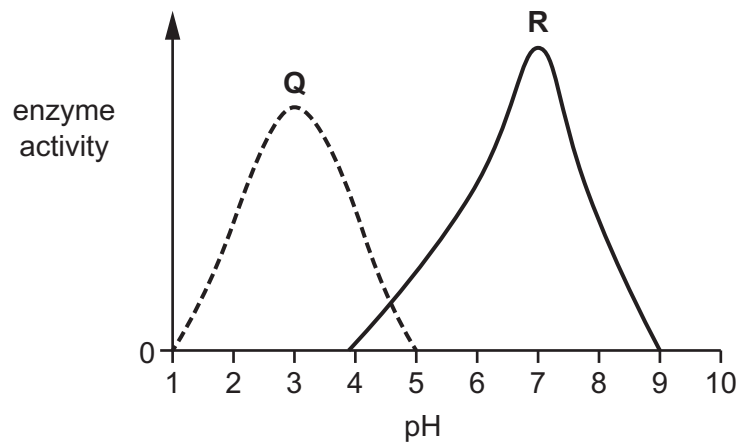


Fig. 1.2

(i) Identify the pH range over which **both** enzymes shown in Fig. 1.2 are active.

Tick (✓) the correct answer.

pH 3–4 ☐

pH 4–5 ☐

pH 5–6 ☐

pH 6–8 ☐

[1]

(ii) Enzyme **R** digests food in the mouth.

Explain why enzyme **R** is **not** active in the stomach.

.....

.....

.....

..... [3]

[Total: 9]

- 2 A student uses inert electrodes to investigate the electrolysis of lead(II) bromide, as shown in Fig. 2.1.

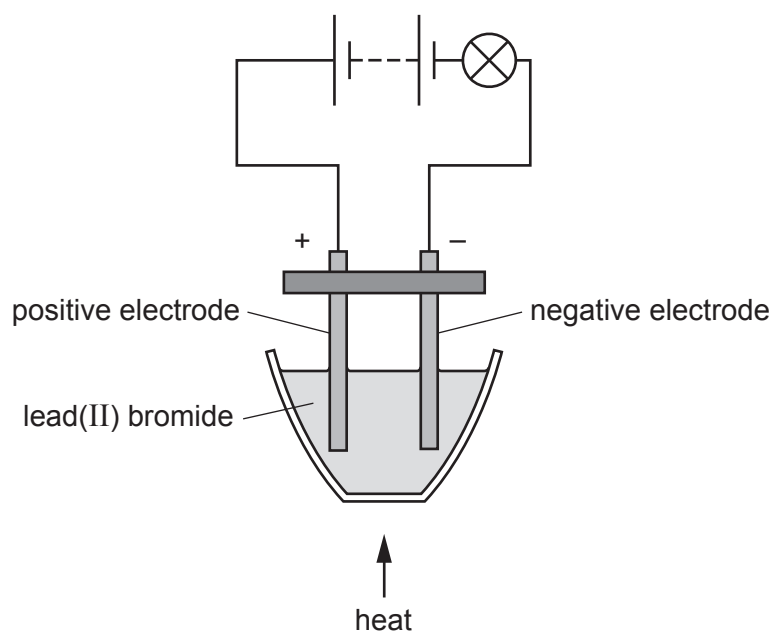


Fig. 2.1

- (a) State the meaning of the term inert.

.....
 [1]

- (b) The lead(II) bromide is heated, and its temperature is recorded.

Table 2.1 shows some of the observations made as the temperature increases.

Table 2.1

temperature / °C	observations
20	no change
100	no change
200	no change
300	no change
400	1. lamp lights up 2. orange vapour seen at positive electrode 3. grey shiny liquid collects below negative electrode

- (i) Suggest why no change is observed at the first four temperatures recorded in Table 2.1.

.....
 [1]

(ii) Explain the **three** observations made at 400 °C.

- 1
-
- 2
-
- 3
-
- [3]

(c) The student repeats the investigation using lead(II) chloride instead of lead(II) bromide.

(i) Two products are formed in the electrolysis of lead(II) chloride.

Write the name and formula of each product.

product 1

name formula

product 2

name formula

[2]

(ii) Suggest **one** difference in the observations made when lead(II) chloride is electrolysed instead of lead(II) bromide.

.....

..... [1]

[Total: 8]

- 3 Fig. 3.1 shows the names of the forces acting on an aircraft flying at a constant speed and at a constant height above the ground.

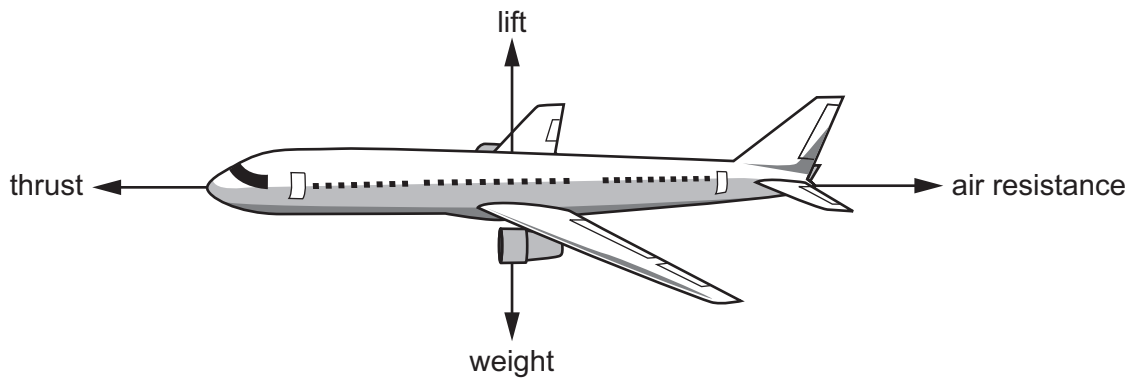


Fig. 3.1

- (a) (i) State the name of the force in Fig. 3.1 caused by friction.

..... [1]

- (ii) Use the names of the forces in Fig. 3.1 to complete the sentence.

The aircraft is flying at a constant speed and at a constant height, so the thrust must be equal to the, and the must be equal to the

[1]

- (b) The aircraft travels a distance of 2170 km at an average speed of 620 km/h.

Calculate the time in hours for this journey.

time = ... h [2]

- (c) The aircraft has a mass of 190 000 kg.

The maximum speed of the aircraft is 720 km/h.

Calculate the kinetic energy of the aircraft at maximum speed.

kinetic energy = ... J [3]

[Total: 7]

- 4 (a) Fig. 4.1 shows part of the breathing system in humans.

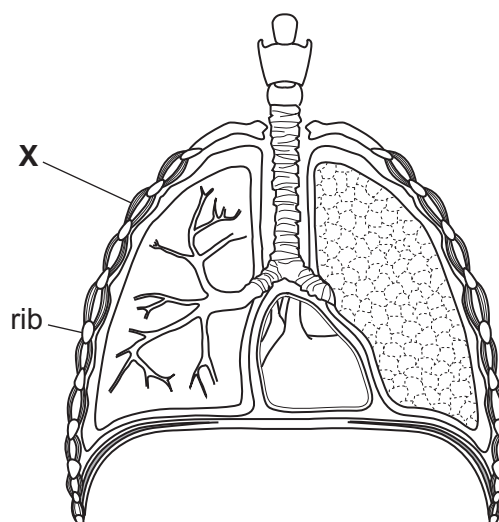


Fig. 4.1

State the name of the part labelled **X** in Fig. 4.1.

..... [1]

- (b) Alveoli are the gas exchange surface in humans.

State **one** feature of the gas exchange surface in humans.

..... [1]

- (c) Complete the sentences about the differences in composition between expired and inspired air.

Expired air contains more carbon dioxide than inspired air. This is because
carbon dioxide is made in cells by the process of

Expired air also contains more than inspired air.

[2]

(d) Fig. 4.2 shows cells that line the bronchi.

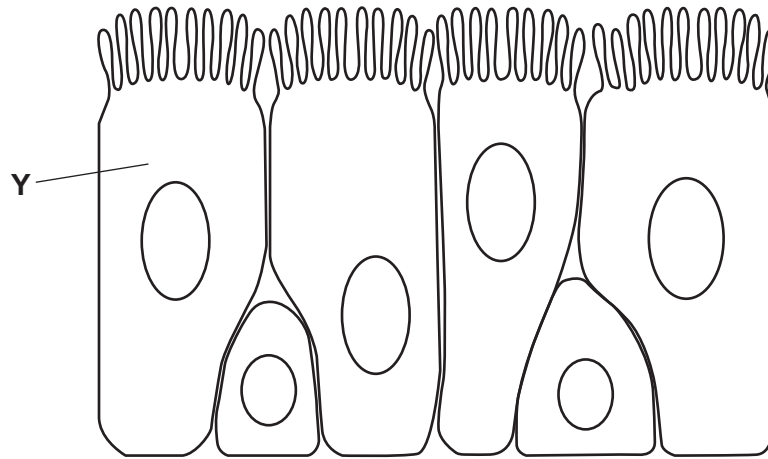


Fig. 4.2

Describe how cell **Y** is adapted to its function.

.....

.....

..... [2]

(e) Tobacco smoking affects the body.

The boxes on the left show different components of tobacco smoke.

The boxes on the right show the effects of these components on the body.

Draw **one** straight line from each component to its effect.

component	effect
carbon monoxide	addiction
nicotine	lung cancer
tar	reduced oxygen transport by red blood cells

[1]

[Total: 7]

- 5 A student does five experiments to investigate the reaction between zinc granules and dilute hydrochloric acid.

In each experiment, the student measures the volume of gas produced during the first 10 s of the reaction, using the apparatus shown in Fig. 5.1.

