UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

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|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | | | | | | CANDIDATE NUMBER | | | | |

*1129003385*

**CHEMISTRY** **0620/31**

Paper 3 (Extended) **October/November 2012**

**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 | |
| Total | |

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


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**1** A list of techniques used to separate mixtures is given below.

filtration

diffusion

fractional distillation

simple distillation

crystallisation

chromatography

From this list, choose the most suitable technique to separate the following mixtures.
A technique may be used once, more than once or not at all.

**(a)** butane from a mixture of propane and butane ..... [1]

**(b)** oxygen from liquid air ..... [1]

**(c)** water from aqueous magnesium sulfate ..... [1]

**(d)** potassium chloride from aqueous potassium chloride ..... [1]

**(e)** silver chloride from a mixture of silver chloride and water ..... [1]

**(f)** glucose from a mixture of glucose and maltose ..... [1]

[Total: 6]

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**2** Three of the halogens in Group VII are listed below.

chlorine
bromine
iodine

**(a) (i)** How does their colour change down the Group?

..... [1]

**(ii)** How do their melting points and boiling points change down the Group?

..... [1]

**(iii)** Predict the colour and physical state (solid, liquid or gas) of astatine, At.

colour .....

physical state ..... [2]

**(b)** A radioactive isotope of iodine, $^{131}_{53}\mathrm{I}$, is used to treat cancer.

**(i)** Define the term *isotope*.

.....

..... [2]

**(ii)** How many protons, electrons and neutrons are there in one atom of $^{131}_{53}\mathrm{I}$?

number of protons .....

number of electrons .....

number of neutrons ..... [2]

**(iii)** When this isotope, $^{131}_{53}\mathrm{I}$, emits radiation, a different element with a proton number of 54 is formed.
What is the name of this element?

..... [1]

**(c)** Fluorine, the most reactive halogen, forms compounds with the other halogens. It forms two compounds with bromine.
Deduce their formulae from the following information.

compound 1
The mass of one mole of this compound is 137 g.

Its formula is ..... [1]

compound 2
0.02 moles of this compound contain 0.02 moles of bromine atoms and 0.1 moles of fluorine atoms.

Its formula is ..... [1]

[Total: 11]

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**[Turn over**

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**3** The speed (rate) of a chemical reaction depends on a number of factors which include temperature and the presence of a catalyst.

**(a)** Reaction speed increases as the temperature increases.

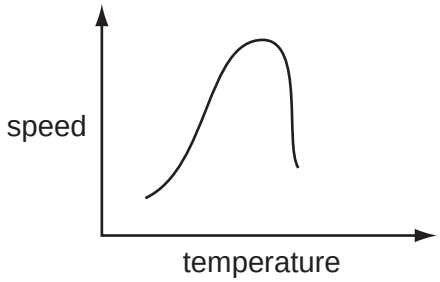
**(i)** Explain why reaction speed increases with temperature.

.....

.....

..... [3]

**(ii)** Reactions involving enzymes do not follow the above pattern.
The following graph shows how the speed of such a reaction varies with temperature.




Suggest an explanation why initially the reaction speed increases then above a certain temperature the speed decreases.

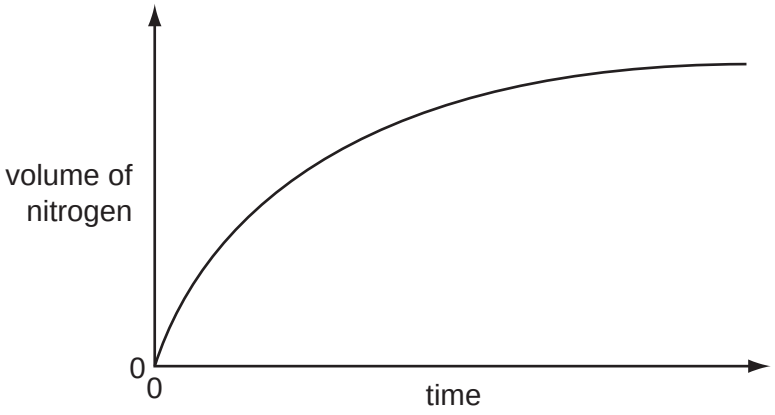
.....

..... [2]

**(b)** An organic compound decomposes to give off nitrogen.

$$C_6H_5N_2Cl(aq) \rightarrow C_6H_5Cl(l) + N_2(g)$$

The speed of this reaction can be determined by measuring the volume of nitrogen formed at regular intervals. Typical results are shown in the graph below.




