



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/41

May/June 2022

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 is a diagram of the gas exchange system in humans.

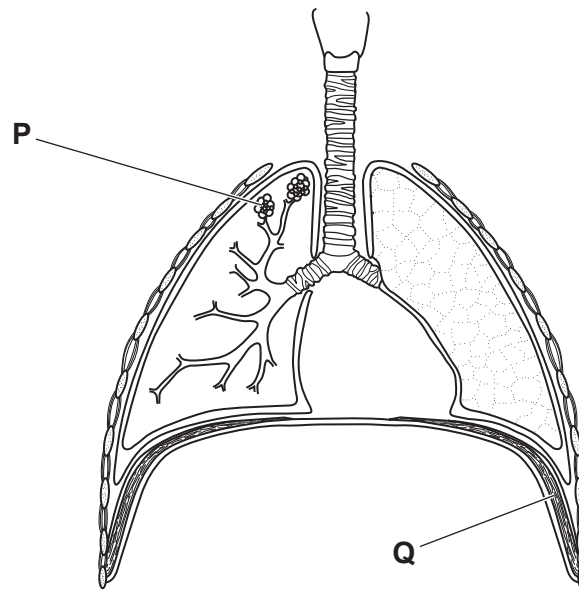


Fig. 1.1

- (i) Identify the part labelled **P** in Fig. 1.1.
Circle the correct answer.

alveoli diaphragm intercostal muscle larynx trachea

[1]

- (ii) Identify the part labelled **Q** in Fig. 1.1.
Circle the correct answer.

alveoli diaphragm intercostal muscle larynx trachea

[1]

- (iii) Tobacco smoke contains carbon monoxide.
Carbon monoxide binds to haemoglobin.
Explain how this affects respiration in the body.

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

- (iv) Goblet cells are found in the tissue of the gas exchange system.
Explain how goblet cells protect the gas exchange system from particles in the air.

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

- (b) Fig. 1.2 shows some data on chronic obstructive pulmonary disorder (COPD) in people of different age groups.

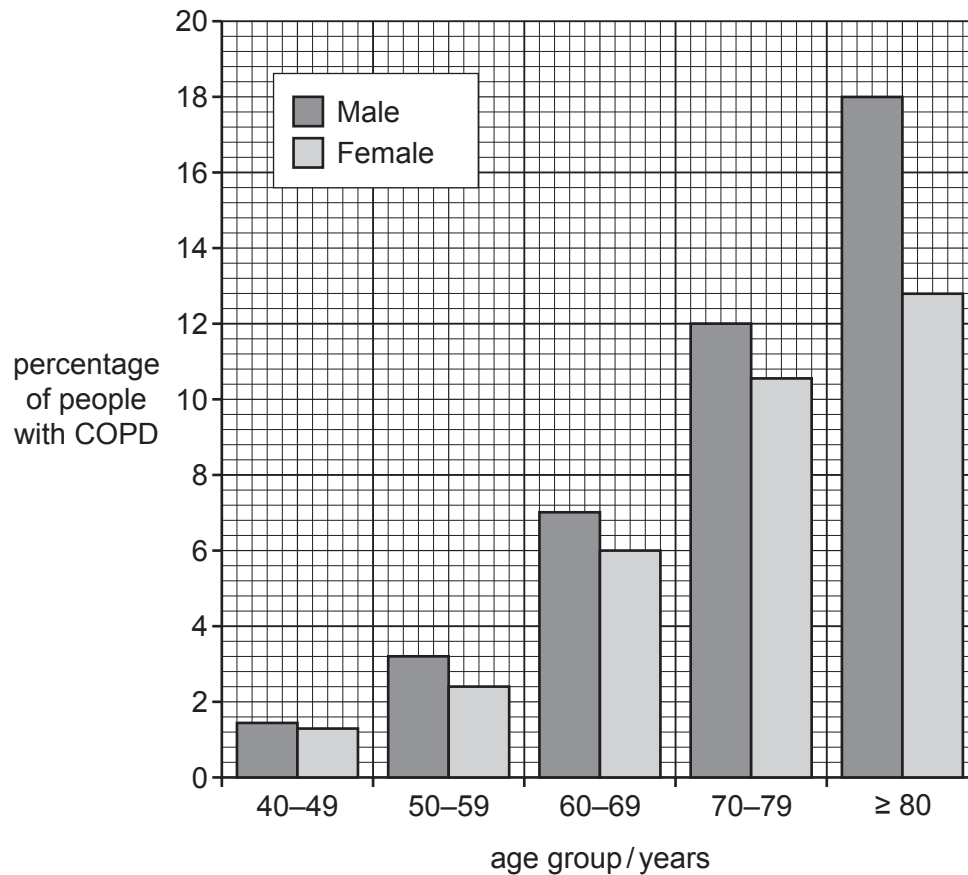


Fig. 1.2

- (i) Identify the percentage of females aged 60–69 with COPD in Fig. 1.2.

..... % [1]

- (ii) Describe **two** trends shown in Fig. 1.2.

1

.....

2

.....

[2]

[Total: 9]

- 2 The outer shell electrons in atoms of elements **X**, **Y** and **Z** are shown in Fig. 2.1.

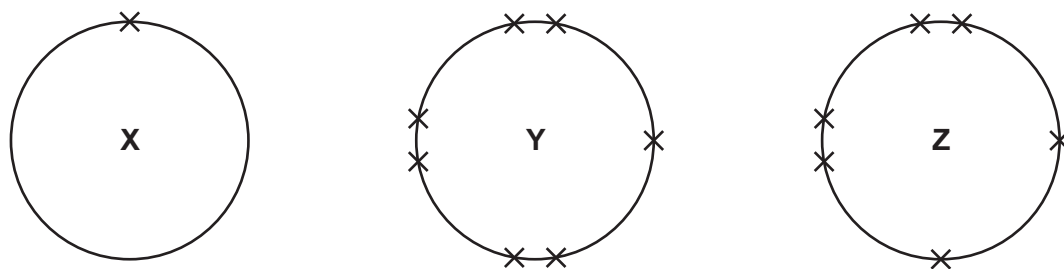


Fig. 2.1

- (a) State the group of the Periodic Table in which element **Y** is placed.

group

[1]

- (b) State the charge on the ion formed from an atom of element **Z**.

Explain your answer.

charge

explanation

.....

.....

[2]

- (c) Table 2.1 shows some information about substances which contain the elements **X**, **Y** and **Z**.

Table 2.1

substance	bonding	structure	element or compound
X₂Z	covalent	simple molecules	
X₂	covalent	simple molecules	
Z₂	covalent	simple molecules	

- (i) Complete Table 2.1 to show whether each substance is an element or a compound. [1]

- (ii) Draw a dot-and-cross diagram to show the outer shell electrons in a molecule of Z_2 .

[2]

- (iii) A student thinks that element **X** is lithium.

Use the information in Table 2.1 to explain why element **X cannot** be lithium.

.....

..... [1]

- (iv) Identify element **X**.

..... [1]

[Total: 8]

- 3 Fig. 3.1 shows a man pushing a shopping trolley forwards along a level surface.



Fig. 3.1

- (a) Fig. 3.2 shows three of the forces acting on the trolley as the man pushes it.

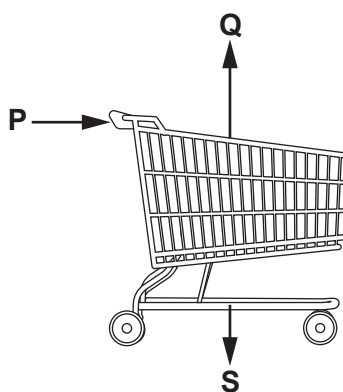


Fig. 3.2

- (i) Draw an arrow on Fig. 3.2 to show the direction of the friction force acting on the trolley.

Label this force **R**.

[1]

- (ii) The trolley has a mass of 15 kg.

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

Calculate the magnitude of force **S**.

force **S** = ... N [1]

- (iii) State the magnitude of force **Q**.

Explain your answer.

force **Q** = ... N

explanation

..... [1]

(b) Fig. 3.3 shows a speed–time graph of the motion of the trolley.

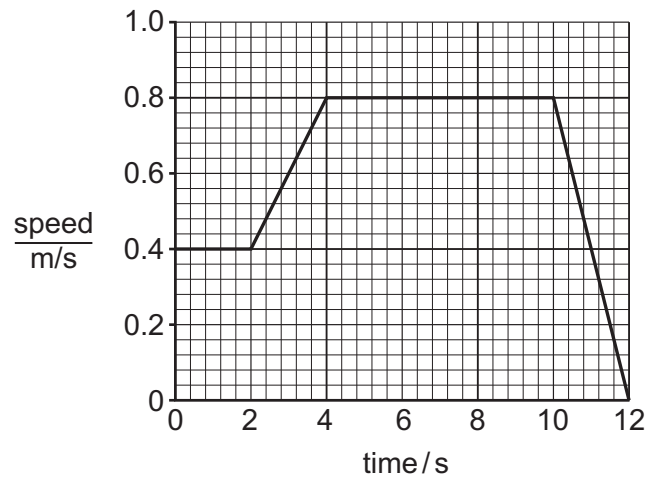


Fig. 3.3

(i) Use Fig. 3.3 to calculate the kinetic energy of the trolley at $t = 1.0$ s.

The trolley has a mass of 15 kg.

kinetic energy = ... J [3]

(ii) Use Fig. 3.3 to calculate the acceleration of the trolley between 2.0 s and 4.0 s.

Give the units of your answer.

acceleration = ... units [3]

(iii) Between 4.0 s and 10.0 s, the man pushes the trolley with a constant force of 25 N.

Calculate the work done by the man on the trolley between 4.0 s and 10.0 s.

work done = ... J [3]

[Total: 12]

[Turn over]

- 4 (a) Fig. 4.1 is a diagram of a wind-pollinated flower.

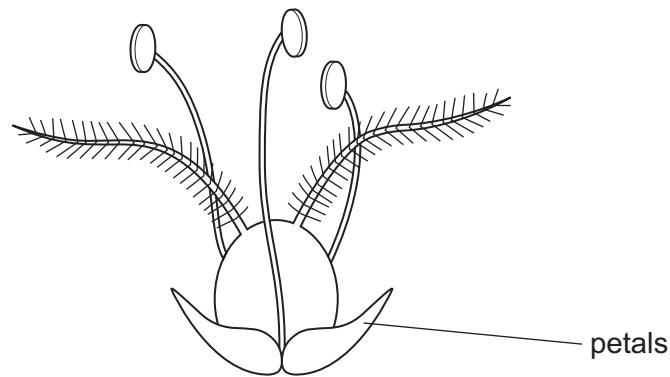


Fig. 4.1

- (i) Draw a label line on Fig. 4.1 to identify the part where fertilisation takes place. Label the line **F**. [1]

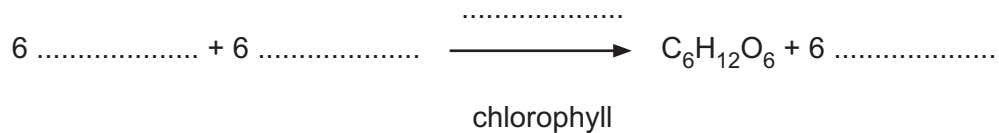
- (ii) State **two** pieces of evidence from Fig. 4.1 that show this flower is a wind-pollinated flower.

