



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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NUMBER

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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.



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]

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, $^{131}_{53}\text{I}$, is used to treat cancer.

(i) Define the term *isotope*.

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

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

number of protons

number of electrons

number of neutrons [2]

(iii) When this isotope, $^{131}_{53}\text{I}$, 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]

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

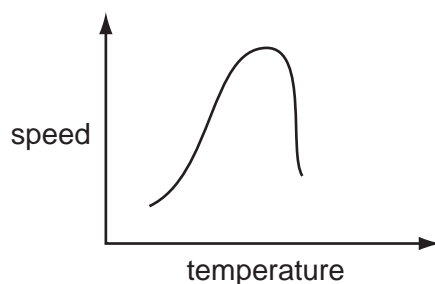
(a) Reaction speed increases as the temperature increases.

(i) Explain why reaction speed increases with temperature.

.....

 [3]

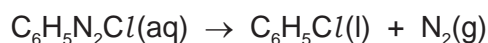
(ii) Reactions involving enzymes do not follow the above pattern. The following graph shows how the speed of such a reaction varies with temperature.



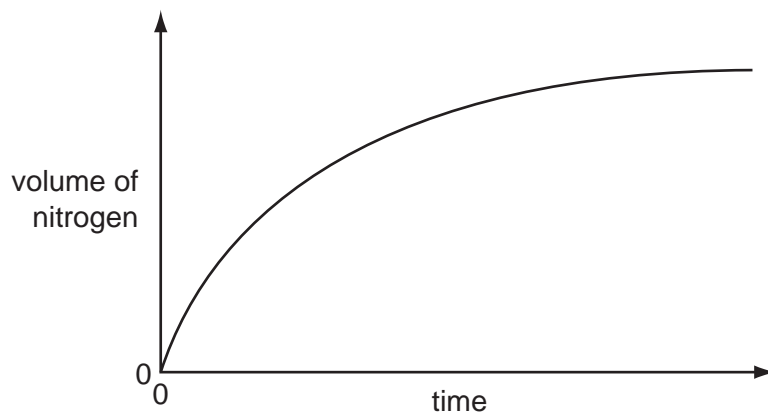
Suggest an explanation why initially the reaction speed increases then above a certain temperature the speed decreases.

.....
 [2]

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



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]

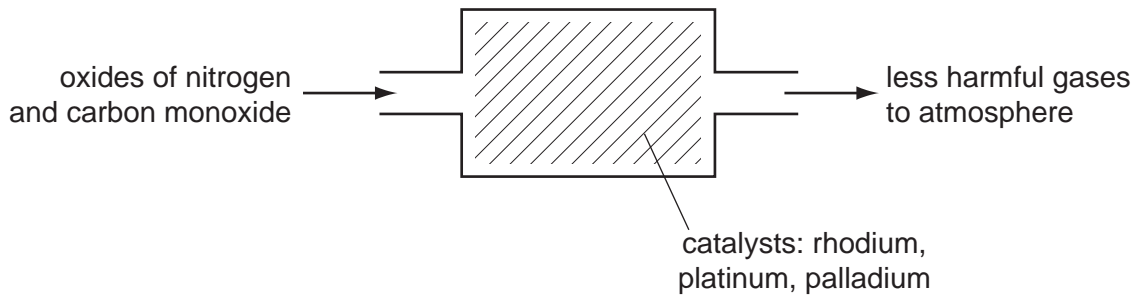
(ii) How does the speed of this reaction vary with time?

..... [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]

- 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.

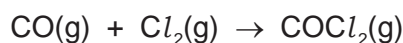
reagent

oxide which reacts [2]

[Total: 8]

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.



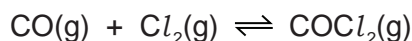
(i) Explain the phrase *photochemical reaction*.

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



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]

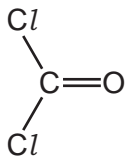
(ii) If the temperature is allowed to increase to above 200 °C, very little carbonyl chloride is formed. Explain why.

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

(iii) Explain why a catalyst is used.

..... [1]

(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.

