UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0662869389

CO-ORDINATED SCIENCES **0654/31**

Paper 3 (Extended) **May/June 2011**

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 soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
A copy of the Periodic Table is printed on page 24.

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.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

This document consists of **22** printed pages and **2** blank pages.

IB11 06_0654_31/4RP

UNIVERSITY *of* CAMBRIDGE
International Examinations

For Examiner's Use

1 **(a)** Fig. 1.1 shows a hot water storage tank in a house. The water is heated by an electric immersion heater at the bottom of the tank.

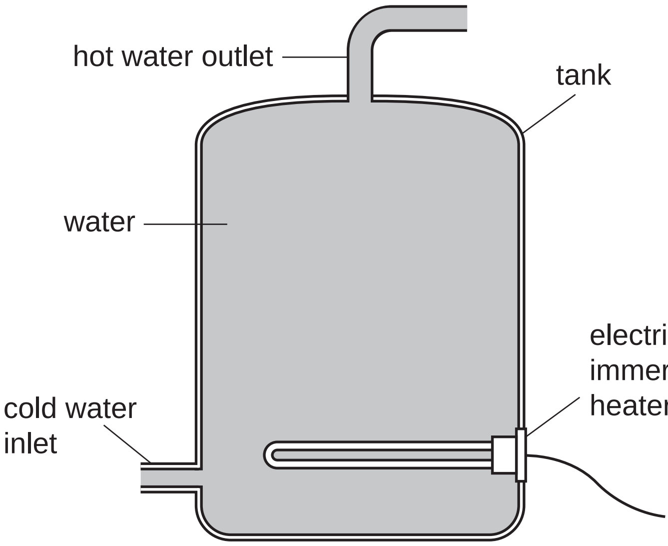


Fig. 1.1

(i) The heater is placed at the bottom of the tank and heats all the water.

Explain why only some of the water would be heated if the heater is placed at the top of the tank.

....

....

....

.... [2]

(ii) The heater has a power output of 5 kW. How much energy does the heater deliver in one second?

.... [1]

(iii) It takes 2 hours to heat up 280 000 cm^3 of water from 20 °C to 50 °C. The density of water is 1000 kg/m^3.

Calculate the specific heating capacity of water.

State the formula that you use and show your working.

formula used

working

.... [4]

(b) Fig. 1.2 shows a circuit breaker. It is designed to switch off the current in a circuit if the current becomes too large.

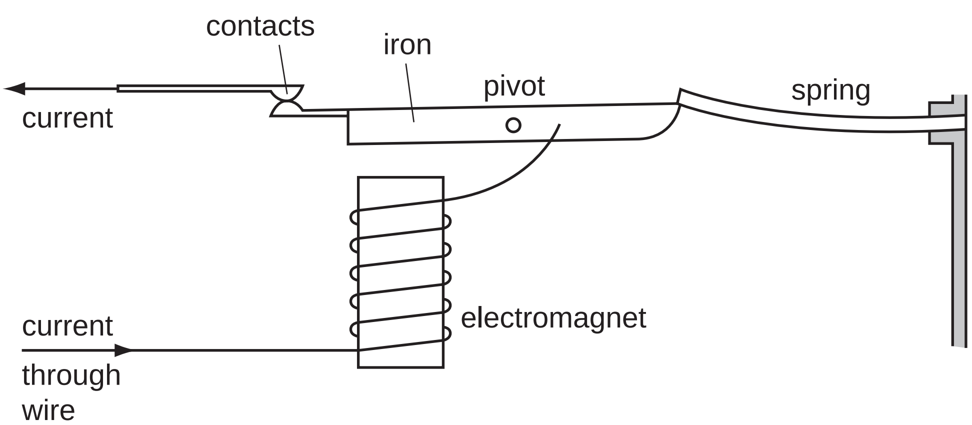


Fig. 1.2

Explain how the circuit breaker switches off the current if the current becomes too large.

....

....

....

