Cambridge IGCSE

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8456131745

CO-ORDINATED SCIENCES **0654/43**

Paper 4 (Extended) **October/November 2019**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 32.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **31** printed pages and **1** blank page.

Cambridge Assessment International Education

1 **(a)** Respiration releases energy. It can occur aerobically or anaerobically.

(i) State the balanced chemical equation for aerobic respiration.

..... [2]

(ii) Name the product of anaerobic respiration in muscles.

..... [1]

(iii) Name the two products of anaerobic respiration in yeast.

1 .....

2 .....
[2]

(b) Respiration is one of the characteristics of living organisms.

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

1 .....

2 .....
[2]

[Total: 7]

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2 **(a)** Ammonia, NH_3, is made by the reaction between nitrogen gas and hydrogen gas in the Haber process.

Construct the symbol equation for this reaction.

..... [2]

(b) Identify a substance that displaces ammonia gas from ammonium chloride.

..... [1]

(c) Ammonia gas reacts with hydrogen chloride gas to form solid ammonium chloride.

Fig. 2.1 shows apparatus a teacher uses to demonstrate this reaction.

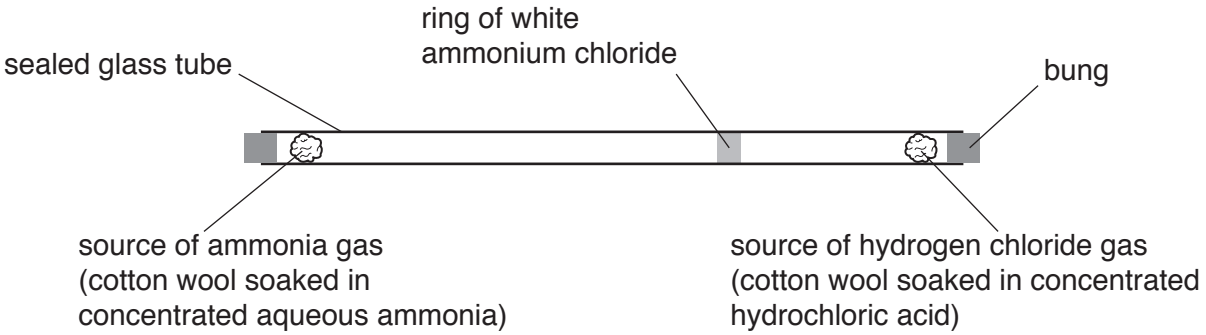

Fig. 2.1

Ammonia molecules and hydrogen chloride molecules start to diffuse away from the cotton wool plugs at the same time.

The ring of white ammonium chloride forms after 1 minute.

(i) Define the term *diffusion*.

.....

..... [2]

(ii) The glass tube is 0.9 m long. The speed of each molecule is more than 1 m/s.

Suggest why it takes more than 1 minute for the white ring to form.

.....

..... [1]

(iii) Show that the relative molecular mass of ammonia, NH_3, is 17.

[A_r: H,1; N,14]

[1]

(iv) The relative molecular mass of hydrogen chloride, HC*l*, is 36.5.

Explain how this experiment shows that the rate of diffusion depends on molecular mass.

.....

.....

.....

..... [2]

[Total: 9]

3 **(a)** Fig. 3.1 shows a bar magnet suspended by a spring above a coil that is connected to a voltmeter.

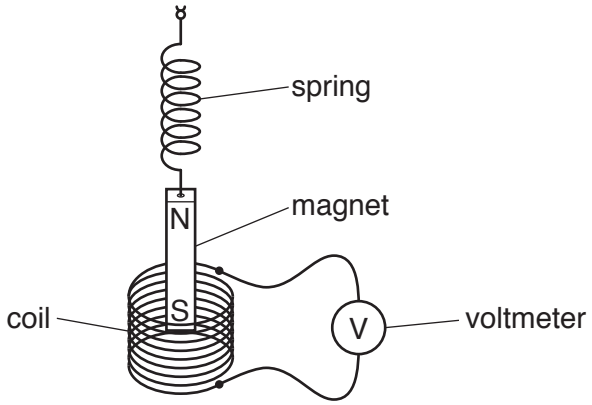

Fig. 3.1

When the magnet is pulled downwards into the coil and then released, it oscillates up and down inside the coil. An alternating voltage is observed on the voltmeter.

Explain why an alternating voltage is observed.

.....

.....

..... [2]

(b) A thin piece of iron wire has a diameter of 0.20 mm.

(i) Name the device which could accurately measure very small distances such as 0.20 mm.

..... [1]

(ii) The wire is 0.10 m in length and has a resistance of 0.30 Ω.

Determine the resistance of a piece of wire made from the same iron metal that is 0.10 m in length but has a diameter of 0.40 mm.

resistance = ... Ω [2]

(c) The isotope iron-55 has a half-life of 2.7 years. A sample of this isotope contains 8×10^{12} atoms.

