UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CO-ORDINATED SCIENCES **0654/32**

Paper 3 (Extended) **October/November 2013**

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 a 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 28.

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.

IB13 11_0654_32/5RP

1 **(a)** Fig. 1.1 shows apparatus that can be used to test the electrical conductivity of the materials contained in beakers **P**, **Q** and **R**.

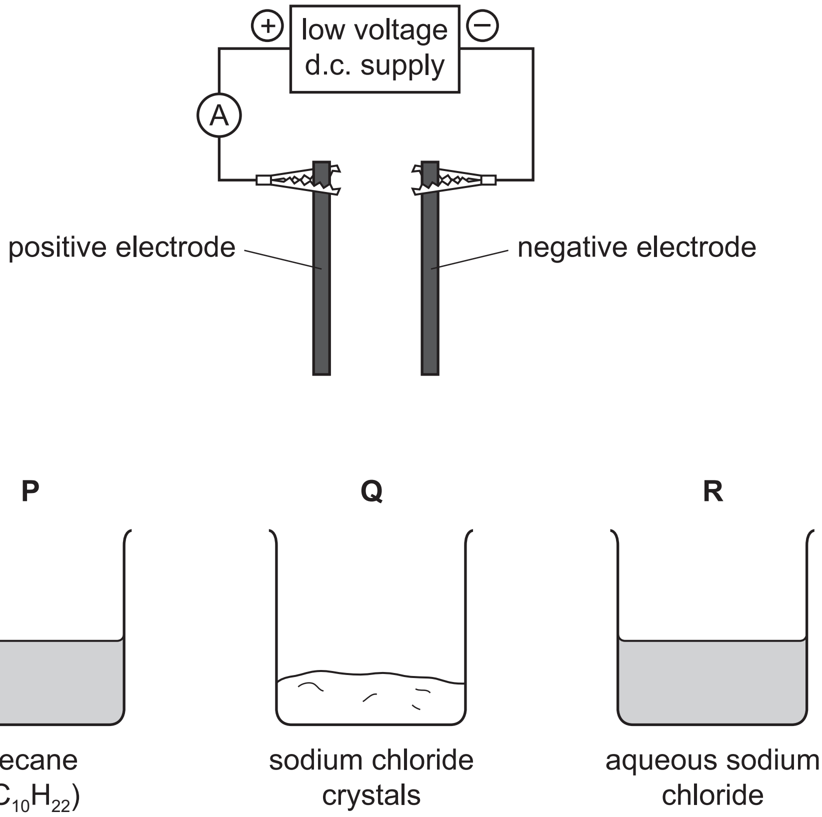


Fig. 1.1

(i) Explain, in terms of protons and electrons, why a sodium ion, Na^+, has a single positive electrical charge.

....

....

.... [2]

(ii) The material in beaker **R** is a good electrical conductor.

The materials in beakers **P** and **Q** are insulators.

Explain these statements in terms of ions.

....

....

....

.... [3]

For Examiner's Use

(iii) The material in beaker **R** is tested using the apparatus in Fig. 1.1.

Bubbles of gas form on the surfaces of both electrodes and the pH of the solution increases.

Name the gas that forms at each electrode and explain briefly why the pH increases.

gas formed at the negative electrode ....

gas formed at the positive electrode ....

reason for the increase in pH ....

....

.... [4]

(b) Fig. 1.2 represents the structure of solid sodium chloride.

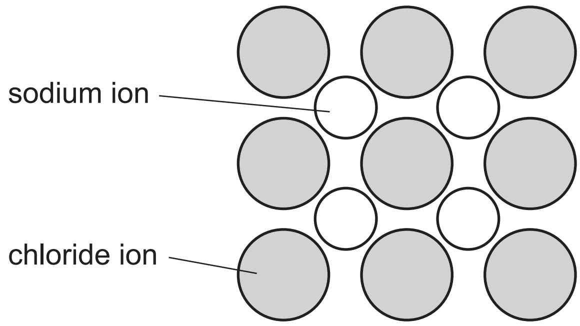


Fig. 1.2

Explain, in terms of its structure and bonding, why sodium chloride has a very high melting point (801 °C).

....

....

....

....

.... [3]

For Examiner's Use

2 **(a)** Fig. 2.1 shows two means of communication between Singapore and Sydney.

