



**Cambridge International Examinations**  
Cambridge International General Certificate of Secondary Education

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**CHEMISTRY**

**0620/33**

Paper 3 (Extended)

**October/November 2014**

**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 an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

A copy of the Periodic Table is printed on page 12.

You may lose marks if you do not show your working or if you do not use appropriate units.

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.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

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

1 For each of the following elements give **one** physical property and **one** chemical property.

(a) bromine (Br<sub>2</sub>)

physical property .....

chemical property .....

[2]

(b) carbon<sub>graphite</sub>(C)

physical property .....

chemical property .....

[2]

(c) manganese (Mn)

physical property .....

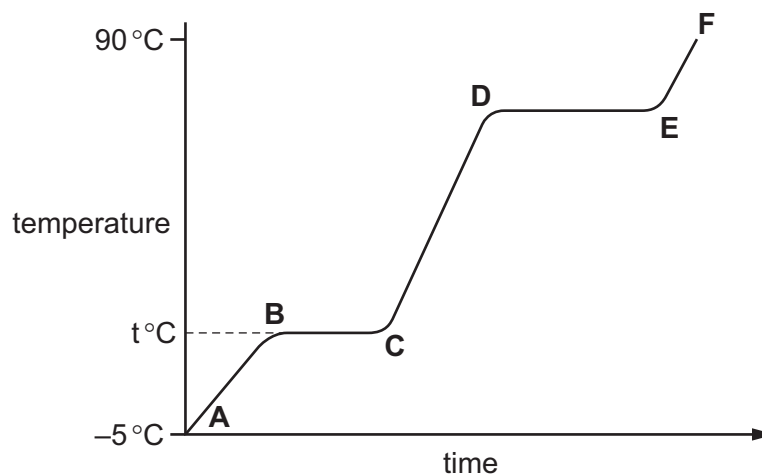
chemical property .....

[2]

[Total: 6]

2 Compound X is a colourless liquid at room temperature.

- (a) A sample of pure X was slowly heated from  $-5.0^{\circ}\text{C}$ , which is below its melting point, to  $90^{\circ}\text{C}$ , which is above its boiling point. Its temperature is measured every minute and the results are represented on the graph.



- (i) Complete the equation for the equilibrium present in the region **BC**.



- (ii) What is the significance of temperature  $t^{\circ}\text{C}$ ?

..... [1]

- (iii) What is the physical state of compound X in the region **EF**?

..... [1]

- (iv) What would be the difference in the region **BC** if an impure sample of X had been used?

..... [1]

(b) Compound X is a hydrocarbon. It contains 85.7% of carbon. The mass of one mole of X is 84 g.

- (i) What is the percentage of hydrogen in the compound ?

..... [1]

- (ii) Calculate the empirical formula of X. Show your working.

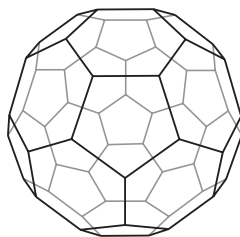
empirical formula = ..... [3]

- (iii) What is the molecular formula of compound X?

..... [1]

[Total: 9]

- 3 In 1985 the fullerenes were discovered. They are solid forms of the element carbon. The structure of the C<sub>60</sub> fullerene is given below.



(a) (i) In the C<sub>60</sub> fullerene, how many other carbon atoms is each carbon atom bonded to?  
 ..... [1]

(ii) Another fullerene has a relative molecular mass of 840.  
 How many carbon atoms are there in one molecule of this fullerene?  
 ..... [1]

(b) Fullerenes are soluble in liquid hydrocarbons such as octane. The other solid forms of carbon are insoluble.  
 Describe how you could obtain crystals of fullerenes from soot which is a mixture of fullerenes and other solid forms of carbon.  
 .....  
 .....  
 .....  
 ..... [3]

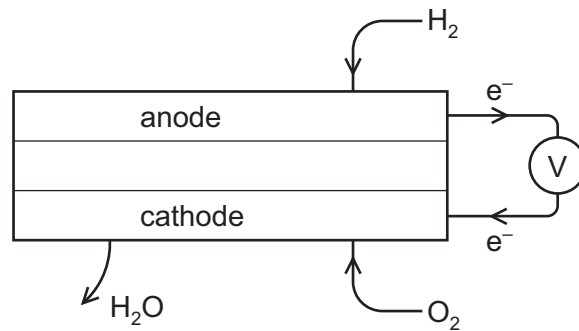
(c) A mixture of a fullerene and potassium is an excellent conductor of electricity.  
 (i) Which other form of solid carbon is a good conductor of electricity?  
 ..... [1]

