

## UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS International General Certificate of Secondary Education

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	
CHEMISTRY			0620/32
Paper 3 (Extend	ded)	Oct	ober/November 2013
			1 hour 15 minutes
Candidates answer on the Question Paper.			

## **READ THESE INSTRUCTIONS FIRST**

No Additional Materials are required.

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.



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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
А	-210	-196	does not conduct	does not conduct
В	777	1627	does not conduct	good conductor
С	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 <b>two</b> 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 <b>two</b> substances could exist as simple covalent molecules?	[1]
	[Total	: 6]

2

(i)	Define the te	erm <i>diatomic</i> .	
(ii)	What do the	electron distributions of the h	alogens have in common?
(iii)	How do their	electron distributions differ?	
(iv)	Complete the		
(iv)	Complete the		colour
(iv)	-	e table.	
(iv)	halogen	solid, liquid or gas at room temperature	colour

(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]

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Examiner's Use (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.

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

The reaction between these two chlorides is photochemical.

$$AgCl + CuCl \rightleftharpoons Ag + CuCl_2$$
 colourless colourless black colourless

low does photochromic glass work?	
	[3]

[Total: 11]

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**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.

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$$
 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 <b>equilibrium 1</b> increases vertemperature.	vith
		[1]
(ii)	oxide in <b>equilibrium 1</b> ? Explain your answer.	
		[2]
iii)	Deduce why <b>equilibrium 2</b> 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.	gen
	$NO_2 + O_2 + \dots \rightarrow \dots HNO_3$	[2]
(v)	Ammonia is more expensive than water and air. Suggest a reason why ammonia-based process is preferred to the electric arc process.	the
		[1]

(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]

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[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.
	lime	ore which is hematite, Fe <sub>2</sub> O <sub>3</sub> estone which is calcium carbonate oon in the form of coke
		cribe the essential reactions in the blast furnace. Each of the four raw materials must mentioned at least once. Give the equation for the reduction of hematite.
		[6]
(b)		h year, blast furnaces discharge millions of tonnes of carbon dioxide into the osphere. 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, Fe <sub>2</sub> O <sub>3</sub> , 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).	For Examiner's Use
	$O^{2-} \rightarrow \dots + \dots + \dots$ [3]	
	[Total: 13]	

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.

	$2Ag(10_3(aq) + 1_2O(0_4(aq) \rightarrow Ag_2O(0_4(3) + 21(10_3(aq))$							
	(a) What difficulty arises if the name of a compound of a transition element does not include its oxidation state, for example iron oxide?							
<b>(b)</b> T	hese questions refer to the preparation of the salt.							
<b>(</b> i								
(ii	) What is the purpose of washing the precipitate?	[1]						
		[1]						
(iii	) Why leave the precipitate in a warm oven?							
		[1]						
(c) (i								
		[1]						
(ii	) What mass of silver(I) nitrate is needed to prepare $100\mathrm{cm^3}$ of silver(I) nitrate solution concentration $0.2\mathrm{mol/dm^3}$ ? The mass of one mole of $\mathrm{AgNO_3}$ is $170\mathrm{g}$ .	on,						
		[2]						
(iii	) What is the maximum mass of silver(I) chromate(VI) which could be obtained from 20 cm $^3$ of aqueous silver(I) nitrate, concentration 0.2 mol/dm $^3$ ?	om						
	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 $Ag_2CrO_4 = 332g$							
	mass of $Ag_2CrO_4$ formed =g	[1]						

10 The following reactivity series shows both familiar and unfamiliar elements in order of 6 decreasing reactivity. Each element is represented by a redox equation. Rb ⇌ Rb<sup>+</sup> + e<sup>-</sup>  $Mq \rightleftharpoons Mq^{2+} + 2e^{-}$  $Mn \rightleftharpoons Mn^{2+} + 2e^{-}$  $Zn \rightleftharpoons Zn^{2+} + 2e^{-}$  $H_2 \rightleftharpoons 2H^+ + 2e^ Cu \rightleftharpoons Cu^{2+} + 2e^{-}$  $Hg \rightleftharpoons Hg^{2+} + 2e^{-}$ 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.  $Cu(OH)_2 \rightarrow \dots + \dots + \dots$ [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

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[Total: 8]

pink/purple solution.