Some time later 7×10^{12} atoms have decayed.

Calculate the time needed for this number of atoms to decay.

time = ... years [3]

(d) Fig. 3.2 shows an iron rod being heated at one end by a Bunsen burner.

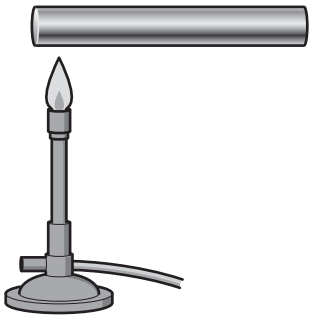

Fig. 3.2

Thermal energy passes through the rod by conduction.

(i) Describe the process of conduction in solid iron, using ideas about the vibration of atoms.

.....

.....

.....

..... [2]

(ii) When heated, the iron rod expands.

Explain in terms of the motion and arrangement of the atoms why iron expands when heated.

.....

.....

..... [2]

[Total: 12]

[Turn over

4 **(a)** Scientists investigate where translocation and transpiration occur in a plant stem.

The scientists test three plant stems.

- Stem **A** is left in its natural state.
- Stem **B** has a ring of phloem removed.
- Stem **C** has a ring of phloem and xylem removed.

Fig. 4.1 shows the stems used.

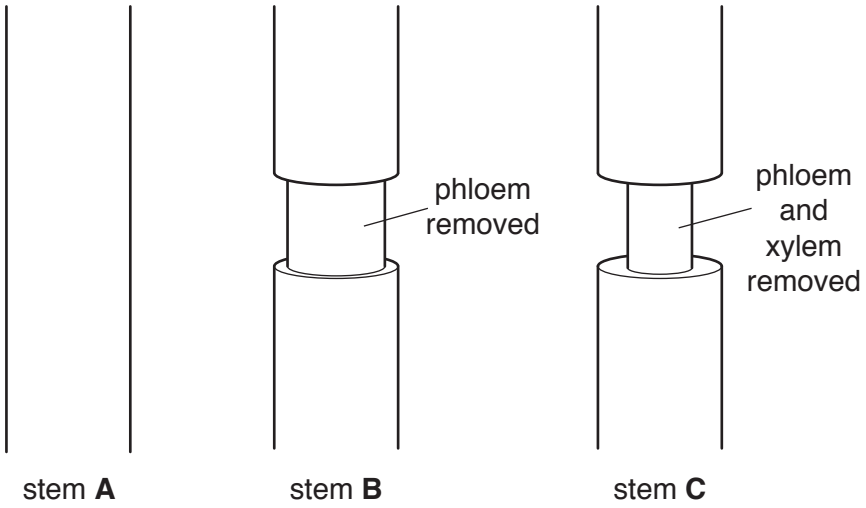

Fig. 4.1

(i) Table 4.1 is used to predict which processes occur in each stem.

Table 4.1

	stem **A**	stem **B**	stem **C**
translocation occurs			
transpiration occurs			

Complete Table 4.1 by placing ticks (✓) in the correct boxes to predict which processes occur in each stem. [2]

(ii) Compare the direction of movement of substances during translocation and transpiration.

.....

.....

.....

..... [2]

(b) Xylem and phloem are specialised to transport substances including water around the plant.

(i) Name two **other** substances moved through the plant during translocation.

1 .....

2 .....
[2]

(ii) Describe **one other** function of xylem.

.....

..... [1]

[Total: 7]

[Turn over

5 **(a)** Fig. 5.1 shows what happens when a teacher ignites a mixture of hydrogen and air.