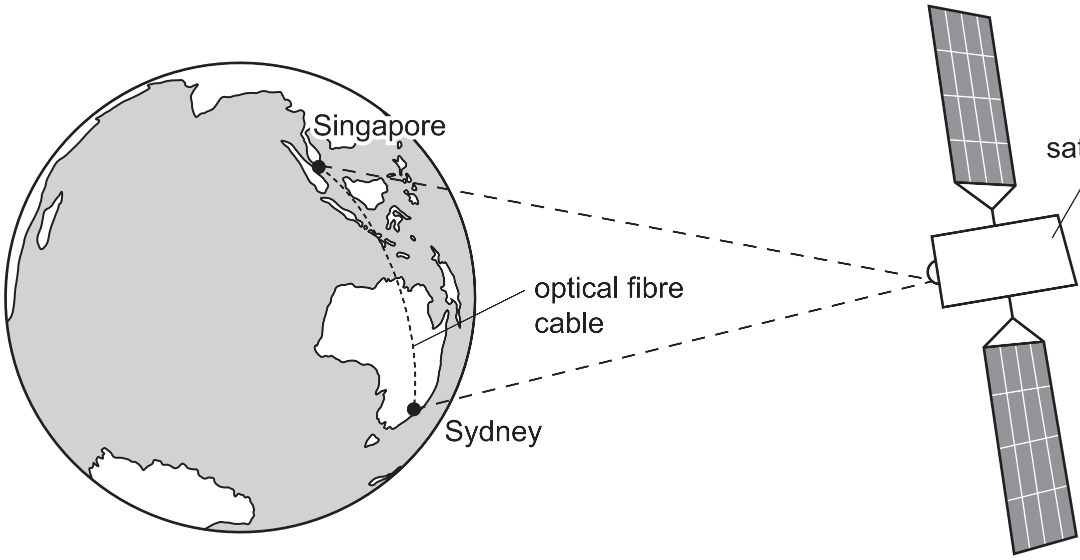


Fig. 2.1

Method 1 Microwave signals are sent by satellite.

Method 2 Infra-red waves carrying a signal are sent through an optical fibre cable.

Fig. 2.2 shows an infra-red ray entering an optical fibre.

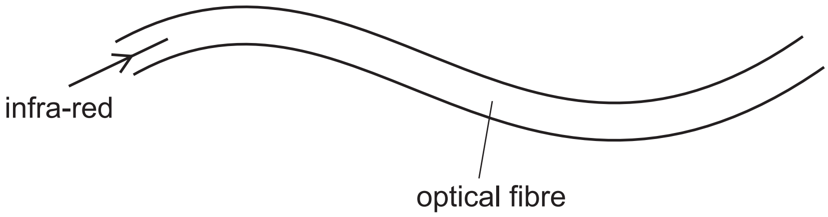


Fig. 2.2

The infra-red ray travels all the way through the optical fibre.

(i) Explain why the infra-red ray stays inside the optical fibre. You may draw on the diagram if it helps your answer.

....

....

....

.... [3]

(ii) The length of an optical fibre cable between Singapore and Sydney is 6.3×10^6 m.

The speed of infra-red waves in an optical fibre is 2.1×10^8 m/s.

Calculate the time taken for the signal to travel from Singapore to Sydney.

State any formula that you use, show your working and state the unit of your answer.

formula

working

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

(iii) The speed at which microwaves travel through space is greater than the speed at which infra-red waves travel through an optical fibre.

Suggest why the time taken by infra-red signals is less than the time taken by the microwave signals to travel from Singapore to Sydney.

....

.... [1]

(b) Fig. 2.3 shows a demonstration of sound transmission using a bell jar.

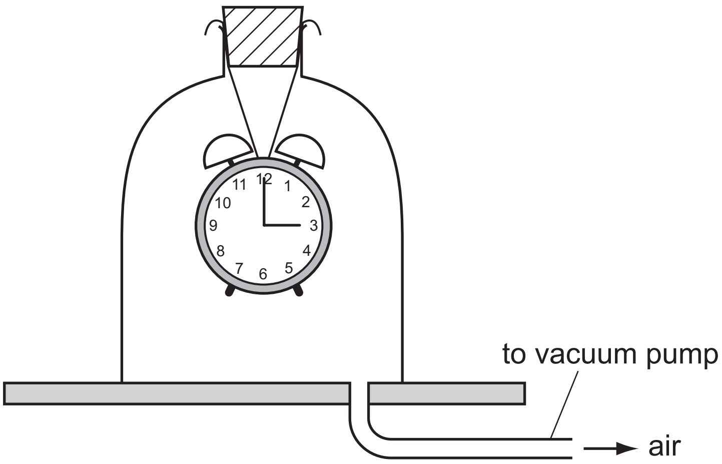


Fig. 2.3

As the air is removed from the bell jar, the ringing sound from inside the bell jar gets quieter. When all the air has been removed, the bell cannot be heard.

