



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

CENTRE  
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**CHEMISTRY**

**0620/32**

Paper 3 (Extended)

**October/November 2013**

**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.

Electronic calculators may be used.

A copy of the Periodic Table is printed on page 16.

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.

This document consists of **14** printed pages and **2** blank pages.



- 1 The table gives the melting points, the boiling points and the electrical properties of six substances A to F.

substance	melting point /°C	boiling point /°C	electrical conductivity as a solid	electrical conductivity as a liquid
A	-210	-196	does not conduct	does not conduct
B	777	1627	does not conduct	good conductor
C	962	2212	good conductor	good conductor
D	-94	63	does not conduct	does not conduct
E	1410	2355	does not conduct	does not conduct
F	1064	2807	good conductor	good conductor

- (a) Which **two** substances could be metals? ..... [1]
- (b) Which substance could be nitrogen? ..... [1]
- (c) Which substance is an ionic solid? ..... [1]
- (d) Which substance is a liquid at room temperature? ..... [1]
- (e) Which substance has a giant covalent structure similar to that of diamond? ..... [1]
- (f) Which **two** substances could exist as simple covalent molecules? ..... [1]

[Total: 6]

2 The halogens are a collection of diatomic non-metals in Group VII.

(a) (i) Define the term *diatomic*.

..... [1]

(ii) What do the electron distributions of the halogens have in common?

..... [1]

(iii) How do their electron distributions differ?

..... [1]

(iv) Complete the table.

halogen	solid, liquid or gas at room temperature	colour
chlorine	.....	.....
bromine	.....	.....
iodine	.....	.....

[2]

(b) The halogens react with other non-metals to form covalent compounds.  
Draw a diagram which shows the arrangement of the valency electrons in one molecule of the covalent compound arsenic trifluoride.

The electron distribution of an arsenic atom is  $2 + 8 + 18 + 5$ .

Use x to represent an electron from an arsenic atom.

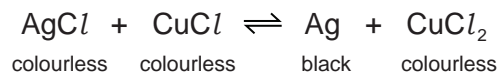
Use o to represent an electron from a fluorine atom.

[3]

- (c) Photochromic glass is used in sunglasses. In bright light, the glass darkens reducing the amount of light reaching the eye. When the light is less bright, the glass becomes colourless increasing the amount of light reaching the eye.

Photochromic glass contains very small amounts of the halides silver(I) chloride and copper(I) chloride.

The reaction between these two chlorides is photochemical.



How does photochromic glass work?

.....

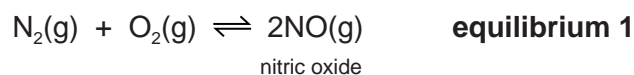
.....

..... [3]

[Total: 11]

- 3 (a) Nitric acid is now made by the oxidation of ammonia. It used to be made from air and water. This process used very large amounts of electricity.

Air was blown through an electric arc and heated to 3000 °C.



The equilibrium mixture leaving the arc contained 5% of nitric oxide. This mixture was cooled rapidly. At lower temperatures, nitric oxide will react with oxygen to form nitrogen dioxide.



Nitrogen dioxide reacts with oxygen and water to form nitric acid.

- (i) Suggest a reason why the yield of nitric oxide in **equilibrium 1** increases with temperature.

..... [1]

- (ii) What effect, if any, would increasing the pressure have on the percentage of nitric oxide in **equilibrium 1**? Explain your answer.

.....

..... [2]

- (iii) Deduce why **equilibrium 2** is only carried out at lower temperatures.

.....

..... [2]

- (iv) Complete the equation for the reaction between nitrogen dioxide, water and oxygen to form nitric acid.

.....NO<sub>2</sub> + O<sub>2</sub> + ..... → .....HNO<sub>3</sub> [2]

- (v) Ammonia is more expensive than water and air. Suggest a reason why the ammonia-based process is preferred to the electric arc process.

..... [1]

**(b) (i)** Nitric acid is used to make the fertiliser ammonium nitrate,  $\text{NH}_4\text{NO}_3$ .  
What advantage has this fertiliser over another common fertiliser, ammonium sulfate,  
 $(\text{NH}_4)_2\text{SO}_4$ ?

..... [1]

**(ii)** Plants need nitrogen to make chlorophyll. Explain why chlorophyll is essential for  
plant growth.

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

[Total: 13]

4 For centuries, iron has been extracted from its ore in the blast furnace. The world production of pig iron is measured in hundreds of million tonnes annually.

(a) The following raw materials are supplied to a modern blast furnace.

- iron ore which is hematite,  $\text{Fe}_2\text{O}_3$
- limestone which is calcium carbonate
- carbon in the form of coke
- air

Describe the essential reactions in the blast furnace. Each of the four raw materials must be mentioned at least once. Give the equation for the reduction of hematite.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

(b) Each year, blast furnaces discharge millions of tonnes of carbon dioxide into the atmosphere. This will increase the percentage of atmospheric carbon dioxide.

