



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

CENTRE  
NUMBER

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**CHEMISTRY**

**0620/32**

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                  |  |
| <b>Total</b>       |  |

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



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<sub>2</sub>. .... [1]
- (c) It can form two oxides, XO and X<sub>2</sub>O<sub>3</sub>. .... [1]
- (d) This element has a hydride of the type XH<sub>3</sub>. .... [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'.



(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]

(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.

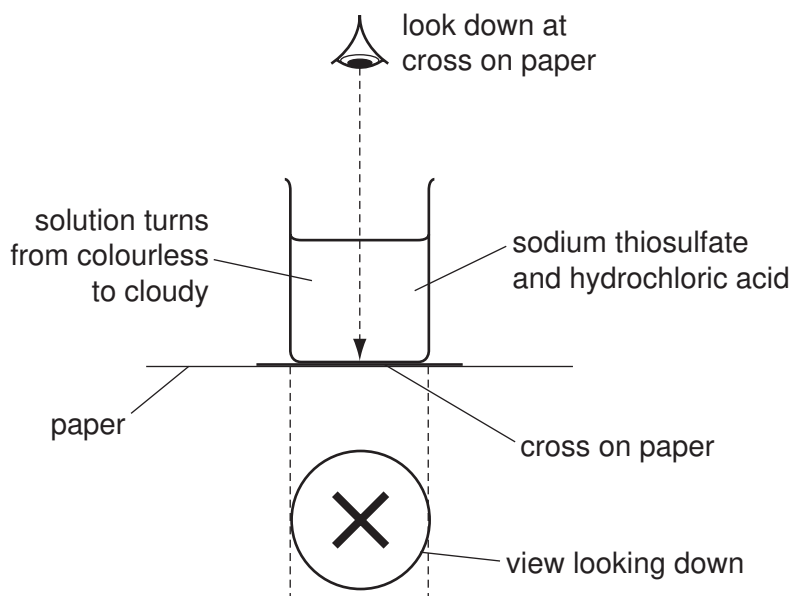
.....  
.....  
..... [4]

[Total: 14]

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



The speed of this reaction was investigated using the following experiment. A beaker containing 50 cm<sup>3</sup> of 0.2 mol/dm<sup>3</sup> sodium thiosulfate was placed on a black cross. 5.0 cm<sup>3</sup> of 2.0 mol/dm<sup>3</sup> 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<sup>3</sup> of 0.2 mol/dm<sup>3</sup> sodium thiosulfate and 25 cm<sup>3</sup> 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 <sup>3</sup> | 50 | 40 | 25 | 10    |
| volume of water / cm <sup>3</sup>       | 0  | 10 | 25 | 40    |
| volume of acid / cm <sup>3</sup>        | 5  | 5  | 5  | 5     |
| total volume / cm <sup>3</sup>          | 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]

(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 <sup>3</sup> | 25 | 25 |
| volume of water / cm <sup>3</sup>              | 25 | 25 |
| volume of acid / cm <sup>3</sup>               | 5  | 5  |
| temperature / °C                               | 20 | 42 |
| time / s                                       | 96 | 40 |

.....

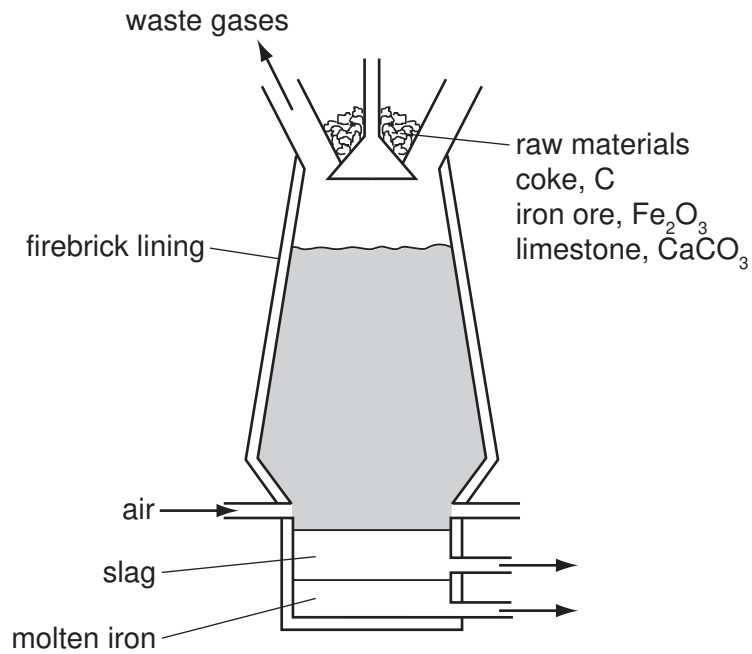
.....

