Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8976035089

CO-ORDINATED SCIENCES **0654/21**

Paper 2 (Core) **October/November 2015**

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, graphs, tables or rough working.
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 International Examinations

1 **(a)** In the Periodic Table the elements are organised into groups and periods. A copy of the Periodic Table is shown on page 32.

(i) State the number of the group that includes nitrogen, N.

..... [1]

(ii) Fig. 1.1 shows the electron arrangement and the number of protons in one atom of nitrogen.

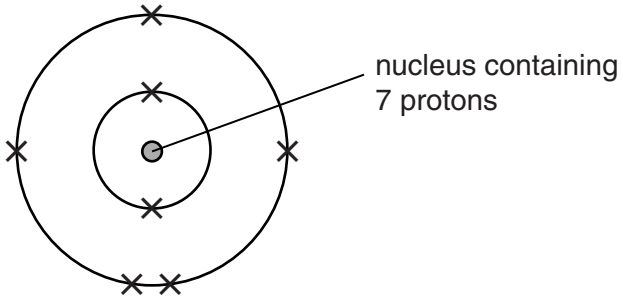


Fig. 1.1

Name the other type of sub-atomic particle contained in this nucleus.

..... [1]

(iii) State which of the three types of sub-atomic particles has the lowest mass.

..... [1]

(b) Describe how and explain why the electrical conductivity of the elements in the third period, sodium to argon, changes from left to right across the period.

.....

.....

..... [2]

(c) Ammonia, NH_3, is made in industry by reacting nitrogen and hydrogen together in the presence of an iron catalyst.

A simplified diagram of the process is shown in Fig. 1.2.

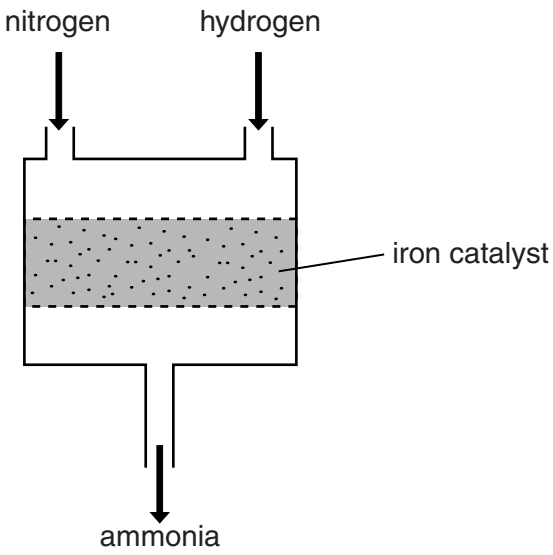


Fig. 1.2

(i) Name the type of chemical bond between nitrogen and hydrogen atoms in ammonia.

..... [1]

(ii) Suggest what would be different about this reaction if the iron catalyst was removed.

..... [1]

(d) Large amounts of NPK fertiliser are added to soil used to grow crops.

The letters NPK are the chemical symbols of the three most important elements that the fertilisers contain.

(i) Ammonia is used to make the fertiliser ammonium nitrate.

Name the important element added to the soil in ammonium nitrate.

..... [1]

(ii) **Name** the other two important elements added to soil in NPK fertiliser.

1 .....

2 .....
[1]

[Turn over

2 Fig. 2.1 shows a plant cell from a leaf.

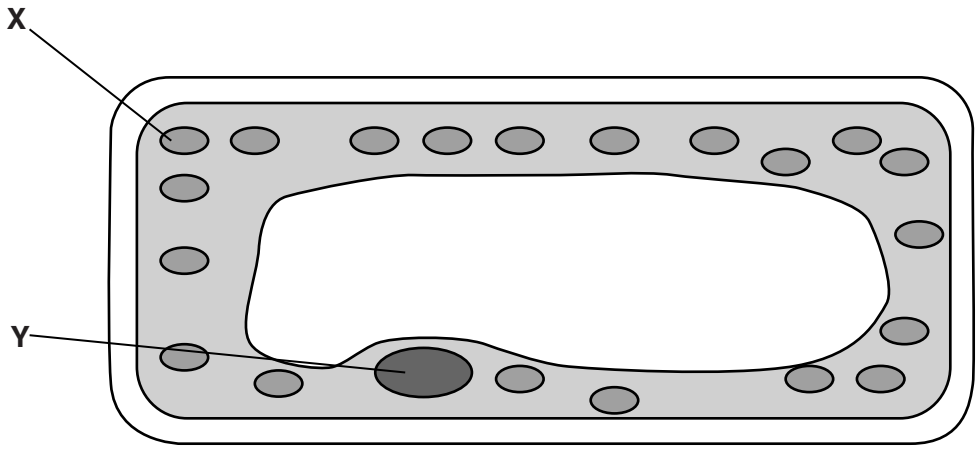


Fig. 2.1

(a) Name the parts of the cell labelled **X** and **Y**.

X .....

Y ..... [2]

(b) Name **two** substances that are used up at **X** when the leaf is photosynthesising.

1 .....

2 ..... [2]

(c) Explain why a living leaf cell of this type usually

- produces oxygen in the light, ...

  .....

  .....

- produces carbon dioxide in the dark. .....

  .....

  ..... [2]

(d) Leaves also contain xylem tissue.

(i) State **one** function of xylem tissue.

..... [1]

(ii) Explain why xylem tissue cannot photosynthesise.

.....

