Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

COMBINED SCIENCE **0653/03**

Paper 3 Extended

May/June 2006

1 hour 15 minutes

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.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
You may use a pencil for any diagrams, graphs, tables or rough working.
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 **21** printed pages and **3** blank pages.

IB06 06_0653_03/3RP   UNIVERSITY *of* CAMBRIDGE
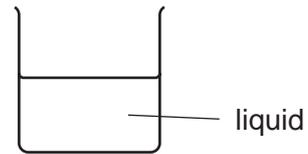
For Examiner's Use

1   (a)   Each box below contains a description of a solid, a liquid or a gas.
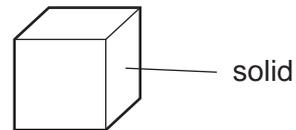
Join each box to the correct diagram.

It takes up the shape of
its container and has
a constant volume.

gas
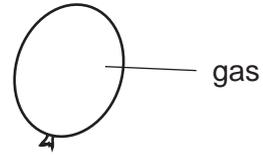
It expands the most
when heated.

liquid

The particles are only
very weakly attracted
to each other.

The particles have very
strong forces of
attraction between them.

solid

[3]

(b) Fig. 1.1 shows a cylinder containing carbon dioxide held in by a piston.

carbon dioxide gas

piston

Fig. 1.1

The volume in the cylinder is reduced by pushing in the piston.

Explain, in terms of particles, how this affects the pressure on the walls of the cylinder.

....

....

....

....

.... [3]

2 Several members of Rohani's family have an illness called PKU.
PKU is caused by a recessive allele, **a**. The normal allele is **A**.

(a) Explain what is meant by a *recessive allele*.

....

....

.... [2]

(b) Rohani has PKU. She has collected information about her parents and grandparents.
This is the family tree that she has drawn.
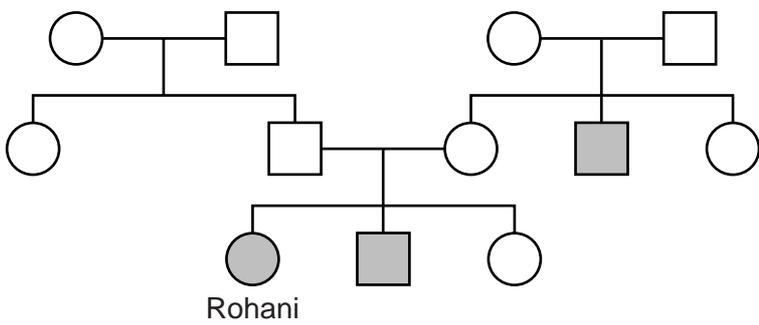
key

◯ unaffected female

⬤ female with PKU

☐ unaffected male

⬛ male with PKU

Rohani

   (i) What is Rohani's genotype?

.... [1]

   (ii) Rohani's parents have the same genotype as each other.

Draw a genetic diagram to show how Rohani inherited PKU from her parents.

[3]

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(c) The bodies of people with PKU cannot use amino acids properly. If they have to
of a particular amino acid in their blood, it can cause brain damage. Rohani has to
special diet to make sure this does not happen.

Suggest which kinds of foods Rohani must be especially careful about.
Explain your answer.

....

....

.... [2]

3 **(a)** Table 3.1 shows some information about the elements in Group VII of the Table. Use the Periodic Table on page 24 to help you with this question.

Complete the table.

Table 3.1

symbol	solid, liquid or gas at 25 °C
Cl	
Br	
I	

[1]

(b) Chlorine exists as diatomic molecules, Cl_2. Chlorine molecules react with methane, CH$_4$, to form a compound having the formula CCl_4.

