UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3900490383

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.

IB13 11_0620_32/2RP

UNIVERSITY *of* CAMBRIDGE International Examinations

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]

For Examiner's Use

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.

$$\underset{\text{colourless}}{AgCl} + \underset{\text{colourless}}{CuCl} \rightleftharpoons \underset{\text{black}}{Ag} + \underset{\text{colourless}}{CuCl_2}$$

How does photochromic glass work?

....

....

.... [3]

[Total: 11]

For Examiner's Use

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.

$$N_2(g) + O_2(g) \rightleftharpoons \underset{\text{nitric oxide}}{2NO(g)}$$ **equilibrium 1**

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.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2$$ **equilibrium 2**

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_2 + O_2 + ... → ....HNO_3 [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]

[Turn over

For Examiner's Use

(b) (i) Nitric acid is used to make the fertiliser ammonium nitrate, NH_4NO_3.
What advantage has this fertiliser over another common fertiliser, ammonium sulfate, $(NH_4)_2SO_4$?

.... [1]

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

....

....

....

....

.... [4]

[Total: 13]

For Examiner's Use

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, Fe_2O_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]

For Examiner's Use

(iii) A method being developed to produce iron with lower emissions of carbon dioxide is by electrolysis. Hematite, Fe_2O_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).

........O^{2-} $\rightarrow$ .... + ... [3]

[Total: 13]

For Examiner's Use

5 Silver(I) chromate(VI) is an insoluble salt. It is prepared by precipitation.
20 cm³ of aqueous silver(I) nitrate, concentration 0.2 mol / dm³, was mixed with 20 cm³ of aqueous potassium chromate(VI), concentration 0.1 mol / dm³. 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.

$$2AgNO_3(aq) + K_2CrO_4(aq) \rightarrow Ag_2CrO_4(s) + 2KNO_3(aq)$$

(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 cm³ of silver(I) nitrate solution, concentration 0.2 mol / dm³?
The mass of one mole of $AgNO_3$ is 170 g.

....

.... [2]

(iii) What is the maximum mass of silver(I) chromate(VI) which could be obtained from 20 cm³ of aqueous silver(I) nitrate, concentration 0.2 mol / dm³?

number of moles of $AgNO_3$ used = ... [1]

number of moles of Ag_2CrO_4 formed = ... [1]

mass of one mole of Ag_2CrO_4 = 332 g

mass of Ag_2CrO_4 formed = ... g [1]

[Total: 11]

For Examiner's Use

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

$$Rb \rightleftharpoons Rb^+ + e^-$$
$$Mg \rightleftharpoons Mg^{2+} + 2e^-$$
$$Mn \rightleftharpoons Mn^{2+} + 2e^-$$
$$Zn \rightleftharpoons Zn^{2+} + 2e^-$$
$$H_2 \rightleftharpoons 2H^+ + 2e^-$$
$$Cu \rightleftharpoons Cu^{2+} + 2e^-$$
$$Hg \rightleftharpoons Hg^{2+} + 2e^-$$

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.

$Cu(OH)_2 \rightarrow$ .... + ... [1]

(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]

For Examiner's Use

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.

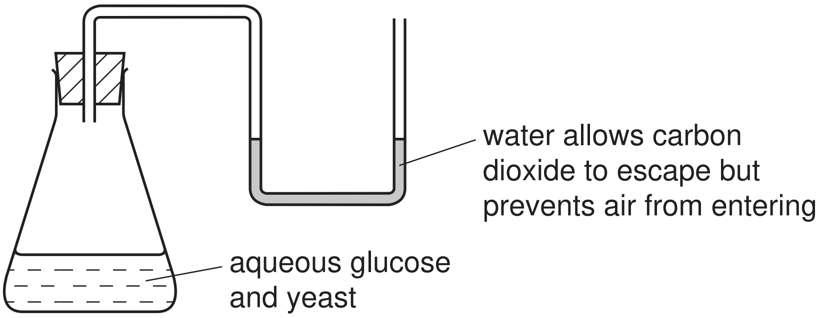
....

.... [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.

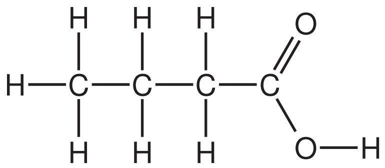
$C_6H_{12}O_6 \rightarrow$ .... + ... [2]

glucose ethanol carbon dioxide

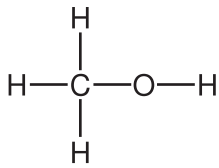
(iii) Why must air be kept out of the flask?

.... [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

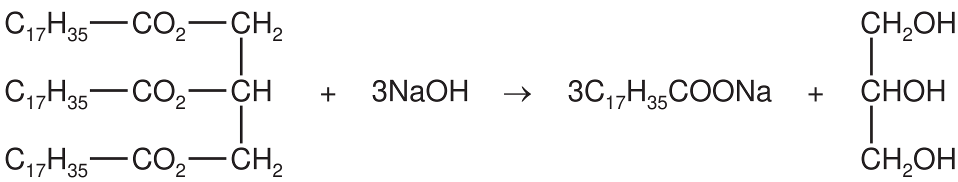


methanol

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, $C_{17}H_{35}$, in this ester saturated or unsaturated? Give a reason for your choice.

.... [1]

(iii) What type of compound is represented by the formula $C_{17}H_{35}COONa$?
What is the major use for compounds of this type?

type of compound ....

use .... [2]

For Examiner's Use

(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.

[3]

[Total: 18]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
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 / **X** / b
a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

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