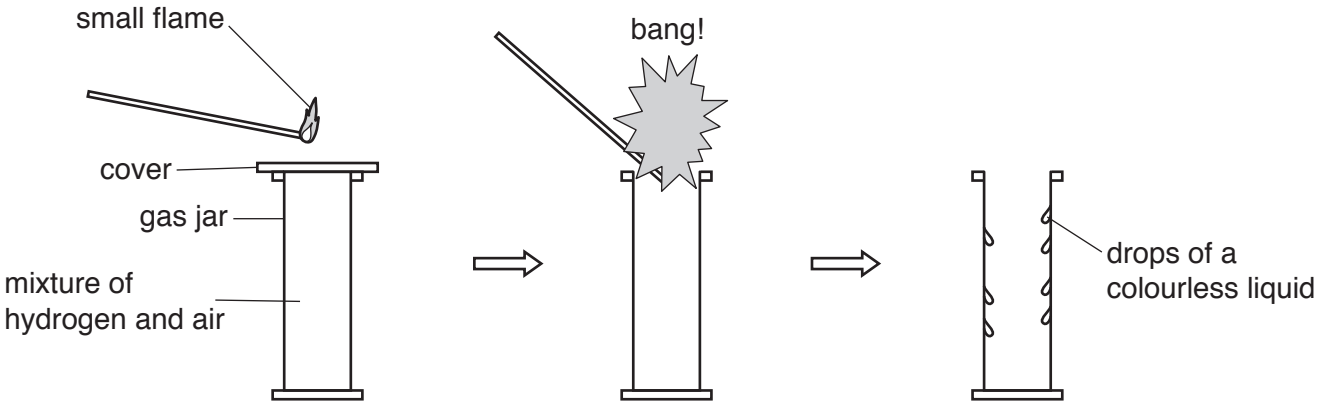

Fig. 5.1

(i) A student concludes that the reaction between hydrogen and oxygen is exothermic.

Suggest the observation that leads him to this conclusion.

..... [1]

(ii) The student mixes the drops of the colourless liquid that form inside the gas jar with anhydrous copper sulfate.

Describe the colour change he observes if this liquid is water.

from ..... to ..... [1]

(iii) Describe how the teacher shows that the reaction between anhydrous copper sulfate and water is reversible.

.....

.....

..... [2]

(b) Fig. 5.2 shows some molecules involved in the reaction between hydrogen and oxygen to make water.

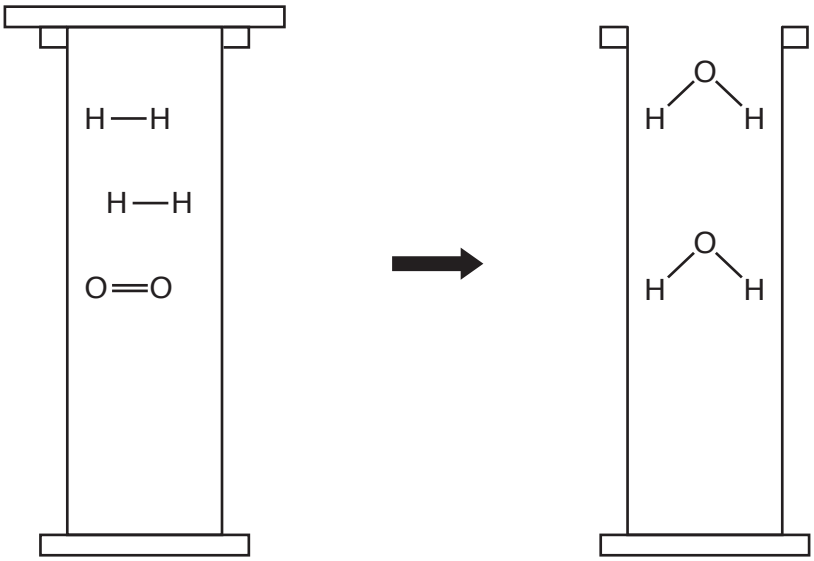

Fig. 5.2

(i) Identify the bonds which break in this reaction.

..... [1]

(ii) Identify the bonds which form in this reaction.

..... [1]

(iii) State the type of bond in the H_2 molecule.

..... [1]

(c) Fig. 5.3 is an energy level diagram for the reaction between hydrogen and oxygen.

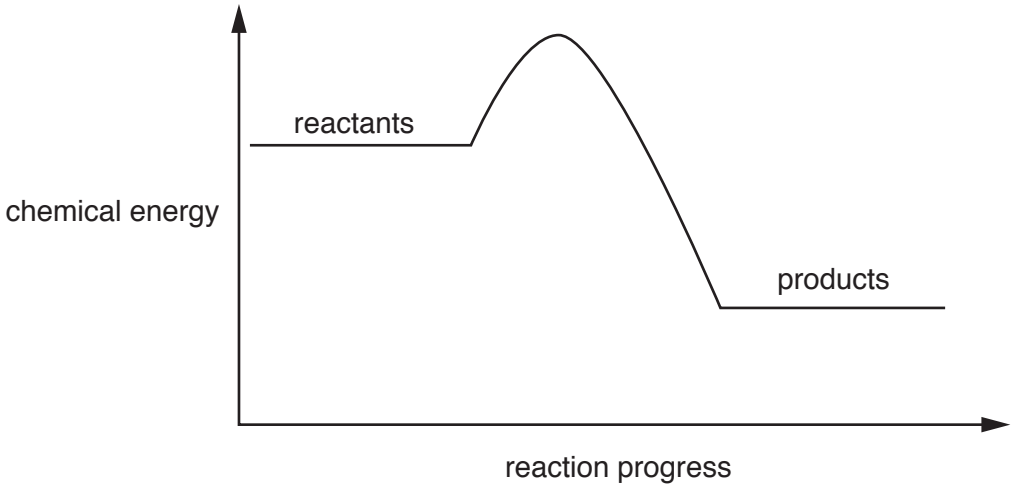

Fig. 5.3

(i) Explain what is meant by an exothermic reaction.