(i) Complete the bonding diagram below to show

- the chemical symbols of the elements in a molecule of methane,

- the arrangement of the outer electrons of each atom.
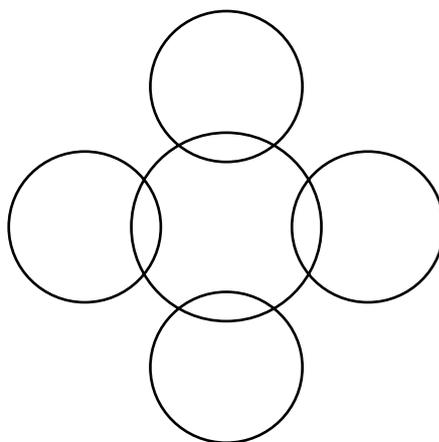
[2]

(ii) The symbolic equation below showing the reaction between chlorine and methane is not balanced.

Balance the equation.

$$Cl_2 \quad + \quad CH_4 \quad \rightarrow \quad CCl_4 \quad + \quad HCl$$ [1]

(iii) Fluorine and bromine also react with methane. Suggest which of the elements, fluorine, chlorine or bromine, reacts with methane most vigorously.

Explain your answer.

element ....

explanation ....

.... [1]

(c) The chemical symbols below represent isotopes of chlorine.

$$^{35}_{17}Cl \qquad ^{37}_{17}Cl$$

(i) Describe how the nuclei of these isotopes differ from one another.

....

....

.... [2]

(ii) Calculate the relative molecular mass of the compound CCl_4.
Show your working.

.... [2]

4 (a) Sodium -21 and sodium -24 are two radioactive isotopes that decay with half-lives seconds and 15 hours respectively.

Sodium -24 can be used to detect leaks in water pipes. Sodium chloride containing sodium -24 is placed in the pipe and a radiation detector is used to check for radiation coming from water leaking out of the pipe.

(i) Explain the meaning of the term *radioactive decay*.

....

.... [2]

(ii) Explain why sodium -24 is more suitable than sodium -21 as a radioactive isotope for detecting leaks in water pipes.

....

.... [1]

(iii) A sample of sodium -24 of mass 1.6 g was stored for a few days.

Calculate the mass of sodium -24 that will remain after 45 hours.

Show your working.

.... [2]
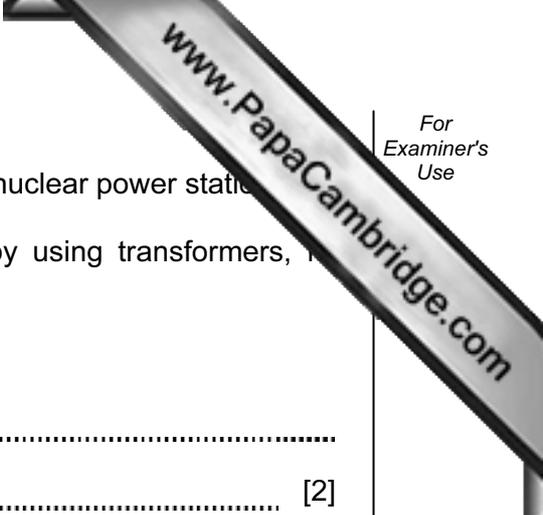
(b) Some radioactive isotopes are used to generate electricity in nuclear power stati

 (i) The voltage of the electricity generated is increased by using transformers,
      transmission through power lines to the users.

  Explain why this is done.

  ....

  .... [2]

 (ii) The electrical supply to a house is at a voltage of 220 V.
      An electric kettle is plugged into the supply.
      The current flowing through the heating element of the kettle is 10 A.

  Calculate the resistance of the heating element.

  Show your working and state the formula that you use.

  formula used

  working

  .... [2]

5 (a) The list below contains descriptions of some different parts of cells.

    A   contains genes made of DNA

    B   controls what enters and leaves the cell

    C   is fully permeable

Write the **letter** or **letters** of the descriptions that fit each of these parts of cells. Each part may have one letter, two letters or no letters at all.

nucleus   ....

cell wall   ....

chloroplast   ....

cell surface membrane   ....   [2]