(i) Explain why this increased percentage of carbon dioxide may cause problems in the future.

.....

..... [2]

(ii) Until the early eighteenth century, charcoal, not coke, was used in the blast furnace. Charcoal is made from wood but coke is made from coal. Explain why the use of charcoal would have a smaller effect on the level of atmospheric carbon dioxide.

.....

.....

..... [2]

- (iii) A method being developed to produce iron with lower emissions of carbon dioxide is by electrolysis. Hematite,  $\text{Fe}_2\text{O}_3$ , is dissolved in molten lithium carbonate and electrolysed. The ore is spilt into its constituent elements.

Write an equation for the reaction at the negative electrode (cathode).

.....

Complete the equation for the reaction at the positive electrode (anode).

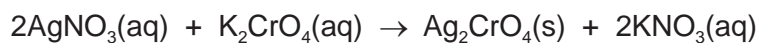
..... $\text{O}^{2-}$   $\rightarrow$  ..... + .....

[3]

[Total: 13]



- 5 Silver(I) chromate(VI) is an insoluble salt. It is prepared by precipitation. 20 cm<sup>3</sup> of aqueous silver(I) nitrate, concentration 0.2 mol/dm<sup>3</sup>, was mixed with 20 cm<sup>3</sup> of aqueous potassium chromate(VI), concentration 0.1 mol/dm<sup>3</sup>. After stirring, the mixture was filtered. The precipitate was washed several times with distilled water. The precipitate was then left in a warm oven for several hours.



- (a) What difficulty arises if the name of a compound of a transition element does not include its oxidation state, for example iron oxide?

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

- (b) These questions refer to the preparation of the salt.

- (i) Why is it necessary to filter the mixture after mixing and stirring?

..... [1]

- (ii) What is the purpose of washing the precipitate?

..... [1]

- (iii) Why leave the precipitate in a warm oven?

..... [1]

- (c) (i) Explain why the concentrations of silver(I) nitrate and potassium chromate(VI) are different.

..... [1]

- (ii) What mass of silver(I) nitrate is needed to prepare 100 cm<sup>3</sup> of silver(I) nitrate solution, concentration 0.2 mol/dm<sup>3</sup>?

The mass of one mole of AgNO<sub>3</sub> is 170 g.

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

- (iii) What is the maximum mass of silver(I) chromate(VI) which could be obtained from 20 cm<sup>3</sup> of aqueous silver(I) nitrate, concentration 0.2 mol/dm<sup>3</sup>?

number of moles of AgNO<sub>3</sub> used = ..... [1]

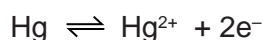
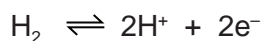
number of moles of Ag<sub>2</sub>CrO<sub>4</sub> formed = ..... [1]

mass of one mole of Ag<sub>2</sub>CrO<sub>4</sub> = 332 g

mass of Ag<sub>2</sub>CrO<sub>4</sub> formed = ..... g [1]

[Total: 11]

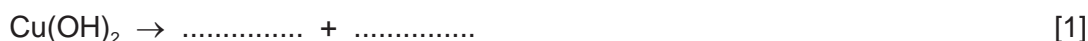
- 6 The following reactivity series shows both familiar and unfamiliar elements in order of decreasing reactivity. Each element is represented by a redox equation.



Two of the uses of the series are to predict the thermal stability of compounds of the metals and to explain their redox reactions.

- (a) Most metal hydroxides decompose when heated.

- (i) Complete the equation for the thermal decomposition of copper(II) hydroxide.



- (ii) Choose a metal from the above series whose hydroxide does not decompose when heated.

..... [1]

- (b) (i) Define in terms of electron transfer the term *oxidation*.

..... [1]

- (ii) Explain why the positive ions in the above equations are oxidising agents.

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

- (c) (i) Which metals in the series above do not react with dilute acids to form hydrogen?

..... [1]

- (ii) Describe an experiment which would confirm the prediction made in (c)(i).

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

- (d) (i) Which metal in the series above can form a negative ion which gives a pink/purple solution in water?

..... [1]

- (ii) Describe what you would observe when zinc, a reducing agent, is added to this pink/purple solution.

..... [1]

[Total: 8]

7 Plants can make complex molecules from simple starting materials, such as water, carbon dioxide and nitrates. Substances produced by plants include sugars, more complex carbohydrates, esters, proteins, vegetable oils and fats.