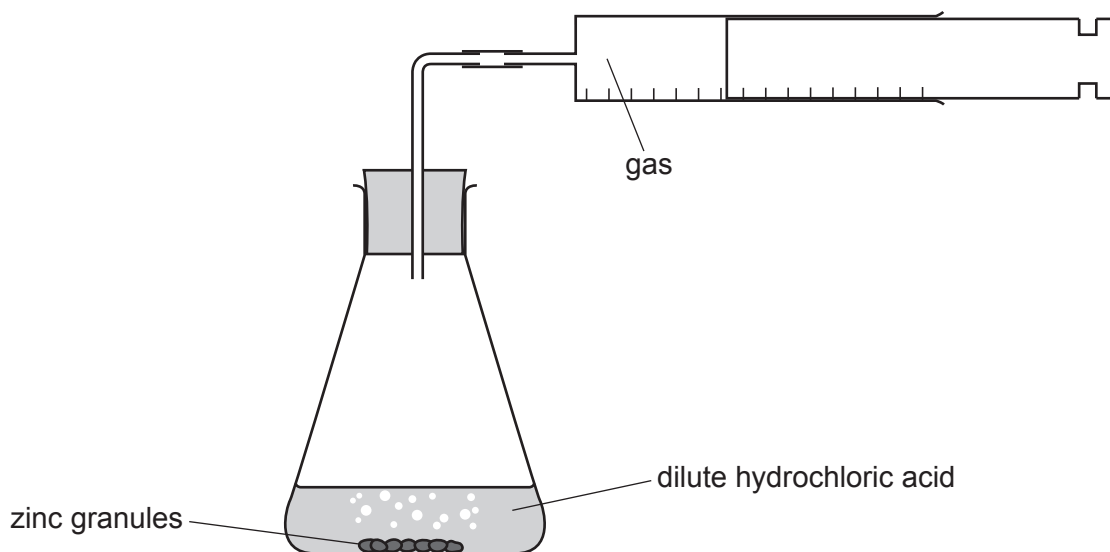


Fig. 5.1

The student uses the same mass of zinc granules and the same volume of dilute hydrochloric acid in each experiment.

The student uses different temperatures and different concentrations of dilute hydrochloric acid.

Table 5.1 shows the results.

Table 5.1

experiment	temperature of acid / °C	concentration of acid mol/dm ³	volume of gas produced /cm ³
1	20	1.0	25
2	20	1.5	38
3	30	1.0	45
4		1.0	15
5	20		9

(a) Suggest a value for:

- the temperature of acid used in experiment 4 °C
- the concentration of acid used in experiment 5. mol/dm³

[2]

- (b) Explain why the results for experiments 1 and 2 are different.

Use ideas about reacting particles in your answer.

.....

.....

..... [2]

- (c) State which experiment listed in Table 5.1 contains the most colliding particles that have the minimum energy (activation energy) to react.

Give a reason for your answer.

experiment

reason

..... [2]

- (d) The student repeats experiment 1 using different metals.

Table 5.2 shows the results.

Table 5.2

metal	volume of gas produced / cm ³
zinc	25
iron	14
magnesium	34

- (i) Explain the differences in the results.

.....

.....

..... [2]

- (ii) Suggest what is observed when copper is used instead of zinc.

Give a reason for your answer.

observation

reason

[1]

[Total: 9]

- 6 (a) Fig. 6.1 shows an incomplete circuit diagram for the heater, two headlamps and two rear lamps in a car.

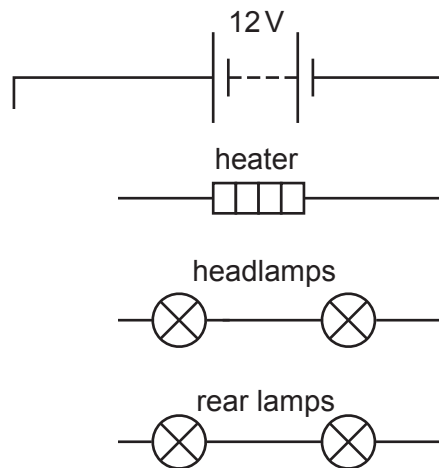


Fig. 6.1

- (i) The headlamps and rear lamps are switched on at the same time by one switch, **S1**.

The heater is switched on separately by switch **S2**.

Complete and label the circuit diagram in Fig. 6.1 to show the positions of switches **S1** and **S2**. [3]

- (ii) Fig. 6.2 shows the four lamps connected together.

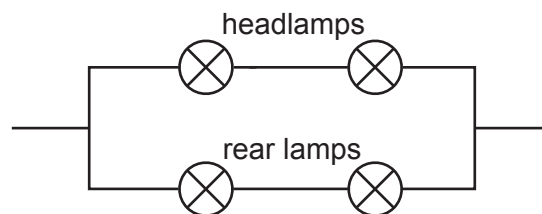


Fig. 6.2

Each headlamp has a resistance of $7.0\ \Omega$.

Each rear lamp has a resistance of $3.5\ \Omega$.

Calculate the total resistance of the four lamps connected together.

resistance = ... Ω [3]

(b) Fig. 6.3 shows the circuit for the starter motor of the car.

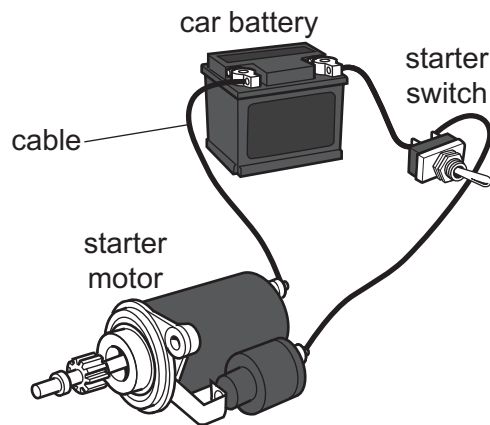


Fig. 6.3

- (i) There is a current of 150A in the starter motor.

Calculate the charge that flows through the starter motor in 30 s.

charge = ... C [2]

- (ii) The cables in the circuit contain very thick copper wires.

Suggest why the wires are very thick.

.....

 [2]

[Total: 10]

- 7 (a) Fig. 7.1 shows an insect-pollinated flower.



Fig. 7.1

- (i) Draw a label line and the letter **C** to identify a carpel in Fig. 7.1. [1]

- (ii) State **two** pieces of evidence that show the flower in Fig. 7.1 is insect-pollinated.

1

2

[2]

- (b) Complete the sentence about the role of chlorophyll in a plant.

Chlorophyll transfers into

energy for the of the carbohydrate glucose.

[2]

- (c) In plants, glucose is converted into the sugar sucrose for transport. Glucose is also converted into a carbohydrate for storage.

- (i) State the name of the structure in plants used to transport the sugar sucrose.

..... [1]

- (ii) State the name of the carbohydrate used for storage.

..... [1]

- (d) Fig. 7.2 shows cells from a plant before and after being immersed in a concentrated sugar solution.

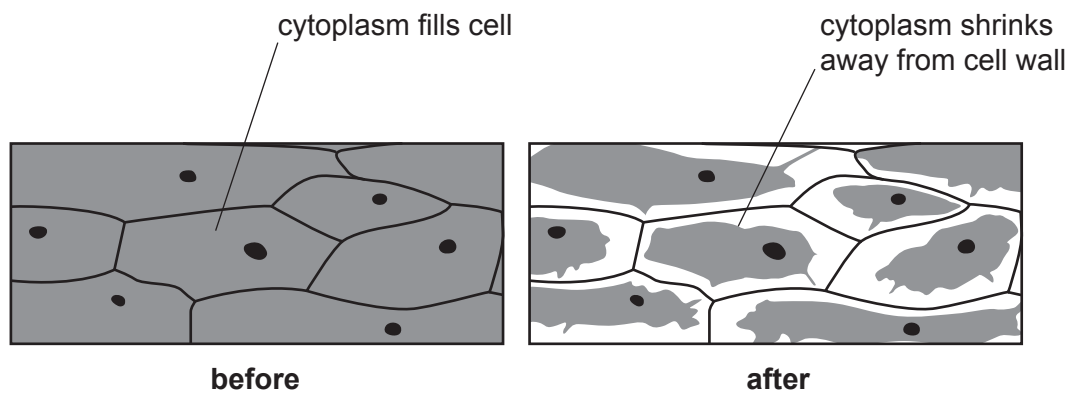


Fig. 7.2

The change seen in Fig. 7.2 is due to movement of water.

Explain the change in the cells shown in Fig. 7.2.

Use the term water potential in your answer.

.....

.....

.....

.....

..... [4]

[Total: 11]

- 8 Table 8.1 gives information on the percentage composition of the atmosphere of the planet Mars.

Table 8.1

gas	percentage of the atmosphere of Mars
carbon dioxide	95.0
nitrogen	1.9
argon	1.9

- (a) (i) State how Table 8.1 shows that the atmosphere of Mars contains gases that are **not** listed in Table 8.1.

.....
 [1]

- (ii) Describe how the percentage composition of the atmosphere of Earth is different from that of Mars.

.....

 [3]

- (b) The bonding in carbon dioxide and nitrogen is represented in Fig. 8.1.



carbon dioxide



nitrogen

Fig. 8.1

- (i) State the number of electrons that are shared between atoms in one molecule of nitrogen.

..... [1]

- (ii) Complete Fig. 8.2 to show the dot-and-cross diagram for carbon dioxide.

Show only the outer shell electrons.

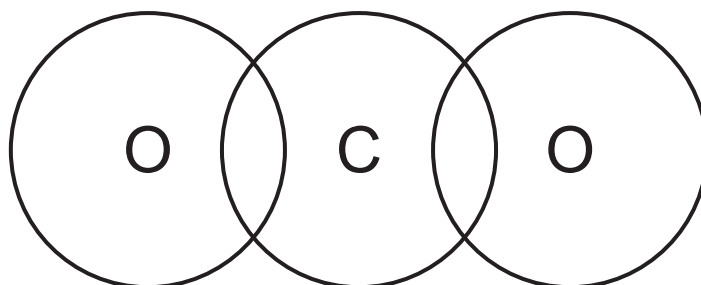


Fig. 8.2

[2]

- (iii) The percentage of carbon dioxide in Earth's atmosphere is increasing.

State how this affects the environment.

.....

.....

..... [2]

[Total: 9]

- 9 (a) Fig. 9.1 represents a sound wave in air.