(b) Fig. 5.1 shows an experiment to investigate osmosis.
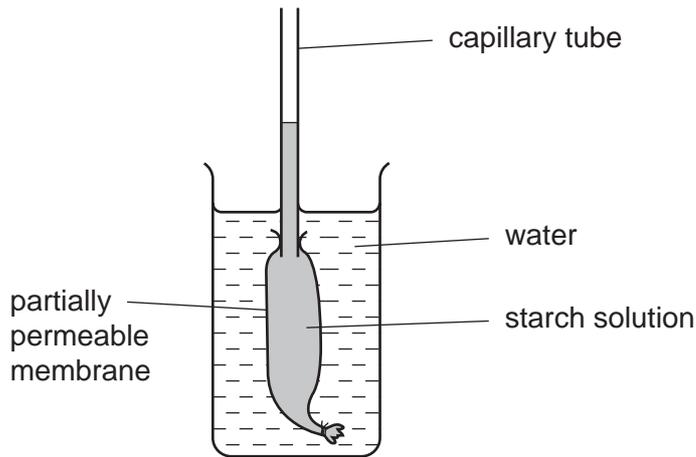
Fig. 5.1

After five minutes, the level of the liquid inside the capillary tube had risen.

(i) Explain why the liquid rose up the tube.

....

....

....

.... [3]

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(ii) At the end of the experiment, the liquid outside the membrane was te⋯ starch.

Describe how this test would be carried out and the colour you would expect to see.

how the test is carried out ....

....

colour expected .... [2]

(c) Plants take up water from the soil into their roots by osmosis. The water is then carried up to the leaves in the xylem vessels.

Describe the pathway that the water takes as it travels from the soil into the xylem vessels in the root.

....

....

.... [2]

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6   Petroleum (crude oil) provides many important products including fuels and polymers.

gaseous fuels

liquid fuels

OIL

polymers

petroleum
(crude oil)

oil refinery
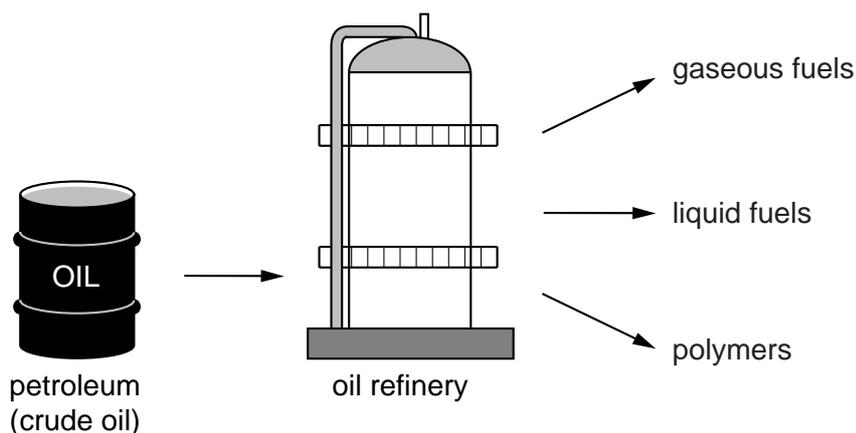
(a) Butane is a gaseous fuel obtained from petroleum.

Name **two** products that are formed when butane burns in the air.

.... [1]

(b) Table 6.1 shows the total number of atoms which are combined in molecules of four compounds **A**, **B**, **C** and **D**.

Table 6.1

compound	A	B	C	D
number of atoms in one molecule	60 000	5	26	2

(i) Suggest and explain briefly which one of these compounds is methane (natural gas).

....

.... [1]

(ii) Suggest and describe the type of chemical reaction that has occurred to form molecules of compound **A**.

....

....

.... [2]

(c) Cracking is a process which converts large hydrocarbon molecules into smalle
some of which contain double covalent bonds in their molecules.

(i) Describe briefly how hydrocarbon molecules are cracked.

....

....

.... [2]

(ii) A colourless hydrocarbon is shaken with aqueous bromine. After some time the bromine has **not** changed colour.

What does this result suggest about the bonding in the hydrocarbon?

Explain your answer.

....

....

.... [2]

7 Fig. 7.1 shows sugar cane growing in Fiji.

Fig. 7.1

(a) In Fiji, much of the land is hilly. It often rains very hard.

With reference to Fig. 7.1, explain how the fields of sugar cane can help to reduce soil erosion.

....