.....

..... [4]

[Total: 10]

- 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.

.....

.....

.....

.....

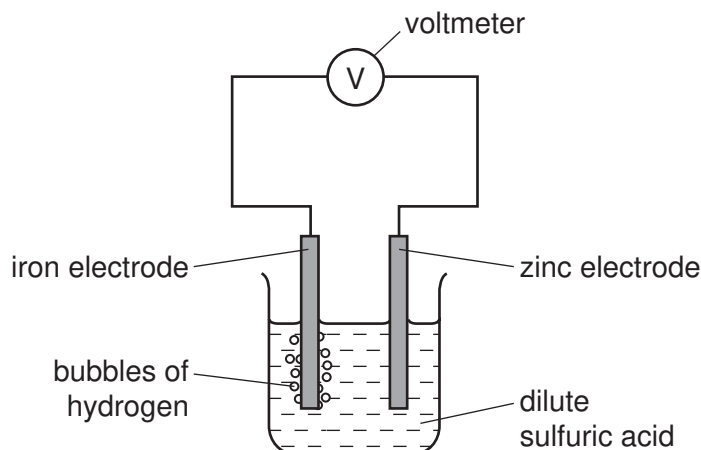
.....

..... [5]

[Total: 5]

5 The diagram shows a simple cell.

For  
Examiner's  
Use



(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.

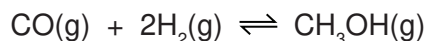
.....  
 ..... [2]

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

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

[Total: 9]

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



The forward reaction is exothermic.

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

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

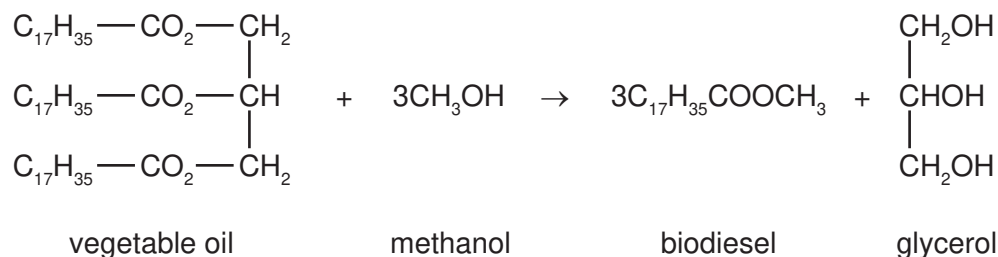
- (ii) Suggest conditions, in terms of temperature and pressure, which would give a high yield of methanol.

.....  
 ..... [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.



- (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]



(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.

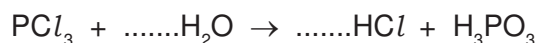
Use x to represent an electron from a phosphorus atom.

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.



[1]

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

.....

.....