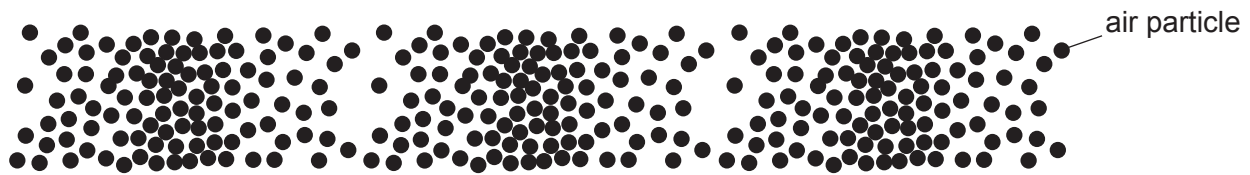


Fig. 9.1

- (i) On Fig. 9.1, draw:

- a label line and the letter **C** to the centre of a compression
- a label line and the letter **R** to the centre of a rarefaction.

[1]

- (ii) The speed of sound in air is 330 m/s.

Calculate the frequency of a sound wave with a wavelength of 1.5 m.

Give the unit of frequency.

frequency = ... unit [3]

- (b) Fig. 9.2 shows the seven regions of the electromagnetic spectrum.

← increasing frequency						
gamma radiation	X-rays	ultraviolet	visible light	infrared	microwaves	radio waves

Fig. 9.2

- (i) State which region of the electromagnetic spectrum has the greatest wavelength.

..... [1]

- (ii) State the speed of electromagnetic waves in a vacuum.

..... [1]

(iii) Electromagnetic waves are transverse waves.

Sound waves are longitudinal waves.

Describe the difference between a transverse wave and a longitudinal wave.

.....

.....

.....

..... [2]

(c) Fig. 9.3 shows how rays from an object close to a thin converging lens are focused to form an image on the screen.

F represents the principal focus of the lens.

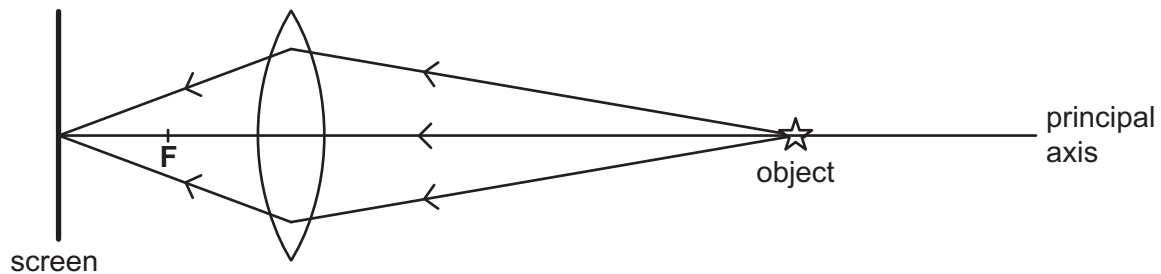


Fig. 9.3

The object is now moved very far away from the lens.

Explain why the lens must be moved closer to the screen to focus the image on the screen.

.....

.....

..... [2]

[Total: 10]

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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													5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19		
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			
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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0653/42

October/November 2023

1 hour 15 minutes

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- The Periodic Table is printed in the question paper.

This document has **20** pages. Any blank pages are indicated.

- 1 (a) (i) Fig. 1.1 shows the transfer of pollen from flower **A** to flower **B**.

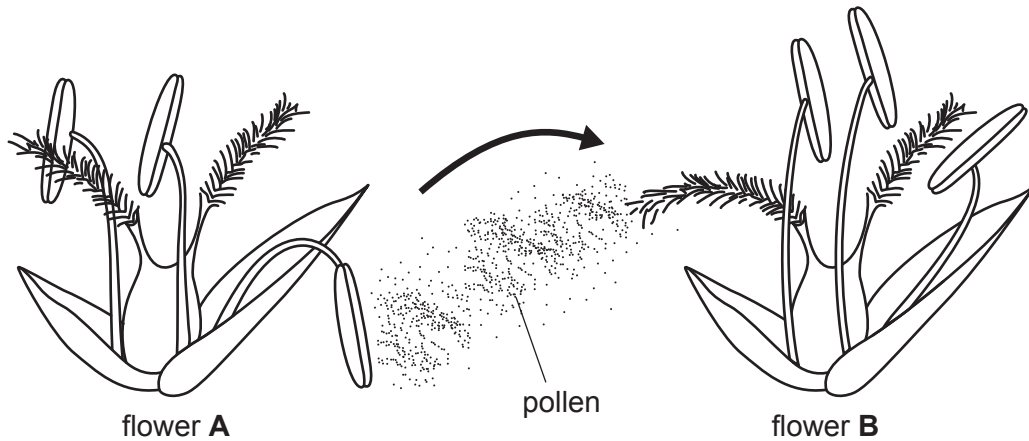


Fig. 1.1

Complete the sentences about Fig. 1.1.

The pollen is transferred from the anthers of flower **A** to the
of flower **B**. The anthers of flower **A** are outside the flower because the agent of
pollination is

[2]

- (ii) Fig. 1.2 is a photomicrograph of a pollen grain with air sacs.

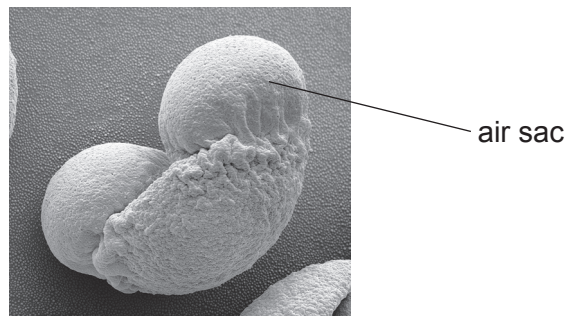


Fig. 1.2

Suggest how air sacs help with the transfer of pollen.

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

- (b) Plants can produce offspring by either sexual reproduction or asexual reproduction.

Sexual reproduction uses gametes. Asexual reproduction does not use gametes.

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

- 1
- 2

[2]

- (c) The male gametes in humans are called sperm.

- (i) Complete Fig. 1.3 to show the pathway of sperm during sexual reproduction.

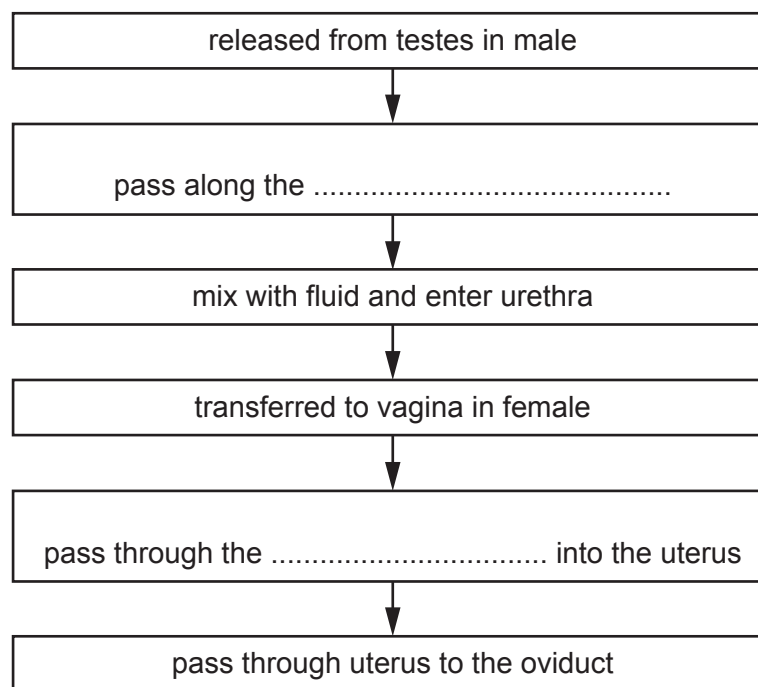


Fig. 1.3

[2]

- (ii) State **two** ways that sperm are adapted for their function.

- 1
- 2

[2]

[Total: 9]

2 (a) Magnesium chloride is a soluble salt.

Magnesium chloride is made in the reaction between solid magnesium oxide and a dilute acid. The apparatus used is shown in Fig. 2.1.

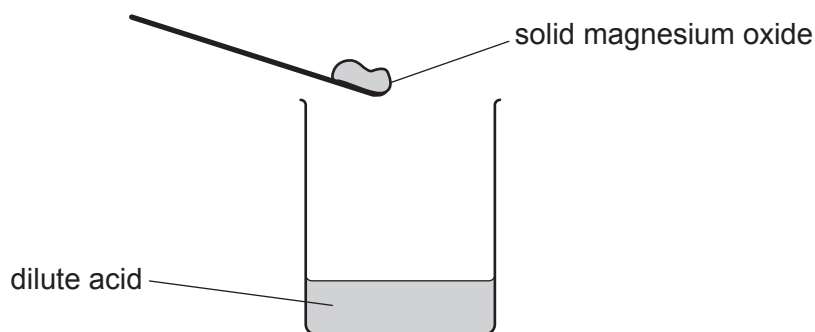


Fig. 2.1

(i) State the name of the acid that reacts with magnesium oxide to form magnesium chloride.

..... [1]

(ii) State the name of the other product of the reaction.

..... [1]

(iii) Magnesium oxide is insoluble in water.

Describe a method to make magnesium chloride crystals from magnesium oxide and dilute acid.

.....
.....
.....
.....
..... [3]

- (b) A student dissolves solid magnesium chloride in one beaker containing water at 20°C and solid potassium chloride in a second beaker containing water at 20°C.

The student measures the temperature of the solution in each beaker after the solids dissolve.

Table 2.1 shows some of the results.

Table 2.1

solid	formula	temperature of solution after solid dissolves /°C	type of reaction
magnesium chloride	MgCl_2	26	exothermic
potassium chloride	KCl		endothermic

- (i) Suggest a value for the temperature of the solution after the potassium chloride dissolves.

temperature = ... °C [1]

- (ii) State why the temperature increases for the exothermic reaction in Table 2.1.

.....
 [1]

- (iii) Explain why magnesium chloride and potassium chloride contain different numbers of chloride ions.

Use the Periodic Table to help you.