(ii) Explain why metals, such as potassium, are good conductors of electricity.  
 .....  
 ..... [2]

(iii) The mixture of fullerene and potassium has to be stored out of contact with air. There are substances in unpolluted air which will react with potassium.  
 Name **two** potassium compounds which could be formed when potassium is exposed to air.  
 ..... [2]

[Total: 10]

- 4 A fuel cell produces electrical energy by the oxidation of a fuel by oxygen. The fuel is usually hydrogen but methane and methanol are two other fuels which may be used. A diagram of a hydrogen fuel cell is given below.



- (a) When the fuel is hydrogen, the only product is water. What additional product would be formed if methane was used?

..... [1]

- (b) Write the equation for the chemical reaction that takes place in a hydrogen fuel cell.

..... [1]

- (c) (i) At which electrode does oxidation occur? Explain your choice.

..... [1]

- (ii) Write an ionic equation for the reaction at this electrode.

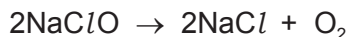
..... [2]

- (d) Fuel cells are used to propel cars. Give **two** advantages of a fuel cell over a gasoline-fuelled engine.

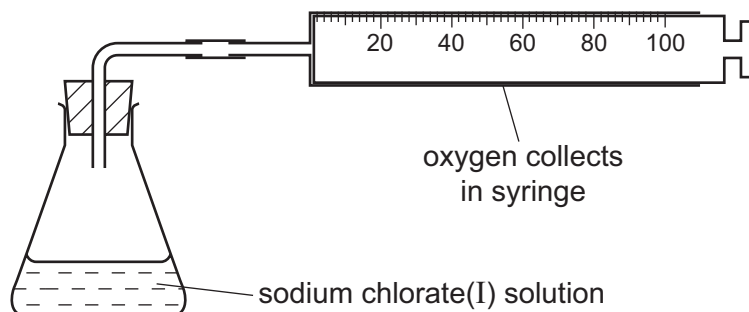
.....  
 ..... [2]

[Total: 7]

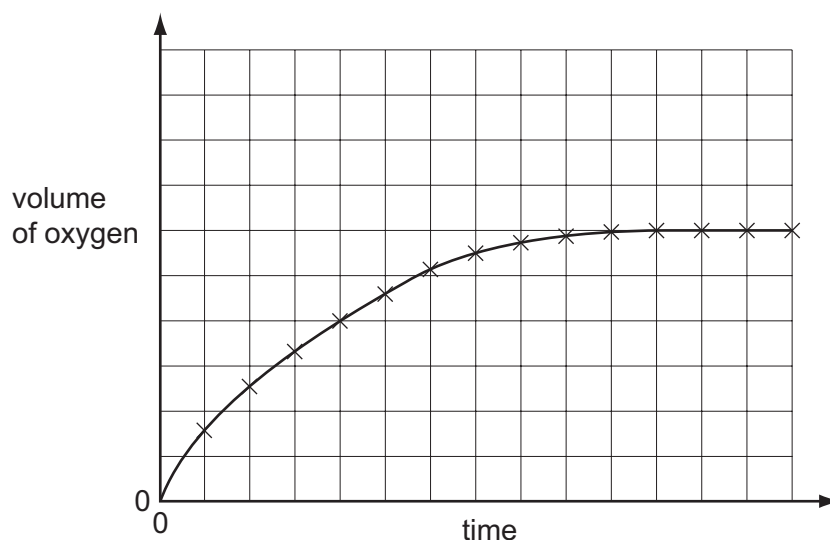
- 5 (a) Sodium chlorate(I) decomposes to form sodium chloride and oxygen. The rate of this reaction is very slow at room temperature provided the sodium chlorate(I) is stored in a dark bottle to prevent exposure to light.



The rate of this decomposition can be studied using the following experiment.



Sodium chlorate(I) is placed in the flask and 0.2 g of copper(II) oxide is added. This catalyses the decomposition of the sodium chlorate(I) and the volume of oxygen collected is measured every minute. The results are plotted to give a graph of the type shown below.



- (i) Explain why the gradient (slope) of this graph decreases with time.