.... [3]

For Examiner's Use

2 The Earth provides raw materials which are processed into useful products.

(a) Choose products from the list to complete the right hand column of Table 2.1.

aluminium **ceramics** **chlorine** **glass** **steel**

Table 2.1

raw material	**useful product**
rock salt	
sand and metal oxides	

[2]

(b) The way in which the atoms are arranged in a substance is often referred to as its structure.

Substances with different structures are listed below.

argon **copper** **glass** **sodium chloride**

(i) State the substances in the list that have a giant structure.

.... [1]

(ii) State the substances in the list whose atoms are arranged in a disorderly (irregular) manner.

.... [1]

(iii) Decane, $C_{10}H_{22}$, is a liquid at room temperature.

When decane is heated gently, a vapour made of unbroken decane molecules is released. Hydrogen gas and black soot made of carbon are **not** released.

Explain these findings in terms of attractive forces between molecules and chemical bonds within molecules.

....

....

....

....

.... [3]

For Examiner's Use

(c) Nitrogen and hydrogen react together to form ammonia.

The balanced equation for this reaction is

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

This reaction requires high temperature and pressure, and an iron catalyst which is present in the form of a large number of small pieces.

(i) Suggest the meaning of the symbol $\rightleftharpoons$ in the equation.

....

.... [1]

(ii) Describe the advantage of using a catalyst broken into a large number of small pieces in this reaction.

....

....

....

....

.... [3]

(iii) The reaction described above involves breaking the bond between the atoms in nitrogen molecules.

Suggest why high temperature and pressure are needed for this reaction to take place.

....

....

....

.... [3]

3 Fig. 3.1 shows a sperm cell.

Fig. 3.1

(a) On Fig. 3.1, use label lines to label and name **two** structures that are found in **all** animal cells. [2]

(b) Name the organ in which sperm are produced. .... [1]

(c) An investigation was carried out into the oxygen use and energy use of sperm while they were at rest and while they were swimming.

For each measurement, the researchers calculated the amount of oxygen and the amount of energy used by 10^9 sperm.

The results are shown in Table 3.1.

Table 3.1

	oxygen use / units per 10^9 sperm per hour	**energy use / joules per 10^9 sperm per hour**
resting sperm	24	46
swimming sperm	83	164

(i) Suggest why the researchers measured the oxygen use and energy use for 10^9 sperm, rather than for a single sperm.

....

.... [1]

For Examiner's Use

(ii) Explain why more oxygen is used when the sperm are using more energy.

....

....

.... [2]

(iii) Calculate the total power output of a group of 10^9 swimming sperm.

State the formula that you use and show your working.

formula

working

.... [3]

(iv) In order to reach an egg, a human sperm has to swim from the top of the vagina to an oviduct, through a thin layer of liquid.

Explain how the shape of the sperm, shown in Fig. 3.1, reduces the energy required to swim this distance.

....

....

....

.... [2]

(d) Describe what happens immediately after a sperm meets an egg in the oviduct.

....

....

....

.... [2]

4 **(a)** In older television sets there is a tube which contains three heated wires (filaments). The picture on the screen is produced when emissions from these wires are made to hit the screen.

(i) Name the particles emitted by these hot wires.

.... [1]

(ii) State the charge on these particles.

.... [1]

(iii) When a television set is in use, a static charge builds up on the screen. Suggest why this happens.

....

.... [1]

(iv) The heated wire has an electrical resistance.

State **two** factors which affect the resistance of a piece of wire.

1 ....

2 .... [1]

(b) Television sets contain microprocessors.

What is a microprocessor?

....

.... [1]

For Examiner's Use

(c) Fig. 4.1 shows the energy transferred each second by a television.

