UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CHEMISTRY **0620/33**

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

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.
You may use a pencil for any diagrams, graphs 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 12.

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	
Total	

This document consists of **12** printed pages.

For Examiner's Use

1 Choose an element from the list below which best fits the description.

Rb **Fe** **Si** **I** **P** **Sr**

(a) An element which reacts with cold water. ..... [1]

(b) It is a solid at room temperature and exists as diatomic molecules, X_2. ..... [1]

(c) It can form two oxides, XO and X_2O_3. ..... [1]

(d) This element has a hydride of the type XH_3. ..... [1]

(e) It has a macromolecular structure similar to that of carbon. ..... [1]

[Total: 5]

2 Tin is an element in Group IV.

(a) The position of tin in the reactivity series is:

zinc
iron
tin
copper

(i) For each of the following, decide if a reaction would occur. If there is a reaction, complete the equation, otherwise write 'no reaction'.

$Cu + Sn^{2+} \rightarrow$ .....

$Fe + Sn^{2+} \rightarrow$ .....

$Sn + Zn^{2+} \rightarrow$ ..... [4]

(ii) Name the **three** products formed when tin(II) nitrate is heated.

.....

..... [2]

(b) Aqueous tin(II) sulfate is electrolysed using carbon electrodes. This electrolysis is similar to that of aqueous copper(II) sulfate using carbon electrodes.

(i) What is the product at the negative electrode (cathode)?

..... [1]

(ii) Write the equation for the reaction at the positive electrode (anode).

..... [2]

(iii) Name the acid formed in this electrolysis.

..... [1]

For Examiner's Use

(c) Steel articles can be plated with tin or zinc to prevent rusting.
When the zinc layer is damaged exposing the underlying steel, it does not rust, but when the tin layer is broken the steel rusts. Explain.

.....

.....

..... [4]

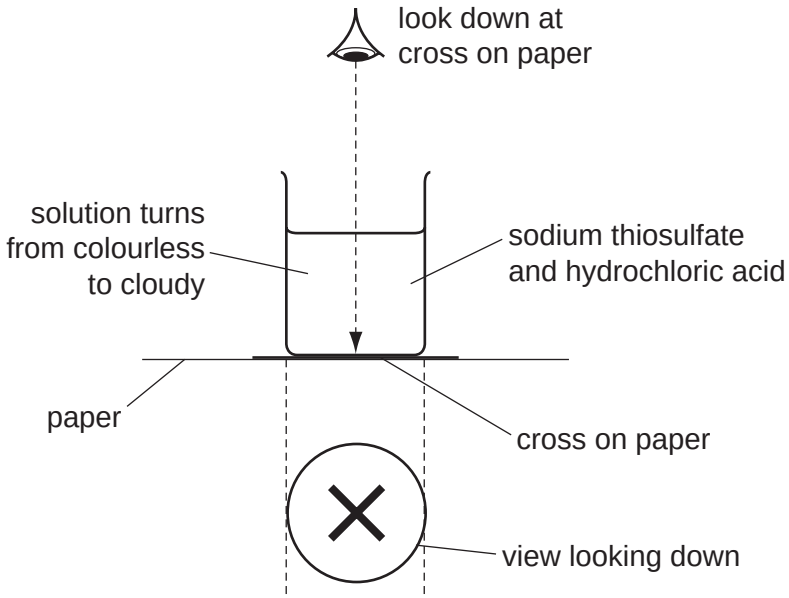
[Total: 14]

For Examiner's Use

3 The equation for the reaction between sodium thiosulfate and hydrochloric acid is given below.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + S(s) + SO_2(g) + H_2O(l)$$

The speed of this reaction was investigated using the following experiment. A beaker containing 50 cm^3 of 0.2 mol / dm^3 sodium thiosulfate was placed on a black cross. 5.0 cm^3 of 2.0 mol / dm^3 hydrochloric acid was added and the clock was started.



Initially the cross was clearly visible. When the solution became cloudy and the cross could no longer be seen, the clock was stopped and the time recorded.

(a) The experiment was repeated with 25 cm^3 of 0.2 mol / dm^3 sodium thiosulfate and 25 cm^3 of water. Typical results for this experiment and a further two experiments are given in the table.

experiment	1	2	3	4
volume of thiosulfate / cm^3	50	40	25	10
volume of water / cm^3	0	10	25	40
volume of acid / cm^3	5	5	5	5
total volume / cm^3	55	55	55	55
time / s	48	60	96	.....