1

2 [2]

- (b) Plants synthesise carbohydrates by the process of photosynthesis.

- (i) Complete the balanced equation for photosynthesis.



[2]

- (ii) Explain the role of chlorophyll in the synthesis of carbohydrates.

.....

.....

..... [2]

(c) Fig. 4.2 shows how transpiration rate and temperature change during the day.

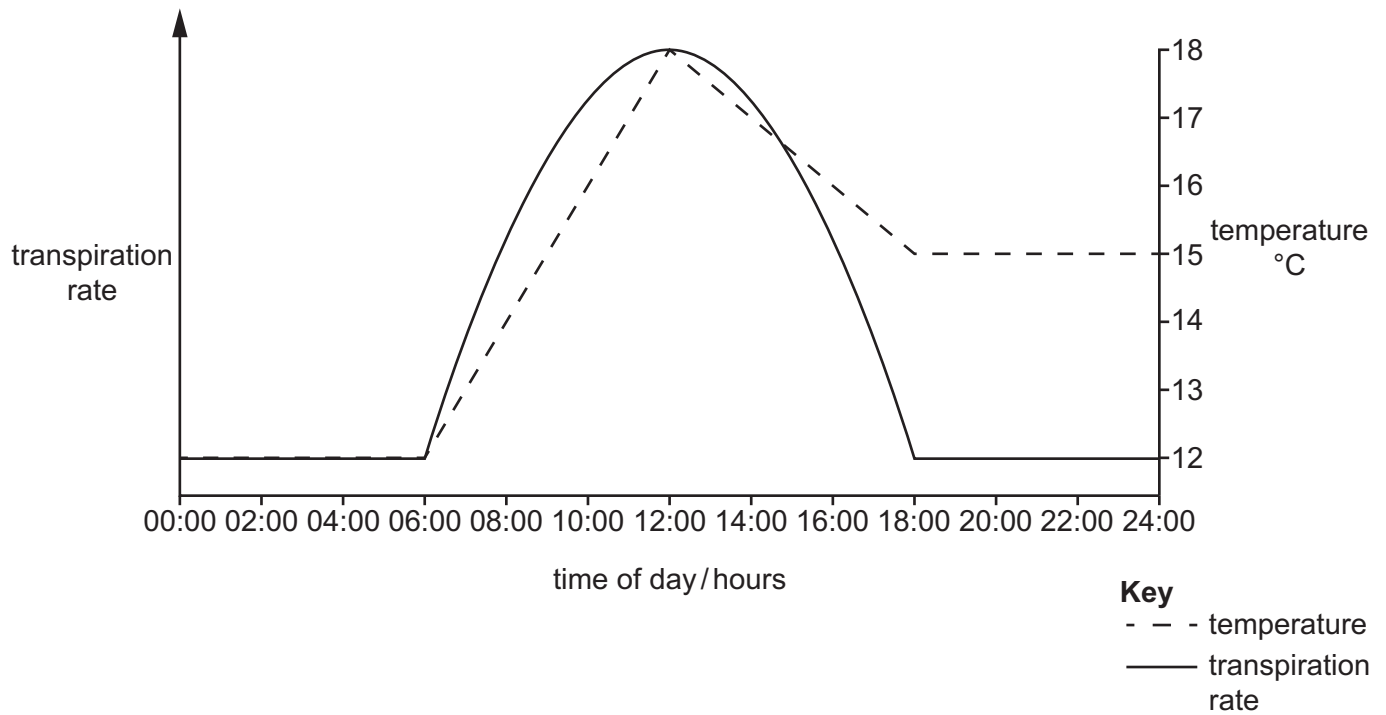


Fig. 4.2

Explain the effect of temperature on changes to transpiration rate between **12:00 and 18:00 hours** in Fig. 4.2.

.....

.....

.....

.....

..... [3]

(d) Water is lost through stomata.

Explain why stomata are important for photosynthesis.

.....

.....

..... [2]

[Total: 12]

- 5 (a) A pH meter is an instrument which measures pH. The tip of the meter is dipped into a solution. The pH of the solution is displayed on a small screen as shown in Fig. 5.1.

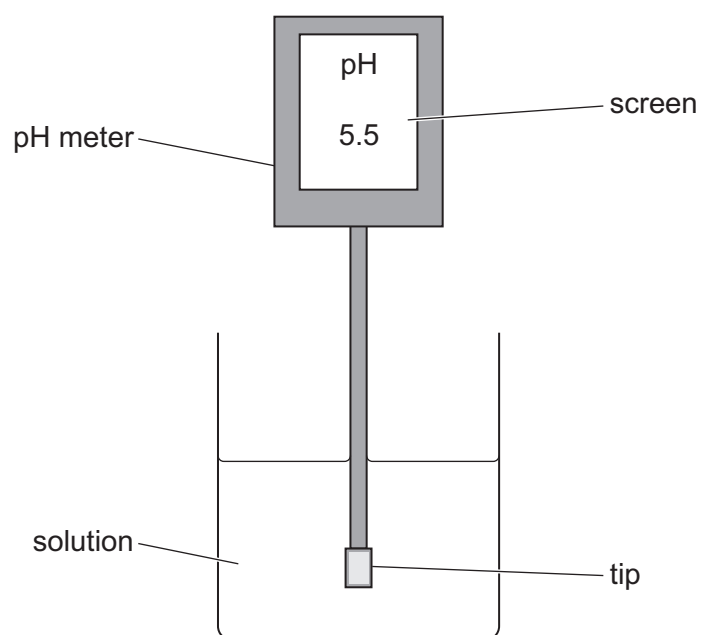


Fig. 5.1

The pH values of some aqueous solutions are measured using universal indicator paper and using a pH meter.

The results are shown in Table 5.1.

Table 5.1

aqueous solution	pH value measured using universal indicator paper	pH value measured using a pH meter
ammonia	12	11.6
ammonium nitrate	5	5.3
ammonium sulfate	5	5.5
sulfuric acid	1	0.5
nitric acid	1	0.5

- (i) Describe the procedure used to measure the pH of a solution using universal indicator paper.

.....

.....

..... [2]

- (ii) Suggest **two** advantages of using a pH meter rather than universal indicator paper to test the pH of some solutions.

Use Fig. 5.1 and Table 5.1 to help you.

- 1
-
- 2
-
- [2]

- (b) Farmers use solid ammonium nitrate and solid ammonium sulfate to improve the growth of crops.

- (i) Aqueous ammonia and dilute sulfuric acid react to make aqueous ammonium sulfate.

Complete the balanced equation for this reaction.



- (ii) Suggest the name of the compound that reacts with aqueous ammonia to form ammonium nitrate.

..... [1]

- (iii) Describe how solid ammonium sulfate is obtained from aqueous ammonium sulfate.

.....

.....

..... [2]

[Total: 9]

6 (a) The Earth is heated by infrared radiation from the Sun.

(i) State the speed at which the infrared radiation travels from the Sun to the Earth.

..... [1]

(ii) The infrared radiation takes 8 min 20 s to travel from the Sun to the Earth.

Use your answer to (a)(i) to calculate the distance in kilometres of the Earth from the Sun.

distance = ... km [3]

(iii) Fig. 6.1 shows an incomplete electromagnetic spectrum.

On Fig. 6.1, write infrared radiation in its correct place.

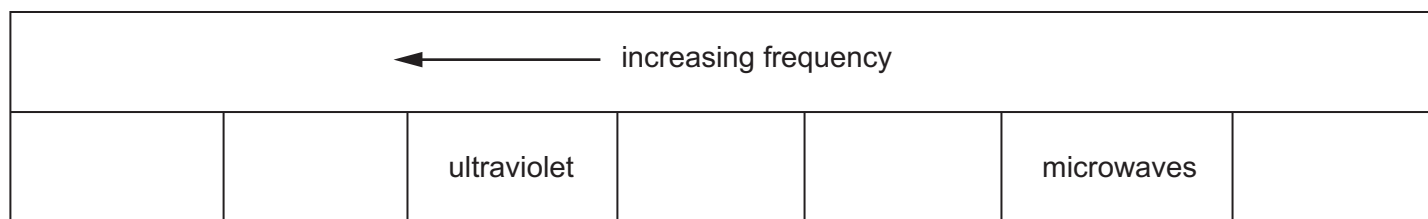


Fig. 6.1

[1]

(b) (i) Fig. 6.2 shows how an infrared ray from the Sun is refracted as it enters the Earth's atmosphere.

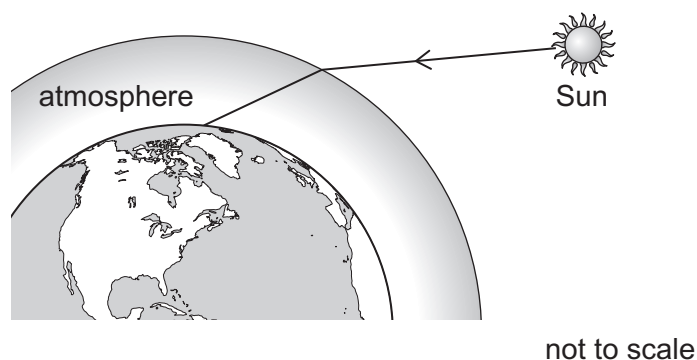


Fig. 6.2

Explain why the ray is refracted as it moves from space into the Earth's atmosphere.

.....
 [1]

(ii) Fig. 6.3 shows sunlight shining on a brick wall.

One half of the wall is painted shiny white and the other half is painted dull black.

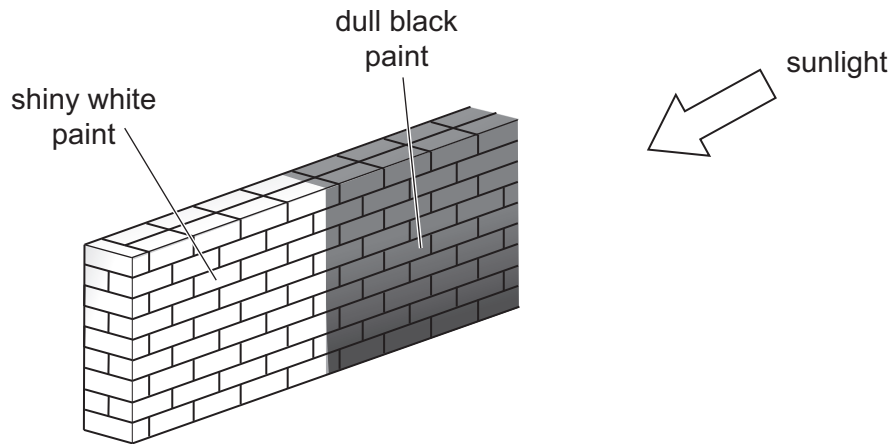


Fig. 6.3

Explain why the temperature of the bricks painted dull black increases faster than the temperature of the bricks painted shiny white.