.....
 [1]

[Total: 8]

3 Fig. 3.1 shows a truck.

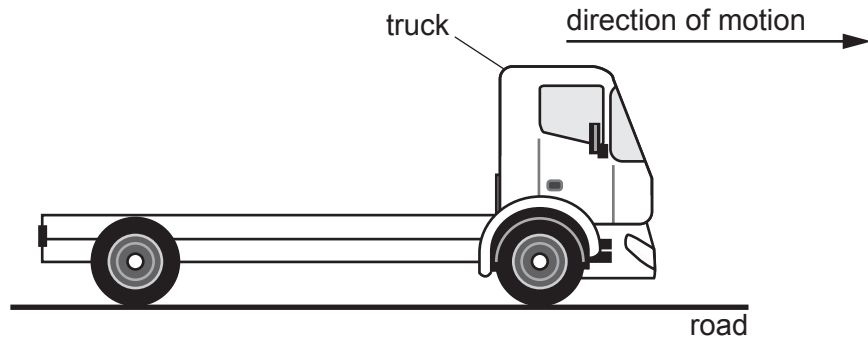


Fig. 3.1

(a) Fig. 3.2 shows a speed–time graph for the motion of the truck on a journey.

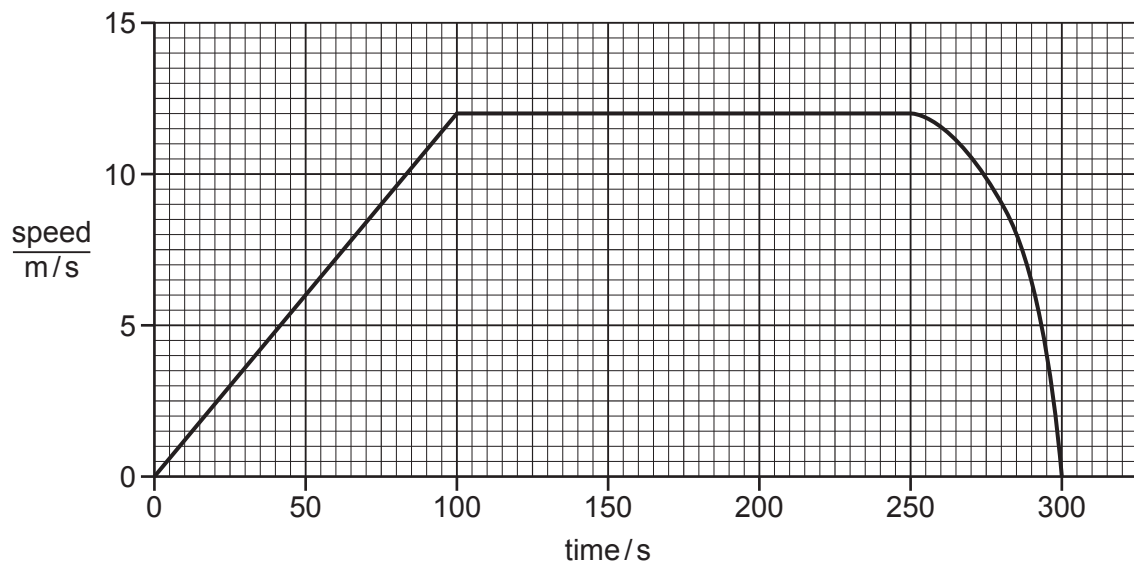


Fig. 3.2

(i) State the time taken by the truck to slow down from maximum speed to a stop.

time = ... s [1]

(ii) On Fig. 3.2, mark with an **X** a point on the graph when the truck is moving at constant speed. [1]

(iii) Calculate the distance travelled by the truck between $t = 0$ and $t = 100$ s.

distance = ... m [2]

- (b) A load of mass 2500 kg is lifted from the ground onto the back of the truck.

The load is lifted a vertical height of 0.95 m.

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

- (i) Suggest a value for the minimum force required to lift the load from the ground.

Give a reason for your answer.

minimum force = ... N

reason

..... [3]

- (ii) Calculate the change in gravitational potential energy (GPE) of the load.

change in GPE = ... J [2]

- (c) The truck is moving along a level road at a constant speed.

Explain why the truck continues to use fuel.

.....

.....

..... [2]

[Total: 11]

4 (a) Fig. 4.1 shows a food web.

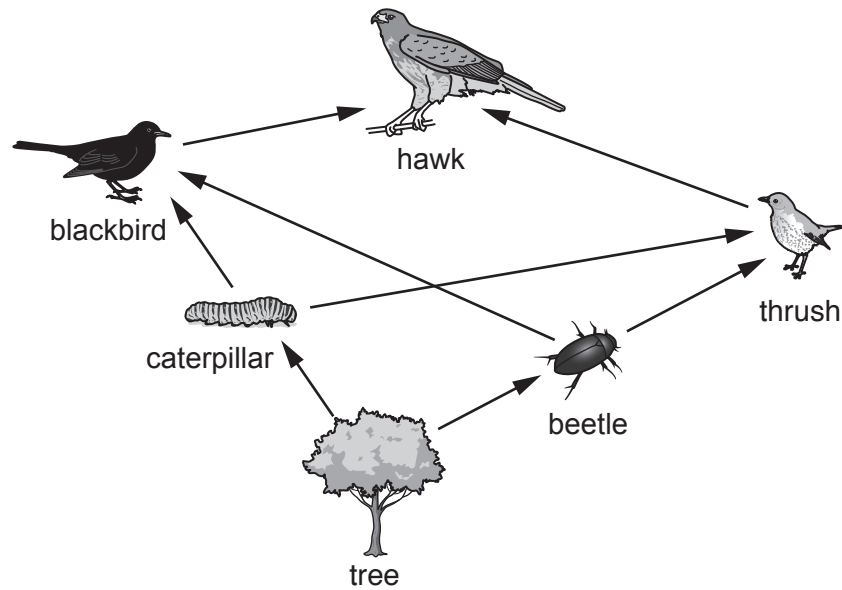


Fig. 4.1

(i) Table 4.1 shows some terms that can be used to describe some of the organisms in Fig. 4.1.

Complete Table 4.1 by placing ticks (✓) in the boxes to show all the terms used to describe each organism.

Table 4.1

organism	carnivore	primary consumer	occupies trophic level 3
blackbird			
caterpillar			
hawk			
thrush			

[3]

(ii) Explain why there are no trophic levels above the hawk.

Use ideas about energy in your answer.

.....

.....

.....

..... [3]

(b) Older trees store more carbon than younger trees.

Scientists record the total number of trees of different species in two forest ecosystems:

- a young forest area where all the trees are less than 20 years old
- a mature forest area where all the trees are over 50 years old.

Fig. 4.2 shows a bar chart of the results.

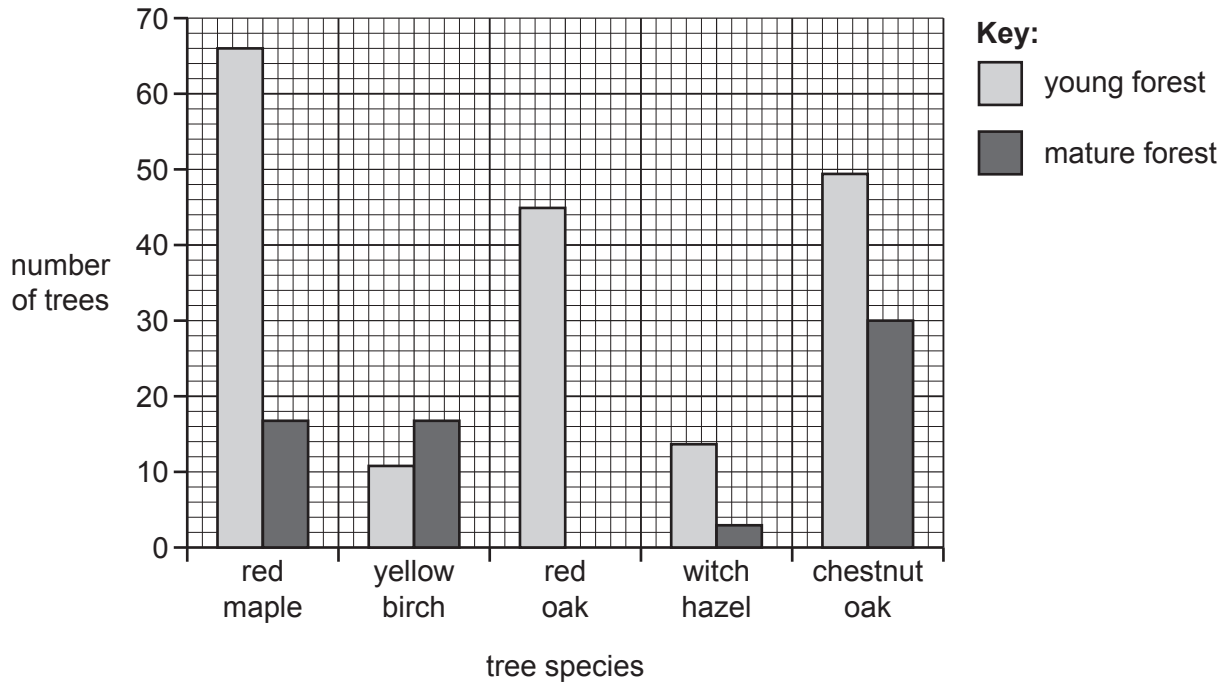


Fig. 4.2

(i) The scientists discover that there is more carbon stored in the young forest area.

Use Fig. 4.2 to explain why.

.....
 [1]

(ii) Identify the tree species in Fig. 4.2 that is **not** found in the mature forest area.

..... [1]

(c) Describe how light energy is used in the production of starch in trees.

.....

 [4]

- 5 A student investigates the reaction of dilute hydrochloric acid with different metals.

The student measures the volume of gas produced during the first 20 s of each reaction using the apparatus shown in Fig. 5.1.

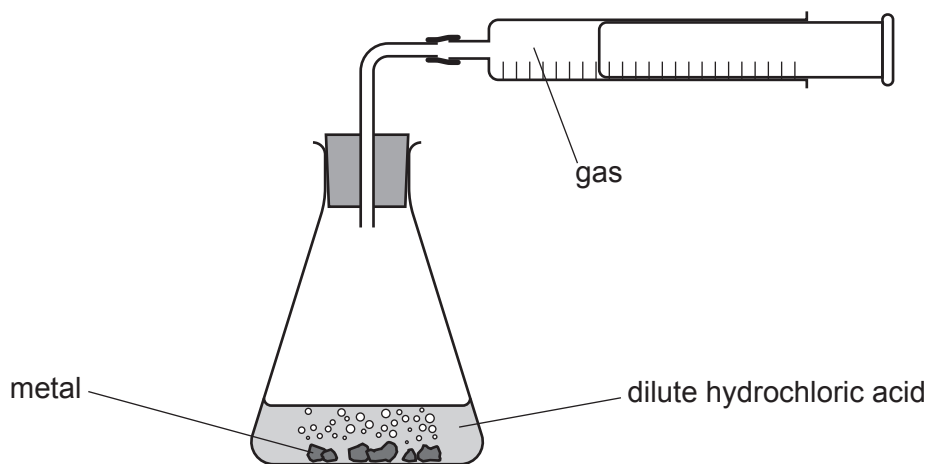


Fig. 5.1

- (a) The results for three metals are shown in Table 5.1.