(i) Explain why it is necessary to keep the total volume the same in all the experiments.

.....

.....

..... [2]

(ii) Complete the table. [1]

For Examiner's Use

(iii) How and why does the speed of the reaction vary from experiment 1 to 4?

.....

.....

..... [3]

(b) The idea of collisions between reacting particles is used to explain changes in the speed of reactions. Use this idea to explain the following results.

volume of sodium thiosulfate / cm^3	25	25
volume of water / cm^3	25	25
volume of acid / cm^3	5	5
temperature / °C	20	42
time / s	96	40

.....

.....

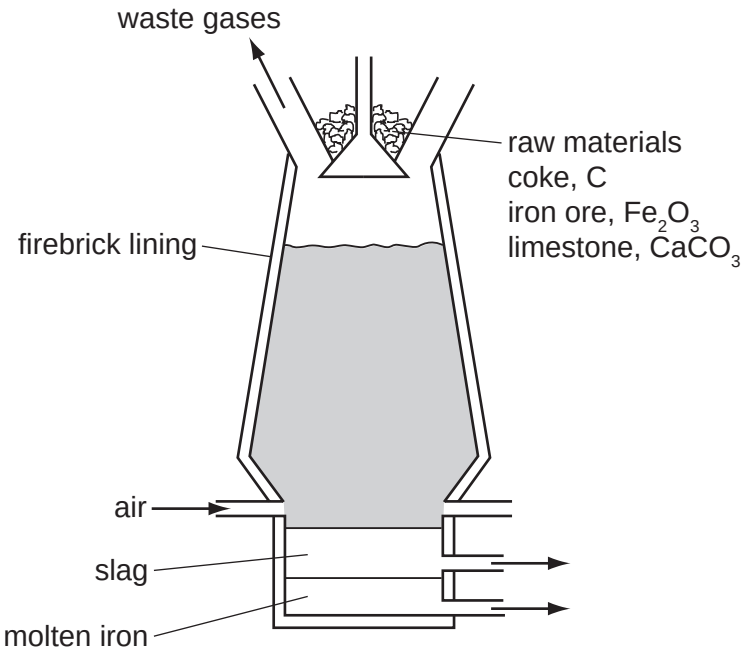
.....

..... [4]

[Total: 10]

For Examiner's Use

4 Iron is extracted from its ore, hematite, in the blast furnace.



Describe the reactions involved in this extraction. Include in your description an equation for a redox reaction and one for an acid / base reaction.

.....

.....

.....

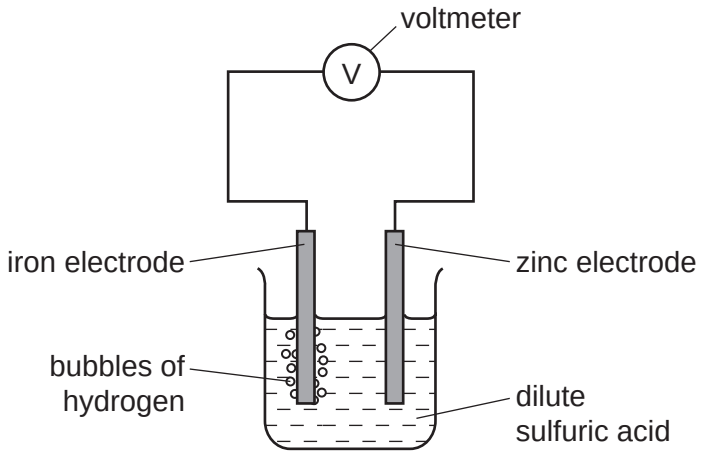
.....

..... [5]

[Total: 5]

For Examiner's Use

5 The diagram shows a simple cell.



(a) Write an equation for the overall reaction occurring in the cell.

..... [2]

(b) Explain why all cell reactions are exothermic and redox.

.....

.....

..... [3]

(c) Which electrode, zinc or iron, is the negative electrode? Give a reason for your choice.

.....

..... [2]

(d) Suggest **two** ways of increasing the voltage of this cell.

.....

..... [2]

[Total: 9]

For Examiner's Use

6 **(a)** Methanol can be made from a mixture of carbon monoxide and hydrogen.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

(i) Explain why the concentration of methanol at equilibrium does not change.

.....

..... [2]

(ii) Suggest conditions, in terms of temperature and pressure, which would give a high yield of methanol.

.....