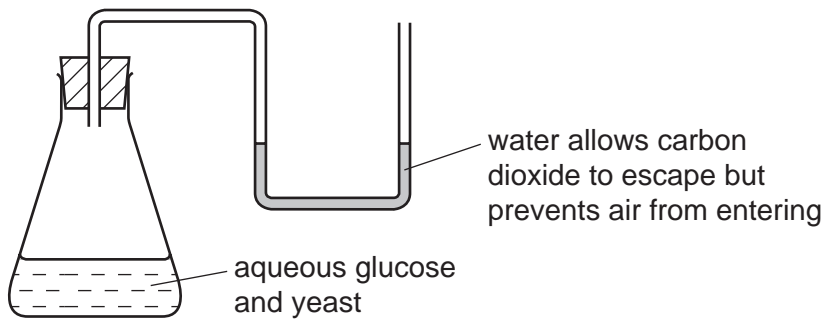
(a) (i) Describe how you could decide from its molecular formula whether a compound is a carbohydrate.

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

(ii) Plants can change the sugar, glucose, into starch which is a more complex carbohydrate. What type of reaction is this?

..... [2]

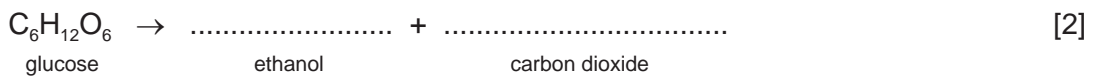
(b) The fermentation of glucose can be carried out in the apparatus shown below. After a few days the reaction stops. A 12% aqueous solution of ethanol has been produced.



(i) The enzyme, zymase, catalyses the anaerobic respiration of the yeast. Explain the term *respiration*.

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

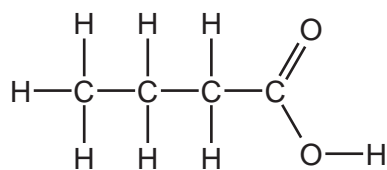
(ii) Complete the equation.



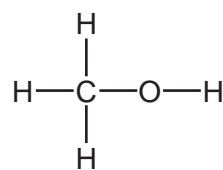
(iii) Why must air be kept out of the flask?

..... [1]

- (c) The ester methyl butanoate is found in apples. It can be made from butanoic acid and methanol. Their structural formulae are given below.



butanoic acid

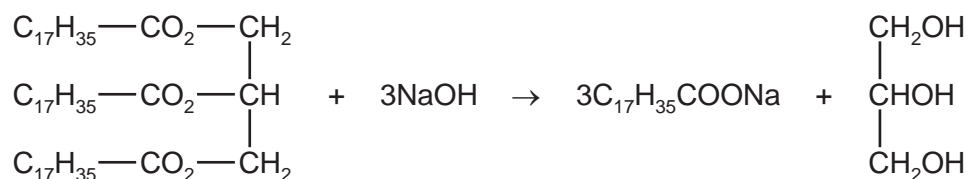


methanol

Use the information given above to deduce the structural formula of methyl butanoate showing all the bonds.

[2]

- (d) The equation represents the hydrolysis of a naturally occurring ester.



- (i) Which substance in the equation is an alcohol? Put a ring around this substance in the equation above. [1]
- (ii) Is the alkyl group,  $\text{C}_{17}\text{H}_{35}$ , in this ester saturated or unsaturated? Give a reason for your choice. [1]
- .....
- (iii) What type of compound is represented by the formula  $\text{C}_{17}\text{H}_{35}\text{COONa}$ ?  
What is the major use for compounds of this type?

type of compound .....

use ..... [2]

- (e) Proteins are natural macromolecules. Draw the structural formula of a typical protein. Include three monomer units. You may represent amino acids by formulae of the type drawn below.



*For  
Examiner's  
Use*

[3]

[Total: 18]





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

Group		I	II	III	IV	V	VI	VII	0							
		1 <b>H</b> Hydrogen 1							4 <b>He</b> Helium 2							
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4				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					
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12			27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	29 <b>P</b> Phosphorus 15	30 <b>S</b> Sulfur 16	31 <b>Cl</b> Chlorine 17	32 <b>Ar</b> Argon 18							
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	48 <b>Ti</b> Titanium 22	51 <b>V</b> Vanadium 23	55 <b>Mn</b> Manganese 25	56 <b>Fe</b> Iron 26	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36	
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	96 <b>Mo</b> Molybdenum 42	101 <b>Ru</b> Ruthenium 44	103 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	128 <b>Te</b> Tellurium 52	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54	
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	178 <b>Hf</b> Hafnium 72	181 <b>Ta</b> Tantalum 73	184 <b>W</b> Tungsten 74	190 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	210 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	210 <b>Rn</b> Radon 86	
87 <b>Fr</b> Francium	88 <b>Ra</b> Radium	89 <b>Ac</b> Actinium														
			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	238 <b>Pa</b> Protactinium 91	238 <b>Np</b> Neptunium 93	238 <b>Pu</b> Plutonium 94	238 <b>Am</b> Americium 95	238 <b>Cm</b> Curium 96	238 <b>Bk</b> Berkelium 97	238 <b>Cf</b> Californium 98	238 <b>Es</b> Einsteinium 99	238 <b>Fm</b> Fermium 100	238 <b>Md</b> Mendelevium 101	238 <b>No</b> Nobelium 102	238 <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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