



CANDIDATE
NAME

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CENTRE
NUMBER

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NUMBER

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0653/41

May/June 2021

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 is a diagram of a human sperm cell.



Fig. 1.1

- (i) State the function of the nucleus.

..... [1]

- (ii) State one way the sperm is adapted to its function in reproduction.

..... [1]

- (iii) Name the part of the male reproductive system that makes sperm.

..... [1]

- (b) Fig. 1.2 shows two different types of cells from the leaf of a plant.

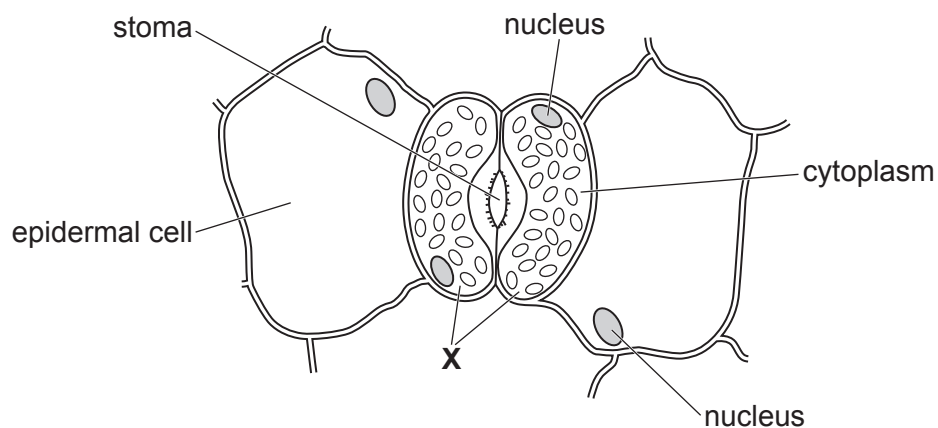


Fig. 1.2

- (i) Identify the cells labelled **X** in Fig. 1.2.

..... [1]

- (ii) Identify **one** structure in cell **X** in Fig. 1.2 that is absent from a sperm cell.

..... [1]

- (c) A student investigates the effect of light intensity on the rate of photosynthesis in an aquatic plant.

Fig. 1.3 shows the apparatus the student uses.

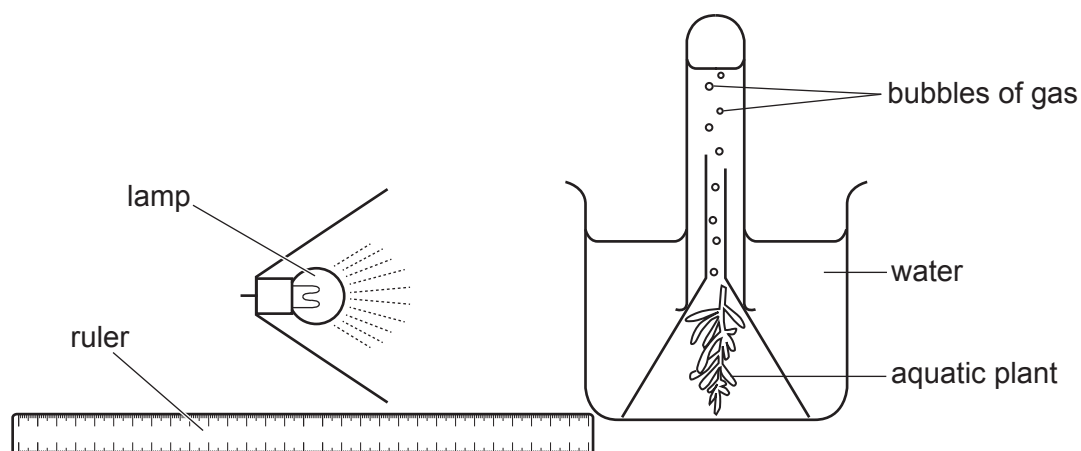


Fig. 1.3

The student:

- places the lamp 10 cm from the beaker
- counts the number of bubbles the aquatic plant produces in 3 minutes
- repeats the count two more times at this distance
- then repeats the experiment with the lamp at different distances from the beaker.

Table 1.1 shows the results.

Table 1.1

distance of lamp from beaker /cm	number of bubbles			average number of bubbles
	attempt 1	attempt 2	attempt 3	
10	120	118	123	120
20	118	120	119	119
30	80	78	75	78
40	48	45	42	45
50	15	12	14	

- (i) Calculate the average number of bubbles when the lamp is 50 cm from the beaker.
Give your answer to the nearest whole number.

..... bubbles [2]

(ii) Describe the effect of light intensity on the rate of photosynthesis shown in Table 1.1.

.....

.....

.....

..... [2]

(d) Explain the role of chlorophyll in photosynthesis.

.....

.....

..... [2]

[Total: 11]

2 Oxygen and hydrogen are gases.

- (a) The dot-and-cross diagrams in Fig. 2.1 show the outer shell electrons in a molecule of hydrogen and a molecule of oxygen.

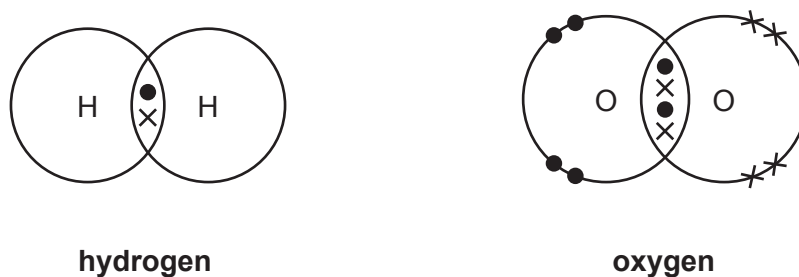


Fig. 2.1

- (i) State how the dot-and-cross diagram for hydrogen shows that it contains a covalent bond.

.....
 [1]

- (ii) The bonding in the hydrogen molecule is different from the bonding in the oxygen molecule shown in Fig. 2.1.

State **and** explain this difference.

difference

explanation

..... [2]

(b) Table 2.1 shows information about some gases in the air.

Table 2.1

gas	formula	percentage in air
oxygen	O ₂	21
nitrogen	N ₂	78
carbon dioxide	CO ₂	0.04
argon	Ar	0.93

(i) Identify the gas in Table 2.1 that is a compound.

Explain your answer.

gas

explanation

[2]

(ii) State **one** use for argon.

[1]

(iii) Argon is a noble gas.

Describe the reactivity of noble gases.

Use ideas about electronic structure in your answer.

[2]

(iv) Explain how the data show that air contains some gases which are **not** listed in Table 2.1.

[1]

[Total: 9]

- 3 Fig. 3.1 shows a motor boat moving forward across the sea.

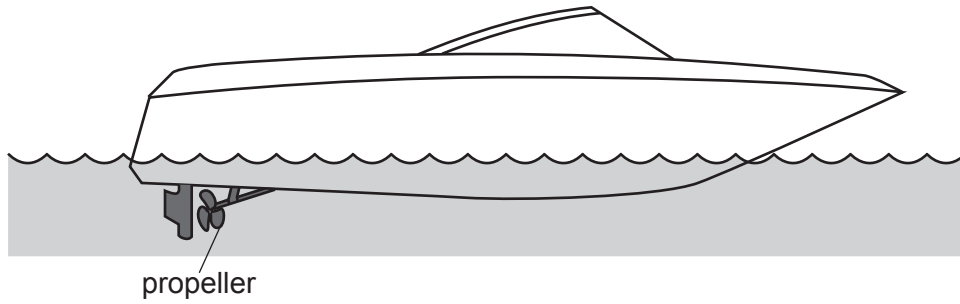


Fig. 3.1

- (a) The boat has a mass of 3100 kg and moves at a constant speed of 12 m/s.

- (i) Calculate the kinetic energy of the moving boat.

kinetic energy = ... J [2]

- (ii) The boat uses a gasoline (petrol) engine to turn the propeller.

Explain why even at constant speed the engine has to power the propeller to keep the boat moving forward.

Use ideas about forces and work done in your answer.

.....

.....

.....

.....

..... [3]

- (b) The boat enters a harbour. Waves from the boat hit the harbour wall. Fig. 3.2 shows water waves behind the boat hitting the harbour wall.

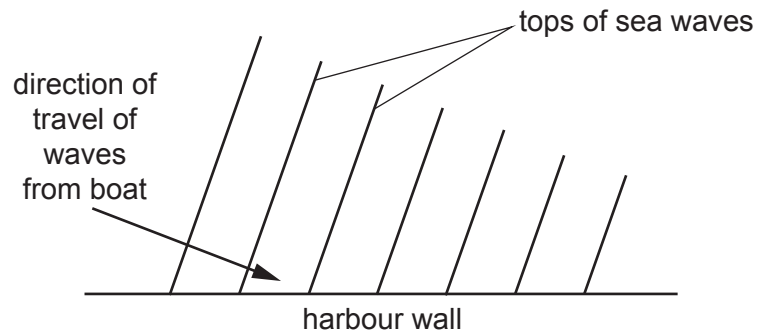


Fig. 3.2

- (i) State what happens to the waves when they hit the harbour wall.

..... [1]

- (ii) On Fig. 3.2 draw an arrow to show the direction of these waves after hitting the harbour wall. [2]

[Total: 8]

- 4 (a) Table 4.1 shows the mass of protein in some different food types.

Table 4.1

food type	mass of protein in 100 g of food /g
beans	6.9
cheese	25.4
eggs	12.5
fish	23.5
lentils	7.6
meat	32.0
nuts	21.1

- (i) Identify the food type that contains the most protein in 100 g of food.

..... [1]

- (ii) The recommended daily intake of protein for an adult male is 56 g.
A man eats 25 g of nuts.

Calculate the percentage of the recommended daily intake of protein he has eaten.
Give your answer to 2 significant figures.

.....% [3]

- (iii) Some people only eat vegetable proteins.

Suggest why eating nuts can be an important part of their diet.

Use the information in Table 4.1 to help you.

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

(b) Proteins are digested in the stomach.