**(i)** The reaction is catalysed by copper.
Sketch the graph for the catalysed reaction on the diagram above. [2]

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**(ii)** How does the speed of this reaction vary with time?

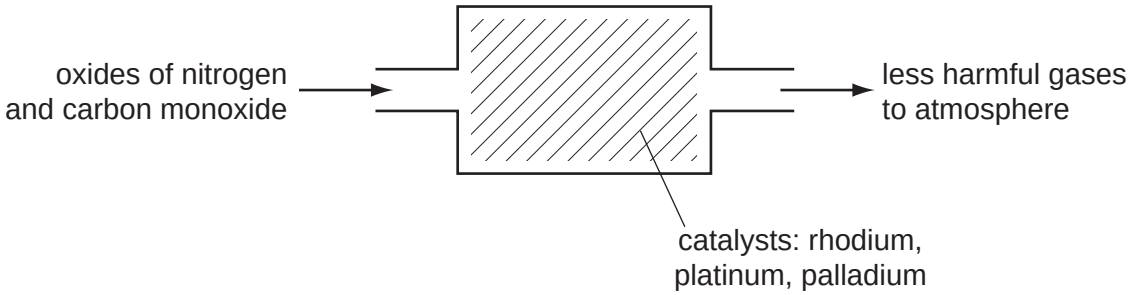
..... [1]

**(iii)** Why does the speed of reaction vary with time?

.....

..... [2]

**(c)** Catalytic converters reduce the pollution from motor vehicles.




**(i)** Describe how carbon monoxide and the oxides of nitrogen are formed in car engines.

.....

.....

.....

..... [4]

**(ii)** Describe the reaction(s) inside the catalytic converter which change these pollutants into less harmful gases. Include at least one equation in your description.

.....

.....

..... [3]

[Total: 17]

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[Turn over

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**4** Silicon(IV) oxide, $SiO_2$, and zirconium(IV) oxide, $ZrO_2$, are both macromolecules.
They have similar physical properties but silicon(IV) oxide is acidic and zirconium(IV) oxide is amphoteric.

**(a)** Define the term *macromolecule*.

.....

..... [1]

**(b) (i)** Predict **three** physical properties of these two oxides.

.....

.....

..... [3]

**(ii)** Name an element which has the same physical properties as these two oxides.

..... [1]

**(c) (i)** Name a reagent that reacts with the oxides of both elements.

..... [1]

**(ii)** Name a reagent that reacts with only one of the oxides.

reagent .....

oxide which reacts ..... [2]

[Total: 8]

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**5** Carbonyl chloride, $COCl_2$, is widely used in industry to make polymers, dyes and pharmaceuticals.

**(a)** Carbonyl chloride was first made in 1812 by exposing a mixture of carbon monoxide and chlorine to bright sunlight. This is a photochemical reaction.

$$CO(g) + Cl_2(g) \rightarrow COCl_2(g)$$

**(i)** Explain the phrase *photochemical reaction*.

.....

..... [2]

**(ii)** Give another example of a photochemical reaction and explain why it is important either to the environment or in industry.

.....

.....

..... [3]

**(b)** Carbonyl chloride is now made by the reversible reaction given below.

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$

The forward reaction is exothermic.
The reaction is catalysed by carbon within a temperature range of 50 to 150 °C.

**(i)** Predict the effect on the yield of carbonyl chloride of increasing the pressure. Explain your answer.

.....

..... [2]

**(ii)** If the temperature is allowed to increase to above 200 °C, very little carbonyl chloride is formed. Explain why.

.....

..... [2]

**(iii)** Explain why a catalyst is used.

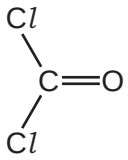
..... [1]

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**[Turn over**

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**(c)** The structural formula of carbonyl chloride is given below.




Draw a diagram showing the arrangement of the outer (valency) electrons in one molecule of this covalent compound.

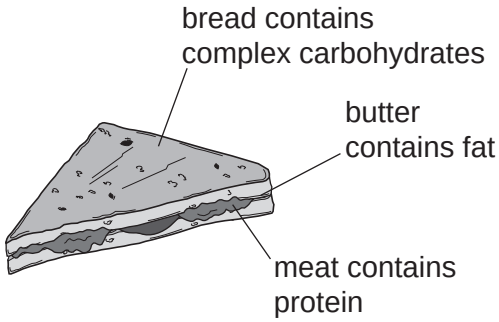
Use o to represent an electron from a carbon atom.
Use x to represent an electron from a chlorine atom.
Use ● to represent an electron from an oxygen atom.