.....

..... [1]

(ii) Explain how the energy level diagram shows that the reaction is exothermic.

.....

..... [1]

(iii) Describe what is meant by the term *activation energy*.

.....

..... [1]

(iv) Label the activation energy on Fig. 5.3. [1]

[Total: 11]

6 **(a)** In a cartoon, a mouse is being chased by a cat.

The mouse accelerates constantly from rest for 1 second and reaches a speed of 3 m/s and then moves at a constant speed of 3 m/s for 8 seconds.

(i) On the grid in Fig. 6.1 draw the speed-time graph to show the motion of the mouse.

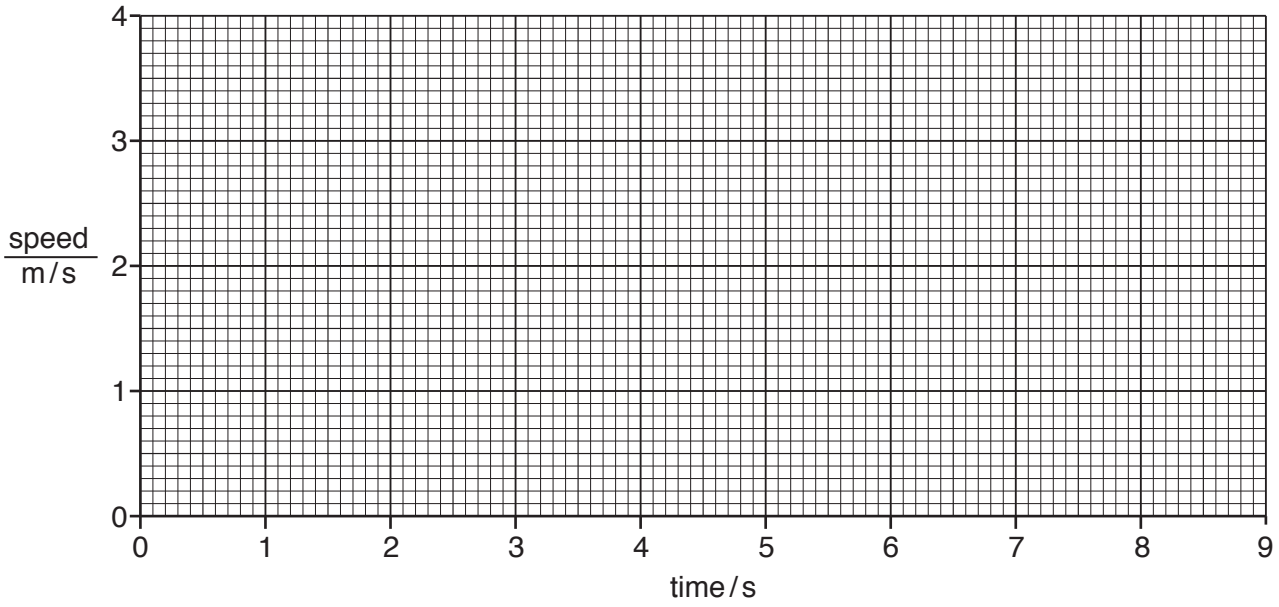

Fig. 6.1

[2]

(ii) The cat accelerates constantly from rest for 9 seconds and reaches a speed of 2 m/s.

Calculate the acceleration of the **cat**.

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

(b) Fig. 6.2 shows the mouse sitting on a cube of cheese, which is on a wooden beam pivoted in the middle.

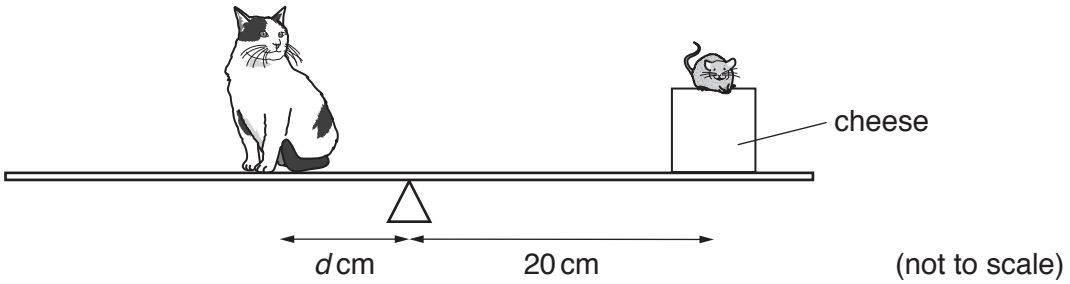

Fig. 6.2

The cat sits on the other end of the beam and balances it.

The weight of the cat is 50 N and the combined weight of the mouse and cheese is 21 N.