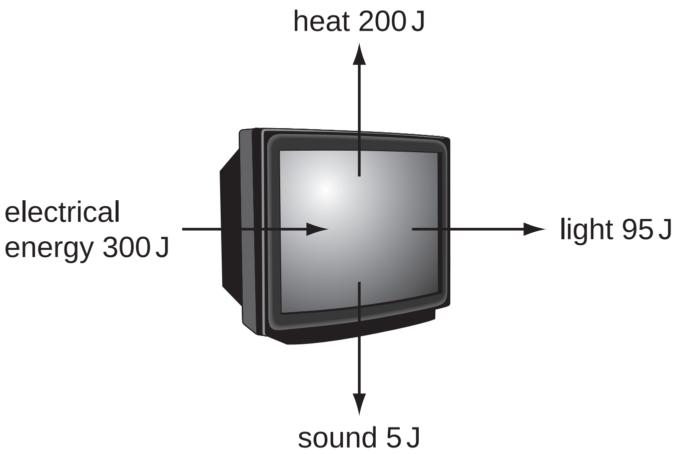


Fig. 4.1

(i) Name the form of energy that is lost as waste energy by the television.

.... [1]

(ii) State the effect of the waste energy on the air around the television.

.... [1]

(iii) Calculate the energy efficiency of the television.

Show your working.

.... % [2]

5 A student carried out an experiment to find which substances in the environment caused nails made of mild steel to become rusty.

She selected three identical nails and placed them in sealed test-tubes, **A**, **B** and **C**, as shown in Fig. 5.1.

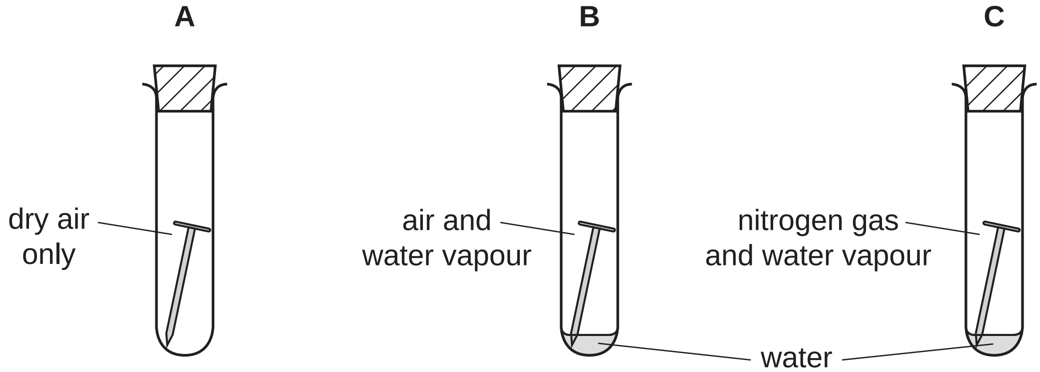


Fig. 5.1

(a) Predict in which tube, **A**, **B** or **C**, the nail became rusty, and explain why the nail did **not** rust in either of the other two tubes.

....

....

.... [2]

(b) Fig. 5.2 shows a simplified diagram of two types of atom, **P** and **Q**, in mild steel.

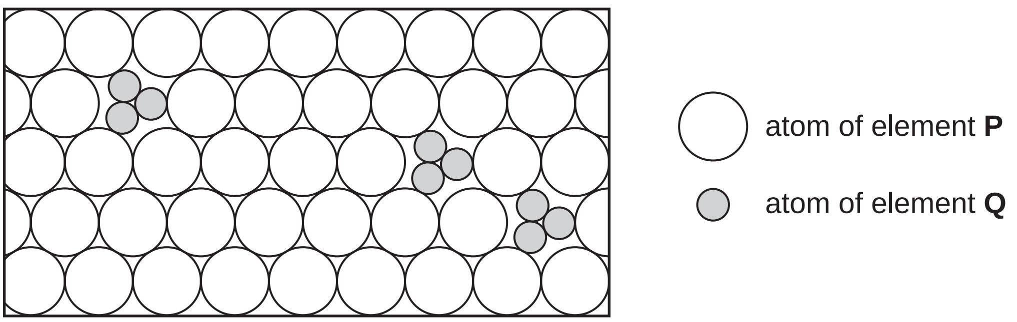


Fig. 5.2

(i) Suggest the name of element **Q**. .... [1]