(i) Mechanical digestion and chemical digestion both take place in the stomach.

Compare mechanical digestion and chemical digestion.

.....

.....

.....

..... [2]

(ii) Hydrochloric acid is found in the stomach.

State why chemical digestion in the stomach requires the presence of hydrochloric acid.

.....

..... [1]

[Total: 8]

5 Some gas ovens use methane as a fuel, other gas ovens use propane.

(a) Complete and balance the equation for the **complete** combustion of propane.



[2]

(b) Fig. 5.1 shows the energy level diagrams for the combustion of methane and the combustion of propane. The diagrams are drawn to the same scale.

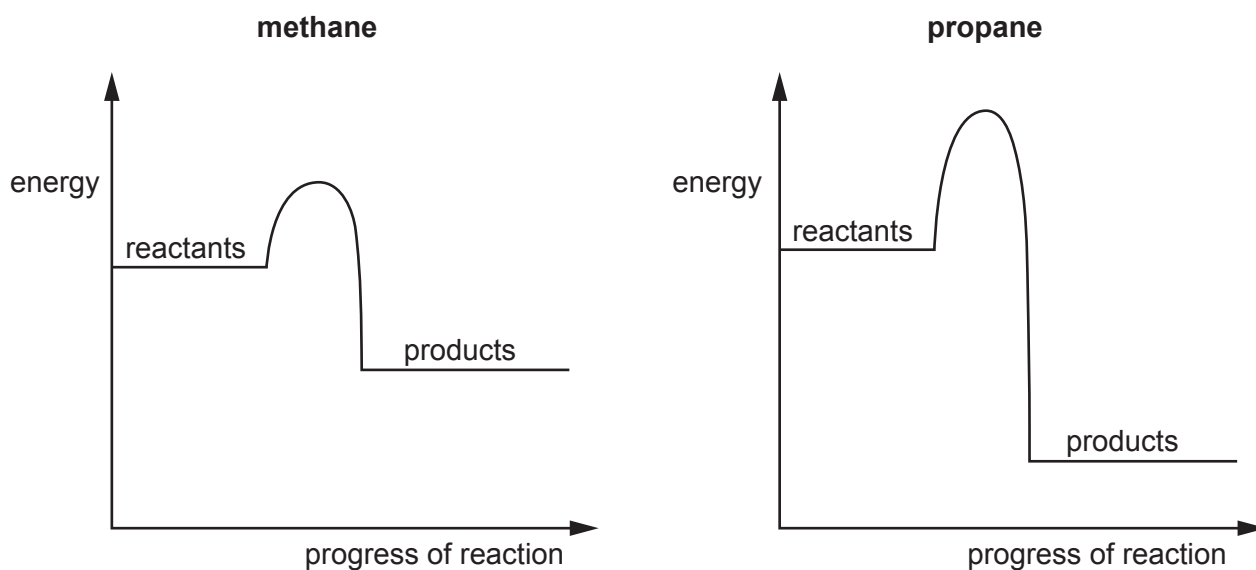


Fig. 5.1

(i) Explain how Fig. 5.1 shows that both reactions are exothermic.

.....

 [2]

(ii) Use Fig. 5.1 to state **two** differences between the energy changes that happen during the combustion of methane and the combustion of propane.

1

 2

[2]

- (c) When the air supply to an oven is limited, carbon monoxide is formed.

State **one** adverse effect of carbon monoxide.

.....

..... [1]

[Total: 7]

- 6 (a) Fig. 6.1 shows a thermometer in a solution of salt in water. The salt solution is boiling.

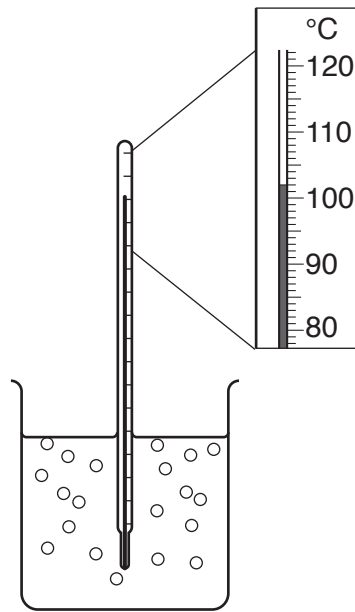


Fig. 6.1

- (i) Use the data in Fig. 6.1 to describe the effect on the boiling point of **pure water** of adding salt to water.

.....

.....

.....

..... [2]

- (ii) The addition of salt to water increases the forces between the particles.

Suggest why this causes the change in the boiling point of the liquid.

.....

..... [1]

- (b) Fig. 6.2 shows a tank full of water. The volume of water in the tank is 1500 dm^3 .

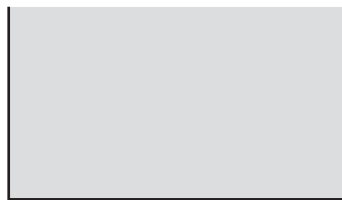


Fig. 6.2

Fig. 6.3 shows the same tank after a large rock fell into the tank. The water in the tank flowed over the top. When the rock was lifted out, only 1075 dm^3 of water was left in the tank.

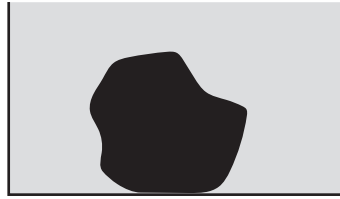


Fig. 6.3

The rock has a mass of 1150 kg.

- (i) Calculate the volume of the rock.

volume = ... dm^3 [1]

- (ii) Use your answer to **(b)(i)** to calculate the density of the rock.

density = ... kg/dm^3 [2]

- (iii) Calculate the weight of the rock.

The gravitational field strength, g , is 10 N/kg .

weight = ... N [1]

- (iv) The rock is lifted back into the tank. The water is emptied from the tank.

The area of the rock in contact with the base of the empty tank is 1.1 m^2 .

Use your answer to **(b)(iii)** to calculate the pressure of the rock on the bottom of the tank. Give the units of your answer.

pressure = ... units [3]

[Total: 10]

- 7 (a) Fig. 7.1 is a photomicrograph of a cross-section of an artery.

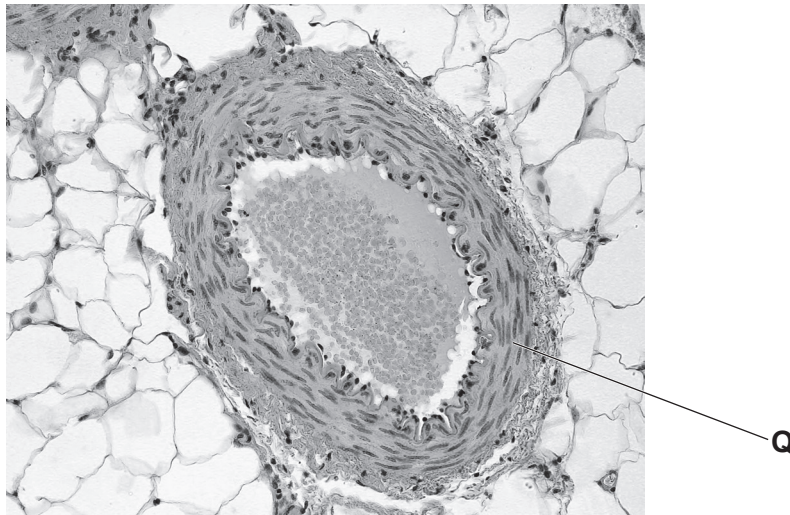


Fig. 7.1

- (i) Identify the type of tissue labelled **Q** in Fig. 7.1.

..... [1]

- (ii) Arteries form part of a double circulatory system in humans.

Explain the advantages of a double circulatory system.

.....

 [2]

- (iii) Blood flows through arteries due to the actions of the heart.
 Describe how the heart pushes blood through the arteries.

.....

 [2]

- (b) Smoking tobacco is a risk factor for coronary heart disease.

Cigarettes contain tobacco.

Fig. 7.2 shows the correlation between number of cigarettes smoked and number of deaths from heart disease.

