



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.

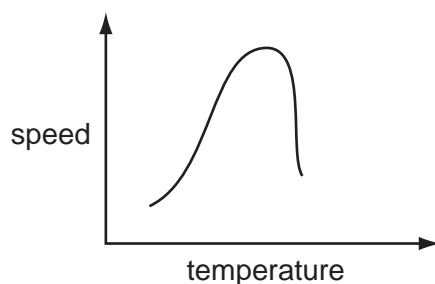
(a) Reaction speed increases as the temperature increases.

(i) Explain why reaction speed increases with temperature.

.....

 [3]

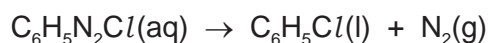
(ii) Reactions involving enzymes do not follow the above pattern. The following graph shows how the speed of such a reaction varies with temperature.



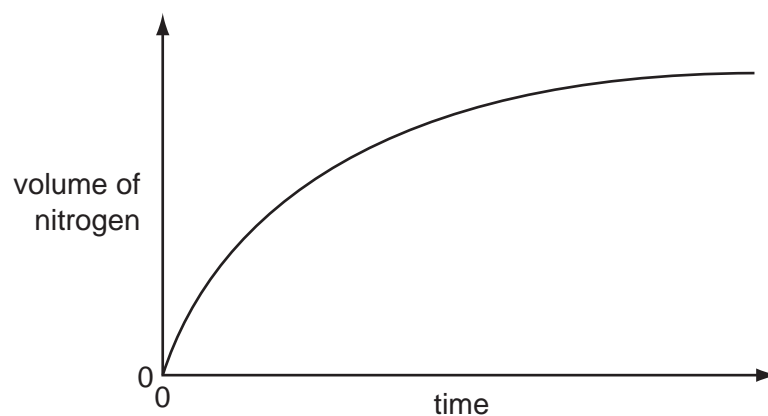
Suggest an explanation why initially the reaction speed increases then above a certain temperature the speed decreases.

.....
 [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]

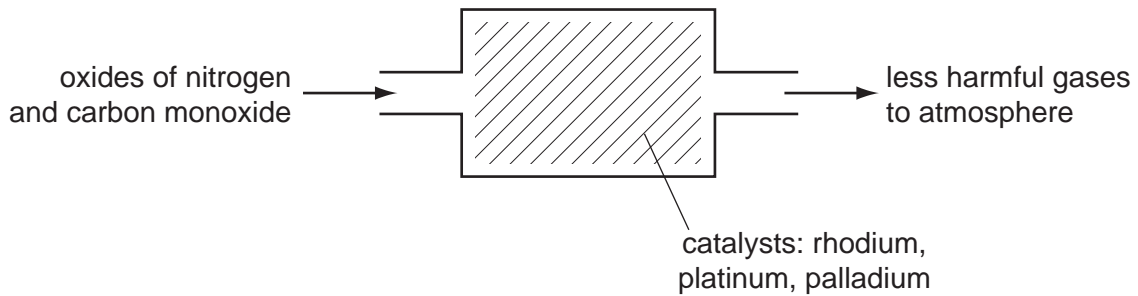
(ii) How does the speed of this reaction vary with time?

..... [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.

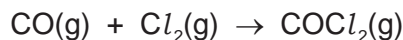
reagent

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.



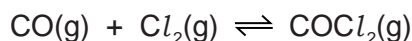
(i) Explain the phrase *photochemical reaction*.

.....
..... [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]

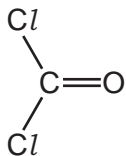
(ii) If the temperature is allowed to increase to above 200 °C, very little carbonyl chloride is formed. Explain why.

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

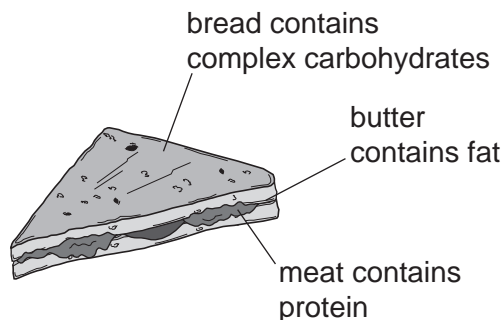
Use x to represent an electron from a chlorine atom.

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]

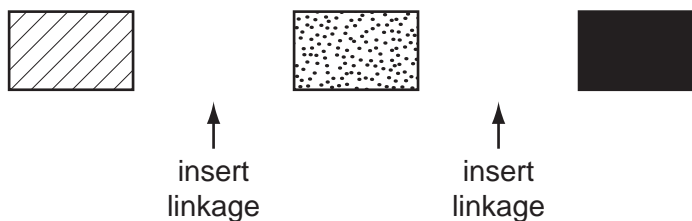
(ii) What type of synthetic polymer contains the same linkage as

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

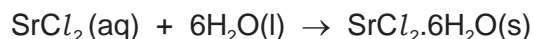
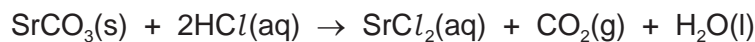
..... [1]

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

.....

 [3]

- (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																						
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10	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	4 He Helium 2														
39 K Potassium 19	40 Ca Calcium 20	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	91 Zr Zirconium 40	93 Nb Niobium 41	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	122 Sb Antimony 51	127 I Iodine 53	131 Xe Xenon 54			
133 Cs Caesium 55	137 Ba Barium 56	141 Pr Praseodymium 59	144 Nd Neodymium 60	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	181 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89	181 Ta Tantalum 73	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	212 Po Polonium 84	210 At Astatine 85	210 Rn Radon 86
232 Th Thorium 90	232 Pa Protactinium 91	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	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	232 Th Thorium 90	238 U Uranium 92	238 Np Neptunium 93	238 Pu Plutonium 94	238 Am Americium 95	238 Cm Curium 96	238 Bk Berkelium 97	238 Cf Californium 98	238 Es Einsteinium 99	238 Fm Fermium 100	238 Md Mendelevium 101	238 No Nobelium 102	238 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 dm³ at room temperature and pressure (r.t.p.).

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