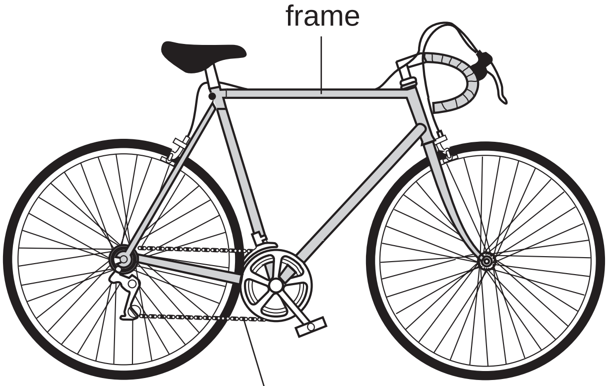
(ii) Use Fig. 5.2 to explain why an alloy such as mild steel is less malleable than a pure metal such as iron.

....

....

.... [2]

(c) Steel is used to make both the frames and the chains of bicycles. In order to prevent rusting, the frames are painted and the chains are covered in an oil made of hydrocarbon molecules.



(i) The oil used to protect the bicycle chain contains mainly alkanes. Alkane molecules are described as being saturated.

Explain, in terms of chemical bonding, the difference between saturated and unsaturated hydrocarbon molecules.

You may draw a diagram to help your explanation.

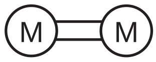
....

....

.... [2]

(ii) The paint used to protect the bicycle frame from rusting often contains substances made by addition polymerisation of suitable monomers.

Use the simplified diagram of a monomer molecule below to explain what happens in addition polymerisation.



....

.... [2]

For Examiner's Use

6

The smell of food cooking can cause a person's salivary glands to secrete saliva.

(a) **(i)** Name this type of response to a stimulus. .... [1]

(ii) Describe how the information about the smell of the food travels from the nose to the salivary glands.

....

....

....

.... [3]

(b) When food has been taken into a person's mouth, it is chewed by teeth and mixed with saliva.

Describe how the molar teeth help in the digestion of food.

....

....

....

.... [3]

(c) Saliva contains the enzyme amylase.

(i) What is an *enzyme*?

....

....

.... [2]

[Turn over

(ii) Describe the function of amylase.

....

....

.... [2]

(iii) State the parts of the alimentary canal, other than the mouth, where amylase is secreted and where it works.

where amylase is secreted ....

where amylase works .... [2]

For Examiner's Use

7 **(a)** Fig. 7.1 shows how radar is used to detect aircraft. Radar uses microwaves with a frequency of about 10 000 MHz. Short microwave pulses are sent from the transmitter, reflected from the aircraft and received. The time it takes for the wave pulse to make the journey there and back is measured.

Microwave pulses travel at 300 000 000 m / s.

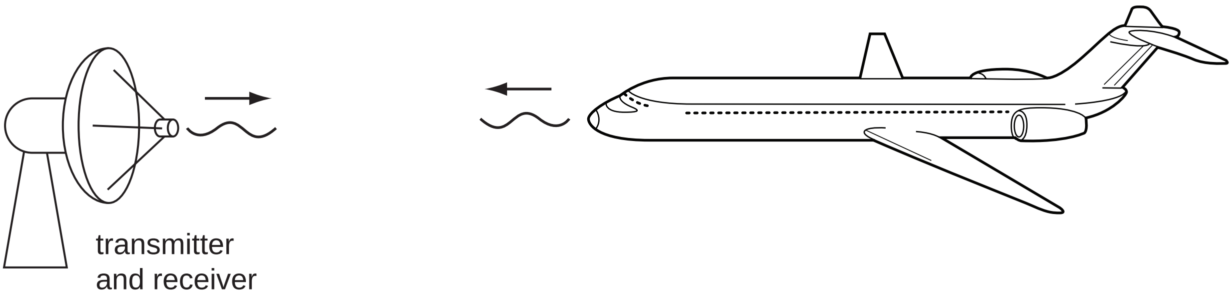


Fig. 7.1

(i) Calculate the wavelength of the microwaves.

State the formula that you use and show your working.

formula used

working

.... [2]

(ii) A radar transmitter sends a microwave pulse which is reflected from the aircraft. The microwave pulse returns to the receiver 0.000 027 s after transmission.

Calculate the distance of the aircraft from the radar transmitter.