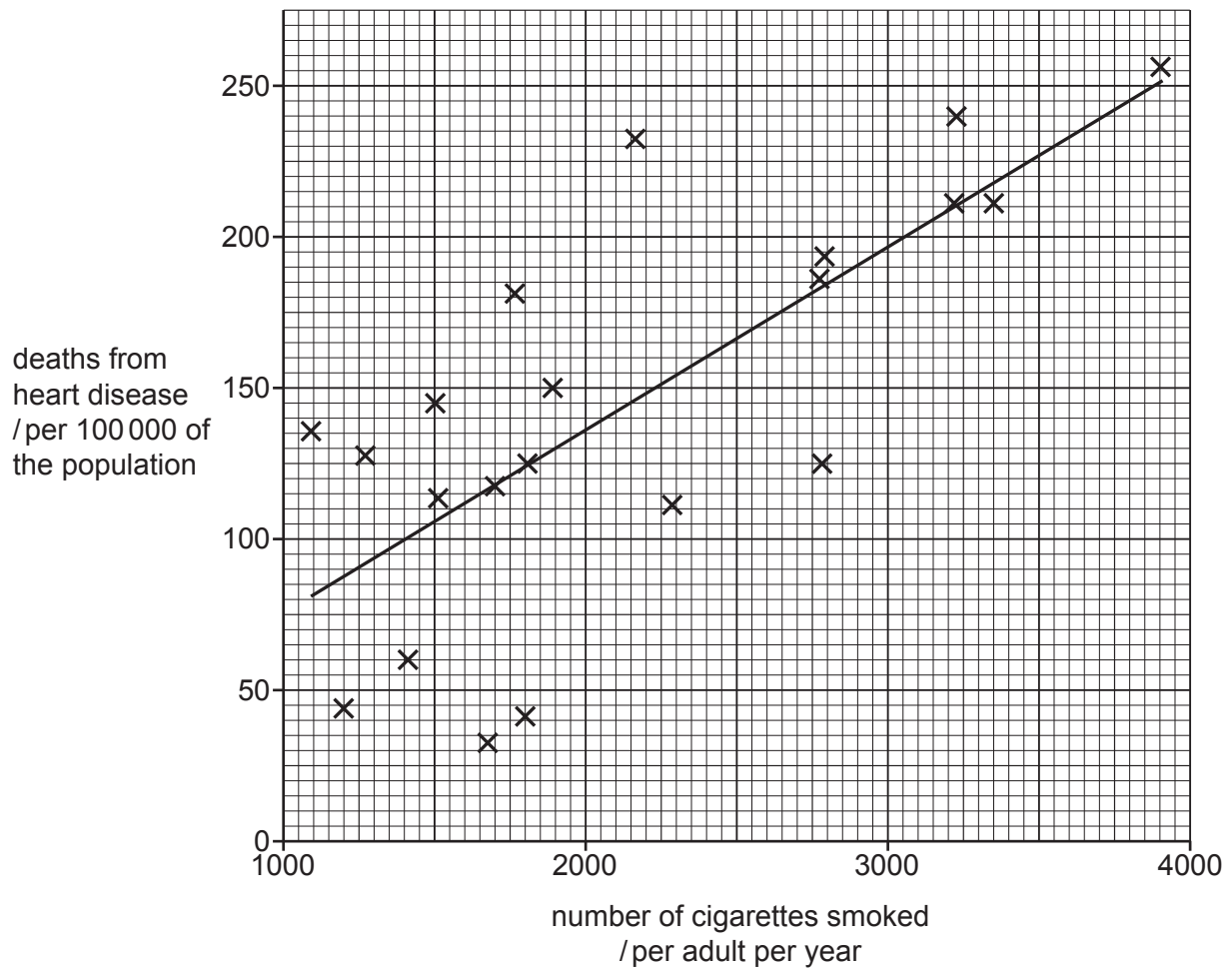


Fig. 7.2

- (i) Describe the correlation in Fig. 7.2.

.....
 [1]

- (ii) Fig. 7.3 shows some cells which line a human airway.

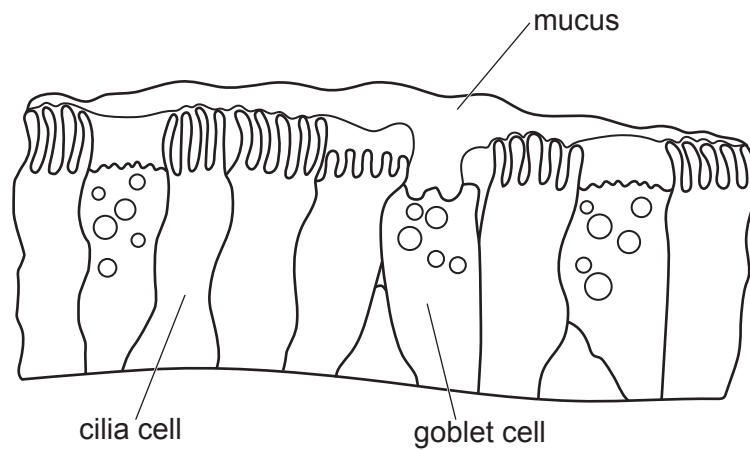


Fig. 7.3

Describe how the cells shown in Fig. 7.3 work to remove the particles inhaled in tobacco smoke.

.....

.....

.....

..... [2]

[Total: 8]

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- 8 Bromine, chlorine and iodine are in Group VII of the Periodic Table.

Table 8.1 shows some information about these elements at room temperature and pressure.

Table 8.1

element	formula	state	colour
bromine	Br_2	liquid	red
chlorine	Cl_2		
iodine	I_2		grey

- (a) (i) Complete Table 8.1. [3]

- (ii) Molecules of bromine, chlorine and iodine are diatomic.

Explain the meaning of the term diatomic.

.....

 [2]

- (b) Explain why bromine, chlorine and iodine are in Group VII of the Periodic Table.

Use ideas about electrons in your answer.

.....
 [1]

- (c) Some Group VII elements are mixed with some aqueous potassium salts.

The word equations show what happens.

bromine + potassium chloride → no reaction

bromine + potassium iodide → iodine + potassium bromide

chlorine + potassium bromide → bromine + potassium chloride

iodine + potassium bromide → no reaction

Use this information to place bromine, chlorine and iodine in order of reactivity.

Explain your answer.

most reactive

↓

least reactive

explanation

[2]

- (d) Potassium reacts with chlorine to form potassium chloride.

- (i) State the type of bonding in potassium chloride.

..... [1]

- (ii) Explain why potassium chloride has a high melting point.

.....

..... [1]

[Total: 10]

- 9 (a) Fig. 9.1 shows an incomplete circuit used to determine the resistance of a length of resistance wire.

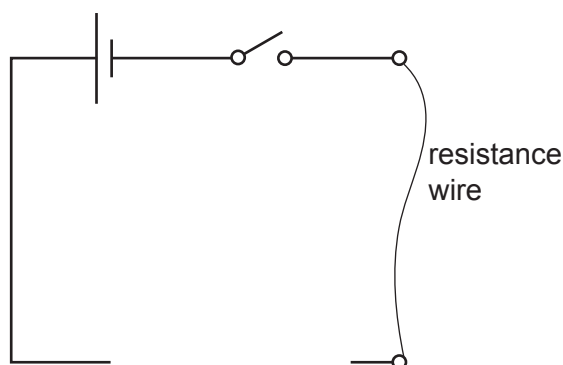


Fig. 9.1

- (i) Complete the circuit diagram by adding the symbols for the instruments used to measure the current and the potential difference across the resistance wire in the circuit. [2]
- (ii) The resistance wire is replaced by a new wire made of the same material, but three times the length and half the cross-sectional area.

The resistance of the first wire is 5.5Ω .

Calculate the resistance of the new wire.

resistance = ... Ω [3]

- (b) Fig. 9.2 shows a circuit with a piece of wire of resistance 5.0Ω connected in parallel with another piece of wire of resistance 10.0Ω .

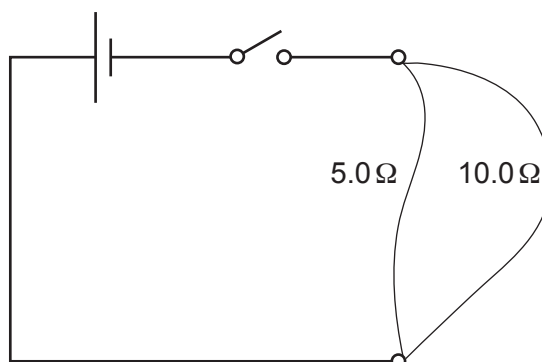


Fig. 9.2

- (i) There is a current of 3.0 A from the source.

State the current in the 5.0Ω resistance wire.

Explain your answer.

current A

explanation

.....

[2]

- (ii) Calculate the combined resistance of the two resistance wires in parallel.

resistance = ... Ω [2]

[Total: 9]

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The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
	11 Na sodium 23	12 Mg magnesium 24	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40									
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —
87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —		114 Fl flerovium —		116 Lv livermorium —		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).



CANDIDATE
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0653/42

May/June 2021

1 hour 15 minutes

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- The Periodic Table is printed in the question paper.

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[Turn over

- 1 (a) Fig. 1.1 shows the flowers of a wind-pollinated plant.



Fig. 1.1

- (i) Complete the sentence about wind pollination.

During wind pollination from the anther of one flower is blown by the wind to the of another flower.

[2]

- (ii) Describe **one** way the anther of a wind-pollinated flower is different from the anther of an insect-pollinated flower.

.....

..... [1]

- (b) After pollination and fertilisation a seed is formed.
Fig. 1.2 shows a bean seed just starting to grow.

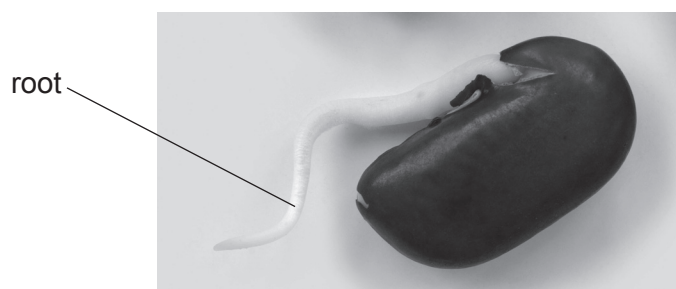


Fig. 1.2

- (i) Circle the name of the process shown in Fig. 1.2.

excretion

germination

nutrition

respiration

[1]

- (ii) The root of the seed is growing downwards away from the light.

Name this tropic response.

..... [1]

- (c) Fig. 1.3 shows the plant growing from the bean seed a few days later.

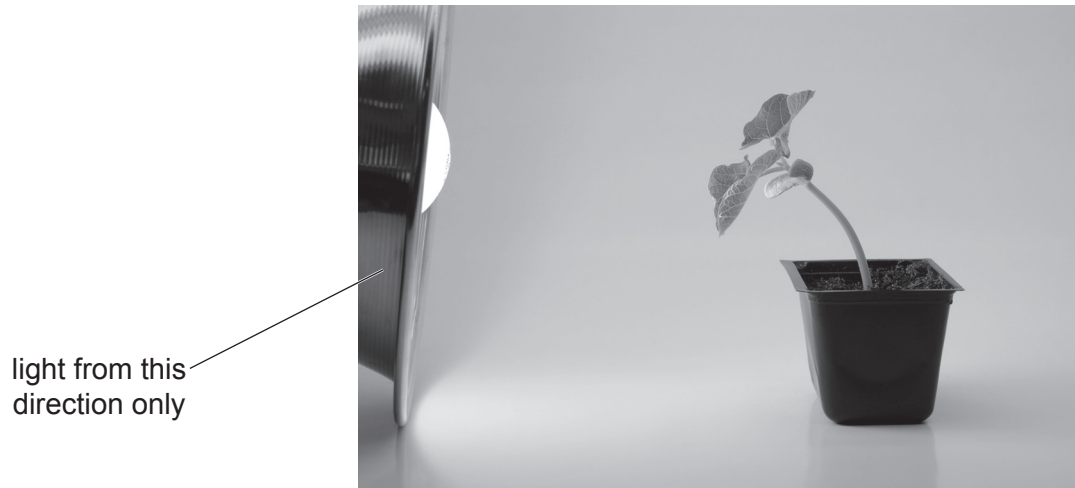


Fig. 1.3

Complete the sentences to explain the role of auxin in controlling the response of the shoot shown in Fig. 1.3.