Calculate the distance *d* when the beam is balanced.

distance *d* = ... cm [2]

(c) Each side of the cube of cheese is 12 cm.

The weight of the cube of cheese is 20.5 N.

Calculate the density of the cube of cheese in g/cm^3.

gravitational field strength = 10 N/kg

density = ...g/cm^3 [4]

(d) Water evaporates from the cat's bowl.

Liquid water turns into water vapour when it evaporates. Water also turns into water vapour when water boils.

State two differences between the processes of evaporation and boiling.

1 .....

.....

2 .....

.....

[2]

[Total: 12]

7 Fig. 7.1 shows an X-ray of a molar tooth.

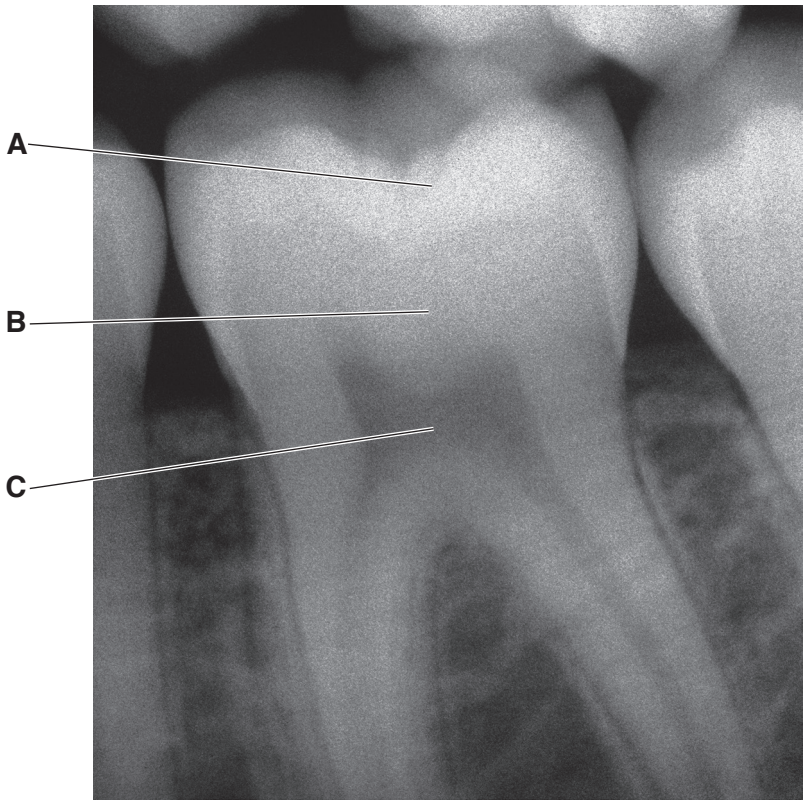

Fig. 7.1

(a) Identify the parts labelled **A**, **B** and **C** in Fig. 7.1.

A .....

B .....

C .....

[3]

(b) Consuming sugary food and drinks can increase the risk of tooth decay.

Describe, in detail, the process of tooth decay.

.....

.....

.....

.....

..... [3]

(c) Describe the role of teeth in terms of mechanical digestion.

.....

..... [1]

(d) Chemical digestion also occurs in the mouth.

Describe the role of enzymes in the chemical digestion that occurs in the mouth.

.....

.....

.....

.....

..... [3]

[Total: 10]

8 Fig. 8.1 shows Group VII of the Periodic Table.

9 F fluorine 19
17 Cl chlorine 35.5
35 Br bromine 80
53 I iodine 127
85 At astatine –

Fig. 8.1

(a) A student adds aqueous chlorine to colourless aqueous sodium bromide and to colourless aqueous sodium iodide as shown in Fig. 8.2.

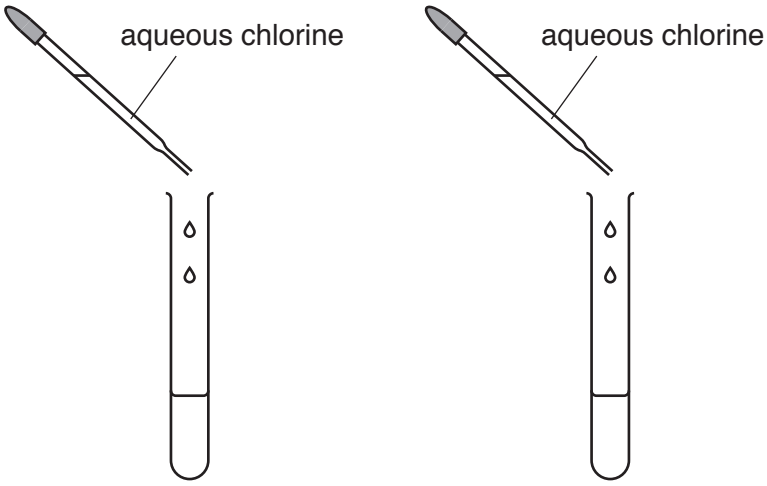

Fig. 8.2

She repeats her experiment adding aqueous bromine to aqueous sodium chloride and to aqueous sodium iodide.