Explain these observations.

....

....

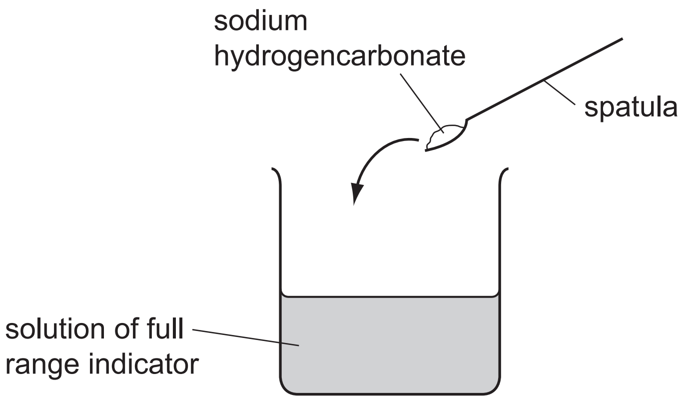
....

.... [2]

For Examiner's Use

3 Sodium hydrogencarbonate, $NaHCO_3$, is a white solid compound which is soluble in water.

(a) A student adds some sodium hydrogencarbonate to a beaker which contains an aqueous solution of full range indicator (Universal Indicator).



When the sodium hydrogencarbonate dissolves, the solution changes colour from green to blue.

(i) State how the pH of the mixture changes when the sodium hydrogencarbonate dissolves.

.... [1]

(ii) The student then adds excess dilute hydrochloric acid to the solution.

Apart from an increase in volume, state **two** observations that are made when the acid is added.

1 ....

....

2 ....

.... [2]

(b) Fig. 3.1 shows apparatus a teacher uses to demonstrate the heating of sodium hydrogencarbonate.

For Examiner's Use

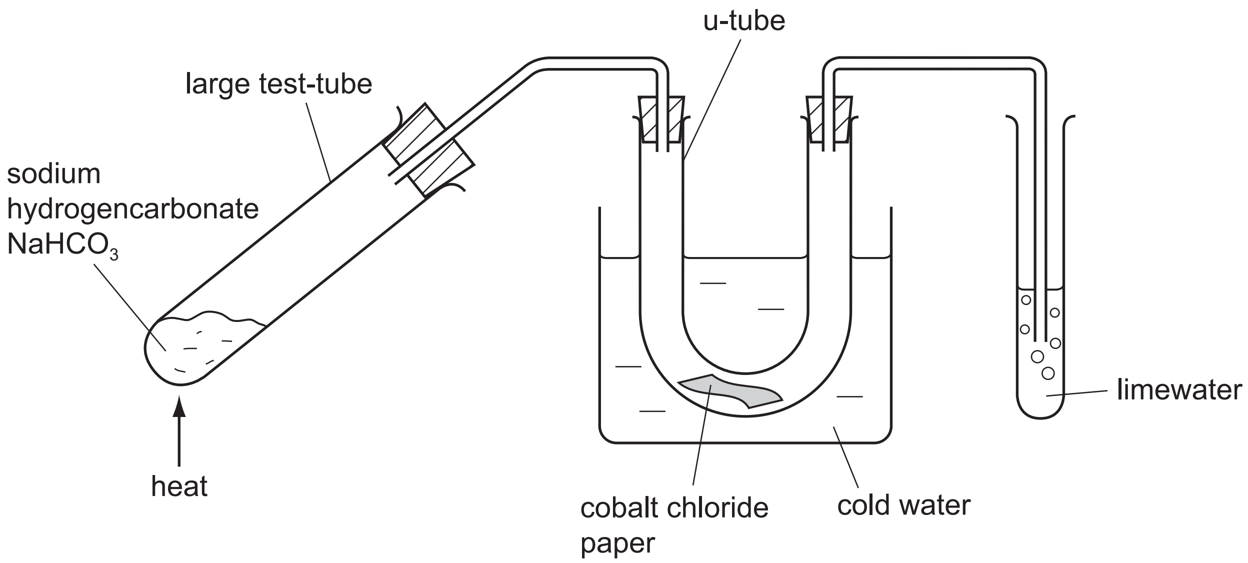


Fig. 3.1

The solid sodium hydrogencarbonate is heated strongly for a few minutes and the following observations are made.

- The cobalt chloride paper changes colour from blue to pink.
- A gas bubbles out through the limewater, turning it cloudy.

After the reaction a white solid remains in the large test-tube.

(i) Explain how the observations show that both water and carbon dioxide are produced.

....

....