..... [1]

[Turn over

3 **(a)** Fig. 3.1 shows a skier using ski sticks and skis to move across the snow.

A ski stick has a pointed end and a large disc a few centimetres above this.

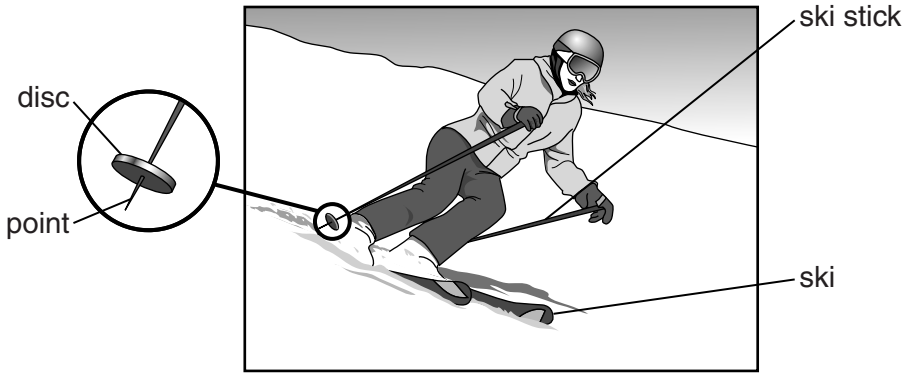


Fig. 3.1

By referring to force and area, explain why the ski sticks sink a few centimetres into the snow but the skis do not.

.....

.....

..... [2]

(b) The skier makes a loud noise 83 m from a rocky cliff.

This is shown in Fig. 3.2.

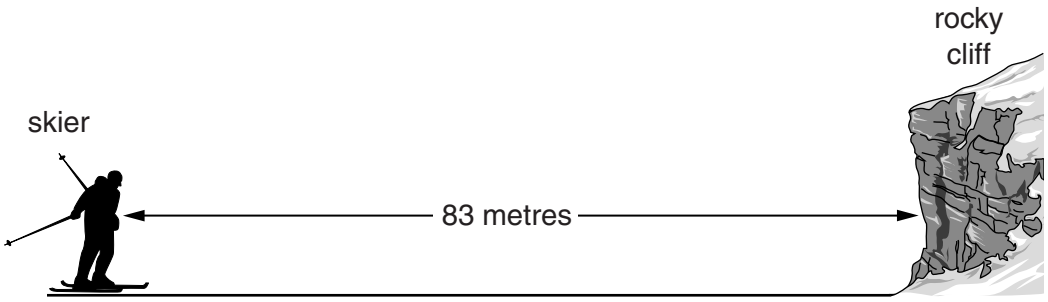


Fig. 3.2

The noise travels through the air as a sound wave.

The skier hears an echo.

(i) State what happens to the sound wave at the rocky cliff that causes the echo to be heard.

..... [1]

(ii) Between the skier making the loud noise and hearing the echo, there is a delay of 0.5 seconds.

Calculate how far the sound wave has travelled in this time.

..... m [1]

(iii) Use your answer to **(b)(ii)** to calculate the speed of sound in air.

State the formula that you use and show your working.

formula

working

..... m/s [2]

(c) The skier notices that some of the snow and ice is melting into water.

Ice is a solid and water is a liquid.

Fig. 3.3 shows three different ways in which particles may be arranged in substances.

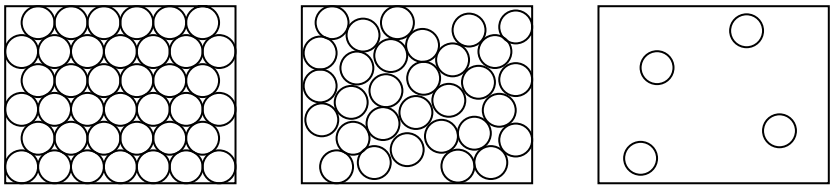


Fig. 3.3

(i) State which diagram best represents the way particles are arranged in a liquid.

Explain your answer.

diagram .....

explanation .....

..... [1]

(ii) State which diagram best represents the way particles are arranged in a solid.

Explain your answer.

diagram .....

explanation .....

..... [1]

(d) The skier notices that some of the water evaporates.

Explain in terms of particles, the process of evaporation.

.....

.....

.....

..... [2]

Please turn over for Question 4.

4 Fig. 4.1 shows some fruit flies. Fruit flies are insects that feed on fruit.

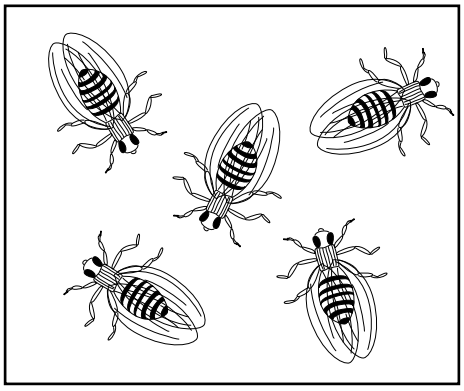


Fig. 4.1

Fruit flies normally have large wings. However, there is a variety of fruit flies with small wings, as shown in Fig. 4.2.