..... [3]

- (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<sup>3</sup> of a gaseous hydrocarbon was burned in 120 cm<sup>3</sup> of oxygen, which is in excess. After cooling, the volume of the gases remaining was 90 cm<sup>3</sup>. Aqueous sodium hydroxide was added to remove carbon dioxide, 30 cm<sup>3</sup> 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]

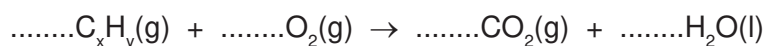
- (iii) Complete the following.

volume of gaseous hydrocarbon = .....cm<sup>3</sup>

volume of oxygen used = .....cm<sup>3</sup>

volume of carbon dioxide formed = .....cm<sup>3</sup> [2]

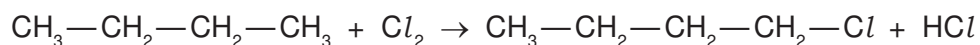
- (iv) Use the above volume ratio to find the mole ratio in the equation below and hence find the formula of the hydrocarbon.



hydrocarbon formula = ..... [2]

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

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



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<br><b>H</b><br>Hydrogen<br>1   |                                   |                                    |                                    |                                    |                                     |                                     |                                  |  |  |  | 4<br><b>He</b><br>Helium<br>2 |
| 7<br><b>Li</b><br>Lithium<br>3    | 9<br><b>Be</b><br>Beryllium<br>4   |                                     |                                    |                                    |                                     |                                     |                                     |                                   |                                     |                                  |                                   | 11<br><b>B</b><br>Boron<br>5       | 12<br><b>C</b><br>Carbon<br>6      | 14<br><b>N</b><br>Nitrogen<br>7    | 16<br><b>O</b><br>Oxygen<br>8       | 19<br><b>F</b><br>Fluorine<br>9     | 20<br><b>Ne</b><br>Neon<br>10    |  |  |  |                               |
| 23<br><b>Na</b><br>Sodium<br>11   | 24<br><b>Mg</b><br>Magnesium<br>12 |                                     |                                    |                                    |                                     |                                     |                                     |                                   |                                     |                                  |                                   | 27<br><b>Al</b><br>Aluminium<br>13 | 28<br><b>Si</b><br>Silicon<br>14   | 31<br><b>P</b><br>Phosphorus<br>15 | 32<br><b>S</b><br>Sulfur<br>16      | 35.5<br><b>Cl</b><br>Chlorine<br>17 | 40<br><b>Ar</b><br>Argon<br>18   |  |  |  |                               |
| 39<br><b>K</b><br>Potassium<br>19 | 40<br><b>Ca</b><br>Calcium<br>20   | 45<br><b>Sc</b><br>Scandium<br>21   | 48<br><b>Ti</b><br>Titanium<br>22  | 51<br><b>V</b><br>Vanadium<br>23   | 52<br><b>Cr</b><br>Chromium<br>24   | 55<br><b>Mn</b><br>Manganese<br>25  | 56<br><b>Fe</b><br>Iron<br>26       | 59<br><b>Co</b><br>Cobalt<br>27   | 59<br><b>Ni</b><br>Nickel<br>28     | 64<br><b>Cu</b><br>Copper<br>29  | 65<br><b>Zn</b><br>Zinc<br>30     | 70<br><b>Ga</b><br>Gallium<br>31   | 73<br><b>Ge</b><br>Germanium<br>32 | 75<br><b>As</b><br>Arsenic<br>33   | 79<br><b>Se</b><br>Selenium<br>34   | 80<br><b>Br</b><br>Bromine<br>35    | 84<br><b>Kr</b><br>Krypton<br>36 |  |  |  |                               |
| 85<br><b>Rb</b><br>Rubidium<br>37 | 88<br><b>Sr</b><br>Strontium<br>38 | 89<br><b>Y</b><br>Yttrium<br>39     | 91<br><b>Zr</b><br>Zirconium<br>40 | 93<br><b>Nb</b><br>Niobium<br>41   | 96<br><b>Mo</b><br>Molybdenum<br>42 | 96<br><b>Tc</b><br>Technetium<br>43 | 101<br><b>Ru</b><br>Ruthenium<br>44 | 103<br><b>Rh</b><br>Rhodium<br>45 | 106<br><b>Pd</b><br>Palladium<br>46 | 108<br><b>Ag</b><br>Silver<br>47 | 112<br><b>Cd</b><br>Cadmium<br>48 | 115<br><b>In</b><br>Indium<br>49   | 119<br><b>Sn</b><br>Tin<br>50      | 122<br><b>Sb</b><br>Antimony<br>51 | 128<br><b>Te</b><br>Tellurium<br>52 | 127<br><b>I</b><br>Iodine<br>53     | 131<br><b>Xe</b><br>Xenon<br>54  |  |  |  |                               |
| 133<br><b>Cs</b><br>Caesium<br>55 | 137<br><b>Ba</b><br>Barium<br>56   | 139<br><b>La</b><br>Lanthanum<br>57 | 178<br><b>Hf</b><br>Hafnium<br>72  | 181<br><b>Ta</b><br>Tantalum<br>73 | 184<br><b>W</b><br>Tungsten<br>74   | 186<br><b>Re</b><br>Rhenium<br>75   | 190<br><b>Os</b><br>Osmium<br>76    | 192<br><b>Ir</b><br>Iridium<br>77 | 195<br><b>Pt</b><br>Platinum<br>78  | 197<br><b>Au</b><br>Gold<br>79   | 201<br><b>Hg</b><br>Mercury<br>80 | 204<br><b>Tl</b><br>Thallium<br>81 | 207<br><b>Pb</b><br>Lead<br>82     | 209<br><b>Bi</b><br>Bismuth<br>83  | 210<br><b>Po</b><br>Polonium<br>84  | 210<br><b>At</b><br>Astatine<br>85  | 210<br><b>Rn</b><br>Radon<br>86  |  |  |  |                               |
| 87<br><b>Fr</b><br>Francium       | 226<br><b>Ra</b><br>Radium<br>88   | 227<br><b>Ac</b><br>Actinium<br>89  |                                    |                                    |                                     |                                     |                                     |                                   |                                     |                                  |                                   |                                    |                                    |                                    |                                     |                                     |                                  |  |  |  |                               |