.... [1]

(ii) The teacher tells her students that

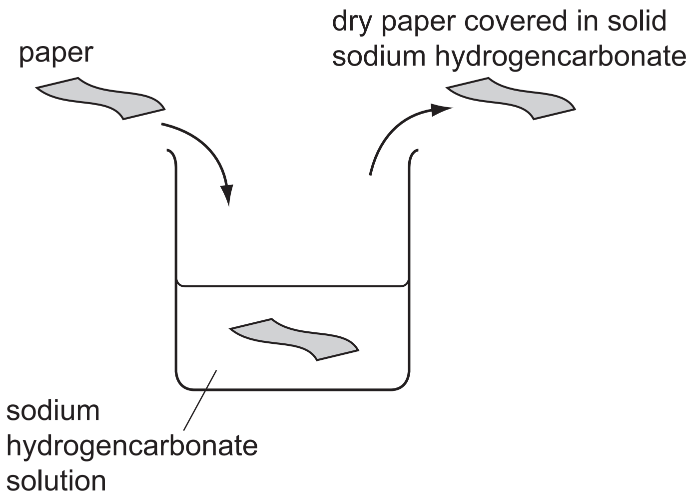
- sodium hydrogencarbonate has been decomposed (broken down into simpler compounds),
- the white solid which remains in the large test-tube is sodium carbonate, Na_2CO_3.

Construct a balanced symbol equation for the decomposition of sodium hydrogencarbonate.

.... [2]

(iii) A student places a piece of paper into a solution of sodium hydrogencarbonate.

She removes the paper and allows it to dry. She notices that crystals of solid sodium hydrogencarbonate are left on the paper.



The student finds that it is now difficult to set fire to the paper.

Use the results of the experiment in Fig. 3.1 to suggest why the student finds it difficult to get the paper to burn.

[2]

(iv) Suggest, with a reason, whether the decomposition of sodium hydrogencarbonate is an exothermic or an endothermic reaction.

[2]

For Examiner's Use

4 Most plants have root hairs near the tips of their roots. A mutation in a plant called land cress affects the growth of its root hairs.

(a) (i) Define the term *mutation*.

....

.... [1]

(ii) State **one** factor that increases the chance of mutation.

.... [1]

(b) The growth of root hairs in normal plants, and in plants with the mutation, is affected by the concentration of phosphate ions in the soil.

Researchers grew normal and mutant land cress plants in soil with different concentrations of phosphate ions. They measured the mean number of root hairs in a small area of the roots, and also the mean length of the root hairs.

Table 4.1 shows their results.

Table 4.1

type of plant	phosphate concentration	mean number of root hairs per unit area	mean length of root hairs / micrometres
normal plants	low	1.26	175
	high	1.70	149
mutant plants	low	1.41	225
	high	1.85	52

(i) Describe how the addition of phosphate ions to the soil affects the root hairs in normal plants.

....

....

.... [2]

(ii) Compare the effect of adding phosphate ions to the soil for normal plants and for mutant plants.

....

....

.... [2]

(iii) Predict and explain how a reduction in the length of its root hairs would affect the growth of a plant.

For Examiner's Use

....

....

....

....

.... [3]

(c) Farmers often add fertilisers containing phosphate ions, potassium ions and nitrate ions to the soil in which they grow crops.

(i) Explain why adding nitrate ions to the soil helps the crop plants to grow faster and larger.

....

....

.... [2]

(ii) Explain how careless use of fertilisers can cause harm to living organisms in rivers and lakes.

....

....

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....

.... [4]

5 Fig. 5.1 shows a bicycle with a front light **A** and a rear light **B** powered by the same battery.

For Examiner's Use

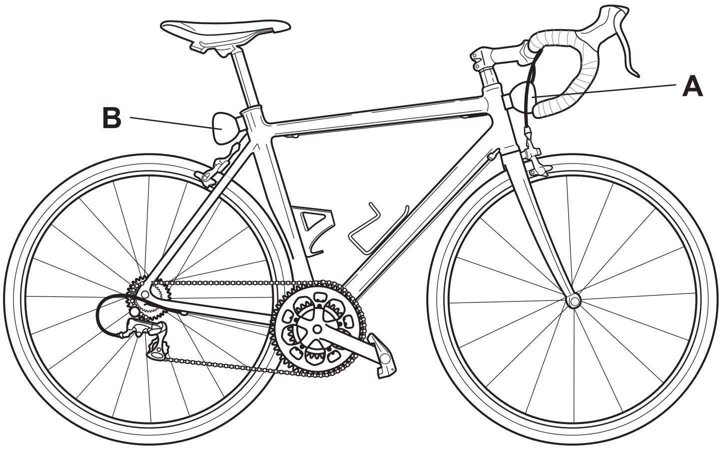


Fig. 5.1

Fig. 5.2 shows how the lights are connected.