Table 5.1

metal	volume of gas produced / cm ³
magnesium	38
zinc	30
copper	0

- (i) State which metal listed in Table 5.1 has the greatest tendency to form positive ions.

Give a reason for your answer.

metal

reason

[1]

- (ii) State which metal listed in Table 5.1 is less reactive than hydrogen.

Give a reason for your answer.

metal

reason

[1]

- (iii) The student repeats the experiment using iron.

Predict the volume of gas produced after 20 s.

Give a reason for your answer.

volume cm^3

reason

.....

[2]

- (b) The student repeats the experiment for magnesium using dilute hydrochloric acid at a higher temperature.

All other conditions are kept the same.

- (i) State the effect of using a higher temperature on the volume of gas produced after 20 s.

Explain your answer using ideas about energy and particles.

effect

explanation

.....

.....

[3]

- (ii) At the end of this reaction, some magnesium remains.

The reaction mixture is tested with universal indicator at the start and at the end of the reaction.

Suggest the pH of the reaction mixture at the start and at the end of the reaction.

Explain your answer.

pH at start

pH at end

explanation

.....

[2]

[Total: 9]

- 6 Fig. 6.1 shows a lighthouse used at night to warn ships of dangerous rocks in the sea.

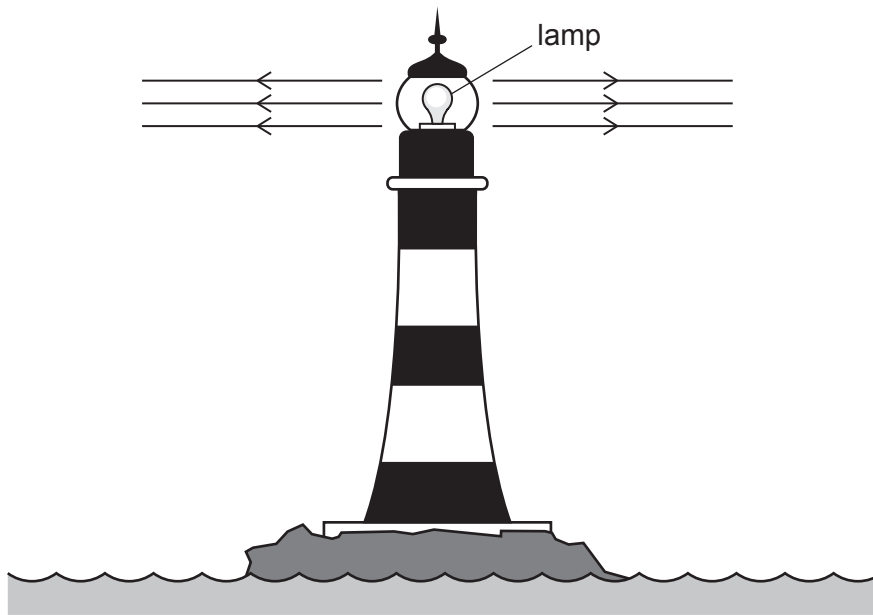


Fig. 6.1

- (a) Light from the lamp in the lighthouse is focused to form two parallel beams using two identical thin converging lenses.

The lamp is centred between the two lenses at point **P**, as shown in Fig. 6.2.



Fig. 6.2

- (i) Complete Fig. 6.2 to show how **six** rays from the lamp at point **P** form the two beams from the lenses. [1]
- (ii) The distance between the lenses is 1.2 m.

State the focal length of each lens.

focal length = ... m [1]

- (b) Fig. 6.3 shows a large foghorn that is also used to warn ships.



Fig. 6.3

In foggy or cloudy weather, the foghorn makes a loud sound that can be heard over long distances.

- (i) The wavelength of the sound from the foghorn is 75 cm.

Calculate the frequency of the sound.

The speed of sound in air is 330 m/s.

frequency = ... Hz [3]

- (ii) The foghorn is operated by a high-powered diesel engine.

Suggest why the diesel engine needs to be high powered to produce the loud sound.

Use the word amplitude in your answer.

.....

 [2]

- (c) Radio waves are used in radar systems for ships.

Fig. 6.4 shows an incomplete electromagnetic spectrum.

Write radio waves on Fig. 6.4 in the correct place.

← increasing frequency						
			visible light	infrared		

Fig. 6.4

[1]

[Total: 8]

- 7 (a) Explain **one** way the structure of an artery is adapted to its function.

.....

.....

..... [2]

- (b) The photomicrograph in Fig. 7.1 shows a blockage in a coronary artery.

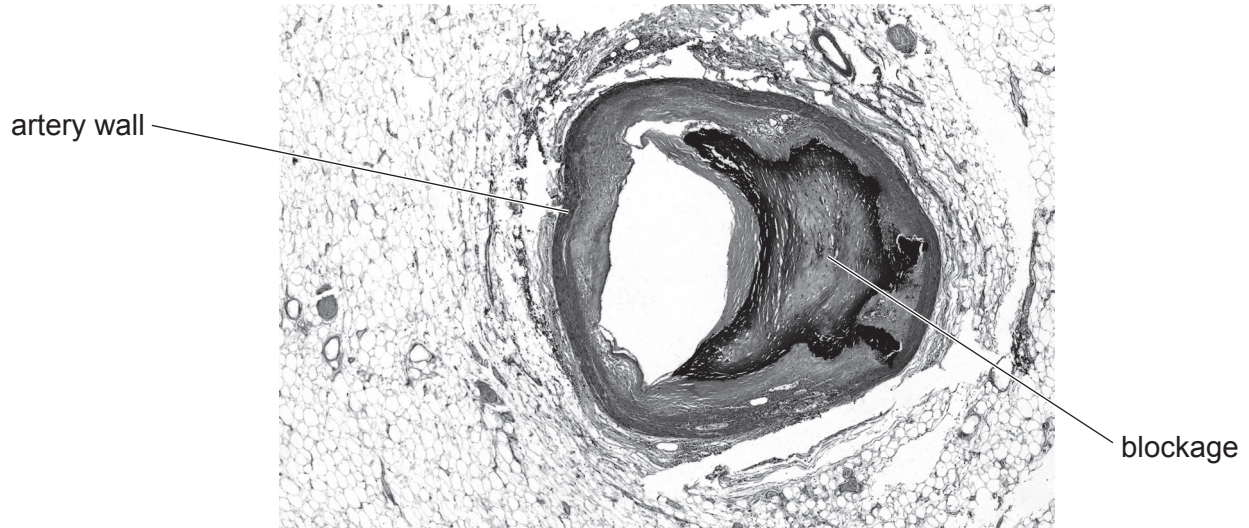


Fig. 7.1

- (i) Explain how the blockage reduces the amount of oxygen reaching the wall of the heart.

.....

.....

..... [2]

- (ii) State **two** possible risk factors for coronary heart disease.

1

2 [2]

[Total: 6]

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- 8 (a) Iron is extracted from hematite in a blast furnace.

The chemical equation for one of the reactions in the blast furnace is shown.



- (i) Complete the balanced chemical equation. [1]

- (ii) State the name of the reducing agent in this reaction.

Give a reason for your answer.

reducing agent

reason

..... [2]

- (b) Identical iron nails **A** and **B** are placed in separate test-tubes.

Oil is added to the test-tube with iron nail **B**, as shown in Fig. 8.1.

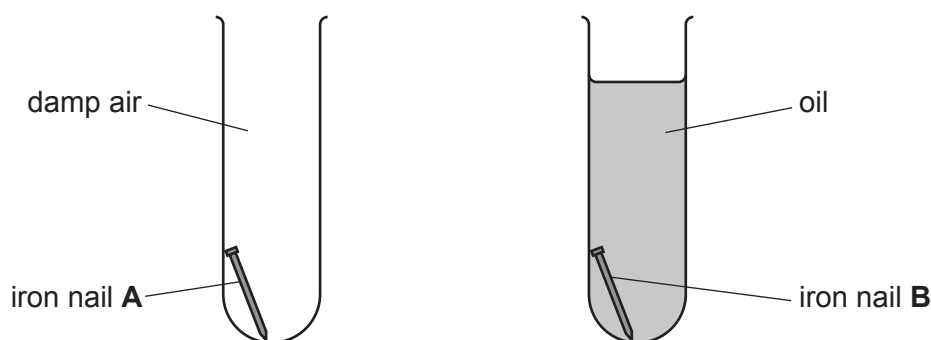


Fig. 8.1

After one week, a layer of rust has formed on iron nail **A**. Iron nail **B** is unchanged.

- (i) Describe how oil prevents iron nail **B** from rusting.

.....

 [2]

- (ii) State **one** other method of rust prevention.

..... [1]

- (c) The electronic structure of an oxygen atom is shown in Fig. 8.2.

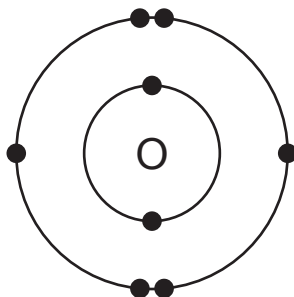


Fig. 8.2

- (i) Describe how the electronic structure of this atom relates to the group of the Periodic Table to which oxygen belongs.

.....
 [1]

- (ii) Complete Fig. 8.3 to show the dot-and-cross diagram of a molecule of oxygen, O_2 .

Show only the outer shell electrons.