\*58-71 Lanthanoid series

†90-103 Actinoid series

|          |                            |
|----------|----------------------------|
| a        | a = relative atomic mass   |
| <b>X</b> | X = atomic symbol          |
| b        | b = proton (atomic) number |

|                                   |  |                                     |                                      |                                     |                                     |                                      |                                     |                                       |                                       |                                    |  |                                     |                                       |
|-----------------------------------|--|-------------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|---------------------------------------|------------------------------------|--|-------------------------------------|---------------------------------------|
| 140<br><b>Ce</b><br>Cerium<br>58  | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 147<br><b>Pm</b><br>Promethium<br>61 | 150<br><b>Sm</b><br>Samarium<br>62  | 152<br><b>Eu</b><br>Europium<br>63  | 157<br><b>Gd</b><br>Gadolinium<br>64 | 159<br><b>Tb</b><br>Terbium<br>65   | 162<br><b>Dy</b><br>Dysprosium<br>66  | 165<br><b>Ho</b><br>Holmium<br>67     | 167<br><b>Er</b><br>Erbium<br>68   | 169<br><b>Tm</b><br>Thulium<br>69      | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71    |
| 232<br><b>Th</b><br>Thorium<br>90 | 232<br><b>Pa</b><br>Protactinium<br>91 | 238<br><b>U</b><br>Uranium<br>92    | 238<br><b>Np</b><br>Neptunium<br>93  | 244<br><b>Pu</b><br>Plutonium<br>94 | 247<br><b>Am</b><br>Americium<br>95 | 251<br><b>Cm</b><br>Curium<br>96     | 257<br><b>Bk</b><br>Berkelium<br>97 | 261<br><b>Cf</b><br>Californium<br>98 | 265<br><b>Es</b><br>Einsteinium<br>99 | 267<br><b>Fm</b><br>Fermium<br>100 | 268<br><b>Md</b><br>Mendelevium<br>101 | 269<br><b>No</b><br>Nobelium<br>102 | 277<br><b>Lr</b><br>Lawrencium<br>103 |

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

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