Auxin is made in the shoot and then spreads through the plant.

Auxin collects on the side of the shoot.

Auxin stimulates cell , which causes the shoot to bend.

[3]

- (d) Oil is sometimes stored inside seeds.
Describe how you can test seeds to show that they contain oil.
Include the expected result in your answer.

method

.....

result

[2]

[Total: 10]

2 Calcium chloride, CaCl_2 , is an ionic compound.

- (a) Fig. 2.1 is a dot-and-cross diagram which shows the arrangement of electrons in the ions in calcium chloride.

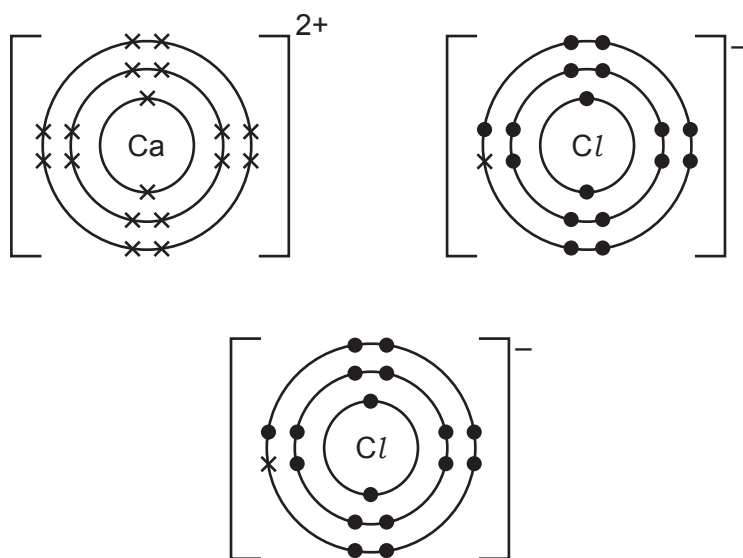


Fig. 2.1

- (i) Describe how a calcium ion is formed from a calcium atom.

.....
 [1]

- (ii) Each chloride ion contains eight electrons in the outer shell. These are represented by seven dots and one cross. Explain why.

.....

 [2]

- (iii) Explain why there are two chloride ions for each calcium ion in calcium chloride.

.....
 [1]

- (b) Sodium bromide is another ionic compound.
Fig. 2.2 represents the arrangement of ions in solid sodium bromide.

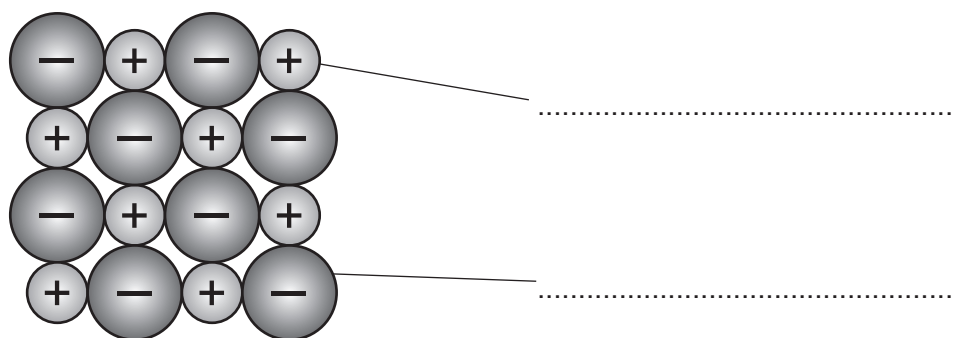


Fig. 2.2

- (i) Complete Fig. 2.2 by labelling the ions in solid sodium bromide. [1]
- (ii) State how Fig. 2.2 shows that sodium bromide is an ionic compound rather than a covalent compound.
.....
..... [1]
- (iii) State **two** reasons why Fig. 2.2 **cannot** be used to represent the arrangement of ions in calcium chloride, CaCl_2 .
1
.....
2
..... [2]

[Total: 8]

3 Fig. 3.1 shows a battery-powered electric bus.

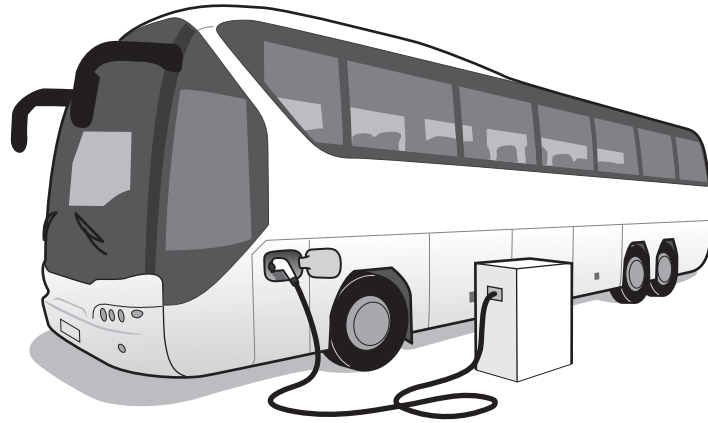


Fig. 3.1

The batteries are charged from the electricity supply through the cable. When the batteries are fully charged, the cable is unplugged and the bus drives away.

(a) Electric buses are replacing buses that use fossil fuels because they cause less damage to the environment.

(i) Describe how electrical energy is obtained from wind energy.

.....

.....

.....

..... [2]

(ii) Wind energy is a renewable energy source.

Name another renewable energy source that can be used to generate the electrical energy to charge the batteries.

..... [1]

(b) Fig. 3.2 shows a graph of a journey made by the bus along a road between two bus stops.

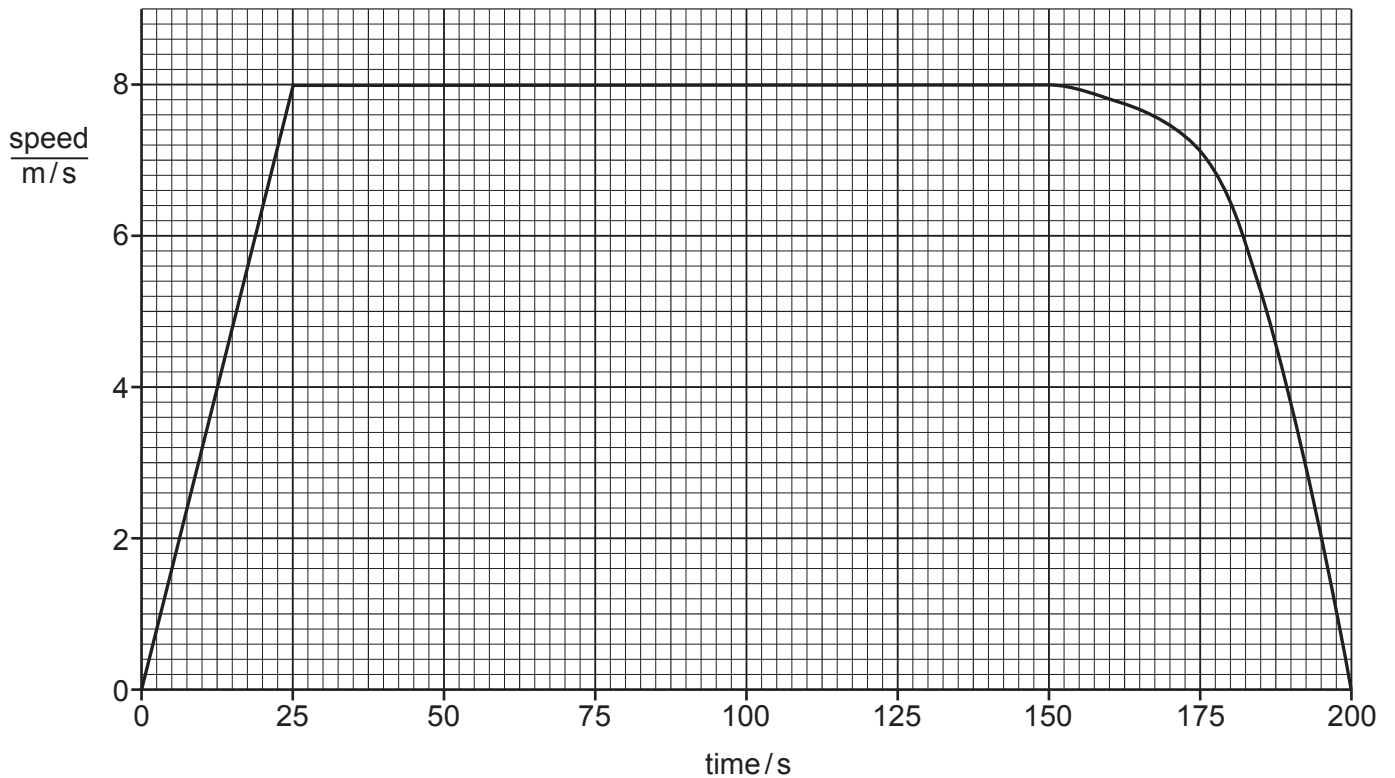


Fig. 3.2

- (i) At one time in the journey, the driver starts to apply the brakes.

State the time the driver starts to apply the brakes. s [1]

- (ii) Use Fig. 3.2 to calculate the distance travelled by the bus between 0 s and 100 s.

distance travelled = ... m [3]

- (iii) The speed limit on the road for this journey is 30 km/h.

Show that the bus does **not** break the speed limit during this journey.
Use Fig. 3.2 to help you.

[2]

[Total: 9]

- 4 (a) Fig. 4.1 is a graph showing the effect of temperature on the activity of an enzyme.