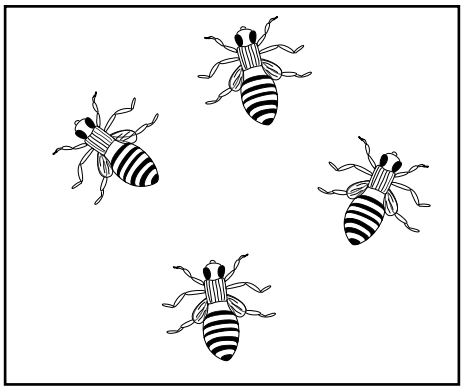


Fig. 4.2

(a) The small-winged variety is caused by a recessive allele. Define the term *recessive*.

.....

..... [1]

(b) A homozygous normal-winged fly is crossed with a homozygous small-winged fly. Using the symbols **N** and **n** for the two alleles, state

(i) the genotypes of these parents,

..... [1]

(ii) the genotypes of their offspring.

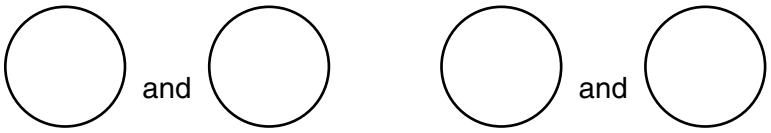
..... [1]

(c) Using the symbols **N** and **n**, complete the genetic diagram below to show the result of a cross between two heterozygous flies.

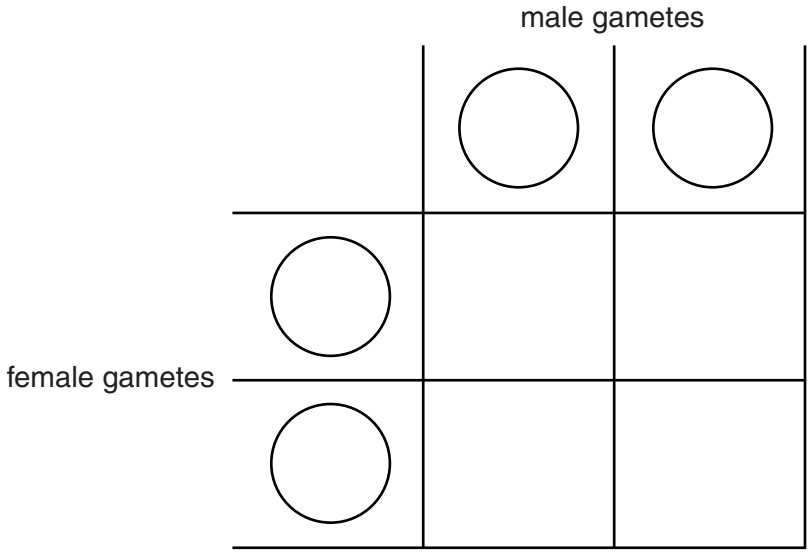
parents

phenotypes ....

genotypes ....

gametes  and and

offspring



ratio of normal-winged to small-winged flies ..... : ..... [4]

(d) Flies with small wings are less well adapted to their environment than normal-winged flies.

Suggest and explain a reason for this.

.....

.....

..... [2]

5 The molecular formulae of four organic compounds, **W** to **Z**, are shown in Table 5.1.

Table 5.1

W	$C_2H_5O_2N$
X	$C_2H_4O_2$
Y	C_3H_8
Z	C_4H_8

(a) (i) State and explain which one of the compounds, **W** to **Z**, could be an amino acid.

compound .....

explanation .....

..... [2]

(ii) State and explain which of the compounds, **W** to **Z**, are hydrocarbons.

compounds .....

explanation .....

..... [2]

(b) A colourless gas contained in a flask is either ethane, C_2H_6, or ethene, C_2H_4.

(i) An ethane molecule contains more hydrogen atoms than an ethene molecule.

Describe **one** other difference between the structures of an ethane molecule and an ethene molecule.

.....

..... [1]

(ii) The gas is shaken with bromine solution.

Describe the observation, if any, that would be made if the gas is

- ethane, ...

  .....

- ethene. .....

  ..... [2]

(c) At room temperature ethene is a colourless gas.

Ethene molecules can join together forming long chains. When this happens a white solid is produced.

(i) Name the type of chemical reaction that occurs when ethene molecules form long chains.

..... [1]

(ii) Name the white solid that is formed.

.....[1]

(d) Ethanol, C_2H_6O, is used as the fuel in spirit burners.

Fig. 5.1 shows a drop of limewater on the end of a glass rod being held in the gas mixture rising from a spirit burner flame.

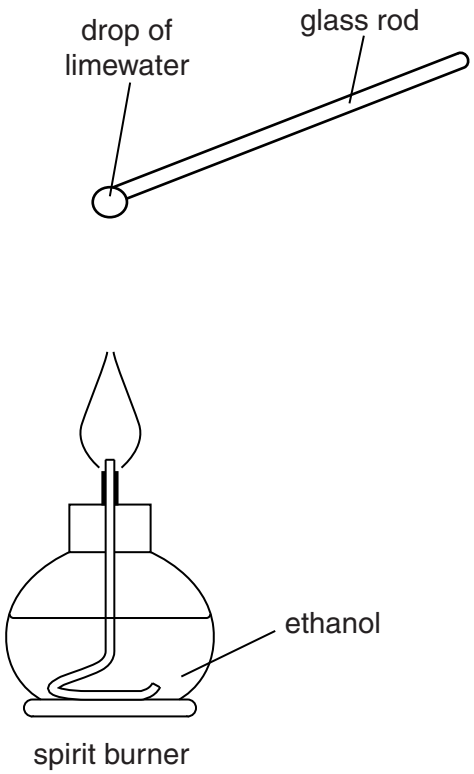


Fig. 5.1

(i) Name the gas that causes the limewater to change in appearance.