.....

.....

..... [2]

[Total: 8]

- 7 (a) Fig. 7.1 shows part of the human alimentary canal and associated organs.

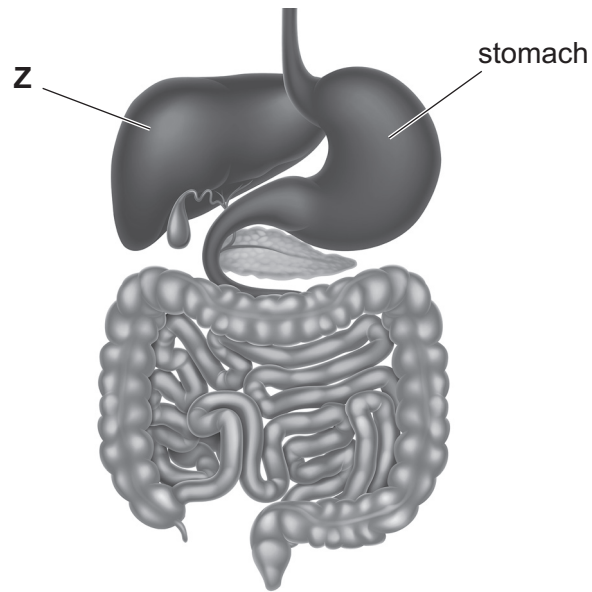


Fig. 7.1

- (i) Identify the part labelled Z in Fig. 7.1.

..... [1]

- (ii) Complete this definition of chemical digestion.

Chemical digestion is the breakdown of large molecules into
smaller molecules.

[1]

- (b) Amylase and lipase are found in the alimentary canal.

Compare the similarities and differences between the functions of amylase and lipase.

similarities

.....

differences

.....

[3]

- (c) Digested nutrients move out of the alimentary canal into the blood stream.

State the component of blood that transports digested nutrients.

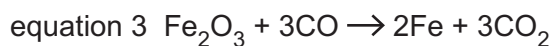
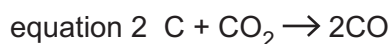
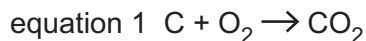
..... [1]

[Total: 6]

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

Equations for three reactions that take place in the blast furnace are listed.



- (i) State which equation, 1, 2 or 3, represents a reaction in which a carbon compound acts as a reducing agent.

Explain your answer.

equation

explanation

[1]

- (ii) Name **two** gases that are produced in these equations and describe a health or environmental problem caused by each.

gas 1

problem

.....

gas 2

problem

.....

[3]

- (iii) Fe_2O_3 contains oxide ions, O^{2-} .

State the charge on each iron ion in Fe_2O_3 .

.....

[1]

- (b) Table 8.1 lists the method of extraction of iron and some other metals from their ores.

Table 8.1

metal	method of extraction
iron	heating with carbon
aluminium	electrolysis
sodium	electrolysis
zinc	heating with carbon

- (i) Identify the metal in Table 8.1 that has the greatest tendency to form positive ions.

Give a reason for your answer.

metal

reason

[1]

- (ii) Copper and magnesium are also extracted from their ores.

Suggest a method of extraction for copper and for magnesium from their ores.

Give reasons for your answers.

Use information from Table 8.1 and your knowledge of the reactivity series to help you.

copper method of extraction

reason

magnesium method of extraction

reason

[3]

[Total: 9]

9 Fig. 9.1 shows an electric circuit.

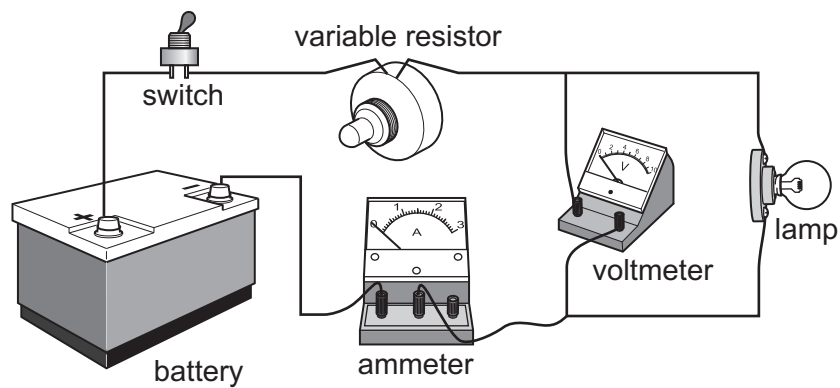


Fig. 9.1

- (a) The switch is turned on, and the variable resistor adjusted until the voltmeter reading is 6.0 V. The ammeter reading is 0.75 A.

(i) Calculate the resistance of the lamp.

resistance = ... Ω [2]

(ii) Calculate the power of the lamp.

power = ... W [2]

- (b) On Fig. 9.2, complete the circuit diagram for the circuit shown in Fig. 9.1.

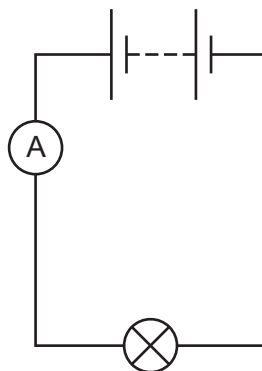


Fig. 9.2

[3]

[Total: 7]

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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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0653/42

May/June 2022

1 hour 15 minutes

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- The Periodic Table is printed in the question paper.

This document has **20** pages.

- 1 (a) Fig. 1.1 shows a healthy human heart and a damaged human heart.

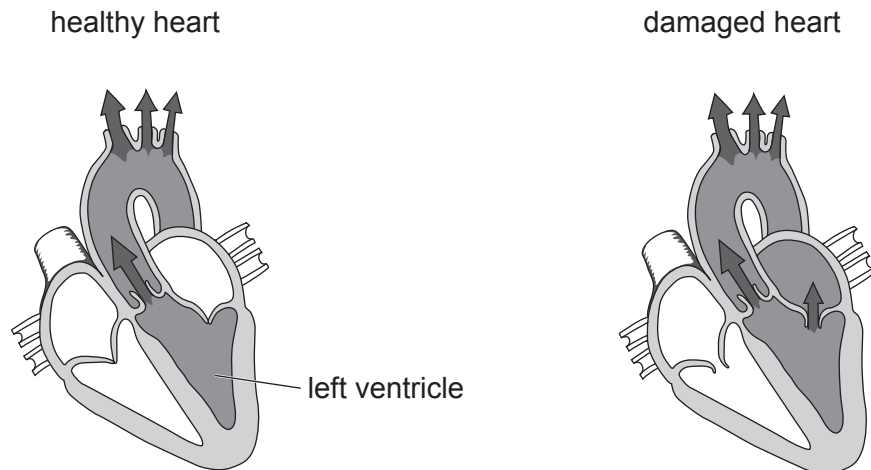


Fig. 1.1

- (i) Draw a label line and the letter **A** to show the position of the aorta on the healthy heart in Fig. 1.1. [1]
- (ii) The arrows on each heart show the direction of blood flow in the left side of the heart when the ventricles contract.

Identify **one** piece of evidence in Fig. 1.1 that shows the damaged heart has a faulty valve.

.....
 [1]

- (iii) Coronary heart disease damages the heart.
 Diet is one risk factor of coronary heart disease.

State **two other** risk factors of coronary heart disease.

1

2

[2]

(b) Fig. 1.2 is a graph showing the effect of physical activity on heart rate.

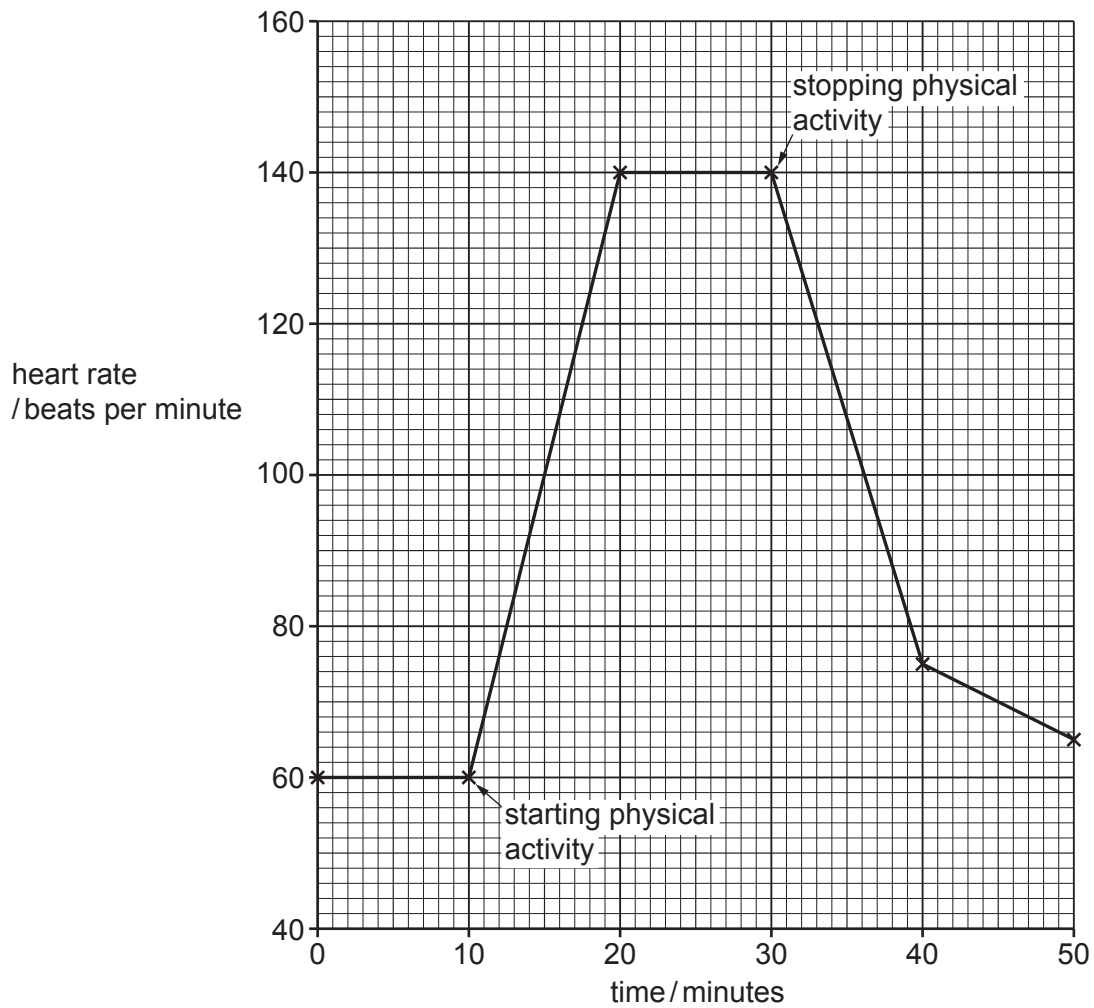


Fig. 1.2

- (i) Calculate the percentage increase in heart rate between starting and stopping physical activity.
Give your answer to the nearest whole number.