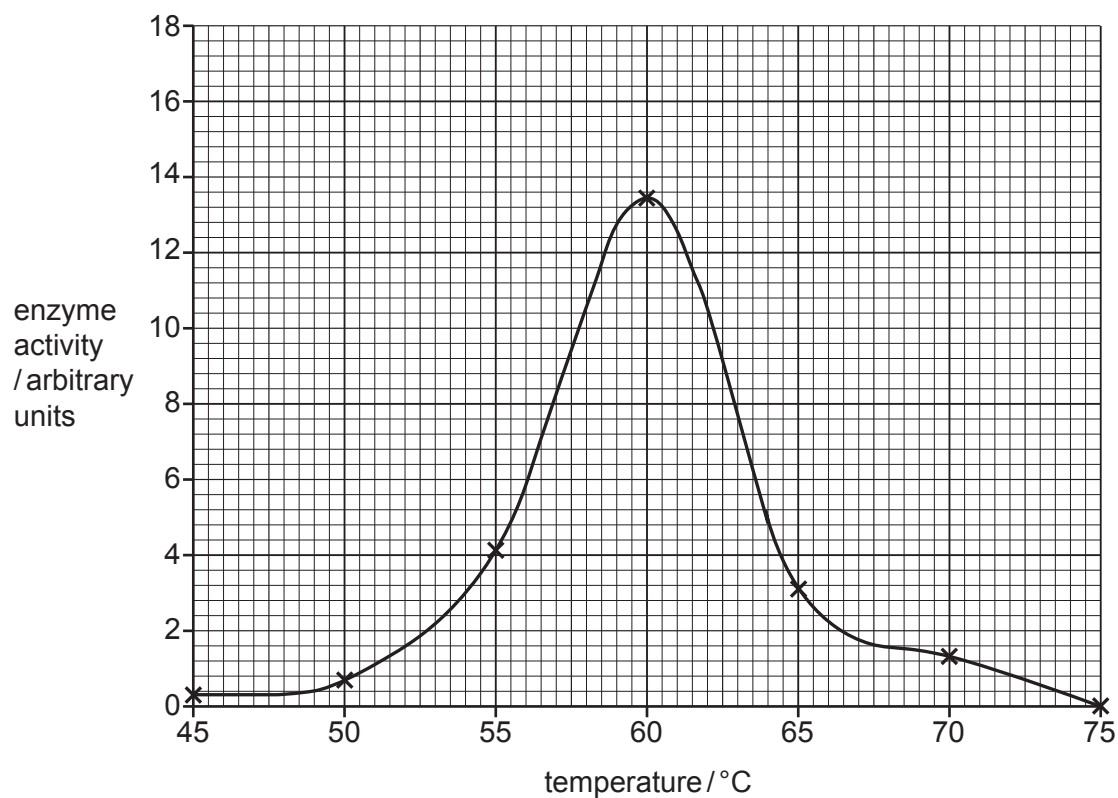


Fig. 4.1

- (i) Identify the temperature when this enzyme is most active.

..... °C [1]

- (ii) Explain why enzyme activity increases between 45 °C and 55 °C in Fig. 4.1.

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

(b) Protease enzymes are found in the stomach of humans.

(i) State the role of protease enzymes in the stomach.

.....

.....

..... [2]

(ii) Fig. 4.2 shows how changing pH affects the activity of three enzymes, **A**, **B** and **C**.

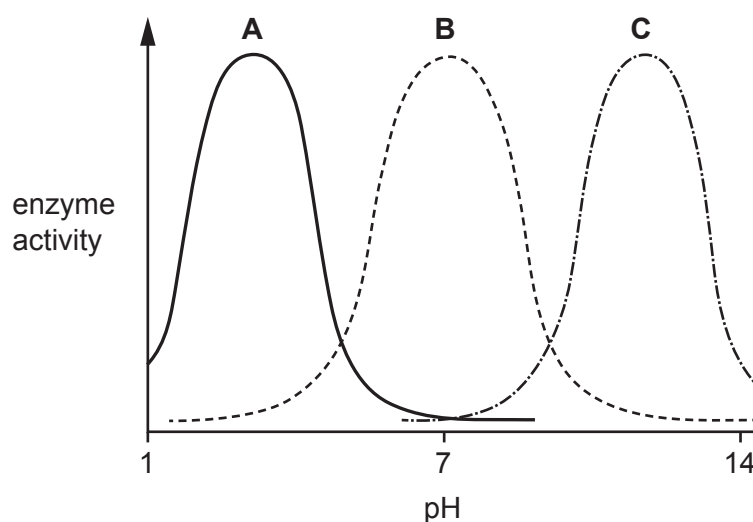


Fig. 4.2

Describe the evidence from Fig. 4.2 that shows that enzyme **A** is the protease enzyme from the stomach.

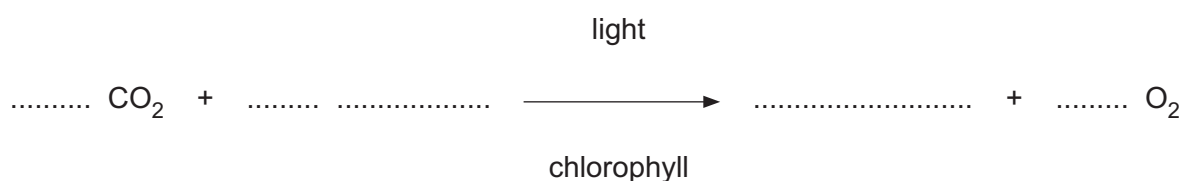
.....

.....

..... [2]

(c) The process of photosynthesis occurs in plants.

Complete the balanced equation for photosynthesis.



[2]

[Total: 9]

- 5 A student investigates the rate of reaction between solid calcium carbonate and dilute hydrochloric acid.

(a) The student:

- uses Universal Indicator paper to measure the pH of the acid before the reaction
- then adds excess calcium carbonate to the acid
- measures the pH of the mixture after the reaction is complete.

(i) Describe how to use Universal Indicator paper to measure pH.

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

(ii) Suggest a value for the pH of the dilute hydrochloric acid before the reaction and a value for the pH of the mixture after the reaction is complete.

acid

mixture

[2]

(b) The student repeats the experiment.

The student uses the same mass of calcium carbonate and the same temperature of acid each time.

The student uses different concentrations of acid and different sized pieces of calcium carbonate, as shown in Table 5.1.

Table 5.1

experiment	concentration of hydrochloric acid mol/dm ³	calcium carbonate pieces
1	0.5	large
2	0.5	small
3	1.0	large
4	1.0	small

State which experiment has the **highest** rate of reaction and which has the **lowest** rate of reaction.

Use ideas about colliding particles to explain your answer.

highest

lowest

explanation

.....

.....

.....

.....

[4]

[Total: 8]

- 6 Fig. 6.1 shows thermal energy being transferred to a beaker of water. A thermometer measures the temperature of the water.

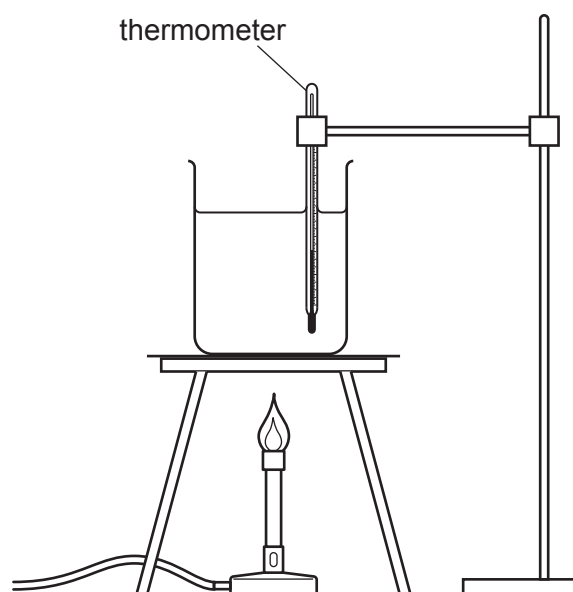


Fig. 6.1

(a) Name the processes by which thermal energy is transferred:

- (i) through the beaker to the water [1]
- (ii) through the water to the thermometer. [1]

(b) In the experiment shown in Fig. 6.1 there is thermal expansion of liquids and gases.

- (i) Identify **one** useful application of thermal expansion taking place in this apparatus.

.....

..... [1]

- (ii) For each degree of temperature rise, gases expand more than liquids at constant pressure.

Use your understanding of the forces and distances between molecules to explain this observation.

.....

.....

.....

..... [2]

- (c) A student reads the thermometer scale using a magnifying glass.

Fig. 6.2 shows a ray diagram of the way the student tries to use the magnifying glass.

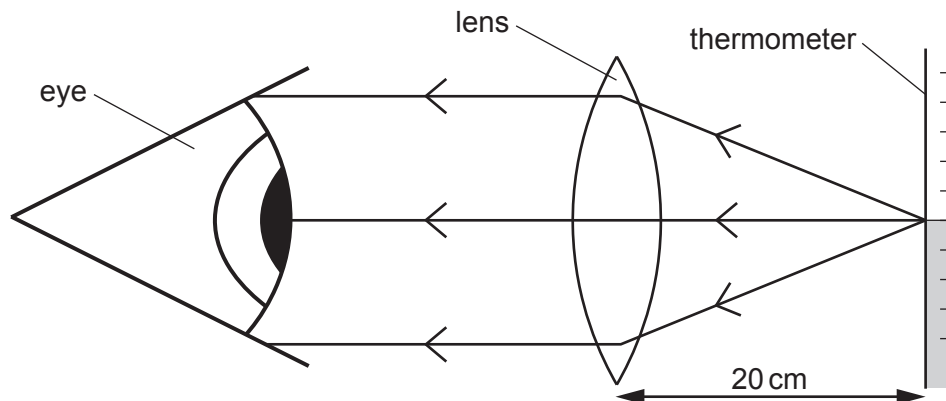


Fig. 6.2

- (i) Name the type of lens used as a magnifying glass.
 [1]
- (ii) Name the property of light shown when the light travels through the glass lens.
 [1]
- (iii) The student **cannot** see a magnified image of the thermometer scale through the lens in Fig. 6.2.