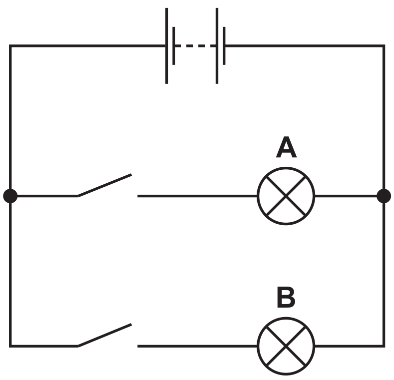


Fig. 5.2

(a) The resistance of light **A** is 10 Ω and the resistance of light **B** is 5 Ω.

Calculate the combined resistance of the two lights in this circuit.

State the formula that you use and show your working.

formula

working

.... Ω [3]

(b) The voltage supplied by the battery is 9 V.

Calculate the current passing through light **A**.

State any formula that you use, show your working and state the unit of your answer.

formula

working

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

For Examiner's Use

For Examiner's Use

6 Fig. 6.1 shows a fetus in the uterus just before it is born.

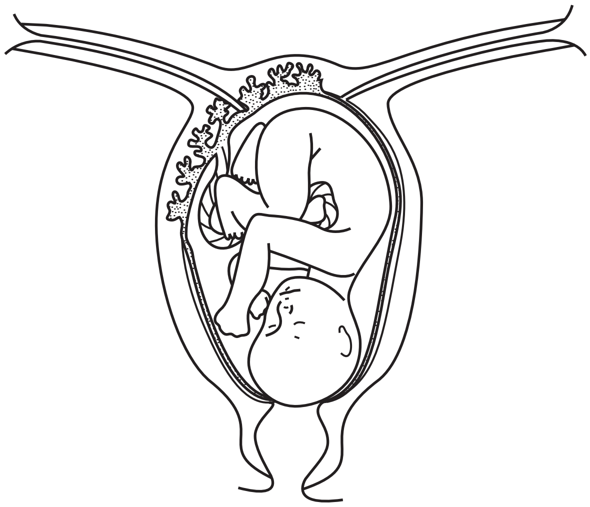


Fig. 6.1

(a) On Fig. 6.1, use the letters **A**, **B** and **C** to label these parts on the diagram:

A – the placenta

B – amniotic fluid

C – the cervix [3]

(b) Describe how the placenta and umbilical cord help to supply the fetus with oxygen.

....

....

....

....

.... [3]

For Examiner's Use

7 **(a)** Fluorine is one of the halogens in Group 7 of the Periodic Table.

Suggest the physical state at room temperature (solid, liquid or gaseous) of fluorine.

Explain your answer in terms of the relative size of fluorine molecules in comparison with those of the other halogens.

physical state of fluorine ....

explanation ....

....

.... [2]

(b) Fluorine is the most reactive element in the Periodic Table. There are only three other elements that do **not** react with fluorine. These elements are all found in the same group of the Periodic Table.

Suggest and explain which group of the Periodic Table contains the elements that do **not** react with fluorine.

group ....

explanation ....

....

.... [3]

(c) In some countries, drinking water contains low concentrations of compounds containing fluoride ions.

One of the compounds found in drinking water is sodium fluoride, NaF.

(i) Explain briefly why, although fluorine is very reactive, it is safe to drink water that contains fluoride ions.

....

....

....

.... [2]

(ii) A sample of drinking water contains sodium fluoride at a concentration of 0.000064 mol / dm^3.

Calculate the mass of sodium fluoride that must be dissolved in 10000 dm^3 of water to obtain this concentration.

Show your working.

For Examiner's Use

.... [3]

8 **(a)** During part of a journey, a car moves 1 km and the driving force is 10 000 N.

For Examiner's Use

(i) Calculate the work done by the driving force.

State any formula that you use, show your working and state the unit of your answer.

formula

working

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

(ii) This work is done in 100 s.

Calculate the useful power output from the car's engine during this time.

State any formula that you use, show your working and state the unit of your answer.

formula

working

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

(b) When the car is stationary, each of its four tyres has an area of $150\,cm^2$ in contact with the road.

The pressure exerted by the car on the road is $300\,000\,N/m^2$.

Calculate the mass of the car.

State any formulae that you use, show your working and state the unit of your answer. (use g = 10 N / kg)

formula

working

.... unit .... [4]

(c) The cooling system of the car uses water to remove heat energy from the hot engine. The heated water goes into the radiator. Heat energy is lost from the radiator.