.....% [3]

- (ii) Explain the change in heart rate between **30 and 40 minutes** in Fig. 1.2.

.....

.....

.....

.....

..... [3]

[Total: 10]

[Turn over

2 A student investigates a solid, a liquid and a gas.

- (a) Three syringes contain 25 cm^3 of either the solid, the liquid or the gas at room temperature and pressure, as shown in Fig. 2.1.

The end of each syringe is sealed.

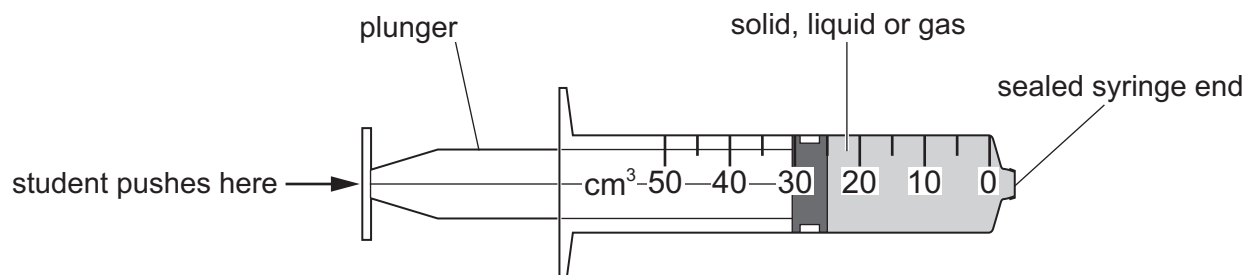


Fig. 2.1

- (i) The student pushes on the plunger of each syringe to increase the pressure.

The results are shown in Table 2.1.

Table 2.1

contents of syringe	volume at the start / cm^3	volume when pressure is increased / cm^3
solid	25	25
liquid	25	25
gas	25	21

Explain the results for each syringe when the pressure is increased.

Use ideas about particles in your answer.

.....

.....

.....

.....

..... [3]

- (ii) In a separate experiment, the student gently increases the temperature of the syringe that contains the gas, without pushing on the plunger.

The volume of the gas changes from 25 cm^3 to 30 cm^3 .

Explain why the volume changes.

Use ideas about particles in your answer.

.....

.....

.....

..... [2]

- (b) The student heats a solid **X** and a liquid **Y** separately in two test-tubes and records the state of each after each 5°C rise in temperature.

Table 2.2 shows the results.

Table 2.2

temperature / $^\circ\text{C}$	state of X	state of Y
20	solid	liquid
25	solid	liquid
30	solid	liquid
35	solid	liquid
40	liquid	liquid
45	liquid	liquid

- (i) Use Table 2.2 to estimate the melting point of **X**.

..... $^\circ\text{C}$ [1]

- (ii) State **one** conclusion that can be made about the boiling point of **Y**.

.....

..... [1]

- (c) The solid **X** used in the experiment can burn.

Explain why burning is a chemical change and melting is **not** a chemical change.

.....

.....

..... [1]

- 3 Fig. 3.1 shows the forces acting as a student rides forwards on a moving scooter.

The scooter has an electric motor.

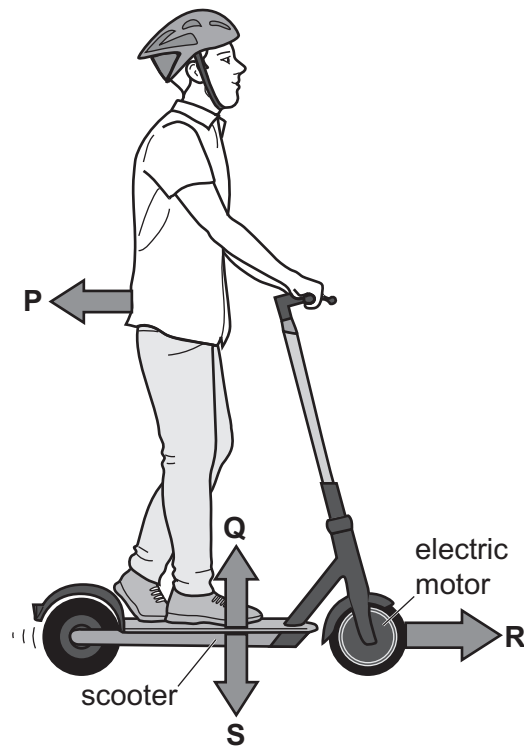


Fig. 3.1

- (a) When the student is standing with both feet on the scooter, force **Q** is 340 N.

State the magnitude of force **S**.

Explain your answer.

force **S** = ... N

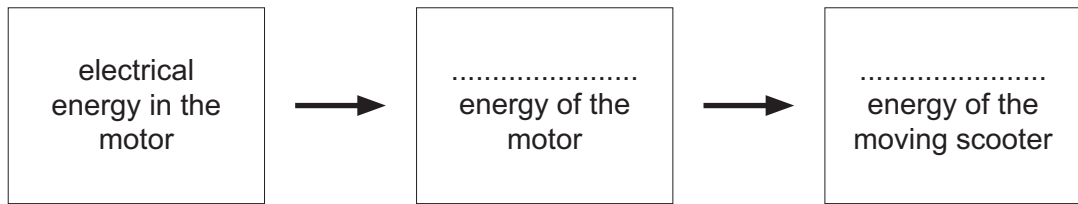
explanation

.....

[1]

- (b) The electric motor pushes the scooter forward with a constant force of 225 N for a distance of 0.30 m.

- (i) Complete the boxes to show the useful energy transfers taking place.



[2]

- (ii) Calculate the work done on the scooter by the electric motor.

work done = ... J [2]

- (iii) The 225 N force is applied for 1.2 s.

Use your answer to (b)(ii) to calculate the useful power supplied to the scooter.

power = ... W [2]

[Total: 7]

- 4 (a) Fig. 4.1 is a diagram of a wind-pollinated flower.

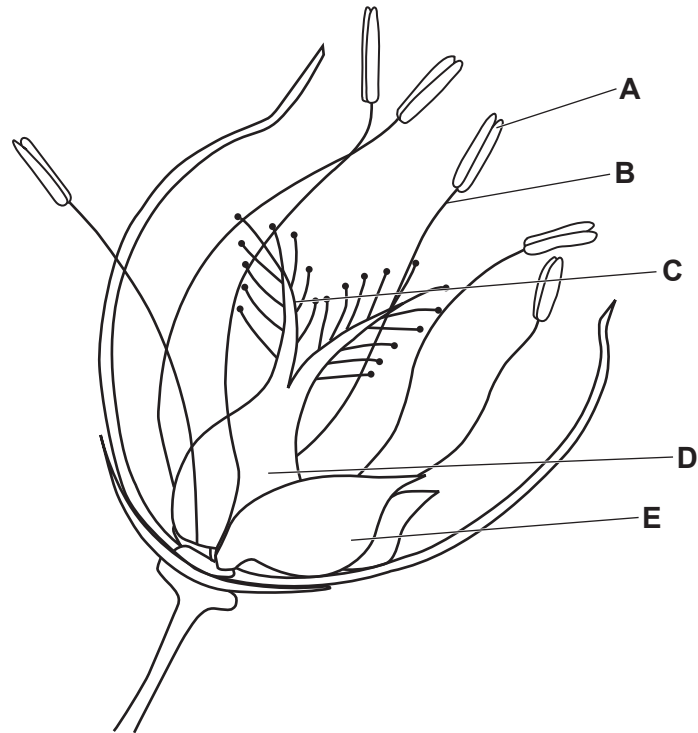


Fig. 4.1

Table 4.1 shows some of the labelled parts in Fig. 4.1 and their function.

Complete Table 4.1.

Table 4.1

letter	name of part	function
A		
D		produce ovules
.....	stigma	

[3]

- (b) State **one** similarity and **one** difference between fertilisation in plants and fertilisation in humans.

similarity

.....

difference

.....

[2]

- (c) After fertilisation in humans, a placenta develops inside the female uterus.

Describe how the placenta protects the fetus **and** allows it to grow.

.....

.....

.....

.....

..... [3]

[Total: 8]

- 5 Fig. 5.1 shows a key made from the alloy brass.

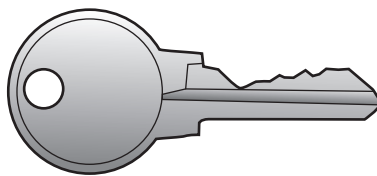


Fig. 5.1

- (a) Suggest **two** reasons why brass is more suitable for making keys than pure copper.

1

2 [2]

- (b) Brass contains copper atoms and zinc atoms, as shown in Fig. 5.2.

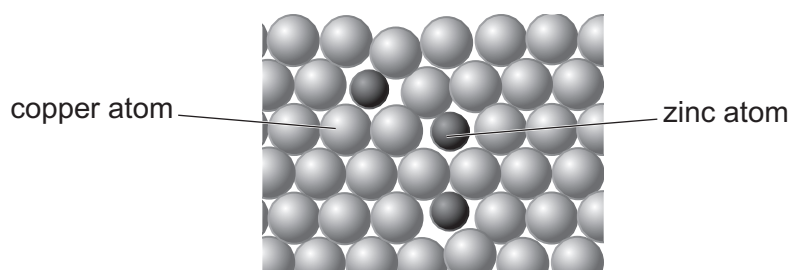


Fig. 5.2

Table 5.1 shows some information about brass.

Table 5.1

	percentage of element in brass	relative size of atom
copper	56	1.0
zinc	37	1.1

Fig. 5.2 is **not** an accurate representation of brass because brass contains more than two elements.

- (i) Describe how the information in Table 5.1 shows that there are more than two elements in brass.

.....

..... [1]

- (ii) State **two other** reasons why Fig. 5.2 is **not** an accurate representation of the atoms in brass.

Use Table 5.1 to help you.

1

2 [2]

- (c) A student investigates the reactivity of copper and zinc.

The student places a zinc rod into a solution containing aqueous copper ions and leaves it for 5 minutes, as shown in Fig. 5.3.