[3]

[Total: 13]

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**6** A sandwich contains three of the main constituents of food.




**(a) (i)** These constituents of food can be hydrolysed by boiling with acid or alkali. Complete the table.

| constituent of food | product of hydrolysis |
|---|---|
| protein | |
| fat | |
| complex carbohydrate | |

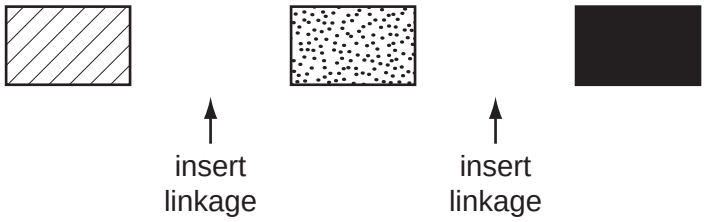
[3]

**(ii)** What type of synthetic polymer contains the same linkage as

fats, .....

proteins? ..... [2]

**(b)** An incomplete structural formula of a protein is given below.
Complete this diagram by inserting the linkages.




[2]

**(c)** Butter contains mainly saturated fats. Fats based on vegetable oils, such as olive oil, contain mainly unsaturated fats.

A small amount of fat was dissolved in an organic solvent.
Describe how you could determine if the fat was saturated or unsaturated.

.....

.....

..... [3]

[Total: 10]

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**7** Both strontium and sulfur have chlorides of the type $XCl_2$. The table below compares some of their properties.

| | strontium chloride | sulfur chloride |
|---|---|---|
| appearance | white crystals | red liquid |
| formula | $SrCl_2$ | $SCl_2$ |
| melting point / °C | 874 | –120 |
| boiling point / °C | 1250 | 59 |
| conductivity of liquid | good | poor |
| solubility in water | dissolves to form a neutral solution | reacts to form a solution of pH 1 |

**(a) (i)** Use the data in the table to explain why sulfur chloride is a liquid at room temperature, 25 °C.

.....

..... [2]

**(ii)** Strontium is a metal and sulfur is a non-metal. Explain why both have chlorides of the type $XCl_2$.
The electron distribution of a strontium atom is 2 + 8 + 18 + 8 + 2.

.....

.....

..... [2]

**(iii)** Deduce the name of the acidic compound formed when sulfur chloride reacts with water.

..... [1]

**(iv)** Explain the difference in the electrical conductivity of liquid strontium chloride and liquid sulfur chloride.

.....

.....

..... [3]

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**(b)** Strontium chloride-6-water can be made from the insoluble compound, strontium carbonate, by the following reactions.

$SrCO_3(s) + 2HCl(aq) \rightarrow SrCl_2(aq) + CO_2(g) + H_2O(l)$

$SrCl_2(aq) + 6H_2O(l) \rightarrow SrCl_2.6H_2O(s)$

The following method was used to prepare the crystals.

1 Add excess strontium carbonate to hot hydrochloric acid.
2 Filter the resulting mixture.
3 Partially evaporate the filtrate and allow to cool.
4 Filter off the crystals of $SrCl_2.6H_2O$.
5 Dry the crystals between filter papers.

**(i)** How would you know when excess strontium carbonate had been added in step 1?

.....

..... [1]

**(ii)** Why is it necessary to filter the mixture in step 2?

..... [1]

**(iii)** In step 3, why partially evaporate the filtrate rather than evaporate to dryness?

..... [1]

**(c)** In the above experiment, 50.0 $cm^3$ of hydrochloric acid of concentration 2.0 $mol/dm^3$ was used. 6.4 g of $SrCl_2.6H_2O$ was made.
Calculate the percentage yield.

number of moles of $HCl$ used = .....

number of moles of $SrCl_2.6H_2O$ which could be formed = .....

mass of one mole of $SrCl_2.6H_2O$ is 267 g

theoretical yield of $SrCl_2.6H_2O$ = .....g

percentage yield = .....% [4]

[Total: 15]

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**DATA SHEET**
**The Periodic Table of the Elements**

| | Group | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | | | | | | | | | III | IV | V | VI | VII | 0 |
| | | | | | | | | | | | | | | | | 4 **He** Helium 2 |
| | | | | | 1 **H** Hydrogen 1 | | | | | | | | | | | |
| | 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

| | |
|---|---|
| a | a = relative atomic mass |
| **X** | X = atomic symbol |
| b | b = proton (atomic) number |

The volume of one mole of any gas is 24 $dm^3$ at room temperature and pressure (r.t.p.).

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