..... [1]

(ii) Describe this change in appearance.

.....

.....[1]

6 **(a)** Fig. 6.1 shows an endoscope being used to observe the inside of a patient's stomach in a hospital.

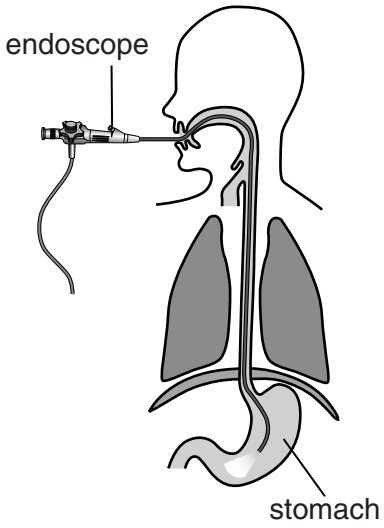


Fig. 6.1

Light passes through the endoscope to the stomach along optical fibres by total internal reflection.

Complete Fig. 6.2 to show how a ray of light travels down an optical fibre by total internal reflection.

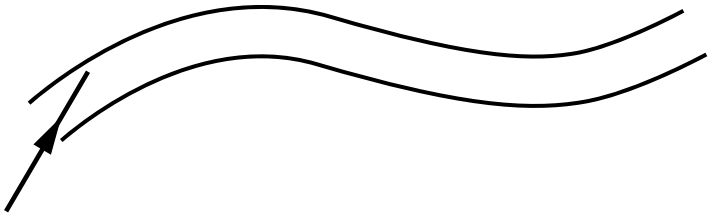


Fig. 6.2 [2]

(b) The hospital has a generator for use in an emergency if the mains electrical supply fails. The generator is driven by an engine using gasoline (petrol) fuel.

Complete Fig. 6.3 to show the energy transformations that take place when this generator is used to supply electricity for the hospital.

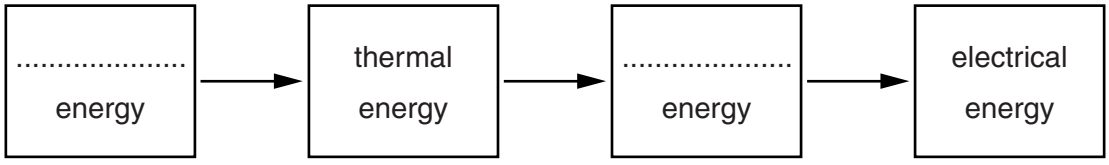


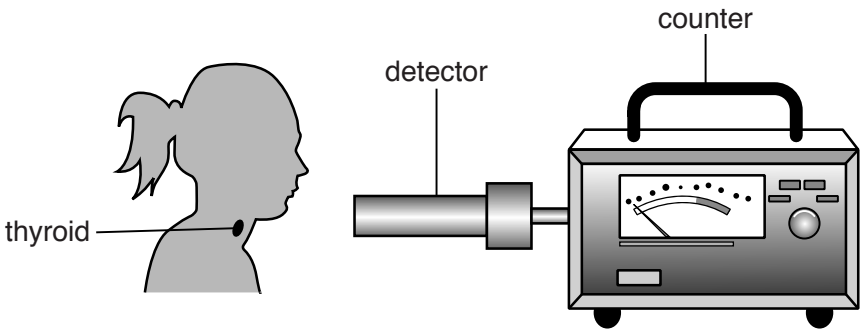
Fig. 6.3

[2]

(c) The radioactive isotope iodine-123 is used by a doctor to examine the thyroid gland of a patient.

The patient takes a pill containing iodine-123, which is absorbed by the thyroid gland.

Iodine-123 emits γ-radiation which is detected outside the body.



Explain why the doctor uses an isotope emitting γ-radiation to examine the thyroid gland rather than an isotope emitting α-radiation or β-radiation.

.....

..... [1]

(d) Visible light and γ-radiation are both parts of the electromagnetic spectrum.

Name **one** other part of the electromagnetic spectrum and suggest a medical use for it in a hospital.

radiation .....

use .....

..... [2]

7 Fig. 7.1 shows the human nervous system.

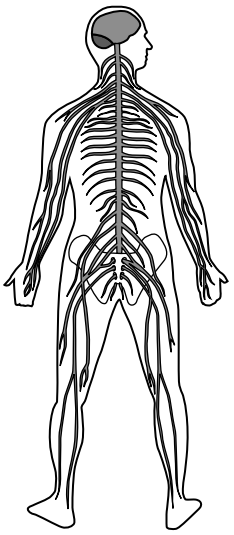


Fig. 7.1

(a) On Fig. 7.1, draw an arrow ending on any part of the peripheral nervous system. [1]

(b) A boy touches a hot plate, and quickly withdraws his hand.

(i) This is an example of a reflex action. State what is meant by a *reflex action*.

.....

.....

.....

..... [2]

(ii) Describe how the peripheral nervous system is involved in this action.

.....

.....

.....

..... [2]

(c) Some responses depend on hormones, such as adrenaline. Describe how adrenaline

- is carried round the body, ...

.....

- is removed from the body. .....

..... [2]

8 **(a)** The bodywork of a car is often made of steel. If the bodywork has been damaged, the surface is repaired with a plastic filler.

A car mechanic can use a magnet to find out if parts of the bodywork have been filled with plastic filler.