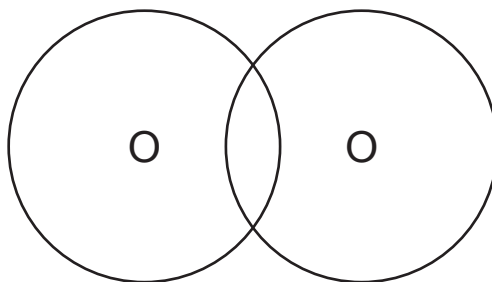


Fig. 8.3

[2]

[Total: 9]

- 9 Fig. 9.1 shows two identical floodlights, **F** and **G**, at a sports ground.

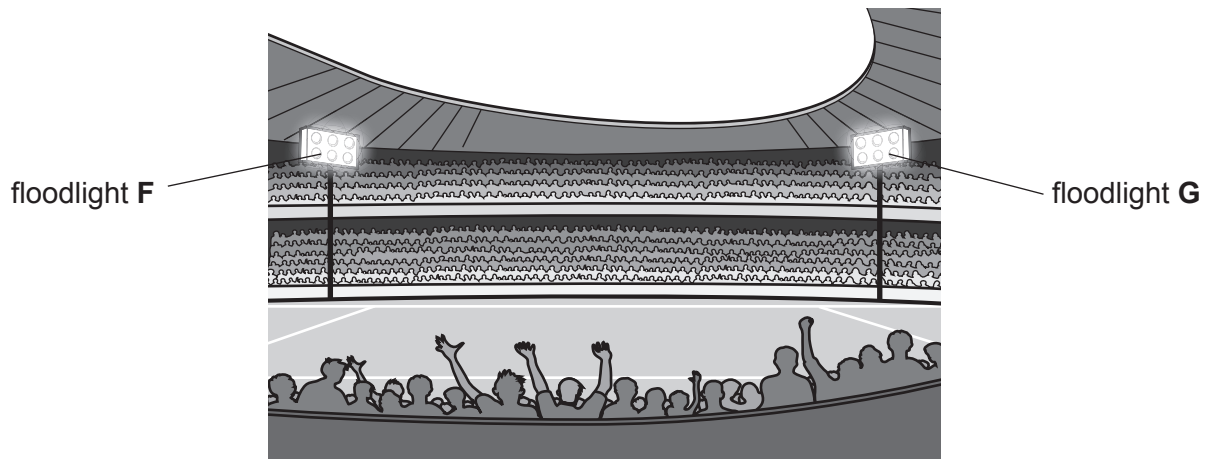


Fig. 9.1

Fig. 9.2 shows a wind turbine used to generate electricity for the two floodlights.

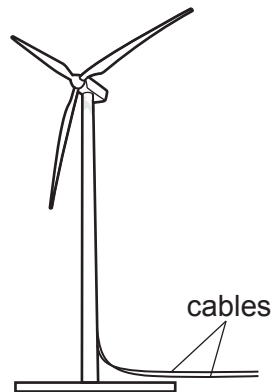


Fig. 9.2

The wind turbine generates an electromotive force (e.m.f.) of 240 V .

There is a current of 18 A in each cable from the wind turbine.

- (a) Calculate the power output from the turbine.

Give the unit of your answer.

power = ... unit [3]

- (b) The two identical floodlights are connected to the wind turbine by cables.

Table 9.1 gives information about the current in each floodlight, and the distance of each floodlight from the wind turbine.

Table 9.1

floodlight	current in floodlight /A	distance from wind turbine /m
F	12.0	200
G	6.0	400

- (i) State the type of circuit connection from the wind turbine to the two floodlights.

Give a reason for your answer.

type of circuit connection

reason

[2]

- (ii) Explain why the current in floodlight **G** is half the current in floodlight **F**.

.....

 [3]

[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 —	113 Nh nihonium —	114 Fl flerovium —	115 Lv livermorium —	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.).



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/43

October/November 2023

1 hour 15 minutes

You must answer on the question paper.

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 **24** pages. Any blank pages are indicated.

- 1 (a) Fig. 1.1 shows part of the breathing system in humans.

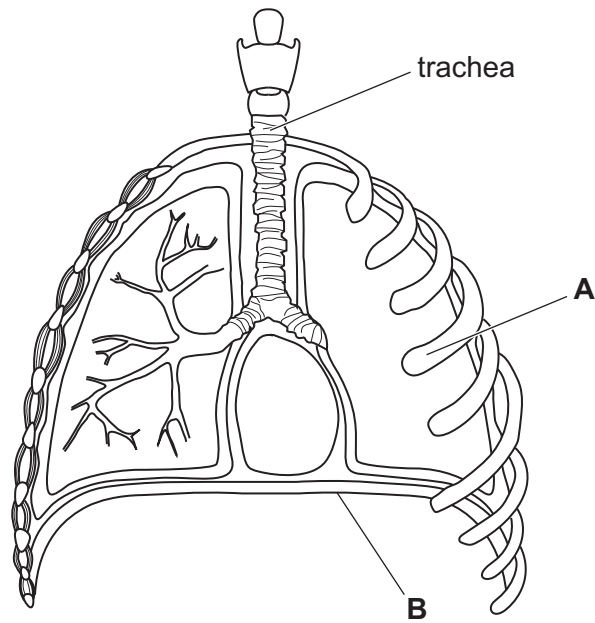


Fig. 1.1

- (i) State the names of the parts labelled **A** and **B** in Fig. 1.1.

A

B

[2]

- (ii) Describe how goblet cells protect the lining of the trachea.

.....

.....

..... [2]

- (b) The breathing rate of four students is measured before and during physical activity.

Table 1.1 shows the results.

Table 1.1

student	breathing rate / breaths per minute		
	before physical activity	during physical activity	difference
1	18	33	15
2	14	32	18
3	16	35	19
4	17	38	21

- (i) Identify the student in Table 1.1 with the lowest breathing rate **before** physical activity.

..... [1]

- (ii) Calculate the average difference in breathing rate.

Give your answer to the nearest whole number.

average difference = ... breaths per minute [2]

- (iii) Explain the effect of physical activity on breathing rate shown in Table 1.1.

Include ideas about carbon dioxide in your answer.

.....

 [3]

[Total: 10]

- 2 Fig. 2.1 shows the electrolysis of concentrated aqueous sodium chloride using platinum electrodes.

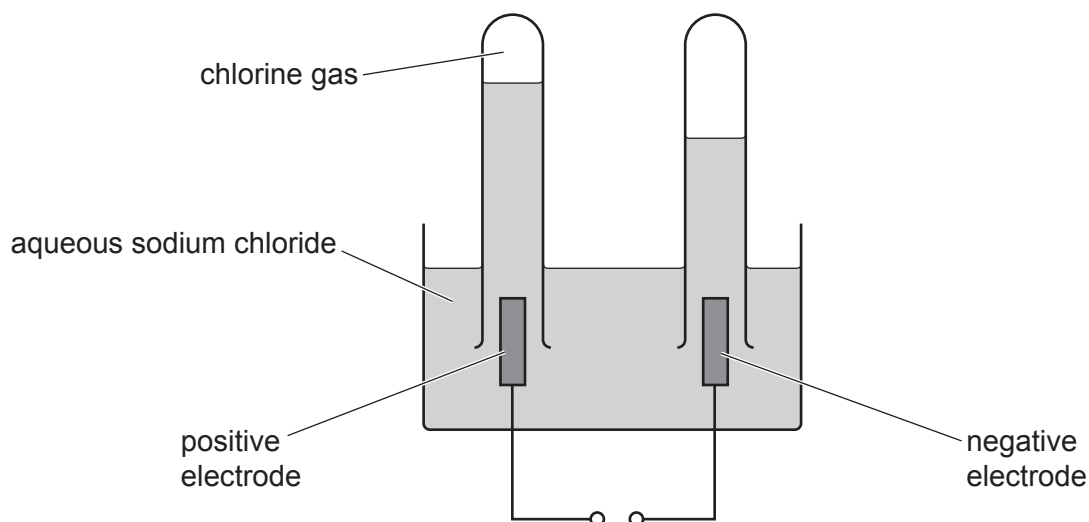


Fig. 2.1

- (a) Some information about ions in the solution is shown in Table 2.1.

Table 2.1

name of ion	formula of ion	source of ion	concentration of ion during the electrolysis
chloride	Cl^-	sodium chloride	decreases
hydrogen		water	
hydroxide	OH^-		stays the same
sodium		sodium chloride	

- (i) Complete Table 2.1. [3]
- (ii) Describe what happens to the chloride ions at the positive electrode during the electrolysis.

Use ideas about ions, electrons, atoms and molecules in your answer.

.....

.....

.....

..... [3]

(b) Platinum is a transition element.

(i) State **one** property of platinum that makes it suitable to use as an electrode.

..... [1]

(ii) State **two** other properties of transition elements that are **not** properties of Group I elements.

1

2 [2]

[Total: 9]

- 3 Fig. 3.1 shows a firefighter standing next to a fire engine.

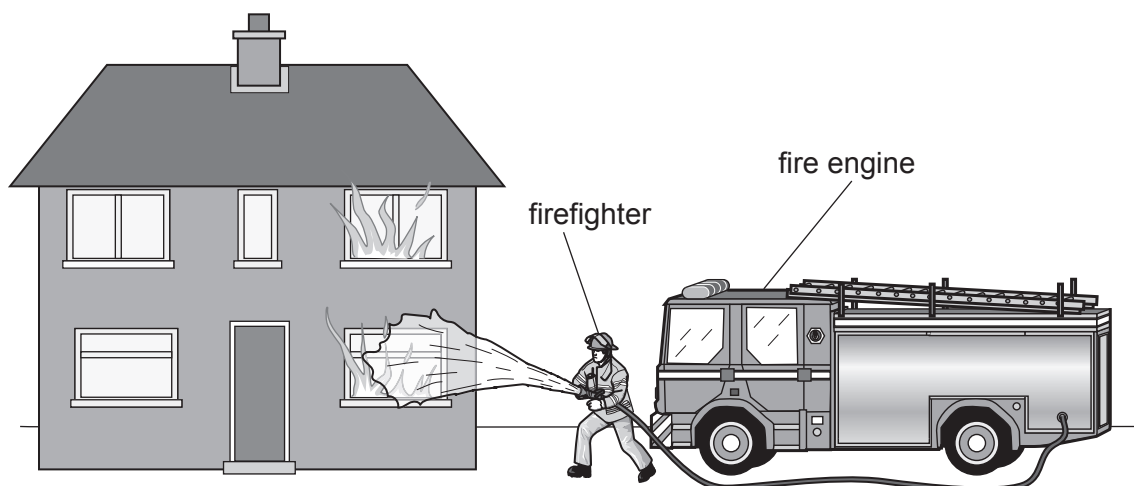


Fig. 3.1

- (a) The firefighter sprays water onto the fire.