State the formula that you use and show your working.

formula used

working

.... [2]

(b) The mass of the aircraft is 140 000 kg.

Calculate the kinetic energy of the aircraft as it travels at 100 m / s.

State the formula that you use and show your working.

formula used

working

.... [2]

(c) As the aircraft lands it is travelling at 85 m / s. It moves along the runway and decelerates at a uniform rate for 40 s until it stops.

(i) Calculate the deceleration of the aircraft along the runway.

State the formula that you use and show your working.

formula used

working

.... [2]

(ii) On the grid, draw a speed-time graph for the aircraft as it slows down from 85 m / s until it stops.

For Examiner's Use

[3]

For Examiner's Use

8 The chemical formulae for some compounds (minerals) found in rocks are shown below.

$CaMg(CO_3)_2$	dolomite
$KAlSi_3O_8$	potassium feldspar
$NaAlSi_3O_8$	sodium feldspar
SiO_2	quartz

(a) A white powder is known to be either potassium feldspar or sodium feldspar.

Describe how a flame test would enable a chemist to find out which of these minerals it is.

....

.... [1]

(b) Dolomite contains three ions, calcium, magnesium and carbonate.

Calcium and magnesium ions are represented by Ca^{2+} and Mg^{2+} respectively.

Deduce the electrical charge carried by a carbonate ion.

Explain how you obtained your answer.

.... [2]

(c) When dolomite is strongly heated it undergoes thermal decomposition, giving off carbon dioxide gas and leaving a mixture of calcium oxide and magnesium oxide.

The balanced equation for this reaction is

$$CaMg(CO_3)_2 \longrightarrow CaO + MgO + 2CO_2$$

(i) Calculate the number of moles of dolomite in 1.84 g.

Show your working.

.... [3]

(ii) State the number of moles of carbon dioxide which is given off when 1.84 g of dolomite completely decomposes.

.... [1]

(d) When excess dilute hydrochloric acid, HC*l*, is added to a mixture of calcium oxide and magnesium oxide, a highly exothermic neutralisation reaction occurs.

(i) Name **two** salts which are present in the mixture after the reaction.

1 ....

2 .... [1]

(ii) Suggest the balanced symbolic equation for the reaction between magnesium oxide and dilute hydrochloric acid.

.... [3]

9 Dung beetles live in places where large herbivores, such as elephants, buffalo or cattle, also live. The beetles collect dung produced by the herbivores and make it into a ball, which they roll away and bury.

They lay eggs on the buried ball of dung, so that when their larvae hatch they can feed on the dung. The adults also feed on the dung.

Fig. 9.1 shows a dung beetle rolling a ball of dung.

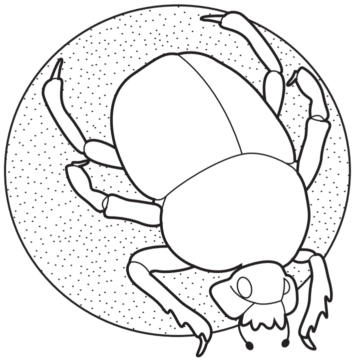


Fig. 9.1

(a) **(i)** State **one** feature of the dung beetle, visible on Fig. 9.1, that shows it is an arthropod.

.... [1]

(ii) State **one** feature of the dung beetle, visible on Fig. 9.1, that shows it is an insect.

.... [1]

(b) Dung beetles play an important role in the carbon cycle.

Using the information above, suggest how dung beetles can help a carbon atom in animal dung to become part of a carbohydrate molecule within a plant.

....

....

....

....

.... [3]

For Examiner's Use

(c) (i) Animal dung contains compounds of nitrogen, such as ammonia. When the dung is buried, the ammonia is converted to nitrates by bacteria in the soil.

Explain how this can help plants to grow better.

....

....

.... [2]

(ii) If there are plenty of dung beetles on a farmer's land, he may need to add fewer nitrogen-containing fertilisers to the areas where his cattle graze.

Suggest how this could benefit the environment.

....

....

....

....

.... [3]

BLANK PAGE

BLANK PAGE

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 †															

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

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

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.).