He tests two areas of the car by placing a magnet near the surface. This is shown in Fig. 8.1.

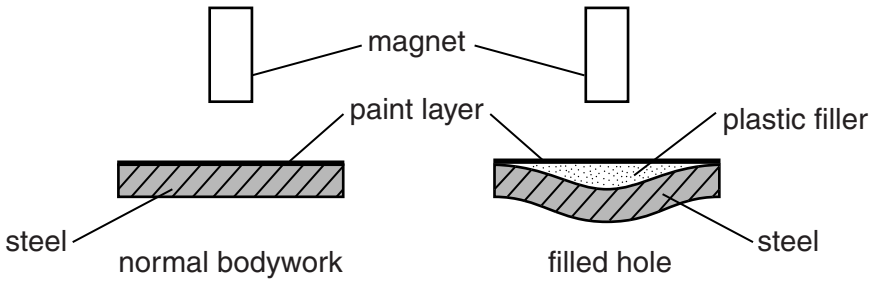


Fig. 8.1

(i) Explain how the magnet helps the mechanic to tell the difference between the normal bodywork and the filled hole.

.....

.....

..... [1]

(ii) Some cars have bodywork made from aluminium.

State whether the method you described in **(a)(i)** would work.

Explain your answer.

.....

..... [1]

(iii) A small panel of the bodywork of a car is painted using an electrostatic paint spray.

The paint droplets leave the spray gun with a positive electric charge.

The bodywork panel is given a negative electric charge.

This is shown in Fig. 8.2.

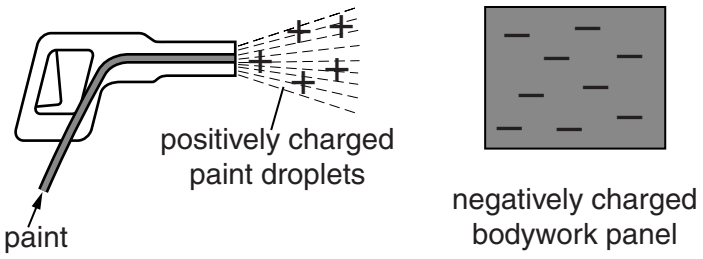


Fig. 8.2

Explain why the positive charges on the paint droplets and the negative charge on the bodywork panel make sure that

- all the paint reaches the panel, ...

  .....

  .....

- the paint is spread evenly. .....

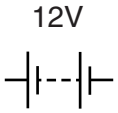
  .....

  ..... [2]

(b) A car has two headlights. The lamp inside each headlight is connected in parallel with the other lamp across a 12V battery.

The resistance of each lamp is 2.5Ω.

(i) Complete the circuit diagram below to show how the lamps are connected to the battery. Include one switch in the circuit which will control both lamps.



[3]

(ii) Using the correct circuit symbol, add a voltmeter into the circuit in **(b)(i)** to measure the potential difference across the battery. [1]

(iii) Calculate the current passing through each lamp.

State the formula that you use and show your working.

formula

working

current = ... A [2]

(iv) The combined resistance of the two lamps connected in parallel is calculated.

From the list below, underline a possible value for the combined resistance of the two lamps.

1.25 Ω **2.5 Ω** **5.0 Ω** **10.0 Ω** [1]

(v) Complete the statement.

An electric current is a flow of ..... [1]

(c) The radiator in a car collects the hot water that has passed through the engine. Some of the thermal energy is lost by radiation.

Name **one** other method of energy transfer from the car radiator.

..... [1]

(d) Fig. 8.3 shows a car travelling across a bridge made from concrete sections. There are gaps between each section, filled with a flexible material.

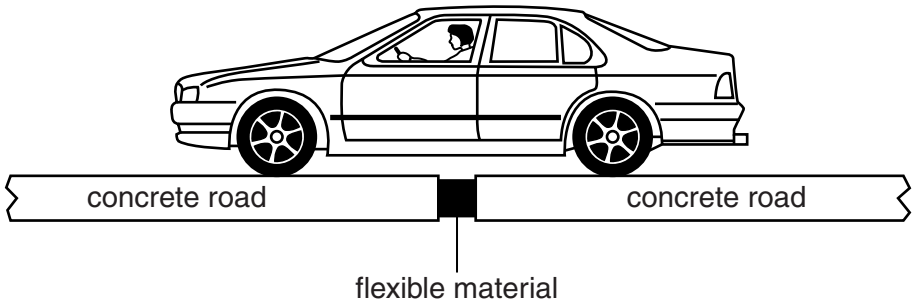


Fig. 8.3

Suggest why these gaps are filled with a flexible material.

.....

.....

..... [2]

9 **(a)** Fig. 9.1 shows a process in which an electric current passes through molten lead bromide.