Describe how the student should move the lens and his eye so he can see a magnified image of the thermometer scale.

.....

 [2]

[Total: 9]

- 7 (a) Define the term ecosystem.

.....

.....

.....

..... [2]

- (b) Fig. 7.1 shows some of the living organisms found in a pond ecosystem.

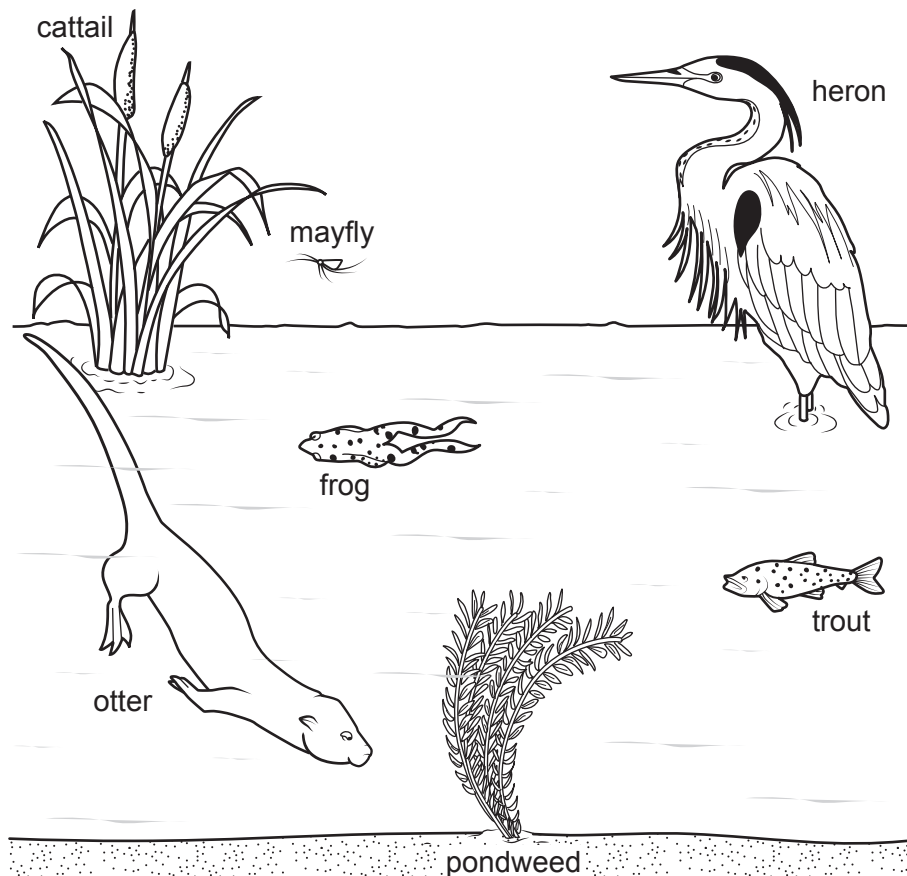


Fig. 7.1

Mayflies eat pondweed. Trout eat mayflies. Herons eat trout.

Construct a food chain using this information.

..... [2]

(c) Fertilisers high in nitrates pollute the pond in Fig. 7.1 causing algae to grow on the surface of the water.

(i) Explain why producers under the surface of the water die.

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

(ii) Explain why the death of producers causes a lack of oxygen in the water.

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

(iii) Explain why a lack of oxygen in the water causes a reduction in the population of herons.

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

[Total: 8]

- 8 The alkanes and the alkenes are both homologous series.

Table 8.1 shows the formulae of some alkanes and alkenes.

Table 8.1

number of carbon atoms	formula of alkane	formula of alkene
2	C_2H_6	C_2H_4
3	C_3H_8	C_3H_6
4	C_4H_{10}	
10	$C_{10}H_{22}$	$C_{10}H_{20}$
15		

- (a) (i) Complete Table 8.1 by filling in the missing formulae. [2]

- (ii) All alkanes are hydrocarbons.
State two **other** similarities between all alkanes.

1

.....

2

.....

[2]

- (b) State the colour change seen when aqueous bromine is added to an alkene.

from

to

[1]

(c) Pentane, C_5H_{12} , can be cracked to form smaller molecules.

Fig. 8.1 shows the structures and the formulae of pentane and some products of cracking pentane.

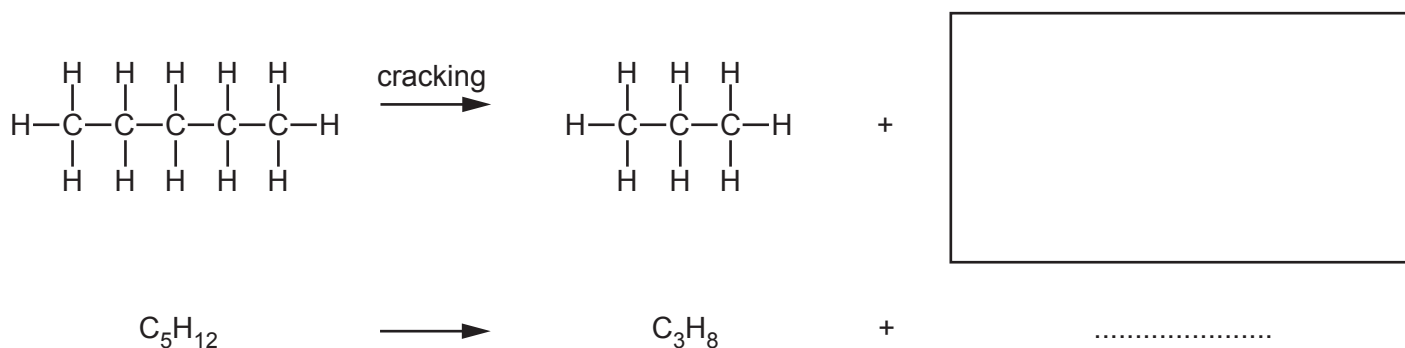
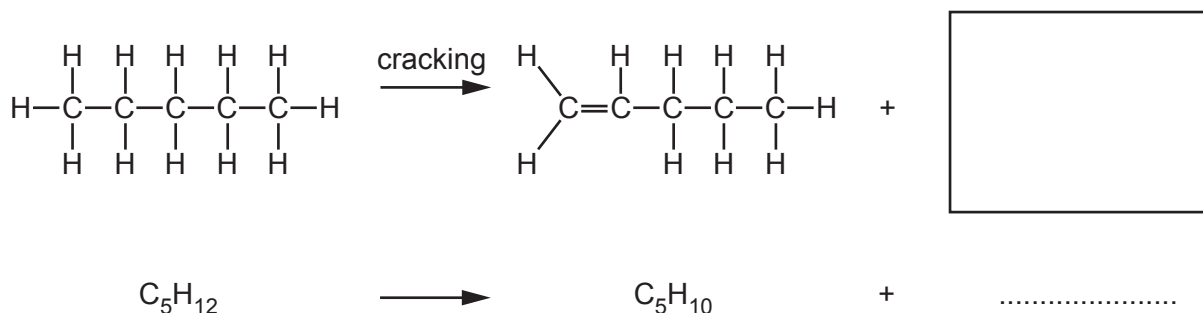


Fig. 8.1

(i) Complete Fig. 8.1 to show the structures and the formulae of the missing products. [3]

(ii) State **two** conditions needed for cracking.

1

2 [2]

[Total: 10]

- 9 Fig. 9.1 shows a car powered by a battery. The battery supplies electrical energy to two identical electric motors, one for each front wheel.

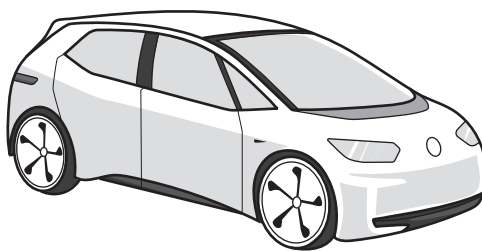


Fig. 9.1

The two motors are connected in parallel.

Both motors are controlled by the same variable resistor.

- (a) On Fig. 9.2 complete the circuit diagram with two motors, one switch and one variable resistor.

Use $\text{---}(\text{M})\text{---}$ as the symbol for an electric motor.

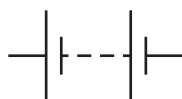


Fig. 9.2

[3]

- (b) The potential difference (p.d.) across each motor when used at maximum power is 96 V.

The maximum power supplied to one motor is 24 kW.

- (i) Calculate the current through the motor when at maximum power.

current = ...A [2]

- (ii) Show that the current supplied by the battery when both motors are at maximum power is 500 A.

[1]

- (c) The car battery is recharged from an electricity supply with a current of 30 A. It takes 4 hours (14 400 seconds) to recharge the battery.

Calculate the total electric charge required to recharge the battery.

State the unit of your answer.

charge = ... unit [3]

[Total: 9]

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The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
	11 Na sodium 23	12 Mg magnesium 24	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40									
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —
87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	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

May/June 2021

1 hour 15 minutes

No additional materials are needed.

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

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[Turn over

- 1 (a) Fig. 1.1 shows the flowers of a wind-pollinated plant.



Fig. 1.1

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

..... [1]

- (ii) Describe two ways the **pollen** of a wind-pollinated flower is different to that of an insect-pollinated flower.

1

2

[2]

- (b) A student investigates the germination of seeds by putting five bean seeds in different environmental conditions.

Table 1.1 shows the different environmental conditions for each bean seed.

Table 1.1

bean seed	environmental conditions			germinates yes/no
	warm or cold	water or <u>no</u> water	light or dark	
A	warm	water	dark	yes
B	warm	<u>no</u> water	light	
C	cold	<u>no</u> water	light	
D	cold	water	dark	
E	warm	water	light	

Complete Table 1.1 to predict if the seeds will germinate or not.

A has been done for you.

[1]

- (c) Table 1.2 shows information about some of the features found in the leaf of a plant.

Table 1.2

feature	adaptation to function
	small pores used for gas exchange
spongy mesophyll layer	
	contain large numbers of chloroplasts for photosynthesis

Complete Table 1.2.