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

- (ii) Cobalt(II) oxide is a more efficient catalyst for this reaction than copper(II) oxide. Sketch, on the grid, the graph for the reaction catalysed by cobalt(II) oxide. All other conditions were kept constant. [2]

(iii) What can you deduce from the comment that sodium chlorate(I) has to be shielded from light?

.....  
..... [1]

(iv) Explain, in terms of collisions between particles, why the initial gradient would be steeper if the experiment was repeated at a higher temperature.

.....  
.....  
.....  
..... [3]

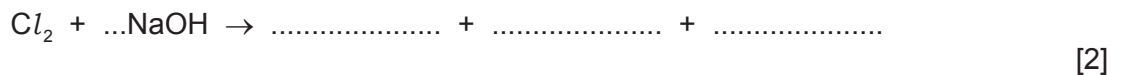
(b) The ions present in aqueous sodium chloride are Na<sup>+</sup>(aq), Cl<sup>-</sup>(aq), H<sup>+</sup>(aq) and OH<sup>-</sup>(aq).

The electrolysis of concentrated aqueous sodium chloride forms three products. They are hydrogen, chlorine and sodium hydroxide.

(i) Explain how these **three** products are formed. Give ionic equations for the reactions at the electrodes.

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

(ii) If the solution of the electrolyte is stirred, chlorine reacts with sodium hydroxide to form sodium chlorate(I), sodium chloride and water. Write an equation for this reaction.



[Total: 14]

**6** Rubidium and strontium are very reactive metals at the top of the reactivity series. Because their ions have different charges, their compounds behave differently when heated.

**(a)** The formulae of the ions of these two elements are  $\text{Rb}^+$  and  $\text{Sr}^{2+}$ .

Explain why these metals, which are in different groups, form ions which have different charges.

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

**(b)** Strontium carbonate is similar to calcium carbonate. It is insoluble in water and it decomposes when heated. Rubidium carbonate is soluble in water and does not decompose when heated.

**(i)** Describe a method to prepare a pure sample of the insoluble salt, strontium carbonate, by precipitation.

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

**(ii)** Complete the equation for the decomposition of strontium carbonate.



**(c)** Metal nitrates decompose when heated.

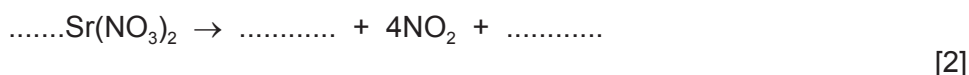
**(i)** Rubidium nitrate decomposes as follows:



What is the name of the compound  $\text{RbNO}_2$ ?

..... [1]

**(ii)** The nitrates of most other metals decompose in a different way. Complete the equation for the decomposition of strontium nitrate.



[Total: 10]



- 7 Butane is oxidised to a mixture of carboxylic acids by oxygen in the presence of a catalyst. The acids formed are methanoic acid, ethanoic acid and propanoic acid – the first three members of the carboxylic acid homologous series.

(a) (i) Give the name and structural formula of the fourth member of this series.

name .....

structural formula showing all the atoms and bonds

[3]

(ii) State **three** characteristics of a homologous series.

.....

.....

..... [3]

(iii) All members of this series are weak acids.

What is meant by the term *weak acid*?

.....

.....

..... [3]

(b) Carboxylic acids react with alcohols to form esters. Ethanol reacts with ethanoic acid to form the ester ethyl ethanoate,  $\text{CH}_3\text{COOCH}_2\text{CH}_3$ .

(i) Give the name and formula of the ester which is formed from methanol and propanoic acid.

name .....

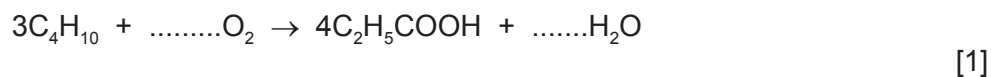
formula .....

[2]

(ii) What is the name of the ester which has the formula  $\text{CH}_3\text{COOCH}_3$ ?

..... [1]

(c) (i) Complete the equation for the oxidation of butane to propanoic acid.



(ii) Name **another** compound which can be oxidised to propanoic acid.

..... [1]

[Total: 14]

- 8 (a) Describe how cobalt chloride paper can be used to test for the presence of water.

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

- (b) Complete the description of the preparation of crystals of the soluble salt, cobalt(II) chloride-6-water,  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ , from the insoluble base, cobalt(II) carbonate.