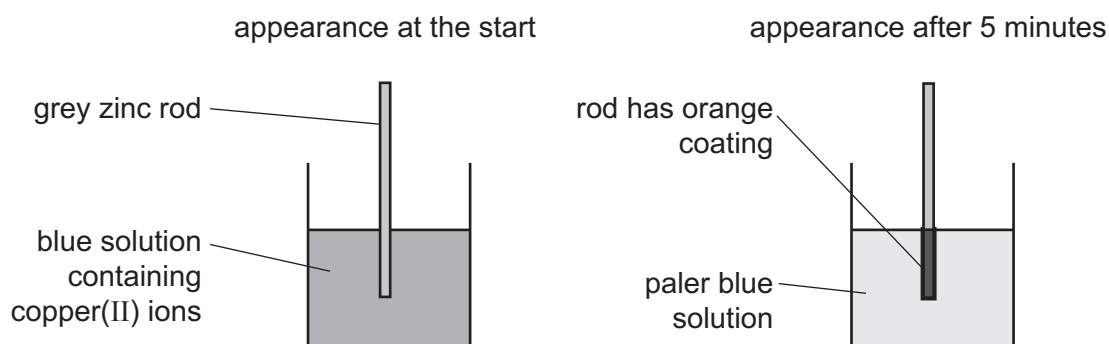


Fig. 5.3

- (i) State why the zinc rod has an orange coating after 5 minutes.

..... [1]

- (ii) State why the colour of the solution changes.

..... [1]

- (iii) In another experiment, a copper rod is placed into an aqueous solution of zinc ions.

Describe the appearance of the rod and the solution after 5 minutes.

Explain your answer.

..... [3]

[Total: 10]

6 Ultraviolet radiation and microwaves are part of the electromagnetic spectrum.

(a) Fig. 6.1 shows an incomplete electromagnetic spectrum.

On Fig. 6.1, write ultraviolet and microwaves in the correct places.

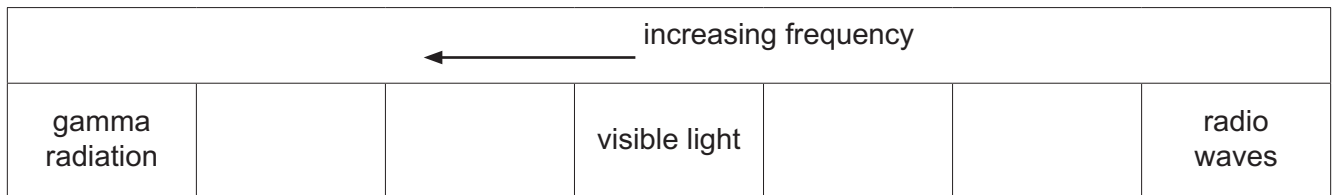


Fig. 6.1

[2]

(b) State **one** danger of ultraviolet radiation.

..... [1]

(c) State **one** use of microwaves.

..... [1]

(d) Complete the sentences about ultraviolet radiation and microwaves.

Circle the correct word or phrase to complete each sentence.

Ultraviolet radiation and microwaves are **audible / longitudinal / transverse** waves.

The speed of microwaves in a vacuum is **equal to / faster than / slower than** the speed of ultraviolet radiation in a vacuum.

[2]

(e) (i) The speed of ultraviolet radiation in a vacuum is 3.0×10^8 m/s.

An ultraviolet lamp emits ultraviolet radiation of wavelength 3.5×10^{-7} m.

Calculate the frequency of ultraviolet radiation at this wavelength.

Give the unit of your answer.

frequency = ... unit [3]

- (ii) Three identical ultraviolet lamps are connected in parallel to a 230 V electricity supply.
Each lamp uses a power of 150 W.
Calculate the total current from the electricity supply.

current = ... A [3]

[Total: 12]

- 7 (a) Fig. 7.1 shows a food chain.

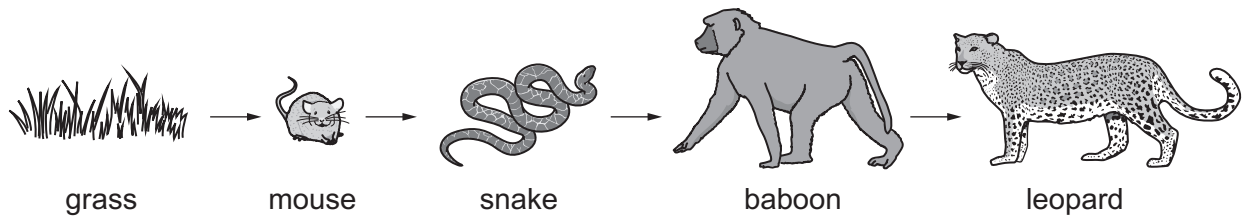


Fig. 7.1

- (i) Identify the primary consumer in Fig. 7.1.

..... [1]

- (ii) Explain why food chains usually have fewer trophic levels than the food chain in Fig. 7.1.

.....

 [2]

- (b) Grass is a type of plant.

- (i) The leaves of a plant have different types of cells with different functions.

State the **main** function of the two types of mesophyll cells.

palisade mesophyll cells

spongy mesophyll cells [2]

- (ii) Plant growth can be affected by ion deficiencies.

Explain the effects of magnesium ion deficiency on plant growth.

.....

 [2]

- (c) In humans, food is digested in the stomach of the alimentary canal.
Hydrochloric acid is found in the stomach.

State **two** functions of hydrochloric acid in the stomach.

1

2

[2]

[Total: 9]

- 8 Energy level diagrams for two reactions are shown in Fig. 8.1. The diagrams are drawn to the same scale.

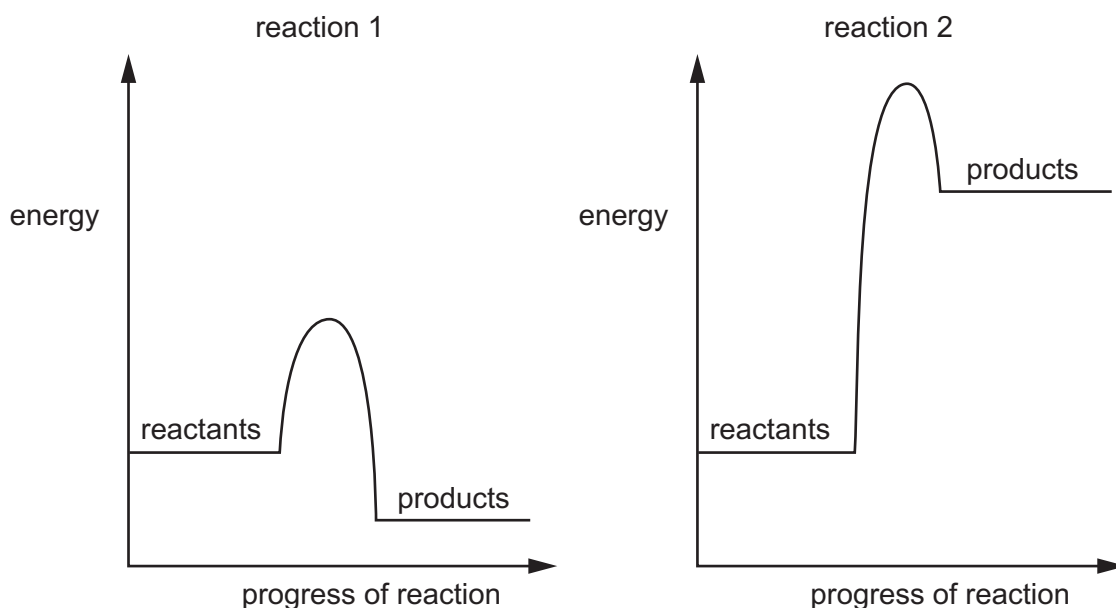


Fig. 8.1

- (a) (i) Compare the activation energies for reaction 1 and reaction 2.

Explain your answer.

comparison

explanation

[1]

- (ii) The temperature of reaction 2 is increased.

Use ideas about activation energy to explain why this increases the rate of reaction 2.

.....

..... [1]

- (b) One of the reactions represents the combustion of propane.

Identify which reaction, 1 or 2, represents the combustion of propane.

Give a reason for your answer.

reaction

reason

.....

[1]

(c) Arrows **A** and **B** on Fig. 8.2 represent changes occurring during reaction 1.

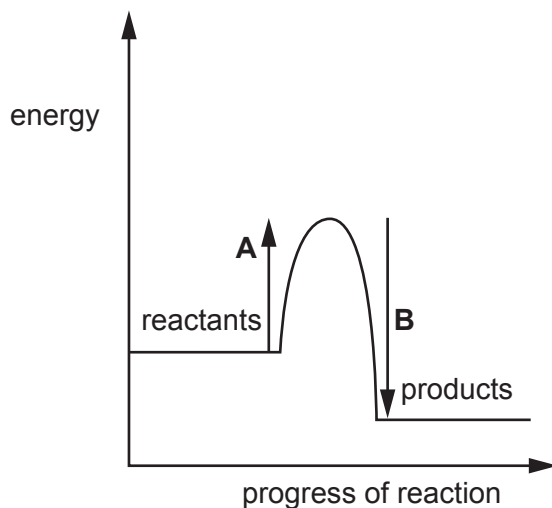


Fig. 8.2

Put ticks (✓) in the boxes to show what these changes represent.

	bonds are being broken	bonds are being formed	energy is being taken in	energy is being given out
arrow A				
arrow B				

[2]

(d) Equations for the combustion of propane are shown in Fig. 8.3.

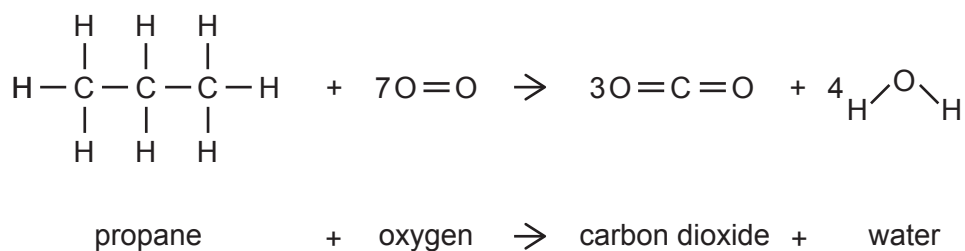


Fig. 8.3

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

..... [1]

(ii) State **two** ways in which the structure of propane shows that it is an alkane.

1

2

[2]

[Total: 8]

- 9 (a) Fig. 9.1 shows a liquid-in-glass thermometer without a scale.



Fig. 9.1

The thermometer measures temperatures between -10°C and $+110^{\circ}\text{C}$.

Table 9.1 gives some information about four liquids, **A**, **B**, **C** and **D**.