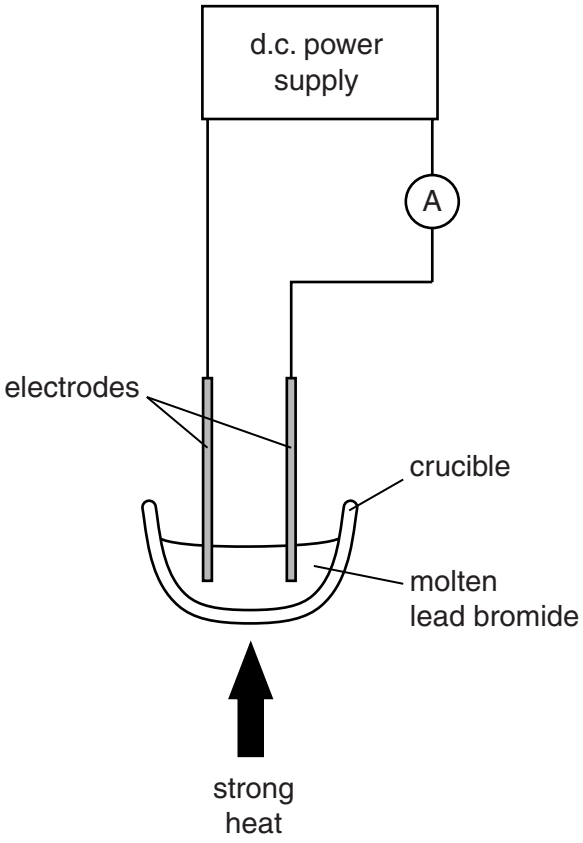


Fig. 9.1

(i) Name the process shown in Fig. 9.1.

..... [1]

(ii) State the observation that suggests one of the products of the process is bromine.

..... [1]

(iii) Explain why no current flows when the molten lead bromide is allowed to cool and solidify.

.....

..... [1]

(b) Sodium is in Group I of the Periodic Table.

Particles of sodium can exist either as atoms or as ions.

State the change in the structure of a sodium atom when it is converted into a sodium ion.

..... [1]

[Turn over

(c) Fig. 9.2 shows a piece of sodium being held under water.

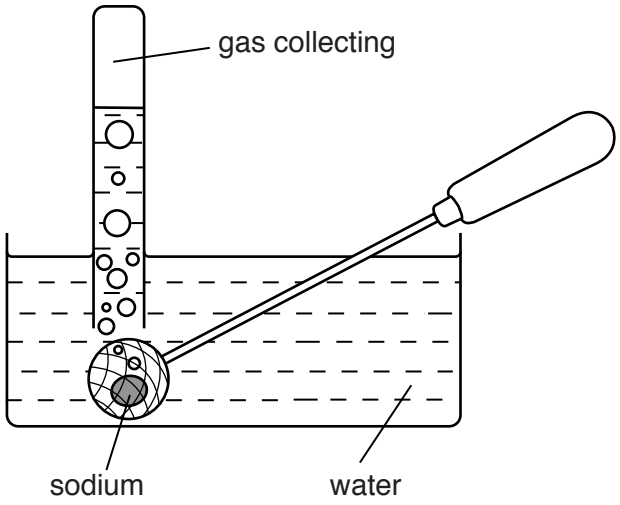


Fig. 9.2

(i) Name the gas that collects in the test-tube.

..... [1]

(ii) Describe a test and its result for the gas you have named in **(i)**.

test .....

result ..... [2]

(iii) The pH of the mixture in the water container increases during the reaction.

Explain why this happens.

.....

..... [1]

(d) Aircraft are subjected to many strong forces, particularly when taking off and landing.

(i) Suggest why aluminium alloys and **not** pure aluminium are used in aircraft manufacture.

..... [1]

(ii) Suggest **one** reason for using alloys of aluminium rather than steel in making aircraft.

.....

..... [1]

Please turn over for Question 10.

10 Some river animals can be used as 'indicator species'. This means that the presence of these species in a river indicates how polluted the water is.

Fig. 10.1 shows, for different pollution levels, the animals that are likely to be found in a river.

pollution level	species present at each pollution level
no pollution	← stonefly nymphs
	← mayfly larvae
	← caddis flies
	← freshwater shrimps
	← water lice
	← bloodworms
high pollution	← sludgeworms

Fig. 10.1

(a) From Fig. 10.1, name an animal whose presence indicates that a river is only slightly polluted.

..... [1]

(b) A farmer allowed fertiliser to pollute a river at one point.

Fig. 10.2 shows how the numbers of freshwater shrimps, mayfly larvae and sludgeworms changed along the stretch of the river where this pollution occurred.