Table 8.1 shows some of her observations.

Table 8.1

halogen solutions	colour of products with halide solutions		
	aqueous sodium chloride	aqueous sodium bromide	aqueous sodium iodide
aqueous chlorine (colourless)			
aqueous bromine (orange)	*pale orange*		*brown*

(i) Complete Table 8.1. [1]

(ii) Explain the observations when aqueous bromine is added to aqueous sodium chloride and to aqueous sodium iodide.

Use ideas about the relative reactivities of the halogens in your answer.

observation with sodium chloride .....

.....

observation with sodium iodide .....

.....

[2]

(b) The ionic equation for the reaction between bromine and sodium iodide is shown.

$$Br_2 + 2I^- \rightarrow 2Br^- + I_2$$

This reaction does **not** involve oxygen.

(i) Explain in detail why this is a redox reaction.

.....

.....

.....

..... [3]

(ii) Identify the oxidising agent in this reaction.

..... [1]

[Total: 7]

[Turn over

9 Fig. 9.1 shows a golf cart used to carry golfers and their golf clubs around a golf course.

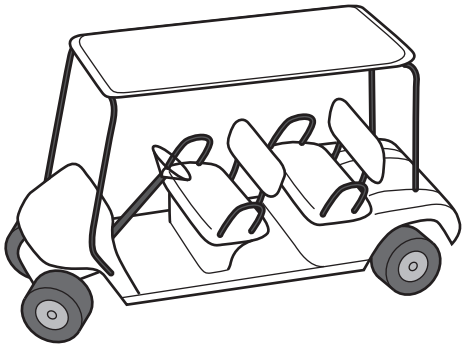

Fig. 9.1

(a) The cart contains an electric motor powered by a 36 V battery. The power rating of the motor is 3000 W.

(i) Calculate the maximum current that passes through the motor.

current = ... A [2]

(ii) Calculate the charge flowing through the motor when it is used at a maximum current for 5 minutes.

charge = ... C [2]

(iii) Fig. 9.2 shows a simple d.c. electric motor.

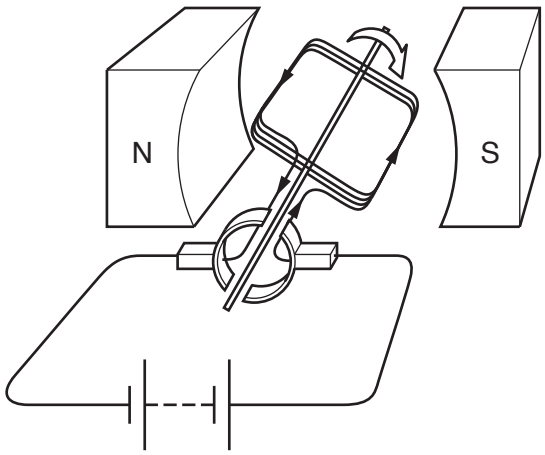

Fig. 9.2

On Fig. 9.2, label the split-ring commutator with the letter **X** and the coil with the letter **C**. [2]

(b) A golfer hits a golf ball.

At one moment, the golf ball has 22.5 J of kinetic energy. The mass of the golf ball is 50 g.

Calculate the speed of the golf ball at that moment.

speed = ... m/s [2]

[Total: 8]

[Turn over

10 **(a)** MRSA is a strain of bacteria that is resistant to antibiotics.

Table 10.1 compares the number of cases of infection caused by MRSA bacteria in one hospital between 1998 and 2008.

Table 10.1

year	number of cases of infection
1998	3
2000	6
2002	22
2004	109
2006	155
2008	167

Calculate the percentage increase in number of cases between **2006** and **2008**.

.....% [2]

(b) The resistant allele in MRSA bacteria developed due to a mutation.

(i) Define the term *mutation*.

.....

..... [1]

(ii) With reference to natural selection, describe how MRSA bacteria have evolved to become resistant to antibiotics.

.....

.....

.....

.....

..... [3]

(c) Bacteria reproduce by asexual reproduction.

Describe one disadvantage to bacteria **without** the resistant allele of reproducing asexually.

.....

.....

.....

..... [2]

[Total: 8]

11 A homologous series is a family of compounds which have the same general formula and similar chemical properties.

Alkanes and alkenes are examples of homologous series.

Ethane, C_2H_6, and propane, C_3H_8, are alkanes.

Ethene, C_2H_4, and propene, C_3H_6, are alkenes.

(a) (i) The general formula for alkanes is C_nH_{2n+2}.

Suggest the general formula for alkenes.