The temperature of the fire is 600°C .

- (i) The firefighter is heated by the fire.

State the main method of energy transfer from the fire to the firefighter.

..... [1]

- (ii) The temperature of the water is 15°C .

State what happens to the water when it is heated from 15°C to 600°C .

..... [1]

- (iii) The fire engine has a tank containing a volume of 1800 dm^3 of water.

Calculate the mass of water in the tank.

The density of water is 1000 kg/m^3 .

mass = ... kg [3]

(b) The fire engine has a weight of 140 000 N.

(i) Calculate the mass of the fire engine.

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

mass = ... kg [2]

(ii) The fire engine has a total area of 0.56 m² in contact with the ground.

Calculate the pressure exerted by the fire engine on the ground.

Give the unit of your answer.

pressure = ... unit [3]

[Total: 10]

- 4 (a) Fig. 4.1 shows part of the human alimentary canal and associated organs.

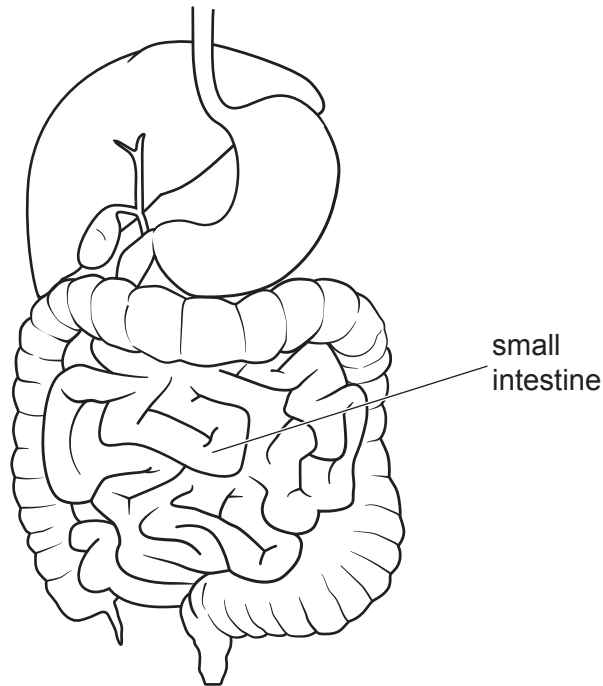


Fig. 4.1

- (i) Draw a label line and the letter **G** on Fig. 4.1 to identify the gall bladder. [1]

- (ii) Starch is digested by an enzyme in the alimentary canal.

State the name of the enzyme and of the product of this digestion.

enzyme

product

[2]

- (iii) Describe how soluble food molecules are absorbed into the blood from the small intestine.

.....

.....

..... [2]

- (b) Fig. 4.2 shows the effect of temperature on the activity of an enzyme that is **not** found in humans.

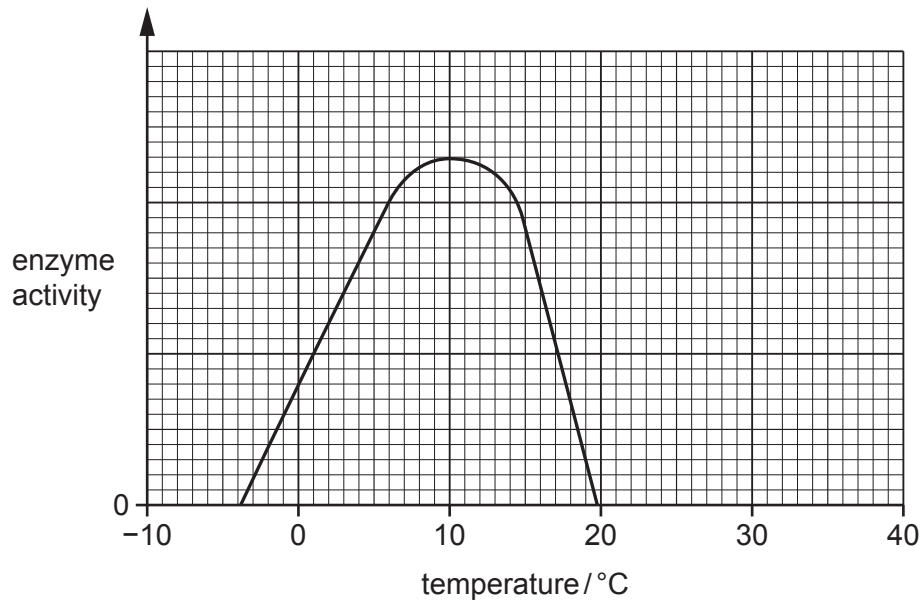


Fig. 4.2

- (i) Identify the temperature at which the enzyme is the most active.

temperature = ... °C [1]

- (ii) Explain the effect of a temperature of 20 °C on the activity of the enzyme.

.....

 [3]

[Total: 9]

- 5 Table 5.1 gives information on the percentage composition of the atmosphere of the planet Mars.

Table 5.1

gas	percentage composition of the atmosphere of Mars
carbon dioxide	95.0
nitrogen	1.9
argon	1.9

- (a) (i) The atmosphere of Mars contains other gases not shown in Table 5.1.

Use Table 5.1 to calculate the percentage of other gases in the atmosphere of Mars.

other gases = ...% [1]

- (ii) More than 20% of the Earth's atmosphere is gas **X**.

Gas **X** is not shown in Table 5.1.

State the name of gas **X**.

..... [1]

(b) The electronic structure of argon is shown in Fig. 5.1.

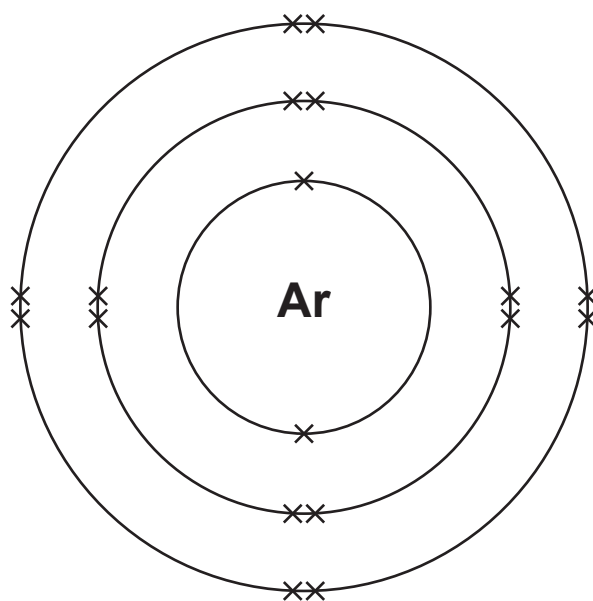


Fig. 5.1

Argon is a noble gas.

Describe how the position of argon in the Periodic Table is related to its electronic structure.

Use ideas about period number and group number in your answer.

.....

.....

.....

..... [3]

- (c) The structure of carbon dioxide is shown in Fig. 5.2.



Fig. 5.2

State the number of electrons that are shared between the carbon atom and one oxygen atom in a molecule of carbon dioxide.

Give a reason for your answer.

number of electrons

reason

[2]

- (d) Complete Fig. 5.3 to show the dot-and-cross diagram of a molecule of nitrogen.

Show all of the outer shell electrons.

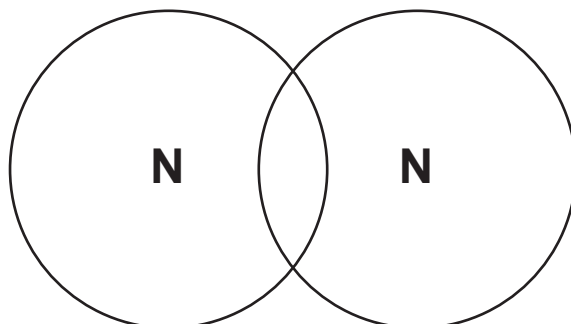


Fig. 5.3

[2]

[Total: 9]

- 6 A spring has an original length of 10.0 cm.

An object is suspended from the spring, and the spring extends to a length of 12.0 cm, as shown in Fig. 6.1.

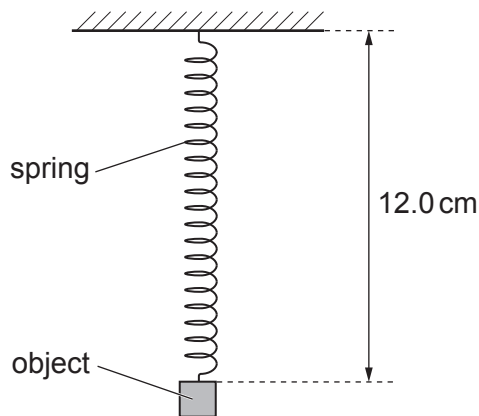


Fig. 6.1

- (a) (i) Determine the extension of the spring.

extension = ... cm [1]

- (ii) The weight of the object is 1.5 N.

Calculate the spring constant k of the spring.

k = ... N/cm [2]

- (iii) State the name of the energy stored in the extended spring.

..... [1]

- (b) The object is pulled down and held at a vertical distance of 3.0 cm from its rest position, as shown in Fig. 6.2.

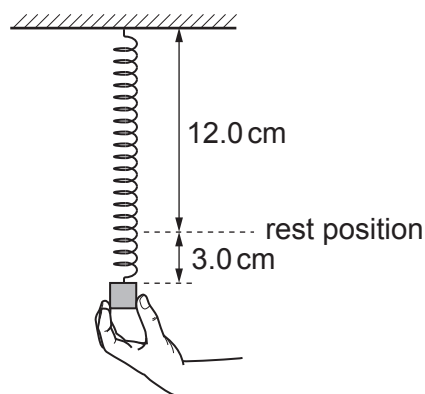


Fig. 6.2

The object is released, and the object oscillates up and down.

The period of an oscillation is the time taken for one complete oscillation.

Fig. 6.3 shows a distance–time graph for the vertical motion of the object after release.