(i) Fig. 8.1 shows a car radiator.

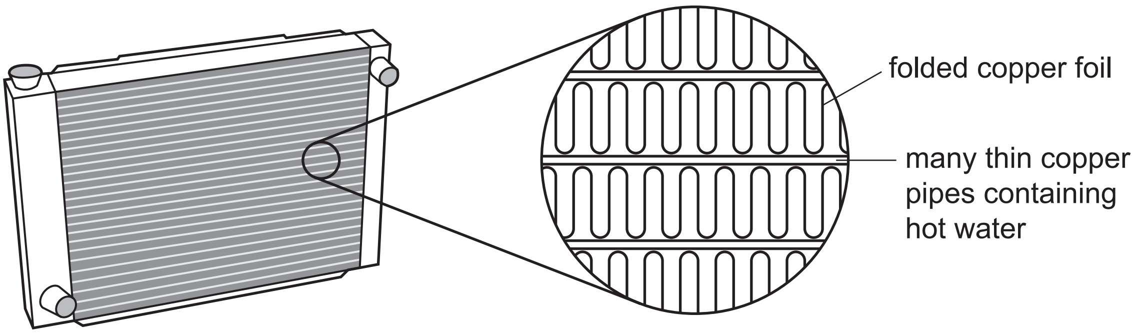


Fig. 8.1

Explain how the features of the radiator that are shown in Fig. 8.1 increase the rate of cooling of hot water.

....

....

.... [2]

For Examiner's Use

(ii) The mass of water in the radiator is 5 kg.

The specific heating capacity of water is 4200 J / kg °C.

Calculate the energy released when the water in the radiator cools by 12 °C.

State any formula that you use, show your working and state the unit of your answer.

formula

working

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

9 Rabbits are often kept as pets. People try to breed rabbits with unusual colours, such as himalayan colouring. Fig. 9.1 shows a rabbit with himalayan fur colour. The rabbit's fur is white with some black areas.

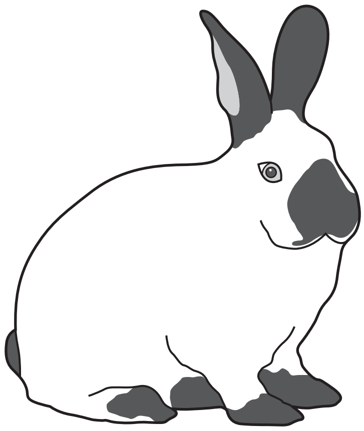


Fig. 9.1

(a) Completely white fur and himalayan-coloured fur are produced by two alleles of a gene.

When a white rabbit and a himalayan rabbit are bred together, all the offspring are white.

When two of these white offspring are bred together, one quarter of their offspring are himalayan and three quarters are white.

(i) Identify which allele is dominant, and suggest suitable symbols for the two alleles.

dominant allele:

colour produced .... symbol ....

recessive allele:

colour produced .... symbol .... [2]

(ii) Two rabbits that are heterozygous for these alleles are crossed.

Construct a genetic diagram, using your symbols from **(i)**, to explain the results of this cross.

[4]

(b) Rabbits, like humans, keep their internal body temperature constant. The body temperature of a rabbit is 38.5 °C.

(i) Explain how a rabbit generates heat within its body.

....

....

.... [2]

(ii) Suggest how the fur of a rabbit helps to maintain its body temperature higher than that of its environment.

....

....

.... [2]

(iii) When himalayan rabbits are first born, they are white all over. The black colour develops gradually. The black pigment is produced by the action of an enzyme that is only active at temperatures below 25 °C.

Use this information to suggest a reason for the distribution of black fur on the body of a himalayan rabbit.

....

....

.... [2]

10 Fig. 10.1 shows the structure of one molecule of a type of compound called a CFC (chlorofluorocarbon).

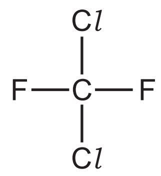


Fig. 10.1

(a) (i) State the number of electrons in the outer shells of chlorine and fluorine atoms.

.... [1]

(ii) State and explain briefly the number of electrons in the outer shells of the chlorine and fluorine atoms in the molecule shown in Fig. 10.1.

number of electrons ....

explanation ....

....

.... [2]

(b) Fig. 10.2 shows a cross-section through an aerosol spray can used to produce a paint spray.