Table 9.1

liquid	melting point $/^{\circ}\text{C}$	boiling point $/^{\circ}\text{C}$
A	-89	$+117$
B	-117	$+79$
C	-39	$+367$
D	$+17$	$+118$

State the letters of the liquids in Table 9.1 that can be used in this thermometer.

..... [1]

- (b) Fig. 9.2 shows a circuit used to heat a beaker of water with an electric heater.

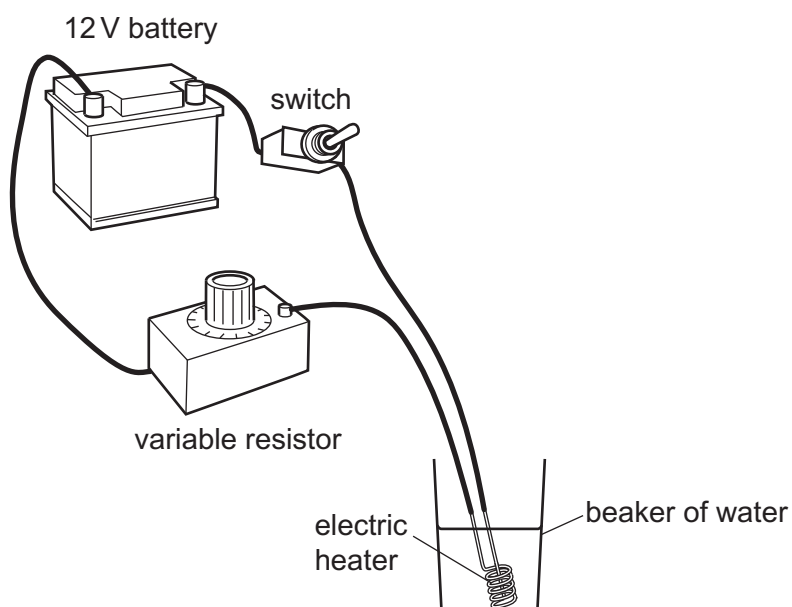


Fig. 9.2

- (i) The circuit contains a variable resistor.

Draw the circuit symbol for the variable resistor.

[1]

- (ii) The variable resistor is adjusted so that the current is 5.0 A.

Calculate the energy in kilojoules supplied by the 12 V battery when the circuit is switched on for 5 minutes.

energy = ... kJ [3]

- (iii) A voltmeter connected across the variable resistor shows a reading of 4.0 V.

Calculate the potential difference across the electric heater.

potential difference = ... V [1]

- (iv) Some electrical energy supplied by the battery is **not** transferred to useful thermal energy in the water.

Suggest how electrical energy from the battery is lost **in the circuit**.

.....

..... [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.).



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/43

May/June 2022

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

- 1 (a) Fig. 1.1 is a diagram of the alimentary canal and associated organs in humans.

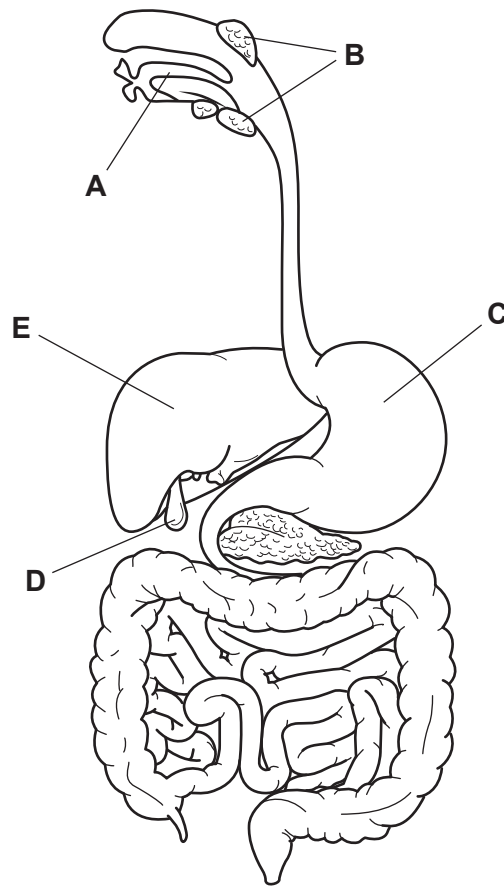


Fig. 1.1

- (i) Table 1.1 shows some of the parts labelled in Fig. 1.1 and their function.

Complete Table 1.1.

Table 1.1

letter	function
.....	digests food and uses hydrochloric acid to kill bacteria
.....	ingestion
B	secretes the enzyme

[3]

- (ii) Draw a label line and the letter **L** to identify the position of the large intestine on Fig. 1.1.

[1]

(b) Describe the function of protease in the alimentary canal.

.....

.....

..... [2]

(c) Digested food is absorbed into the blood and transported through arteries and veins.

Describe **two** ways the structure of an artery is different to the structure of a vein.

1

.....

2

..... [2]

(d) Complete these sentences about coronary heart disease.

Coronary heart disease is caused by a in the coronary artery.

Possible risk factors of coronary heart disease include poor diet, smoking and

..... predisposition.

[2]

[Total: 10]

- 2 Sodium, potassium and rubidium are elements in Group I of the Periodic Table.

Table 2.1 shows some information about these elements.

Table 2.1

element	melting point /°C	reaction with water
sodium	98	reacts very quickly to produce hydrogen and an alkaline solution
potassium		reacts violently to produce hydrogen and an alkaline solution
rubidium	39	reacts explosively to produce hydrogen and an alkaline solution

- (a) Predict a value for the melting point of potassium.

..... °C [1]

- (b) Lithium is another element in Group I.

Predict the reaction of lithium with water.

.....
 [1]

- (c) A piece of sodium is added to water that contains universal indicator.

- (i) Predict the colour change of the universal indicator during the reaction.

from to [1]

- (ii) State the name of the product of the reaction between sodium and water that causes this colour change.

..... [1]

- (d) (i) Explain why sodium, potassium and rubidium are all in Group I of the Periodic Table.

Use ideas about the arrangement of electrons in your answer.

.....
 [1]

- (ii) Explain why potassium is below sodium in Group I.

Use ideas about the arrangement of electrons in your answer.

.....
 [1]

(e) Iron is a transition element.

- (i) Use the word **higher** or **lower** to complete each sentence about the properties of iron and sodium.

The melting point of iron is than that of sodium.

The density of iron is than that of sodium.

The reactivity of iron is than that of sodium.

[1]

- (ii) Barrier methods are used to prevent iron from rusting.

State **one** barrier method and explain how it prevents rusting.

method

explanation

.....

[1]

[Total: 8]

- 3 (a) Fig. 3.1 shows a man standing still and holding a bucket filled with water.

The weight of the bucket of water is 75.0 N.



Fig. 3.1

- (i) Calculate the mass of the bucket of water.

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

mass = ... kg [2]

- (ii) The man lowers the bucket of water to the ground from a height of 1.2 m.

Calculate the loss in gravitational potential energy of the bucket of water.

loss in gravitational potential energy = ... J [2]

- (iii) The area of the base of the bucket is 400 cm².

Calculate the pressure in pascals (Pa) of the bucket on the ground.

pressure = ... Pa [3]

(b) Fig. 3.2 shows two buckets, **A** and **B**, of identical size and shape.

Bucket **A** is made of shiny metal. Bucket **B** is made of dull black plastic.

Each bucket is filled with hot water and covered by a lid.

The buckets are placed on the ground to cool.

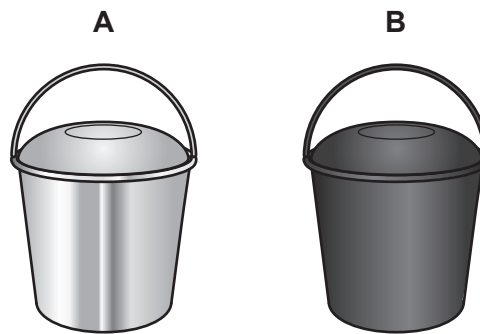


Fig. 3.2

Thermal energy leaves the buckets by **conduction** and **radiation**.

Suggest, with a reason, which one of these processes:

will cool bucket **A** more effectively

reason

.....

will cool bucket **B** more effectively.

reason

.....

[2]

[Total: 9]

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

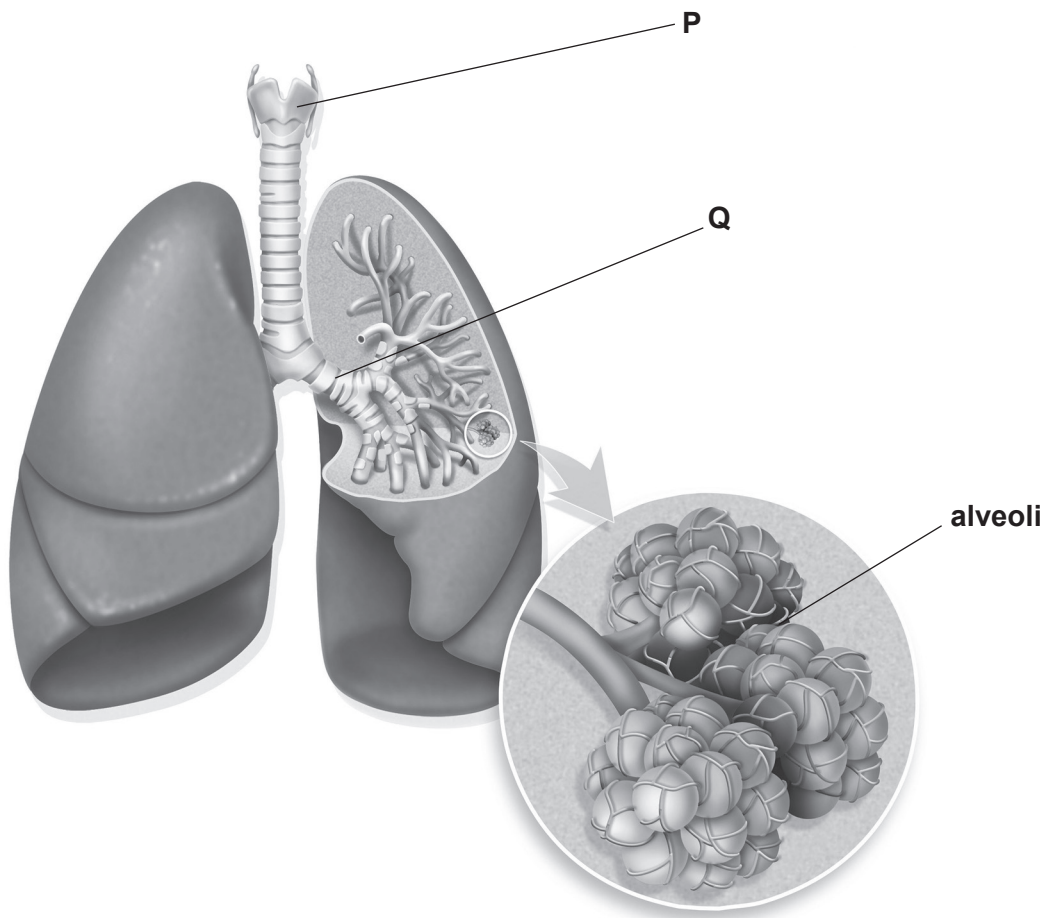


Fig. 4.1

- (i) Name the parts labelled **P** and **Q** in Fig. 4.1.