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)		e fermentation of glucose can be carried out in the apparatus shown below. After a few s the reaction stops. A 12% aqueous solution of ethanol has been produced.
		water allows carbon dioxide to escape but prevents air from entering aqueous glucose and yeast
	(i)	The enzyme, zymase, catalyses the anaerobic respiration of the yeast.

Explain the term *respiration*.

.....[2]

(ii) Complete the equation.

$$C_6H_{12}O_6 \rightarrow \dots + \dots$$
 [2] glucose ethanol carbon dioxide

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

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

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

methanol

[2]

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

butanoic acid

- (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<sub>17</sub>H<sub>35</sub>COONa? What is the major use for compounds of this type?

type of compound .....

use ......[2]

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**(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.

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[3]

[Total: 18]

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DATA SHEET
The Periodic Table of the Elements

	0	4 <b>He</b> Helium	20 Neon 10	40 <b>Ar</b>	. <b>Kr</b>		Radom 86		175 Lu um Lutetium	
			19 Fluorine	35.5 <b>C 1</b> Chlorine			At Astatine 85		Yb Ytterbium	°Z
	>		16 Oxygen	32 <b>S</b> Suffur	79 Selenium 34	128 <b>Te</b> Tellunum	Po Polonium 84		169 <b>Tm</b> Thulium	M
	>		14 <b>N</b> itrogen 7	31 Phosphorus 15	As Arsenic	Sb Antimony 51			167 <b>Er</b> Erbium 68	Fm
	≥		12 <b>C</b> Carbon	28 <b>Si</b> Silicon	73 <b>Ge</b> Germanium 32	<b>S</b> In	207 <b>Pb</b> Lead		Holmium 67	
	≡		11 Boron 5	27 <b>A1</b> Aluminium 13	70 <b>Ga</b> Gallium	115 <b>In</b>	204 <b>T 1</b> Tallium		Dy Dysprosium 66	Č
					65 <b>Zn</b> Zinc 30	112 <b>Cd</b> Cadmium 48			159 <b>Tb</b> Terbium 65	ă
					64 Copper 29	108 <b>Ag</b> Silver	197 <b>Au</b> Gold		157 <b>Gd</b> Gadolinium 64	
Group					59 Nickel	106 Pd Palladium 46	195 <b>Pt</b> Platinum 78		152 <b>Eu</b> Europium 63	
Ģ					Co Cobalt	103 <b>Rh</b> Rhodium 45	192 <b>Ir</b> Iridium		Sm Samarium 62	
		Hydrogen			56 <b>Fe</b> Iron	Ru Ruthenium 44	190 <b>Os</b> Osmium 76		Pm Promethium 61	S
					Mn Aanganese	Tc Tc Technetium	186 <b>Re</b> Rhenium 75		Neodymium 60	238 <b>U</b>
					52 <b>Cr</b> Chromium 24	Molybdenum 43	184 <b>W</b> Tungsten 74		Pr Praseodymium 59	Ба
					51 V Vanadium 23		181 <b>Ta</b> Tantalum 73		140 <b>Ce</b> Cerium	232 <b>Th</b>
					48 <b>T</b> Titanium	91 <b>Zr</b> Zirconium 40	178 <b>Hf</b> Hafnium 72			iic mass ool
					Scandium	89 <b>×</b>	La Lanthanum 57 *	227 <b>Ac</b> Actinium	series eries	<ul><li>a = relative atomic mass</li><li>X = atomic symbol</li></ul>
	=		9 <b>Be</b> Beryllium	Mg Magnesium	40 <b>Ca</b> Calcium	Sr Strontium	137 <b>Ba</b> Barium 56	226 <b>Ra</b> Radium 88	*58-71 Lanthanoid series 190-103 Actinoid series	ω ×
	_		7 <b>Li</b> Lithium	23 <b>Na</b> Sodium	39 <b>X</b> Potassium	85 <b>Rb</b> Rubidium 37	133 <b>Cs</b> Caesium 55	<b>Fr</b> Francium 87	8-71 L	Xe Y

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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