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	

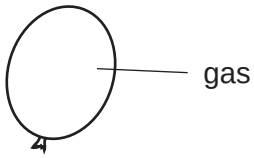
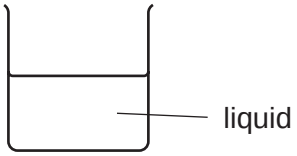
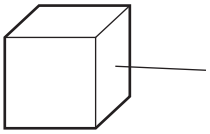
This document consists of **21** printed pages and **3** blank pages.

UNIVERSITY of CAMBRIDGE International Examinations
[Turn over

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.

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**.

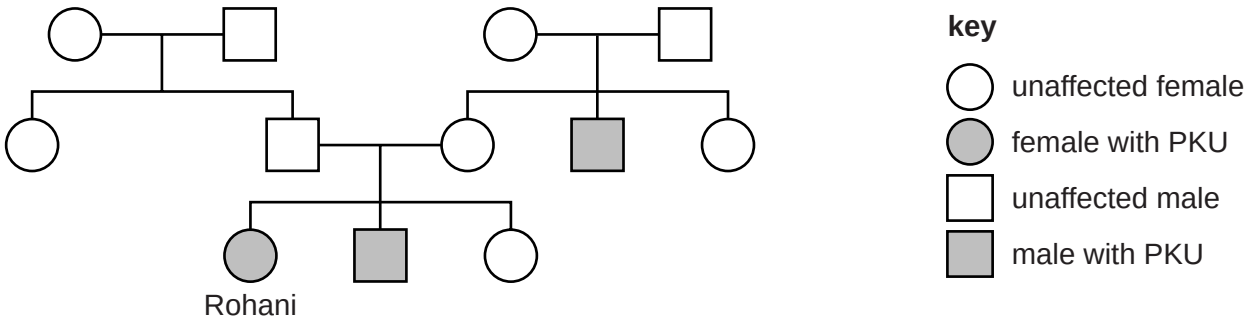
(a) Explain what is meant by a *recessive allele*.

.....

.....

..... [2]

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



(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]

(c) The bodies of people with PKU cannot use amino acids properly. If they have too much of a particular amino acid in their blood, it can cause brain damage. Rohani has to eat a 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 Periodic Table. Use the Periodic Table on page 24 to help you with this question.

Complete the table.

Table 3.1

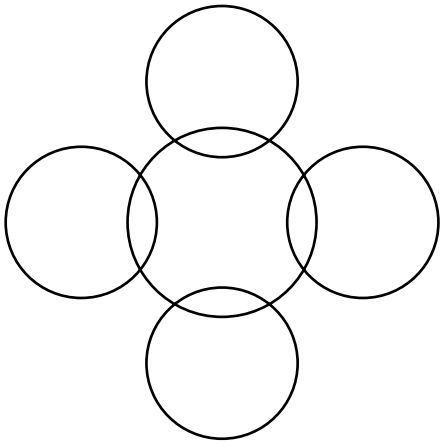
symbol	solid, liquid or gas at 25 °C
Cl	
Br	
I	

[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.

$$C l_2 \quad + \quad CH_4 \quad \rightarrow \quad CC l_4 \quad + \quad HC l$$ [1]

(iii) Fluorine and bromine also react with methane. Suggest which of the three 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.

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

(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 of 23 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 stations.

(i) The voltage of the electricity generated is increased by using transformers, for 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.

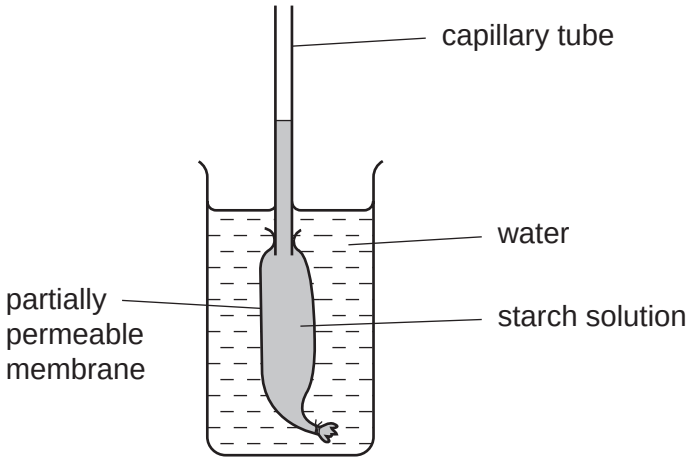


Fig. 5.1

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

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

.....

.....

.....

..... [3]

(ii) At the end of the experiment, the liquid outside the membrane was tested for 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.