....

.... [2]

(b) Sugar cane has flowers that are pollinated by the wind.
Suggest **one** feature you would expect these flowers to have.

....

.... [1]

(c) Sugar cane produces glucose by photosynthesis. The glucose is changed int.......
sugars. These sugars can be used to make sweet foods such as cakes and chocol......

A man eats a cake containing glucose.

(i) Describe how the glucose is absorbed into his blood.

....

....

.... [2]

(ii) Explain how his blood sugar level will be prevented from rising too high after he has eaten the cake.

....

....

....

.... [3]

(iii) The process that controls the level of blood sugar is an example of negative feedback.

Explain the meaning of the term *negative feedback*.

....

....

.... [2]

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8   The element iron is extracted from iron ore, which is a rock found in the Earth's crust.

  (a) The main iron compound in iron ore is iron oxide. When iron oxide reacts with carbon monoxide, iron is produced. The word equation for this reaction is shown below.

    iron oxide   +   carbon monoxide   →   iron   +   carbon dioxide

   (i) State **one** difference between an element such as iron and a compound such as iron oxide.

   ....

   ....

   .... [1]

   (ii) The formula of iron oxide is Fe_2O_3 and the formula of oxide ions is O^{2-}.

    Deduce the formula of the iron ions in iron oxide.

    Explain your working.

    ....

    .... [2]

  (b) Fig. 8.1 shows a diagram of a car.

car body made
from mild steel

galvanised underside
of car
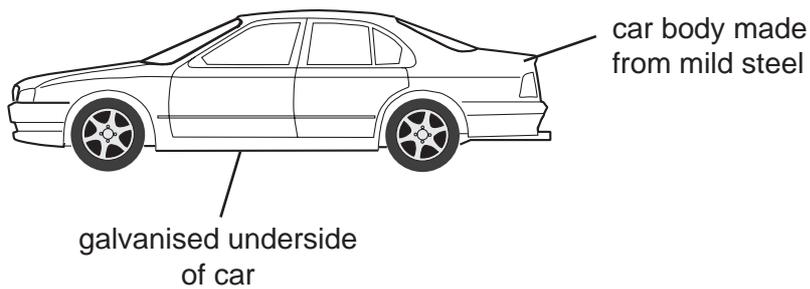
Fig. 8.1

   Explain how galvanising prevents the steel on the underside of the car from rusting.

   ....

   ....

   .... [2]

(c) Fig. 8.2 shows a test-tube containing dilute sulphuric acid reacting with pieces
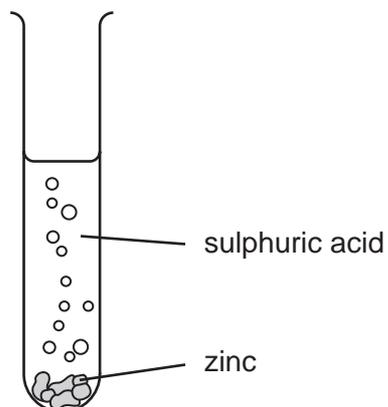The zinc was in excess and eventually all of the acid had reacted.

sulphuric acid

zinc

Fig. 8.2

(i) State the formula and charge of an ion which is present in **all** acidic solutions.

.... [1]

(ii) State **one** observation which would show that all of the acid had reacted.

....

.... [1]

(iii) Predict and explain what would be observed if a piece of magnesium is added to
the solution remaining in the test-tube.

....

....

....

.... [3]

9   **(a)** An athlete takes part in a race. His performance is shown on the speed-time g
    Fig. 9.1.