P

Q [2]

- (ii) The alveoli are the gas exchange surface in humans.

List **two** features of a gas exchange surface.

1

2 [2]

- (b) Fig. 4.2 shows how the volume of oxygen taken in and used by an athlete changes during and after physical exercise.

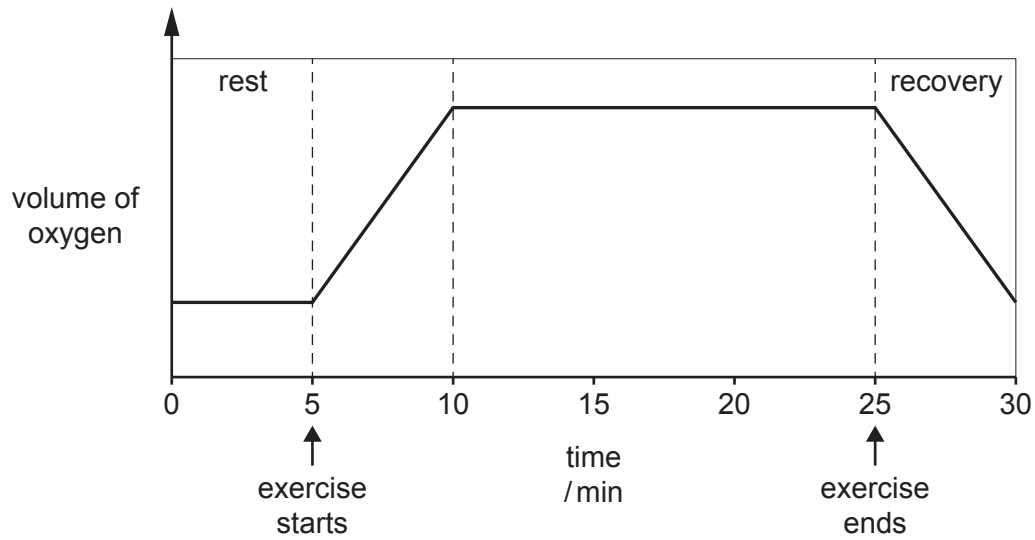


Fig. 4.2

- (i) Explain the results between **5 and 10 minutes** in Fig. 4.2.

.....

 [3]

- (ii) Describe **two** ways the athlete's breathing changes between **25 and 30 minutes** in Fig. 4.2.

1

 2
 [2]

- (c) Tobacco smoke also affects breathing.

State the toxic component of tobacco smoke that causes addiction.

..... [1]

[Total: 10]

- 5 The structure of a molecule of ethene is shown in Fig. 5.1.

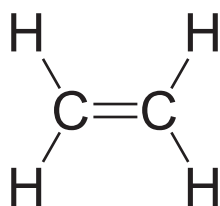


Fig. 5.1

- (a) State how Fig. 5.1 shows that ethene is an alkene.

..... [1]

- (b) Ethene is made from naphtha in an industrial process.

Name this process.

..... [1]

- (c) Ethene undergoes a polymerisation reaction.

- (i) State the name of the polymer formed.

..... [1]

- (ii) State the type of polymerisation reaction that happens when ethene forms a polymer.

..... [1]

- (d) A student investigates the combustion of ethene.

A cold surface is held near burning ethene. Drops of colourless liquid collect on the cold surface, as shown in Fig. 5.2.

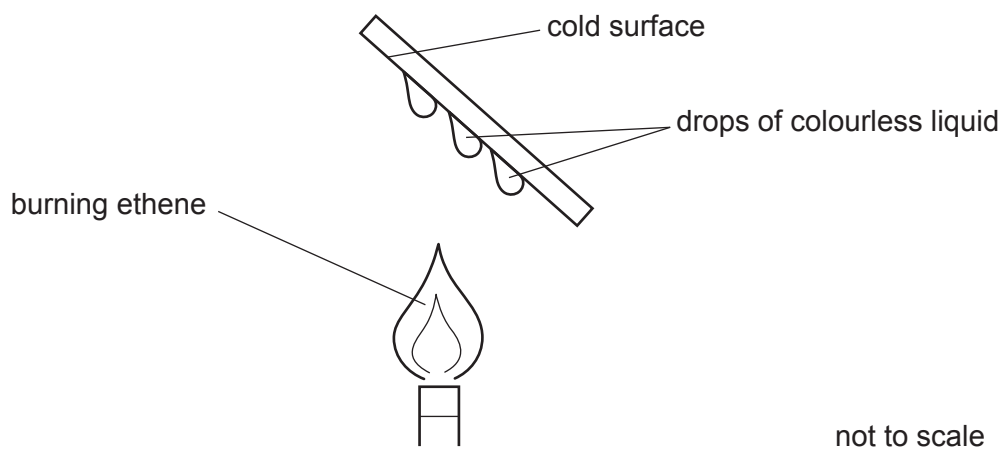


Fig. 5.2

- (i) The student does a test which shows that the colourless liquid contains water.

Describe a chemical test for water.

State the colour change observed.

test

colour change

from to [2]

- (ii) During combustion, water forms as a gas.

State the change that occurs when the gas collects as a liquid on the cold surface in Fig. 5.2.

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

- (iii) State the name of the **other** product formed during the complete combustion of ethene.

..... [1]

[Total: 8]

- 6 A glacier is a very large area of ice that moves slowly down a slope or valley.

Fig. 6.1 shows a glacier as it flows into a lake.

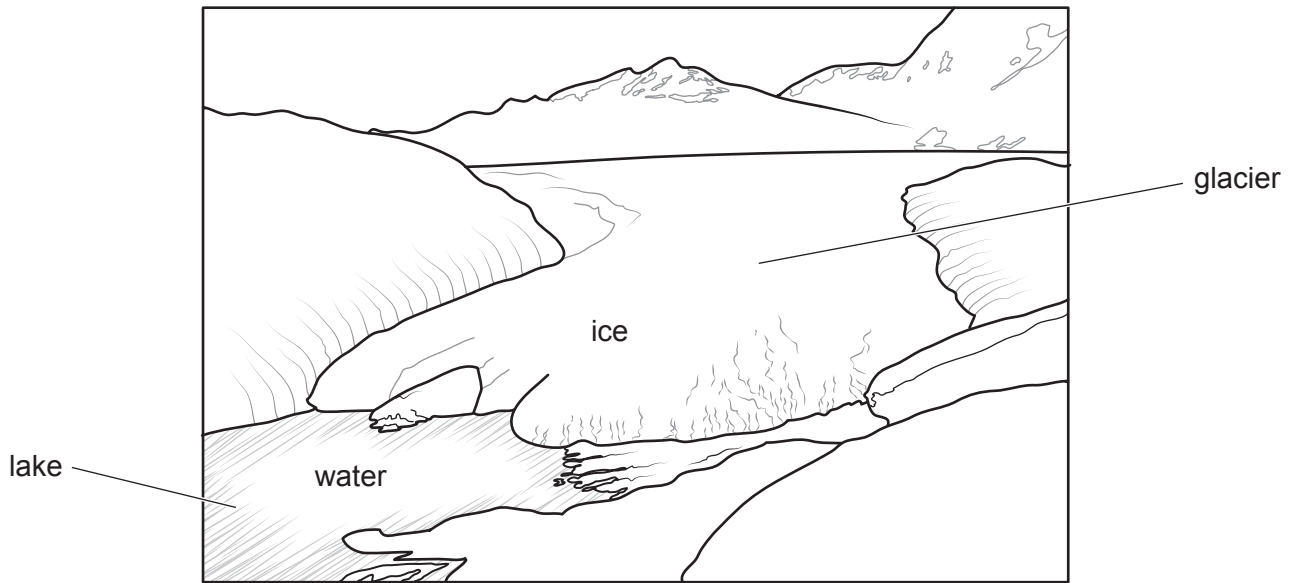


Fig. 6.1

- (a) At the end of the glacier, the ice in contact with water is melting.

The temperature of the water is 4°C .

- (i) State the temperature of the melting ice.

temperature = ... $^{\circ}\text{C}$ [1]

- (ii) Complete the sentences using words from the list.

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

chemical	electrical	potential	power
pressure	resistance	temperature	thermal

The ice melts because energy is transferred from the water to the ice. This causes the of the water to decrease. [2]

- (b) Ice is a solid. Water is a liquid.

Describe the differences between a solid and a liquid in terms of:

- the forces between the molecules
- the motion of the molecules.

.....

.....

.....

..... [2]

- (c) A scientist standing on the glacier sees a large rock fall onto the glacier 1900 m away.

The rock makes a loud sound as it hits the glacier.

- (i) Show that the time for the sound to travel 1900 m through air to the scientist is 5.8 s.

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

[1]

- (ii) Use data to explain why the scientist sees the rock fall onto the glacier before she hears the sound.

.....

.....

..... [2]

- (iii) The scientist actually hears the sound of the rock falling onto the glacier just 0.49 s after seeing the rock fall.

Suggest why this time is less than the time in (c)(i).

.....

.....

..... [2]

[Total: 10]

7 Fig. 7.1 shows a food chain from a pond.

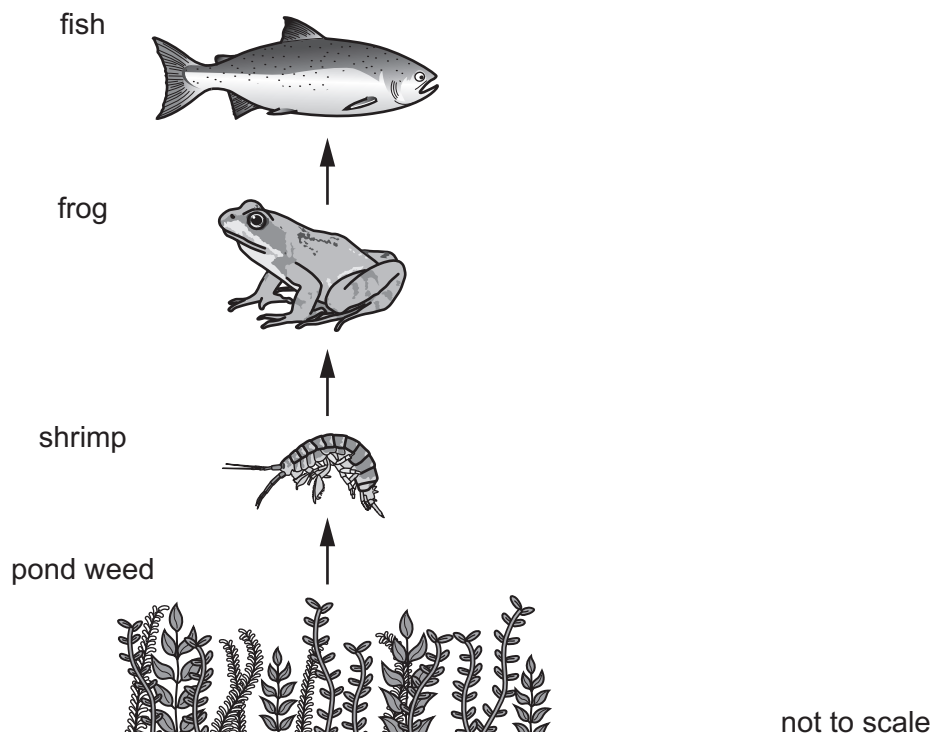


Fig. 7.1

(a) Identify the organism at the second trophic level in Fig. 7.1.