[3]

[Total: 7]

- 2 Apparatus used for the electrolysis of molten lead(II) bromide is shown in Fig. 2.1.

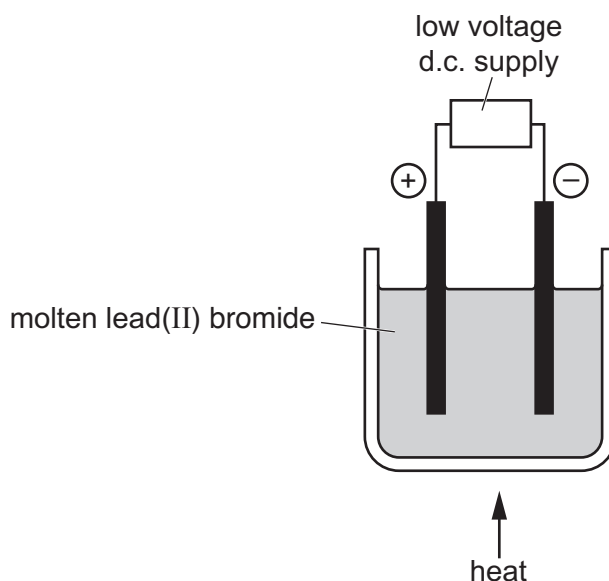
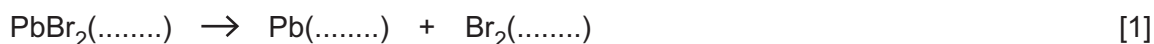


Fig. 2.1

- (a) The products of the reaction are molten lead and bromine gas.

- (i) Add state symbols to the equation for this reaction.



- (ii) During the electrolysis of lead(II) bromide, ions move to the positive and negative electrodes.

Describe what happens to the ions at each electrode.

Use ideas about electrons in your answer.

at the positive electrode (anode).....

.....

.....

at the negative electrode (cathode).....

.....

.....

[4]

- (b) The melting point of lead(II) bromide is 373 °C.

The temperature in the electrolysis cell is 400 °C.

When the apparatus cools, lead(II) bromide solidifies first while the lead metal produced is still a liquid.

Use this information to suggest a value for the melting point of lead.

..... °C [1]

- (c) The electrodes used are made from carbon. They do not change during the electrolysis.

State the word used to describe electrodes that do **not** change during electrolysis.

..... [1]

- (d) The melting point of magnesium oxide is 2850 °C.

The apparatus in Fig. 2.1 reaches a maximum temperature of 1000 °C.

Explain why the apparatus in Fig. 2.1 **cannot** be used to electrolyse magnesium oxide.

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

[Total: 9]

- 3 Fig. 3.1 shows a man lying down on a sandy beach on a sunny day.



Fig. 3.1

- (a) The man lies on the beach for a long time. The Sun emits electromagnetic radiation that causes the man to get painful sunburn.

- (i) Name the type of electromagnetic radiation that causes sunburn.

..... [1]

- (ii) Sunscreen cream can help to prevent sunburn.

Suggest what happens to the electromagnetic radiation responsible for sunburn when it meets the sunscreen cream.

.....

..... [1]

- (b) The man stands up.

Pressure from his feet leaves deep footprints in the sand.

The surface area of **one** foot is 155 cm^2 .

The mass of the man is 75 kg.

The gravitational field strength g is 10 N/kg .

Calculate the pressure he exerts on the sand when he stands on **two** feet.

pressure = ... Pa [4]

(c) Fig. 3.2 shows the man about to dive into the sea from a diving board.

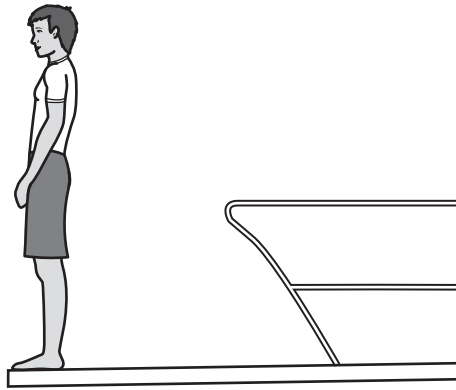


Fig. 3.2

Fig. 3.3 shows his speed-time graph as he goes down and into the water.

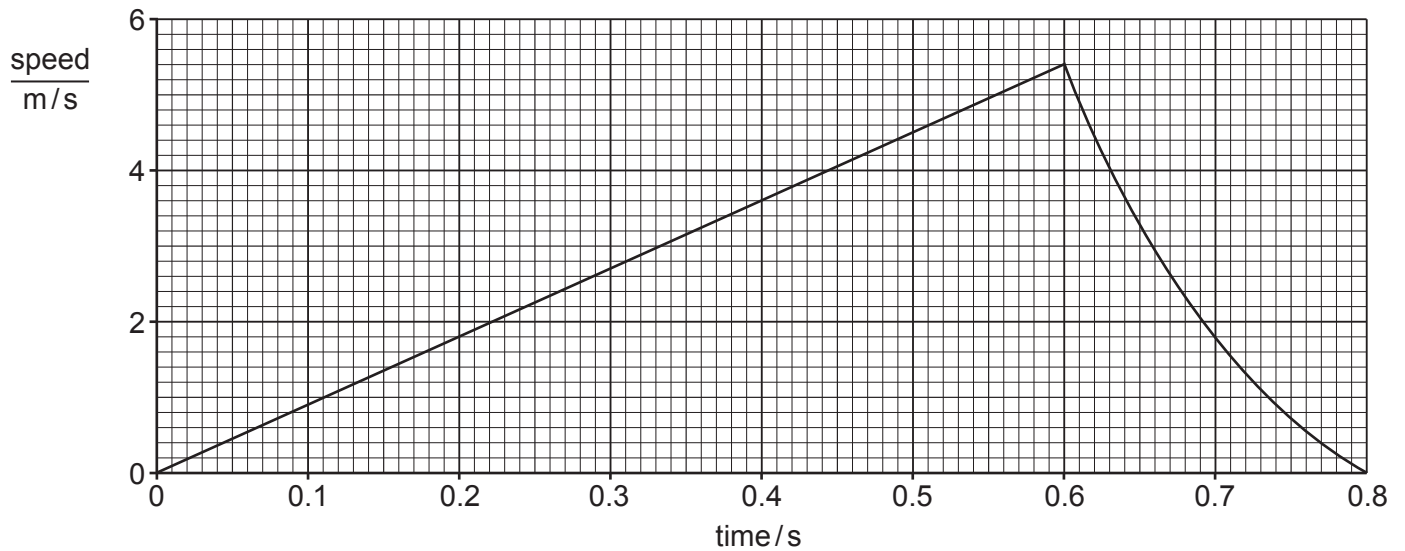


Fig. 3.3

The diver enters the water at 0.60 s.

(i) Use Fig. 3.3 to calculate the height of his dive.

height = ... m [2]

(ii) Use Fig. 3.3 to calculate his acceleration before he enters the water.

acceleration = ... m/s² [2]

[Total: 10]

[Turn over]

- 4 (a) Fig. 4.1 is a diagram of a section through a human heart.

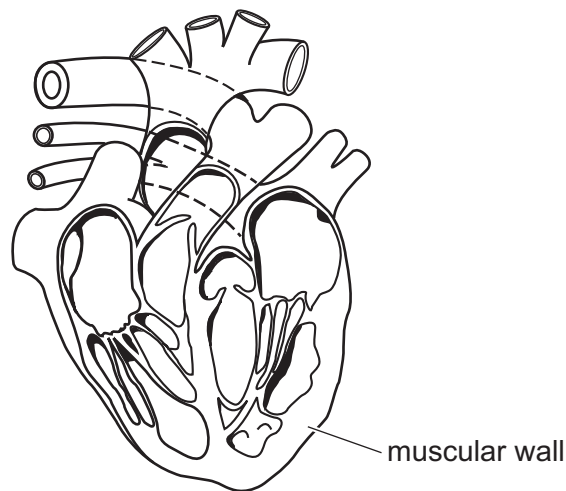


Fig. 4.1

- (i) On Fig. 4.1 use a label line and the letter **R** to identify the right ventricle of the heart. [1]
- (ii) Describe the role of the muscular wall in the function of the heart.

.....

.....

..... [2]

- (b) Fig. 4.2 is a graph that compares the number of males and females with coronary heart disease in different age categories.

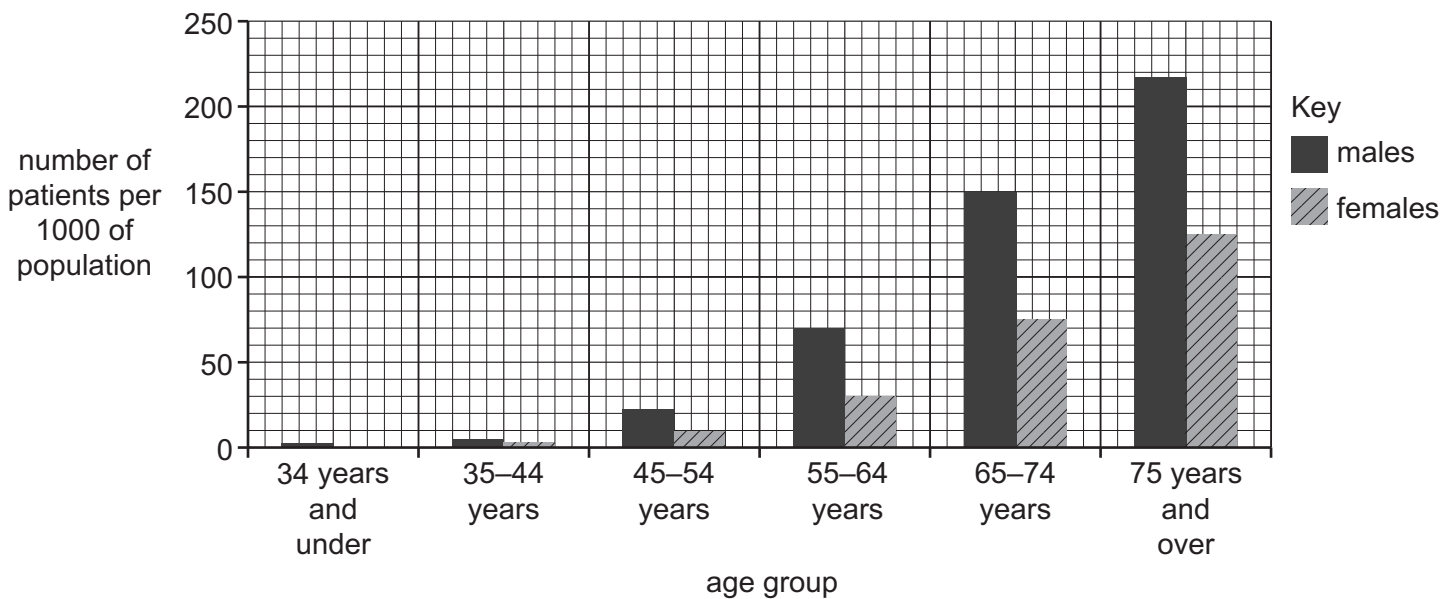


Fig. 4.2

- (i) Identify the age group that has **no women** with coronary heart disease.