Fig. 9.1

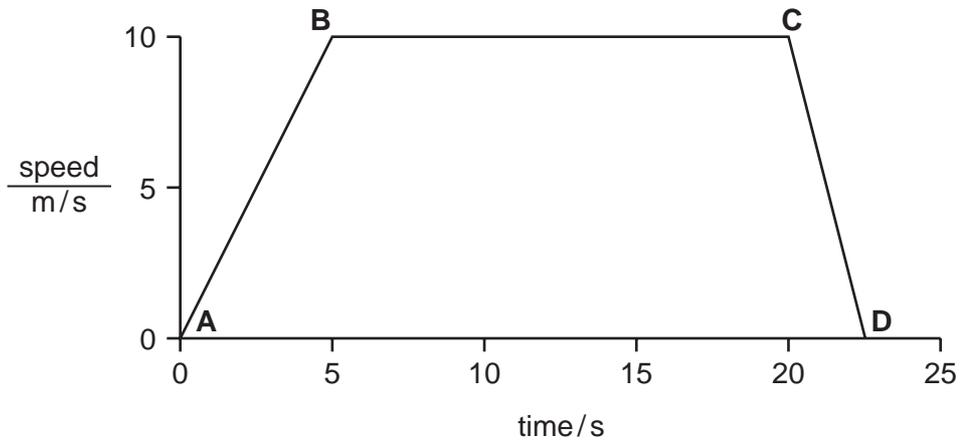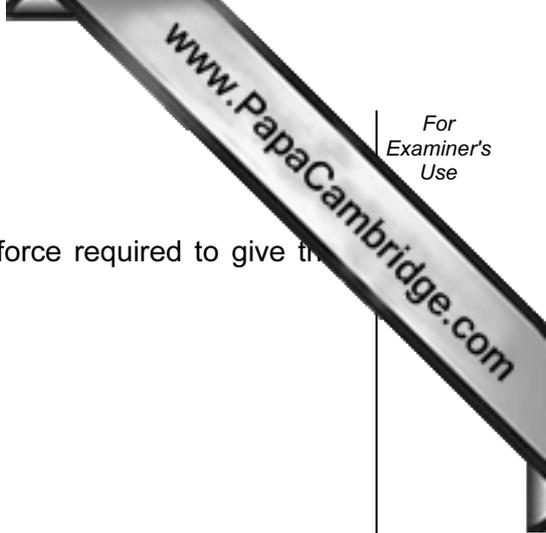Use the graph to describe the motion of the athlete between

(i) **A** and **B**, ...

(ii) **B** and **C**. .... [2]

(b) Calculate the distance travelled between 0 seconds and 20 seconds.

Show your working.

.... [2]

(c) During part of the race, the athlete is travelling at a constant speed. What can be said
about the forward and backward forces acting on the athlete at this time?

.... [1]

(d) The mass of the athlete is 60 kg.

   (i) His initial forward acceleration is 2 m/s^2. Calculate the force required to give th... acceleration.

     Show your working and state the formula that you use.

     formula used

     working

                                         .... [2]

  (ii) The athlete does 3000 J of work in 5 seconds. Calculate the power developed by the athlete.

     Show your working and state the formula that you use.

     formula used

     working

                                         .... [2]

(e) Fig. 9.2 shows three designs for a trophy, **P**, **Q** and **R**. The position of the ce
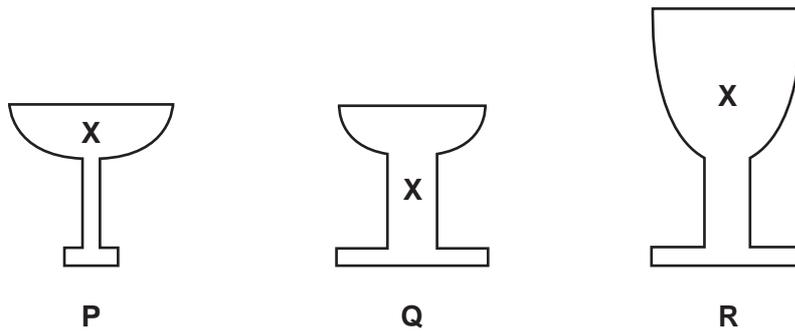mass of each trophy is marked with an **X**.

P   **Q**   **R**

Fig. 9.2

State and explain which trophy would be the most stable. You may draw diagrams if it helps your answer.

....

.... [2]

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23

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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 **A*l*** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulphur 16	35.5 **C*l*** 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** Ytrium 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 **T*l*** 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 dm³ at room temperature and pressure (r.t.p.).