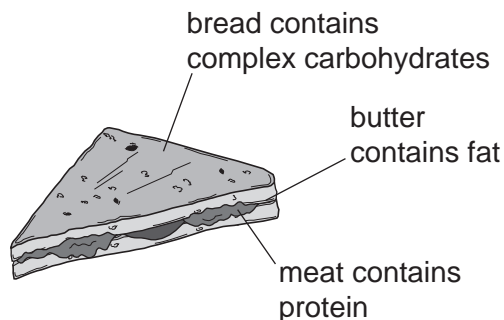
Use x to represent an electron from a chlorine atom.

Use • to represent an electron from an oxygen atom.

[3]

[Total: 13]

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]

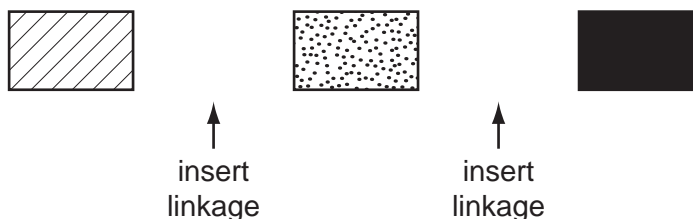
(ii) What type of synthetic polymer contains the same linkage as

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]

- 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/ $^{\circ}C$	874	-120
boiling point/ $^{\circ}C$	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, $25^{\circ}C$.

.....
 [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.

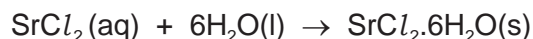
..... [1]

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

.....

 [3]

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



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 $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$.
- 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 $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ was made. Calculate the percentage yield.

number of moles of HCl used =

number of moles of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ which could be formed =

mass of one mole of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ is 267 g

theoretical yield of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ =g

percentage yield =%

[4]

[Total: 15]

DATA SHEET
The Periodic Table of the Elements

		Group																			
I	II	III	IV	V	VI	VII	0														
1 H Hydrogen 1												2 He Helium 2									
3 Li Lithium 7	4 Be Beryllium 9											5 B Boron 11									
11 Na Sodium 23	12 Mg Magnesium 24	13 Al Aluminium 27	14 Si Silicon 28	15 P Phosphorus 31	16 S Sulfur 32	17 Cl Chlorine 35.5	18 Ar Argon 40					19 F Fluorine 9	20 Ne Neon 10								
19 K Potassium 39	20 Ca Calcium 40	21 Sc Scandium 45	22 Ti Titanium 48	23 V Vanadium 51	24 Cr Chromium 52	25 Mn Manganese 55	26 Fe Iron 56	27 Co Cobalt 59	28 Ni Nickel 59	29 Cu Copper 64	30 Zn Zinc 65	31 Ga Gallium 70	32 Ge Germanium 73	33 As Arsenic 75	34 Se Selenium 79	35 Br Bromine 80	36 Kr Krypton 84				
37 Rb Rubidium 85	38 Sr Strontium 88	39 Y Yttrium 89	40 Zr Zirconium 91	41 Nb Niobium 93	42 Mo Molybdenum 96	43 Tc Technetium 99	44 Ru Ruthenium 101	45 Rh Rhodium 103	46 Pd Palladium 106	47 Ag Silver 108	48 Cd Cadmium 112	49 In Indium 115	50 Sn Tin 119	51 Sb Antimony 122	52 Te Tellurium 128	53 I Iodine 127	54 Xe Xenon 131				
55 Cs Caesium 133	56 Ba Barium 137	57 La Lanthanum 139	72 Hf Hafnium 178	73 Ta Tantalum 181	74 W Tungsten 184	75 Re Rhenium 186	76 Os Osmium 190	77 Ir Iridium 192	78 Pt Platinum 195	79 Au Gold 197	80 Hg Mercury 201	81 Tl Thallium 204	82 Pb Lead 207	83 Bi Bismuth 209	84 Po Polonium 209	85 At Astatine 210	86 Rn Radon 222				
87 Fr Francium 223	88 Ra Radium 226	89 Ac Actinium 227																			
<p>*58-71 Lanthanoid series †90-103 Actinoid series</p>																					
<table border="1"> <tr> <td>a</td> <td>X</td> </tr> <tr> <td>b</td> <td></td> </tr> </table> <p>Key a = relative atomic mass X = atomic symbol b = proton (atomic) number</p>		a	X	b		<p>The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).</p>															
a	X																				
b																					

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