..... [1]

(ii) Complete Fig. 11.1 to show the structures of an ethane molecule and an ethene molecule.

C C **C C**

ethane ethene

Fig. 11.1

[2]

(b) (i) The equation for the complete combustion of propane is shown.

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

Complete steps 1 to 3 to calculate the volume of carbon dioxide when 1000 dm^3 of propane is burned.

All gas volumes are measured at room temperature and pressure.

The volume of 1 mole of any gas is 24 dm^3 at room temperature and pressure.

step 1

Calculate the number of moles in 1000 dm^3 of propane.

number of moles = ...

step 2

Use your answer to step 1 and the balanced equation to calculate the number of moles of carbon dioxide produced by burning 1000 dm^3 of propane.

number of moles = ...

step 3

Calculate the volume of carbon dioxide produced by burning 1000 dm^3 of propane.

volume = ... dm^3

[3]

(ii) Describe the effect of increased emission of carbon dioxide on the environment.

.....

.....

..... [2]

(c) Two reactions of the alkenes ethene and propene are:

- combustion
- polymerisation.

Describe **one** other chemical reaction of alkenes.

Explain why alkenes can undergo this chemical reaction.

reaction .....

explanation .....

..... [2]

(d) **(i)** State **one** difference between *addition polymerisation* and *condensation polymerisation*.

.....

.....

..... [1]

(ii) Nylon is a condensation polymer made from monomer molecules **A** and **B**.

Fig. 11.2 shows a few of these monomer molecules.

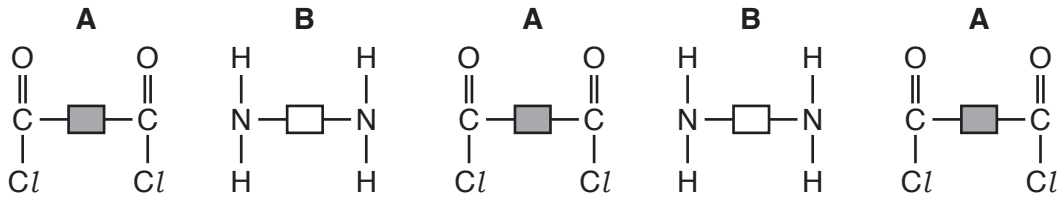

Fig. 11.2

Fig. 11.3 shows an incomplete section of the nylon molecule.

Fig. 11.3

Complete Fig. 11.3 to show how a molecule of monomer **B** has chemically combined with a molecule of monomer **A**. [1]

(iii) State the formula of the other compound that is formed during the polymerisation to make nylon.

..... [1]

[Total: 13]

12 A gardener cuts grass with an electric mower.

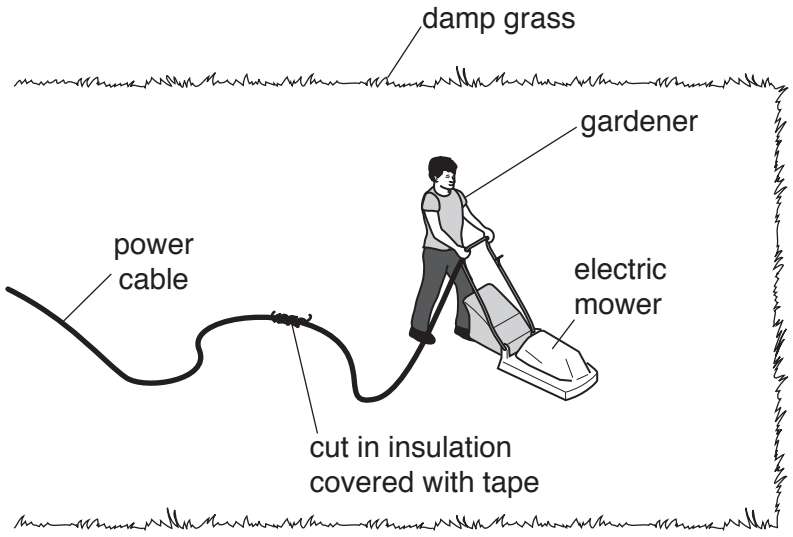

Fig. 12.1

(a) Use the information in Fig. 12.1 to explain why the cut in insulation is an electrical hazard.

.....

..... [1]

(b) The mower is noisy. Sound waves from the lawn mower pass through the air as a series of compressions and rarefactions.

(i) State what is meant by a *compression*.

.....

..... [1]

(ii) Describe the wavelength of a sound wave in terms of compressions.

.....

..... [1]

[Turn over

(iii) Sound waves are longitudinal waves.

Describe the differences between longitudinal and transverse waves.

You may draw a diagram if it helps your answer.

.....

.....

.....

.....

..... [2]

(c) The gardener places mirrors in his garden to scare cats away. When a cat sees its image in the mirror it runs away.