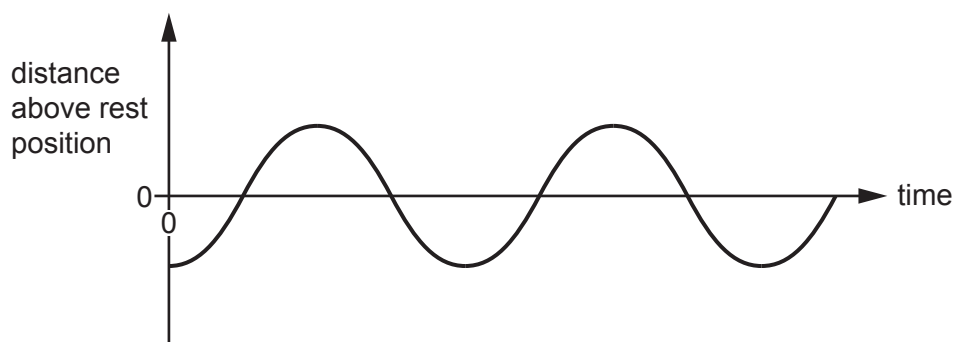


Fig. 6.3

- (i) On Fig. 6.3, use a double-headed arrow ($\updownarrow$ or $\leftrightarrow$) to show:

- the period of the oscillation and label this **T**
- the amplitude of the oscillation and label this **A**.

[2]

- (ii) The mass of the object is 0.15 kg.

During oscillation, the object has a maximum speed of 0.012 m/s.

Calculate the kinetic energy of the object at its maximum speed.

kinetic energy = ... J [2]

- (iii) A student suggests that the energy stored in the spring in Fig. 6.2 before the object is released is the same value as the kinetic energy calculated in **(b)(ii)**.

State whether you think the student is correct or incorrect.

Give a reason for your answer.

student is

reason

..... [1]

[Total: 9]

- 7 (a) Fig. 7.1 shows the drawing of a cross-section through a root.

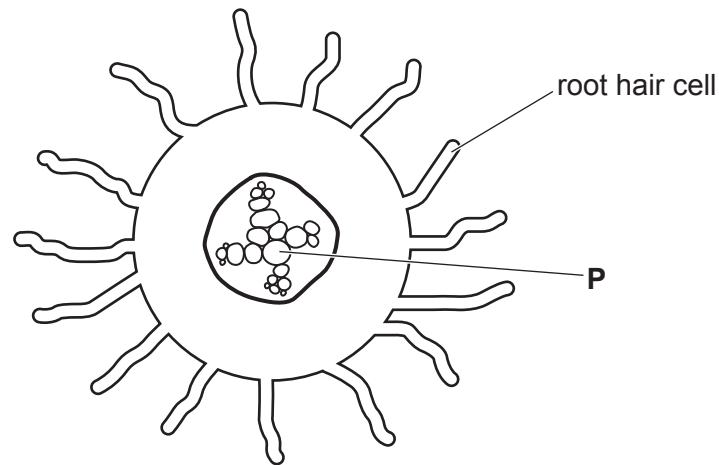


Fig. 7.1

- (i) State **two** functions of the part labelled **P** in Fig. 7.1.

1

2 [2]

- (ii) Describe **one** way the root hair cell is adapted for absorption.

.....

..... [1]

- (b) Scientists measure the concentration of dissolved oxygen in pond **A** and in pond **B** for 24 hours.

Fig. 7.2 is a graph of the results.

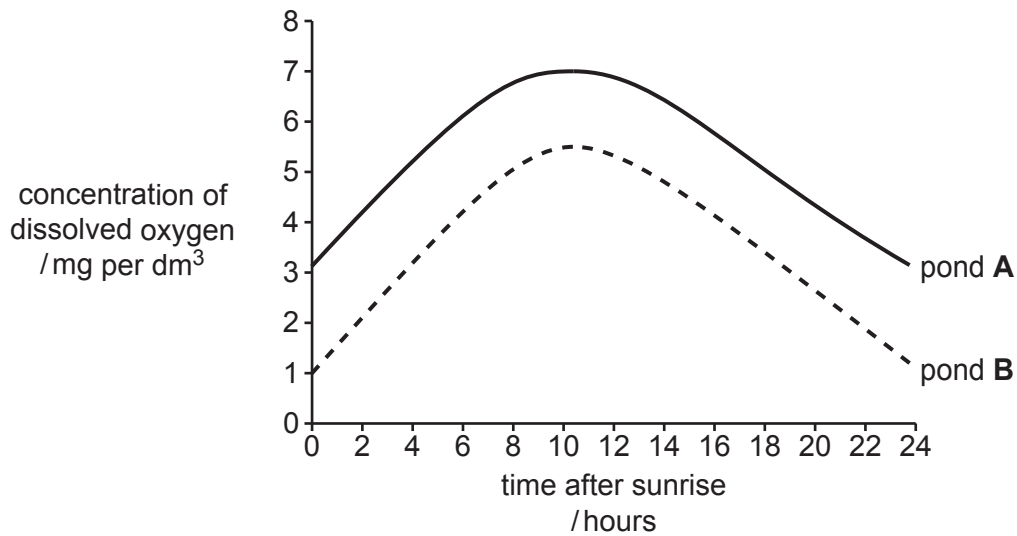


Fig. 7.2

- (i) Complete the sentences about aquatic plants that are growing in pond **A**.

During daylight hours, chlorophyll in aquatic plants in the pond transfers light into
 energy.

This is part of the process of in the aquatic plants. [2]

- (ii) Pond **B** is polluted with nitrate fertiliser, which increases the availability of nitrates in pond **B**.

Explain the difference in concentration of dissolved oxygen between pond **A** and pond **B**.

.....

 [3]

[Total: 8]

- 8 Table 8.1 shows some information about some alkanes and alkenes.

Table 8.1

number of carbon atoms in one molecule	alkane		alkene	
	name	formula	name	formula
2	ethane	C_2H_6	ethene	
3	propane	C_3H_8	propene	C_3H_6
4		C_4H_{10}	butene	C_4H_8
8	octane		octene	C_8H_{16}

- (a) The general formula for the alkenes is C_nH_{2n} .

- (i) Deduce the general formula for the **alkanes**.

..... [1]

- (ii) Complete Table 8.1. [3]

- (b) The structure of propane is shown in Fig. 8.1.

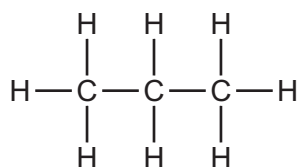


Fig. 8.1

- (i) Describe how Fig. 8.1 shows that propane is a saturated hydrocarbon.

.....

 [2]

- (ii) Draw a diagram, similar to Fig. 8.1, to show the structure of **propene**.

[2]

[Total: 8]

- 9 (a) Fig. 9.1 shows an ultraviolet torch used to kill bacteria and viruses on surfaces.

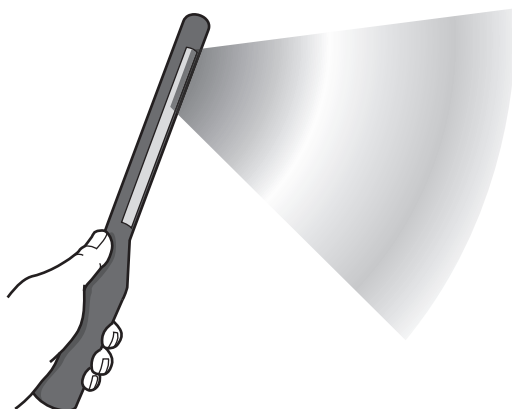


Fig. 9.1

When switched on, the torch emits both ultraviolet radiation and visible light.

- (i) Fig. 9.2 shows an incomplete electromagnetic spectrum.

On Fig. 9.2, write ultraviolet and visible light in their correct places.

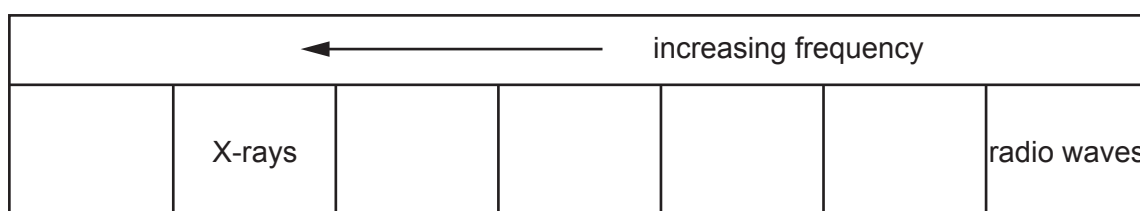


Fig. 9.2

[2]

- (ii) State **one** danger of ultraviolet radiation.

..... [1]

- (iii) The torch uses a 3.7 V battery.

The power rating of the torch is 3.0 W.

Calculate the current in the torch.

current = ... A [2]

- (b) A student has a box of $10\ \Omega$, $15\ \Omega$ and $22\ \Omega$ resistors. There are at least three resistors of each value in the box.

The student takes three resistors and connects them together as shown in Fig. 9.3.

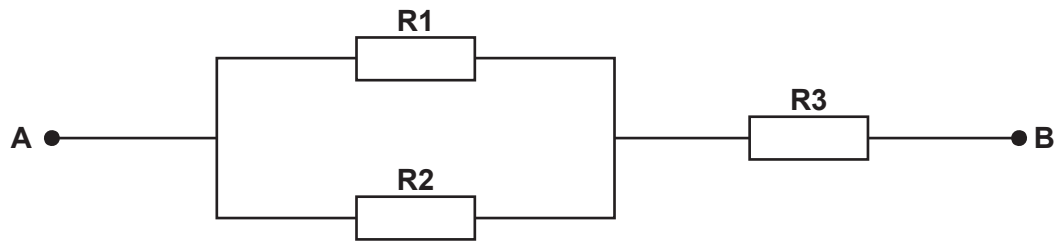


Fig. 9.3

The total resistance between points **A** and **B** is $28\ \Omega$.

Find values for **R1**, **R2** and **R3** that give a total resistance of $28\ \Omega$.

Show calculations to support your values.

R1 = ... Ω **R2** = ... Ω **R3** = ... Ω [3]

[Total: 8]

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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													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.).