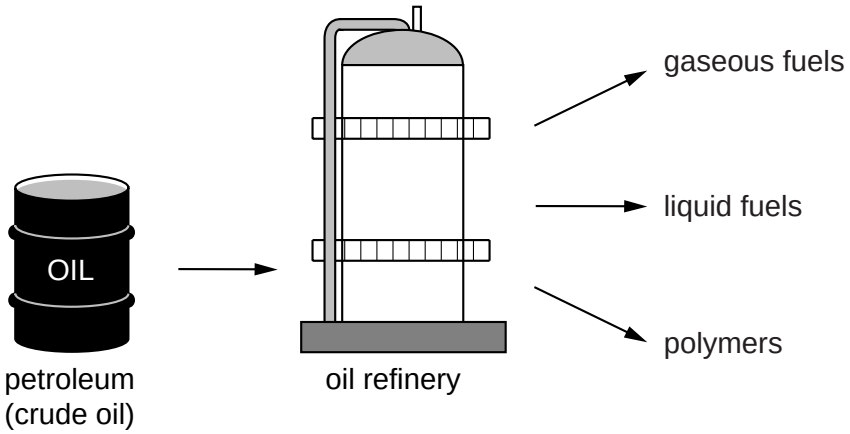
Describe the pathway that the water takes as it travels from the soil into the xylem vessels in the root.

.....

.....

..... [2]

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



(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 smaller ones, 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 into other sugars. These sugars can be used to make sweet foods such as cakes and chocolate.

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]

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.

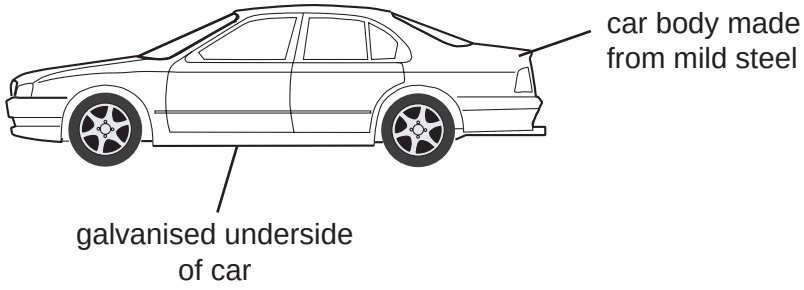


Fig. 8.1

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 of zinc. The zinc was in excess and eventually all of the acid had reacted.

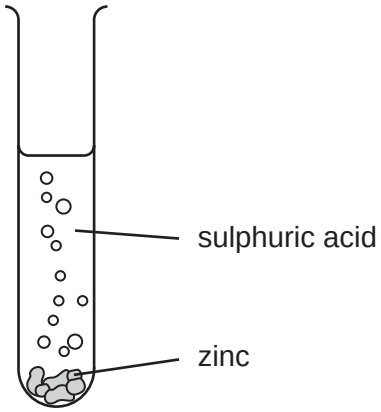


Fig. 8.2

(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.

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[3]

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

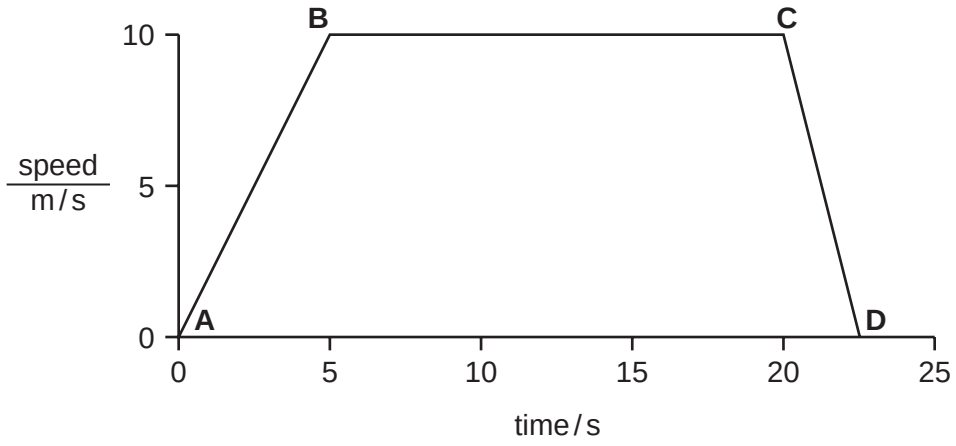

Fig. 9.1

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 this 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 centre of mass of each trophy is marked with an **X**.

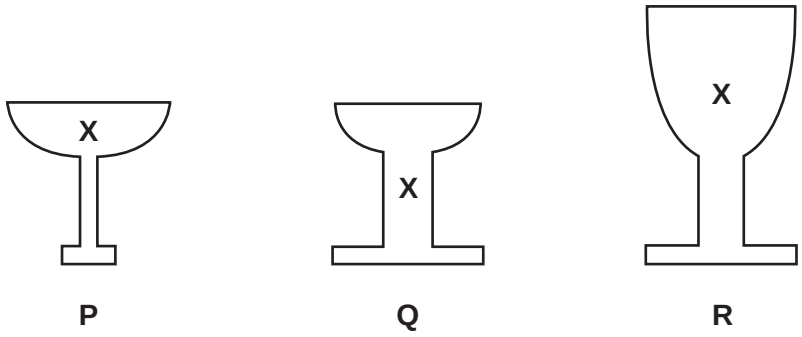

Fig. 9.2

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

.....

..... [2]

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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 Sulphur 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.).