Describe the image formed in a plane mirror by using three words or phrases from the list.

laterally inverted	**magnified**	**not upside down**	**real**
same size	**smaller**	**upside down**	**virtual**

1 .....

2 .....

3 .....

[2]

(d) Fig. 12.2 shows a heater in the garden. The heater burns butane gas.

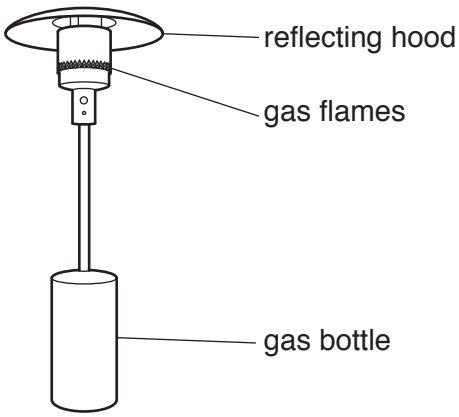

Fig. 12.2

The underside surface of the hood is shiny and light in colour.

Suggest why this is a more suitable surface than a dull and dark colour.

.....

..... [1]

[Total: 8]

13 **(a)** The blood glucose concentration of a person is monitored for 180 minutes after eating a meal.

Fig. 13.1 shows the results.

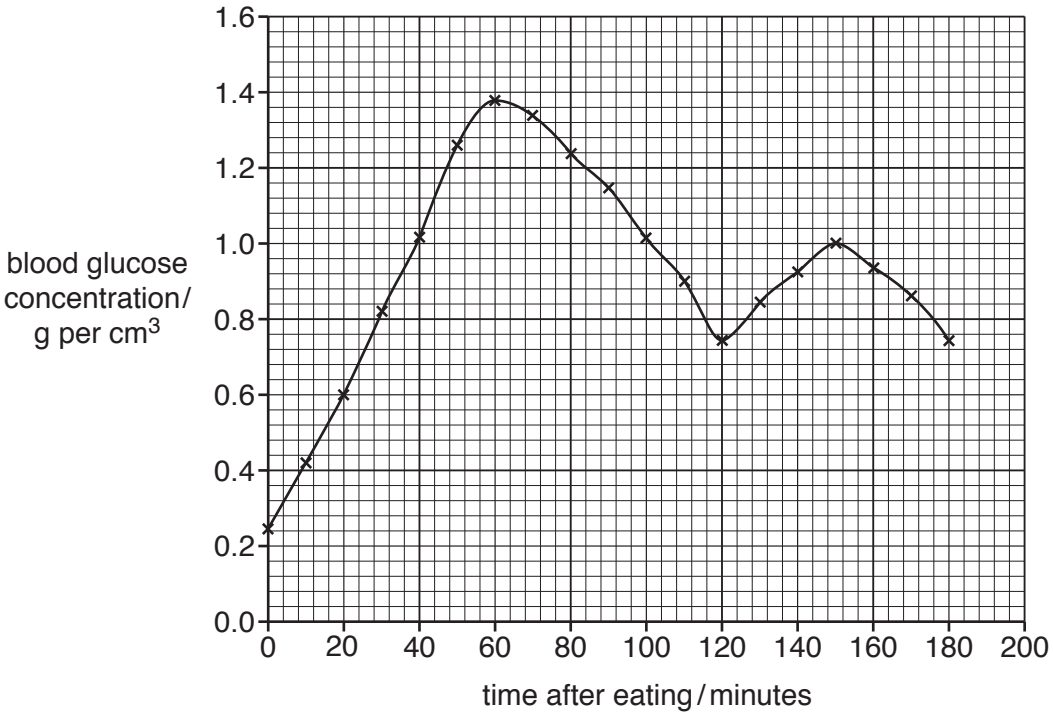

Fig. 13.1

(i) State the name of the hormone that causes the change between **60–120** minutes.

..... [1]

(ii) Suggest **one other** way to cause a similar change to blood glucose concentration as shown between **60–120** minutes.

..... [1]

(iii) Describe how the liver and pancreas work together to cause the changes shown between **120–150** minutes.

.....

.....

.....

.....

..... [3]

(b) State a term that can be used to describe the control of blood glucose concentration.

..... [1]

(c) The blood glucose concentration is controlled by hormones. Some of the body's responses are controlled by the nervous system.

Table 13.1 compares some of the features of the hormonal and nervous control systems.

Table 13.1

type of control system	hormonal	nervous
method of information transfer	chemical hormones	....
speed of information transfer	....	....
longevity of action	....	short-lived

Complete Table 13.1 to compare the hormonal and nervous control systems. [2]

[Total: 8]

The Periodic Table of Elements

Key

atomic number atomic symbol name relative atomic mass

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
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 $24\,dm^3$ at room temperature and pressure (r.t.p.).