..... [1]

(b) Sewage containing high levels of nitrate gets into the pond.

Explain why a high concentration of nitrate in the pond may result in the death of animals in the food chain.

.....

.....

.....

.....

.....

..... [4]

- (c) Sewage damages the ecosystem.

Increasing carbon dioxide concentration in the atmosphere also damages ecosystems.

Explain why planting more trees reduces the carbon dioxide concentration in the atmosphere.

.....

.....

..... [2]

[Total: 7]

8 Calcium carbonate reacts with dilute hydrochloric acid to produce a gas.

(a) Name the gas produced in this reaction.

..... [1]

(b) The reaction also produces calcium chloride.

Calcium chloride contains calcium ions, Ca^{2+} , and chloride ions, Cl^- .

Deduce the formula for calcium chloride.

..... [1]

(c) In an investigation, 5 g of calcium carbonate reacts with 20 cm³ of dilute hydrochloric acid, as shown in Fig. 8.1.

The volume of gas collected during the first 10 s is measured.

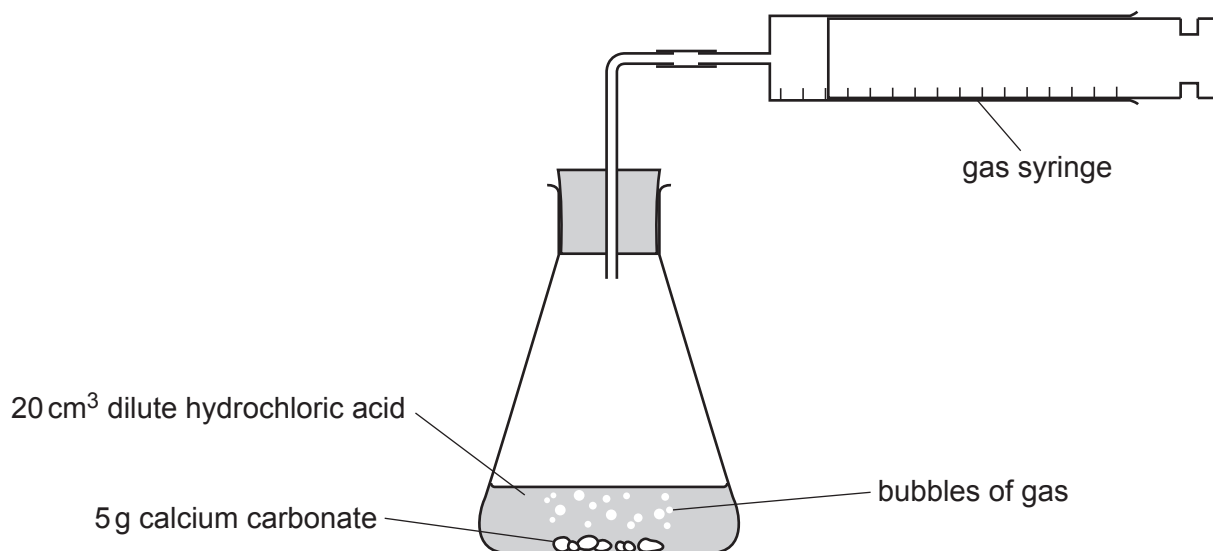


Fig. 8.1

The experiment is repeated using the same mass of calcium carbonate and the same volume of dilute acid.

Different concentrations of dilute acid and different temperatures are used.

The results are shown in Table 8.1.

Table 8.1

experiment	concentration of dilute <u>hydrochloric acid</u> mol/dm ³	temperature /°C	volume of gas collected during the first 10 s /cm ³
1	1.0	20	25
2	2.0	20	43
3	0.5	10	9
4	0.5	20	14
5	1.0	30	37

- (i) State the effect of increasing the temperature on the rate of a reaction.

.....
 [1]

- (ii) Identify **two** experiments from Table 8.1 that can be used to show the effect of increasing the temperature on the rate of the reaction.

Explain the reason for your choices.

experiment and experiment
 explanation
 [2]

- (iii) Explain why the results for **experiment 1** and **experiment 4** are different.

Use ideas about collisions between reacting particles in your answer.

.....

 [3]

- (d) The energy level diagram for the reaction between calcium carbonate and dilute hydrochloric acid is shown in Fig. 8.2.

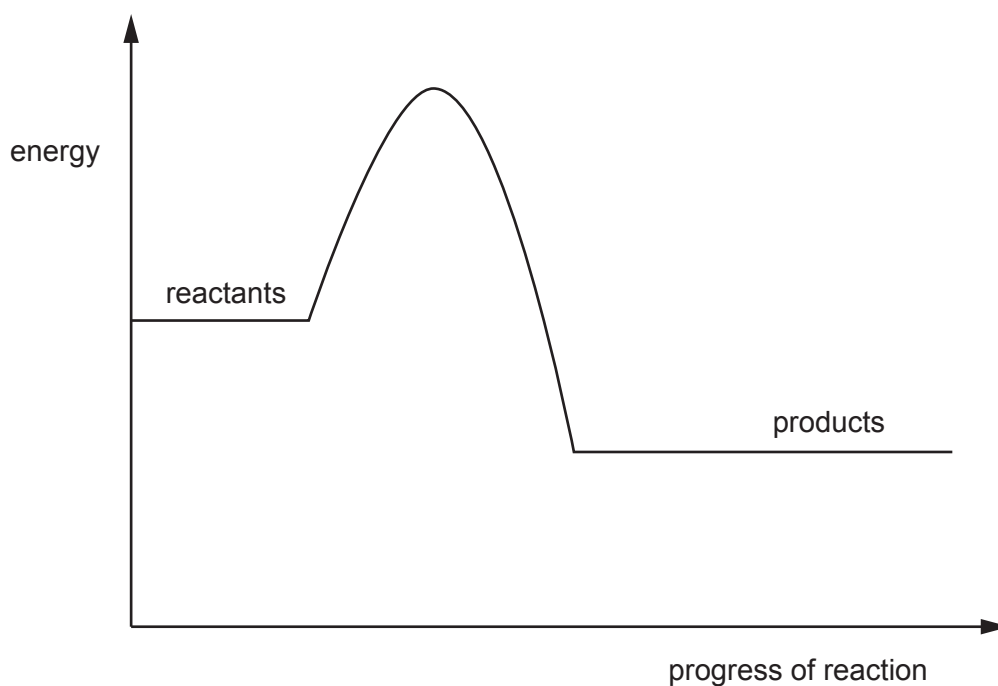


Fig. 8.2

- (i) Draw an arrow on Fig. 8.2 to show the activation energy for the reaction.

Label this arrow **A**.

[1]

- (ii) Draw an arrow on Fig. 8.2 to show the energy change of this reaction.

Label this arrow **B**.

[1]

[Total: 10]

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9 Fig. 9.1 shows a traffic light.

The traffic light has three different-coloured lamps, red, yellow and green.

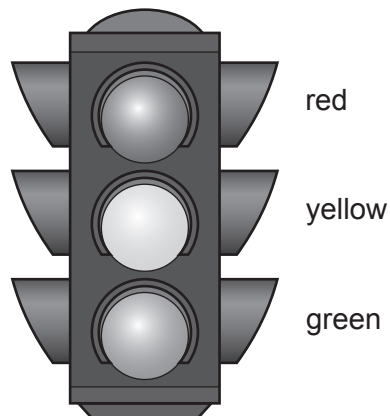


Fig. 9.1

(a) (i) Red, yellow and green are all types of visible light.

Fig. 9.2 shows an incomplete electromagnetic spectrum.

On Fig. 9.2, write visible light in the correct position.

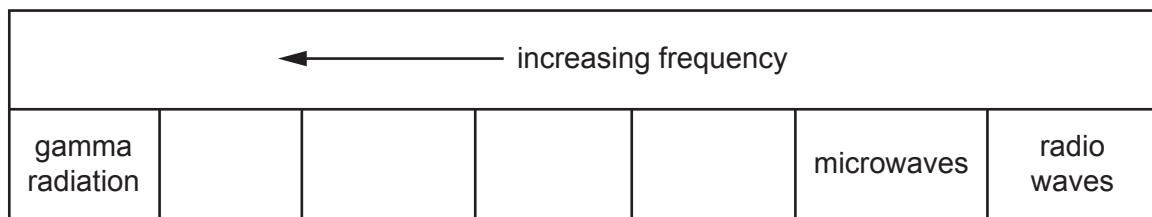


Fig. 9.2

[1]

(ii) The frequency of the visible red light is 4.58×10^{14} Hz.

Calculate the wavelength of the visible red light.

wavelength = ... m [2]

(b) Fig. 9.3 shows the circuit diagram for the traffic light.

The voltage of the a.c. power supply is 110 V.

Each lamp has a power rating of 60 W.

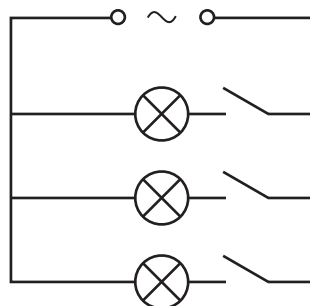


Fig. 9.3

(i) The red lamp is switched on.

Calculate the current in the red lamp.

current = ... A [2]

(ii) The red lamp and the yellow lamp are switched on at the same time. The green lamp is still switched off.

Calculate the current from the a.c. power supply at this time.

current = ... A [1]

(iii) One advantage of connecting the three lamps in parallel is that each lamp gets the full supply voltage across it.

Suggest **two** other advantages of connecting the three lamps in parallel.

1

.....

2

.....

[2]

[Total: 8]

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The Periodic Table of Elements

Group																		
I	II	Key										III	IV	V	VI	VII	VIII	
		atomic number atomic symbol name relative atomic mass										1 H hydrogen 1						
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	2 He helium 4	
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.).