..... [1]

- (ii) Describe **two** general trends shown in Fig. 4.2.

1

.....

2

.....

[2]

- (c) Risk factors for coronary heart disease include age, diet and your sex.

- (i) List two **other** risk factors for coronary heart disease.

1

2

[2]

- (ii) Describe how malnutrition can cause coronary heart disease.

.....

.....

..... [2]

[Total: 10]

- 5 Table 5.1 shows information about the electrons in atoms of elements **V**, **W**, **X**, **Y** and **Z**. **V**, **W**, **X**, **Y** and **Z** are **not** the symbols for the elements.

Table 5.1

elements	number of electrons in the outer shell of each atom	total number of electrons in each atom
V	1	1
W	4	6
X	6	16
Y	2	4
Z	7	9

- (a) Use the letters **V**, **W**, **X**, **Y** and **Z** to identify:

the element in Group VII

the **two** elements which form negative ions and

the metallic element

the element with the highest proton number

[5]

(b) Element **W** and element **Z** form a covalent compound.

The formula for this compound is **WZ₄**.

- (i) Use the information in Table 5.1 and the Periodic Table on page 20 to identify elements **W** and **Z**.

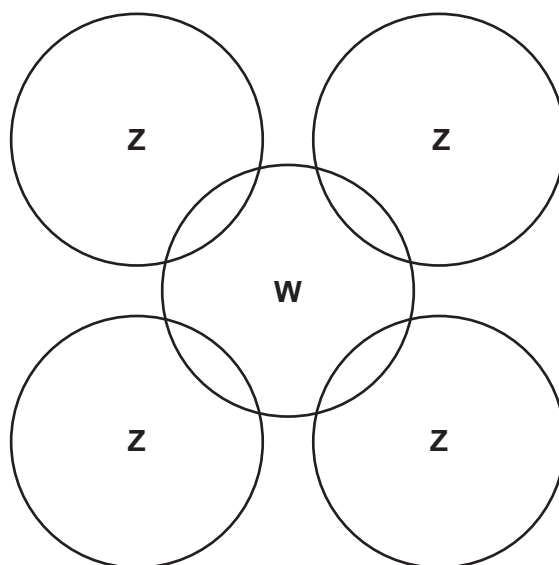
W

Z

[2]

- (ii) Complete the dot-and-cross diagram to show the bonding in **WZ₄**.

Show **all** the outer shell electrons.



[2]

[Total: 9]

- 6 (a) Table 6.1 shows the melting and boiling points of six substances.

Table 6.1

substance	melting point/°C	boiling point/°C
ammonia	−78	−33
benzene	6	80
bromine	−7	59
lactic acid	53	105
mercury	−39	357
sulfur	113	445

- (i) Identify the substance which is a liquid over the smallest range of temperature.

..... [1]

- (ii) Identify the substance which has the slowest moving molecules when it turns from a liquid into a gas.

..... [1]

- (iii) The thermal conductivity of the metal mercury is 40 times higher than the thermal conductivity of the non-metal sulfur.

Suggest why the thermal conductivity of mercury is so much greater.

.....

..... [1]

- (b) Mercury vapour is used in street lamps. One colour of light emitted is green, which has a wavelength of $546 \times 10^{-9} \text{ m}$.

The speed of light is $3.0 \times 10^8 \text{ m/s}$.

Calculate the frequency of the green light.

State the unit of your answer.

frequency = ... unit [3]

(c) A street lamp requires a power input of 175 W from the electricity supply.

(i) Only 20% of the energy input is emitted as light.

Suggest the form of energy output for the remaining 80% of the input.

..... [1]

(ii) The street lamp is used for 8 hours.

Calculate the total energy input.

energy = ... J [3]

[Total: 10]

- 7 (a) Fig. 7.1 is a graph showing the effect of temperature on two different enzymes, **A** and **B**.

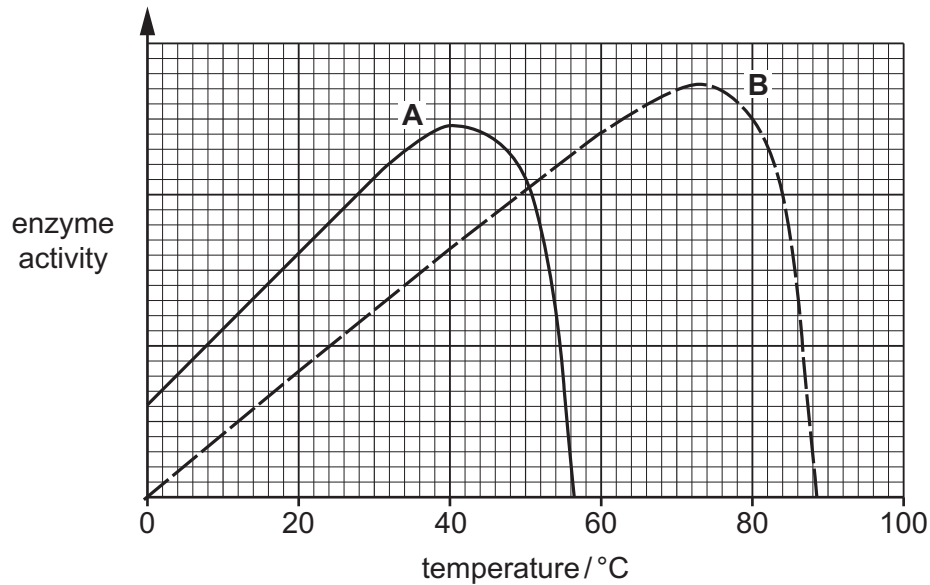


Fig. 7.1

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

..... °C [1]

- (ii) Compare the effect of temperature on the two enzymes.

.....

 [3]

- (iii) Explain the effect of temperature on the activity of enzyme **B** above 75°C.

.....

 [2]

- (b) Lipase enzymes are found in the small intestine of humans.

State the role of lipase enzymes in the small intestine.

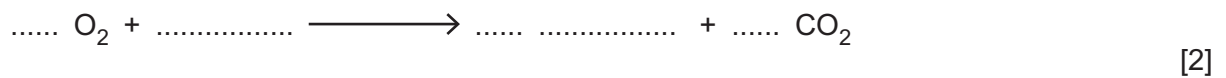
.....

.....

..... [2]

- (c) Enzymes are used in aerobic respiration.

Complete the balanced chemical equation for aerobic respiration.



[Total: 10]

8 Fig. 8.1 shows the structures of ethane and ethene.

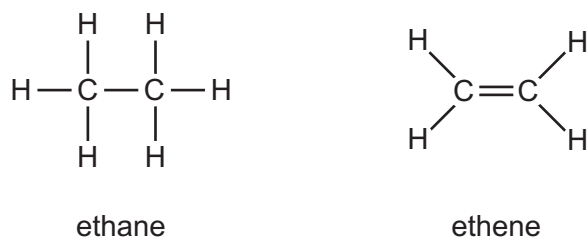


Fig. 8.1

(a) (i) Ethane and ethene are hydrocarbons. State what is meant by the term hydrocarbon.

.....
 [2]

(ii) Use Fig. 8.1 to explain what is meant by the term unsaturated.

.....
 [1]

(b) The polymerisation of ethene forms the polymer poly(ethene).

(i) Identify this type of polymerisation.

..... [1]

(ii) Describe what happens to the ethene molecules during polymerisation.

.....
 [1]

(iii) Ethane **cannot** form a polymer.
 Explain why.

.....
 [1]

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



[2]

[Total: 8]

- 9 Fig. 9.1 shows a car travelling forwards along a road.

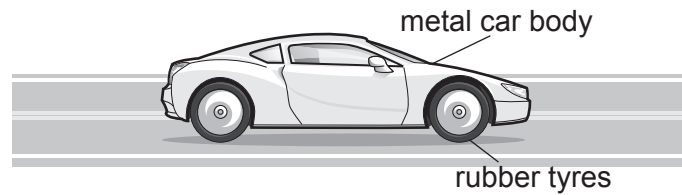


Fig. 9.1

As the car drives along, electrostatic charges build up on the car.

- (a) (i) State what causes an electrostatic charge to form on the car.

..... [1]

- (ii) Name the particles transferred when an electrostatic charge builds up on the car.

..... [1]

- (iii) Explain why the electric charge does **not** travel to the ground while the car is being driven along the road.

.....

.....

..... [2]

- (b) When the car stops, the driver gets out and touches the metal car body. The electric charge on the car travels through the driver to the ground. The electric current through the driver as the charge travels to the ground is 0.015A and lasts for 0.3ms.

- (i) Calculate the total electric charge that travels through the driver.

charge = ... C [2]

- (ii) The total resistance of the driver's body and shoes is 40 000 Ω .

Show that the potential difference between the driver and the car before she touches the door handle is 600V.

[1]

[Total: 7]

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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.).