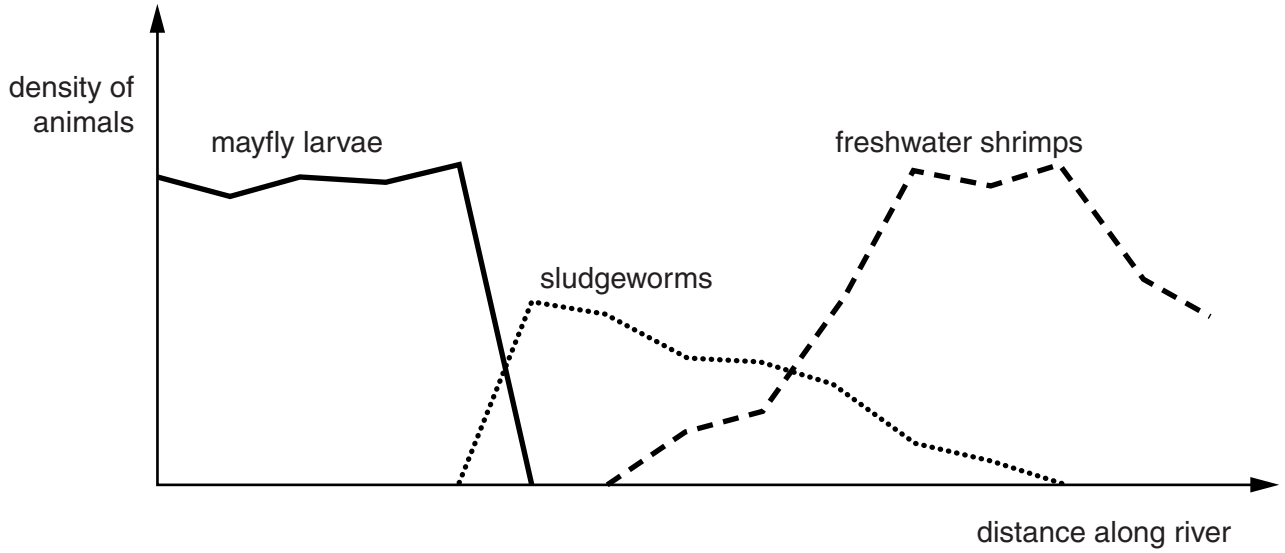


Fig. 10.2

(i) On Fig. 10.2, suggest a point at which the pollution occurred. Indicate this with an arrow. [1]

(ii) Suggest and explain why stonefly nymphs might be killed in a river polluted with

- sewage, ...

  .....

  .....

- chemical waste. .....

  .....

  ..... [3]

(c) An increased concentration of carbon dioxide in the atmosphere can contribute to global warming.

(i) State what is meant by *global warming*.

.....

.....

..... [2]

(ii) Give **one** source of carbon dioxide in the atmosphere, other than respiration.

..... [1]

(iii) Suggest **two** ways in which the carbon dioxide concentration in the atmosphere could be reduced.

1 .....

2 ..... [2]

11 **(a)** An elephant lifts a tree trunk.

State the **two** quantities which would need to be known to calculate the work done by the elephant.

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

(b) The mass of the elephant is 4000 kg. The volume of the elephant is 3.9 m^3.

Calculate the density of the elephant.

State the formula that you use and show your working.

formula

working

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

(c) An elephant can communicate with other elephants using infrasound. This is a very low frequency vibration, which is usually impossible for a human to hear.

(i) Suggest a possible frequency for the infrasound used by elephants.

Explain why you chose your answer.

frequency = ... Hz

explanation .....

..... [1]

(ii) State the meaning of the term *frequency*.

.....

..... [1]

(iii) Fig. 11.1 shows the distribution of particles in a sound wave and on the surface of a water wave and the direction of movement of the two waves.

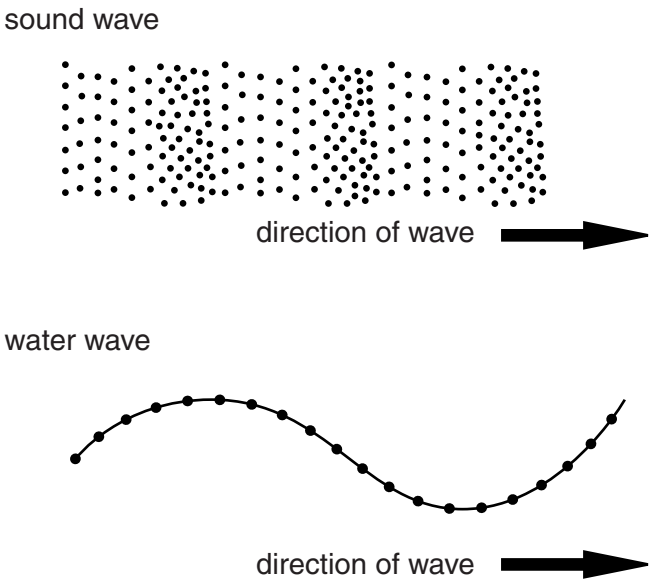


Fig. 11.1

On Fig. 11.1 draw arrows

- to show the direction of movement of particles in a sound wave,
- to show the direction of movement of particles in a water wave. [2]

12 Acids react with other substances to form salts.

(a) Complete the word equations below which show reactions to make the three salts, magnesium sulfate, copper chloride and zinc sulfate.

magnesium	+	sulfuric acid	→	magnesium sulfate	+			
copper oxide	+		→	copper chloride	+	water		
zinc carbonate	+	sulfuric acid	→	zinc sulfate	+		+	

[3]

(b) Fig. 12.1 shows what happens to the temperature when a student adds a solution of sodium hydrogencarbonate to dilute hydrochloric acid.