..... [2]

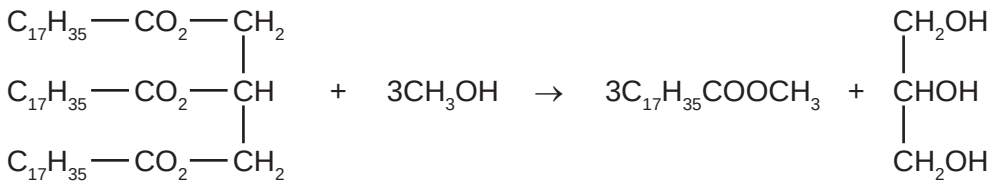
(iii) How would the conditions used in practice compare with those given in **(ii)**? Give an explanation of any differences.

.....

.....

..... [2]

(b) Biodiesel is made from a vegetable oil by the following reaction.



vegetable oil methanol biodiesel glycerol

(i) What type of compound are vegetable oil and biodiesel?

..... [1]

(ii) What other useful product is made from vegetable oil by heating it with aqueous sodium hydroxide?

..... [1]

(iii) Suggest an explanation why making and using biodiesel has a smaller effect on the percentage of carbon dioxide in the atmosphere than using petroleum-based diesel.

.....

.....

..... [2]

For Examiner's Use

(c) Petroleum-based diesel is a mixture of hydrocarbons, such as octane and octene.

(i) 'Oct' means eight carbon atoms per molecule. Draw a structural formula of an octene molecule.

[1]

(ii) Describe a test which would distinguish between octane and octene.

test .....

result with octane .....

result with octene ..... [3]

[Total: 14]

7 Chlorine reacts with phosphorus to form phosphorus trichloride.

(a) Draw a diagram showing the arrangement of the **valency** electrons in one molecule of the covalent compound, phosphorus trichloride.
Use x to represent an electron from a phosphorus atom.
Use o to represent an electron from a chlorine atom.

[2]

(b) Phosphorus trichloride reacts with water to form two acids.

(i) Balance the equation for this reaction.

$$PCl_3 + ...H_2O \rightarrow .....HCl + H_3PO_3$$

[1]

(ii) Describe how you could show that phosphorus acid, H_3PO_3, is a weaker acid than hydrochloric acid.

.....

.....

..... [3]

For Examiner's Use

(iii) Two salts of phosphorus acid are its sodium salt, which is soluble in water, and its calcium salt which is insoluble in water. Suggest a method of preparation for each of these salts from aqueous phosphorus acid. Specify any other reagent needed and briefly outline the method.

sodium salt .....

.....

.....

..... [2]

calcium salt .....

.....

.....

..... [2]

[Total: 10]

8 Hydrocarbons are compounds which contain only carbon and hydrogen.

(a) 20 cm^3 of a gaseous hydrocarbon was burned in 120 cm^3 of oxygen, which is in excess. After cooling, the volume of the gases remaining was 90 cm^3. Aqueous sodium hydroxide was added to remove carbon dioxide, 30 cm^3 of oxygen remained. All volumes were measured at r.t.p..

(i) Explain why it is essential to use excess oxygen.

.....

..... [2]

(ii) Carbon dioxide is slightly soluble in water. Why does it dissolve readily in the alkali, sodium hydroxide?

..... [1]

(iii) Complete the following.

volume of gaseous hydrocarbon = ...cm^3

volume of oxygen used = ...cm^3

volume of carbon dioxide formed = ...cm^3 [2]

(iv) Use the above volume ratio to find the mole ratio in the equation below and hence find the formula of the hydrocarbon.

$$\text{.....}C_xH_y(g) + \text{.....}O_2(g) \rightarrow \text{.....}CO_2(g) + \text{.....}H_2O(l)$$

hydrocarbon formula = ... [2]

For Examiner's Use

(b) Alkanes are hydrocarbons and are generally unreactive. Their reactions include combustion, substitution and cracking.

(i) Chlorine reacts with butane in a substitution reaction.

$$CH_3—CH_2—CH_2—CH_3 + Cl_2 \rightarrow CH_3—CH_2—CH_2—CH_2—Cl + HCl$$

Give the structural formula of another possible product of this reaction.

[1]

(ii) What is the essential condition for this reaction?

..... [1]

(iii) Explain what is meant by *cracking*. Give an example of a cracking reaction and explain why the process is used.

.....

.....

.....

.....

..... [4]

[Total: 13]

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: box with a (top), **X** (centre), b (bottom)
- 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.).