50 cm<sup>3</sup> of dilute hydrochloric acid, concentration 2.2 mol/dm<sup>3</sup>, was heated and cobalt(II) carbonate was added in small amounts until .....

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

- (c) 6.31 g of cobalt(II) chloride-6-water crystals were obtained. Calculate the percentage yield to 1 decimal place.

number of moles of HCl in 50 cm<sup>3</sup> of acid, concentration 2.2 mol/dm<sup>3</sup> = .....

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

mass of 1 mole of  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  = 238 g

maximum yield of  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  = ..... g

percentage yield = .....%

[4]

[Total: 10]

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

		Group																																																																		
I	II	III	IV	V	VI	VII	0																																																													
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4	1 <b>H</b> Hydrogen 1	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	13 <b>Al</b> Aluminium 13	14 <b>N</b> Nitrogen 7	15 <b>O</b> Oxygen 8	16 <b>F</b> Fluorine 9	17 <b>Ne</b> Neon 10	18 <b>Ar</b> Argon 18	19 <b>K</b> Potassium 19	20 <b>Ca</b> Calcium 20	21 <b>Sc</b> Scandium 21	22 <b>Ti</b> Titanium 22	23 <b>V</b> Vanadium 23	24 <b>Cr</b> Chromium 24	25 <b>Mn</b> Manganese 25	26 <b>Fe</b> Iron 26	27 <b>Co</b> Cobalt 27	28 <b>Ni</b> Nickel 28	29 <b>Cu</b> Copper 29	30 <b>Zn</b> Zinc 30	31 <b>Ga</b> Gallium 31	32 <b>Ge</b> Germanium 32	33 <b>As</b> Arsenic 33	34 <b>Se</b> Selenium 34	35 <b>Br</b> Bromine 35	36 <b>Kr</b> Krypton 36	37 <b>Rb</b> Rubidium 37	38 <b>Sr</b> Strontium 38	39 <b>Y</b> Yttrium 39	40 <b>Zr</b> Zirconium 40	41 <b>Nb</b> Niobium 41	42 <b>Mo</b> Molybdenum 42	43 <b>Tc</b> Technetium 43	44 <b>Ru</b> Ruthenium 44	45 <b>Rh</b> Rhodium 45	46 <b>Pd</b> Palladium 46	47 <b>Ag</b> Silver 47	48 <b>Cd</b> Cadmium 48	49 <b>In</b> Indium 49	50 <b>Sn</b> Tin 50	51 <b>Sb</b> Antimony 51	52 <b>Te</b> Tellurium 52	53 <b>I</b> Iodine 53	54 <b>Xe</b> Xenon 54	55 <b>Cs</b> Caesium 55	56 <b>Ba</b> Barium 56	57 <b>La</b> Lanthanum 57	72 <b>Hf</b> Hafnium 72	73 <b>Ta</b> Tantalum 73	74 <b>W</b> Tungsten 74	75 <b>Re</b> Rhenium 75	76 <b>Os</b> Osmium 76	77 <b>Ir</b> Iridium 77	78 <b>Pt</b> Platinum 78	79 <b>Au</b> Gold 79	80 <b>Hg</b> Mercury 80	81 <b>Tl</b> Thallium 81	82 <b>Pb</b> Lead 82	83 <b>Bi</b> Bismuth 83	84 <b>Po</b> Polonium 84	85 <b>At</b> Astatine 85	86 <b>Rn</b> Radon 86	87 <b>Fr</b> Francium 87	88 <b>Ra</b> Radium 88	89 <b>Ac</b> Actinium 89	†
												140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	159 <b>Tb</b> Terbium 65	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71	232 <b>Th</b> Thorium 90	238 <b>U</b> Uranium 92	91 <b>Pa</b> Protactinium 91	93 <b>Np</b> Neptunium 93	94 <b>Pu</b> Plutonium 94	95 <b>Am</b> Americium 95	96 <b>Cm</b> Curium 96	97 <b>Bk</b> Berkelium 97	98 <b>Cf</b> Californium 98	99 <b>Es</b> Einsteinium 99	100 <b>Fm</b> Fermium 100	101 <b>Md</b> Mendelevium 101	102 <b>No</b> Nobelium 102	103 <b>Lr</b> Lawrencium 103																														

\*58-71 Lanthanoid series  
†90-103 Actinoid series

Key  

a	<b>X</b>
b	

 a = relative atomic mass  
 x = atomic symbol  
 b = proton (atomic) number

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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