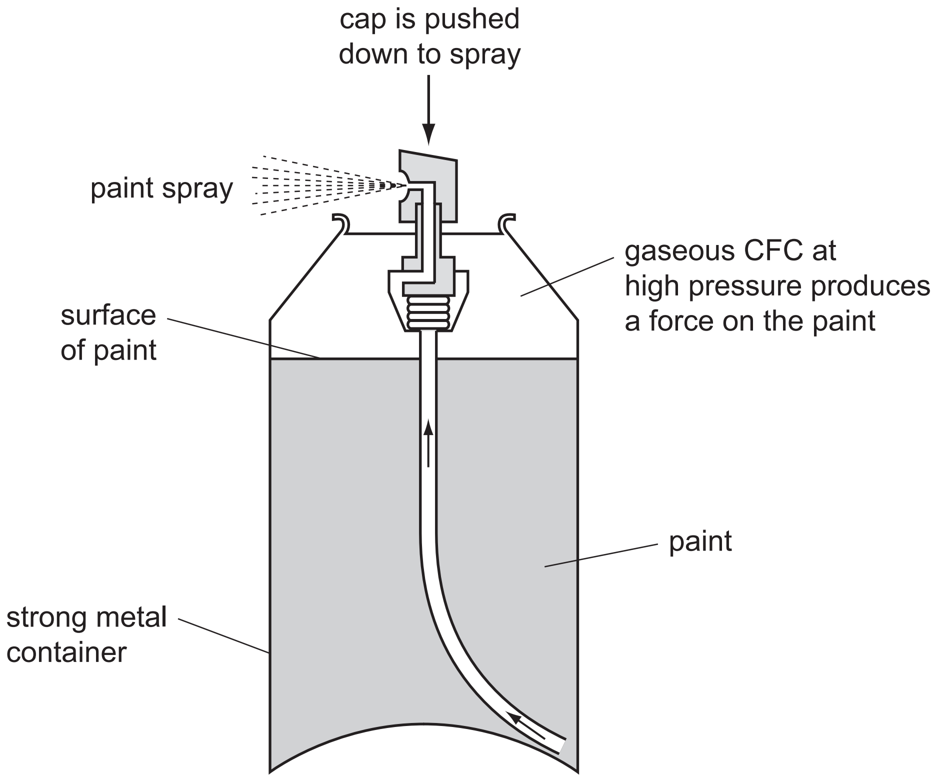


Fig. 10.2

(i) Explain, in terms of molecules, how the gaseous CFC produces a force on the surface of the paint.

....

....

.... [2]

(ii) Scientists have discovered that CFC molecules are causing damage to the atmosphere because they react with molecules of the gas ozone, O_3.

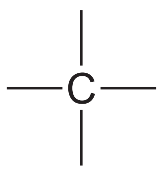
Describe how a molecule of ozone differs from a molecule of gaseous oxygen, O_2.

....

.... [1]

(c) CFCs have been replaced in most aerosol spray cans by gaseous hydrocarbons such as propane and butane.

(i) Complete the molecular structure diagram of one molecule of propane.



[2]

(ii) Suggest **one** disadvantage of using hydrocarbons in aerosol spray cans.

....

.... [1]

For Examiner's Use

11 (a) A mobile phone (cell phone) is powered by a rechargeable battery.

Fig. 11.1 shows a mobile phone being charged. The charger contains a circuit which acts as a transformer.