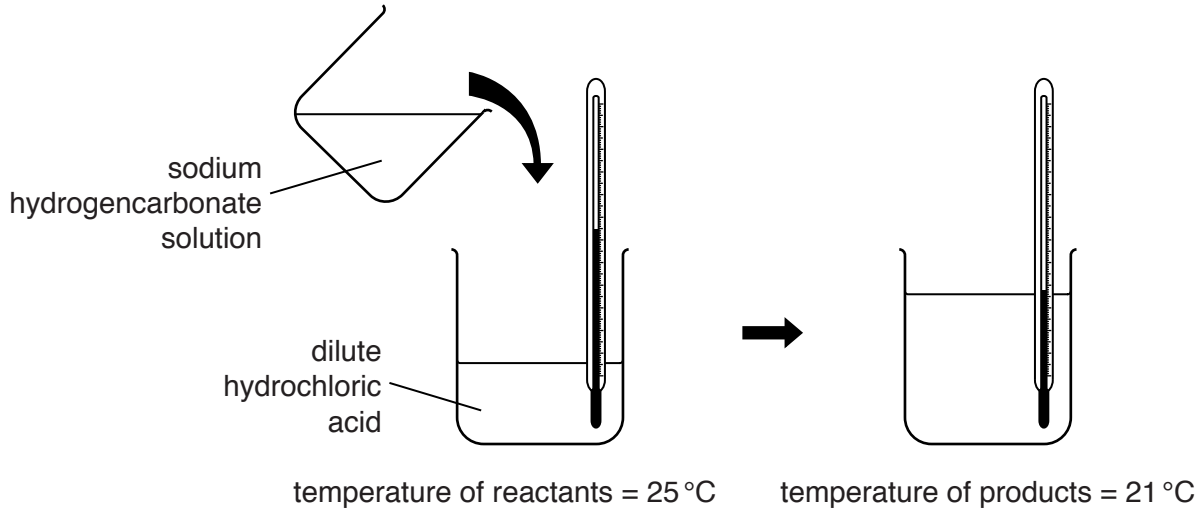


Fig. 12.1

(i) State the term used to describe a reaction in which the products have a lower temperature than the reactants.

..... [1]

(ii) Suggest how the student can check whether or not she has produced a neutral mixture.

.....

.....

..... [2]

(c) Fig. 12.2 shows apparatus the student uses to investigate the rate of reaction between calcium carbonate and excess dilute hydrochloric acid.

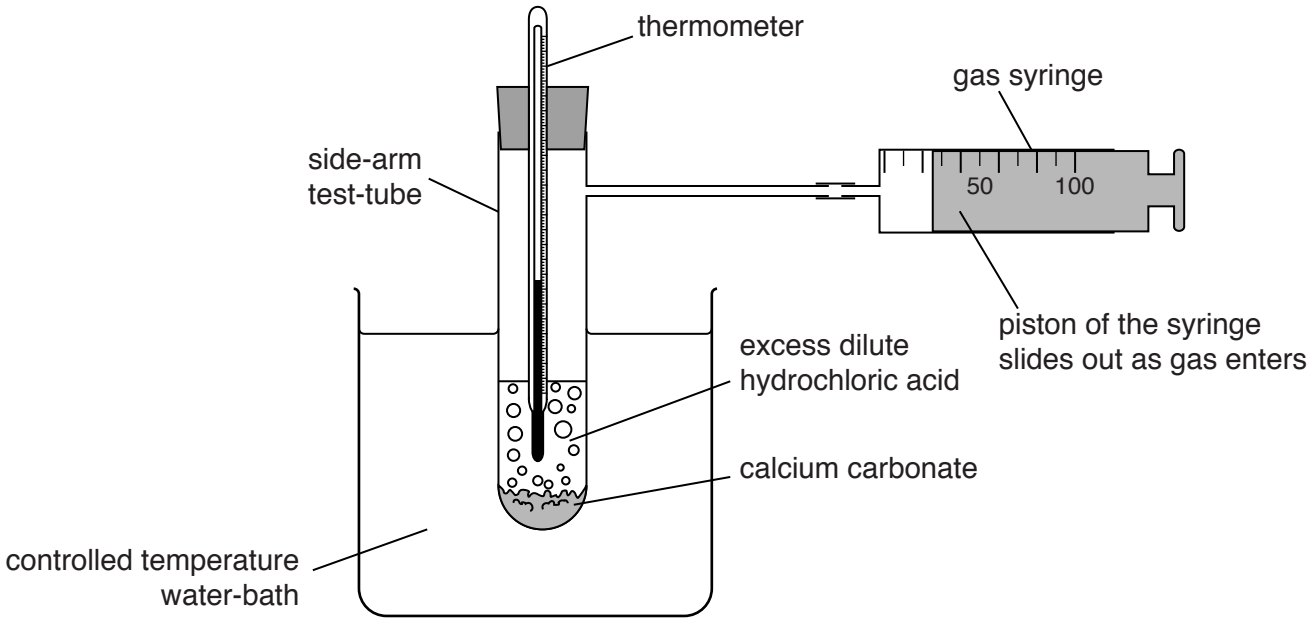


Fig. 12.2

State **three** changes to the reaction conditions that the student can make which will **increase the time** it takes for gas syringe to fill.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(d) Calcium carbonate is sometimes added to the water in lakes.

Suggest why this is done.

.....

..... [1]

13 **(a)** Draw lines to connect each of the terms to its definition. One has been done for you.

term	definition
amino acid	a protein that acts as a catalyst
cell	breaking down large insoluble molecules
digestion	one of the basic units of a protein
egestion	one of the basic units of an organism
enzyme	passing undigested food out of the alimentary canal
ingestion	taking food into the alimentary canal

[4]

(b) **(i)** State where in the alimentary canal egestion occurs.

..... [1]

(ii) Name a component of the diet that would normally be egested.

..... [1]

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DATA SHEET
The Periodic Table of the Elements

Group

I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	209 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86
223 **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

* 58–71 Lanthanoid series
† 90–103 Actinoid series

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	147 **Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	231 **Pa** Protactinium 91	238 **U** Uranium 92	237 **Np** Neptunium 93	244 **Pu** Plutonium 94	243 **Am** Americium 95	247 **Cm** Curium 96	247 **Bk** Berkelium 97	251 **Cf** Californium 98	252 **Es** Einsteinium 99	257 **Fm** Fermium 100	258 **Md** Mendelevium 101	259 **No** Nobelium 102	260 **Lr** Lawrencium 103

Key

a **X** b

a = relative atomic mass
X = atomic symbol
b = atomic (proton) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).