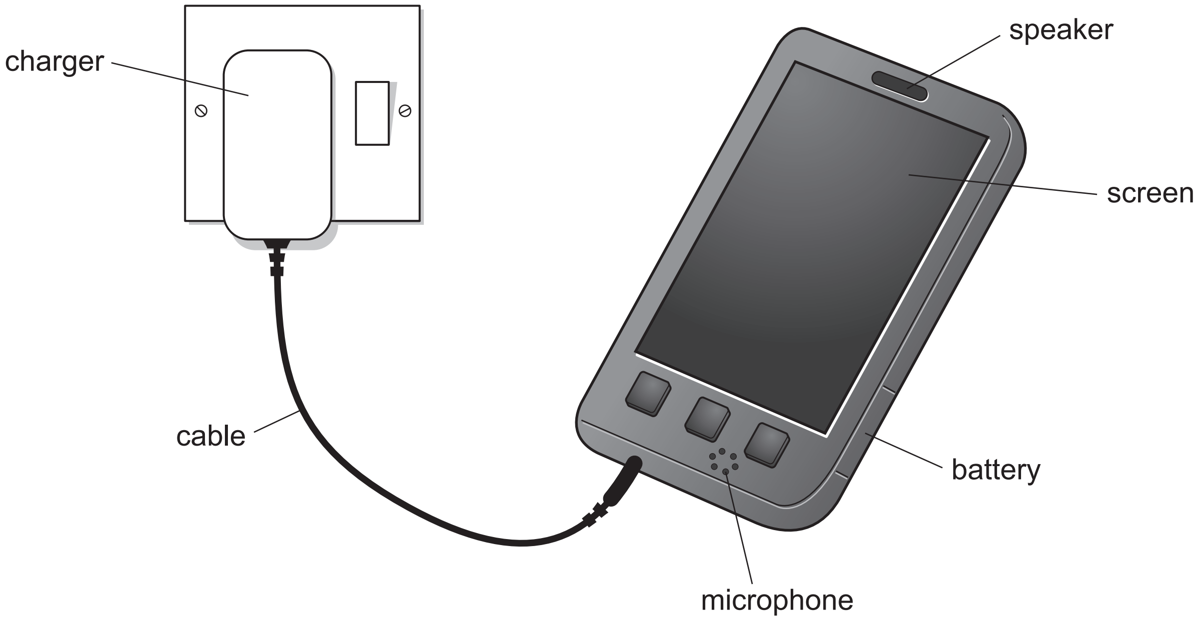


Fig. 11.1

Link each description in Table 11.1 with one of the labelled parts shown in Fig. 11.1.

Write your answers next to the descriptions in Table 11.1

Table 11.1

description	part
This transforms electrical impulses into sound energy	
This transforms electrical energy to stored chemical energy	
This transforms electrical energy to light energy	
This reduces the mains voltage to a lower voltage.	

[4]

(b) A simple transformer is shown in Fig. 11.2.

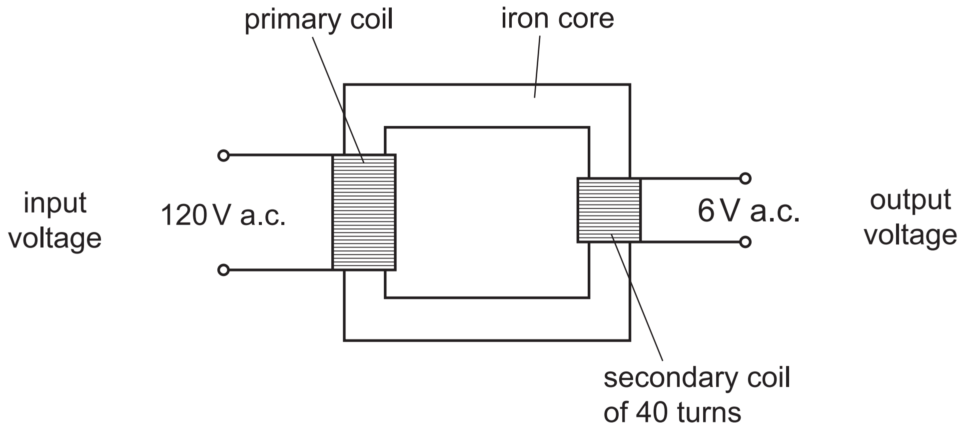


Fig. 11.2

(i) Calculate the number of turns on the primary coil.

State the formula that you use and show your working.

formula

working

.... turns [3]

(ii) State the function of the iron core in a transformer.

....

.... [1]

(iii) State how step-up transformers reduce the electrical energy lost in transmission through a grid from a power station to the point of use.

....

....

.... [2]

For Examiner's Use

(c) (i) Draw lines to show the magnetic field around the bar magnet in Fig. 11.3

Fig. 11.3

[2]

(ii) Draw lines to show the shape of the magnetic field produced by the solenoid coil in Fig. 11.4, when an electric current passes through it.

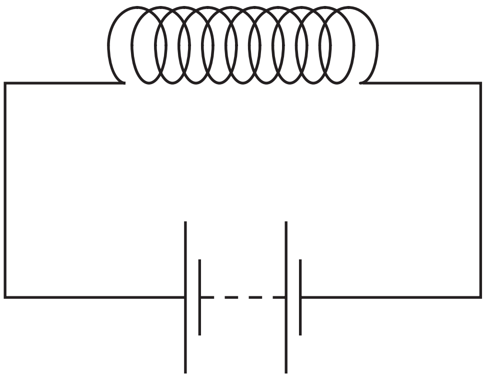


Fig. 11.4

[1]

For Examiner's Use

12 Cigarette smoke contains many harmful substances.

(a) List **four** harmful components of cigarette smoke.

1 ....

2 ....

3 ....

4 .... [2]

(b) Some of the components of cigarette smoke prevent cilia from working properly.

Explain how this can lead to an increase in infections of the lungs by bacteria.

....

....

....

.... [2]

(c) Describe the roles of white blood cells in defending the body against infections by bacteria.

....

....

....

.... [3]

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	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**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	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

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

Key: a
X
b

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

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