



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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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.

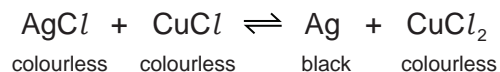
Use o to represent an electron from a fluorine atom.

[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?

.....

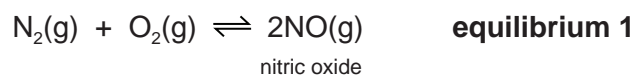
.....

..... [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.



- (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, NH_4NO_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]

- (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).

.....

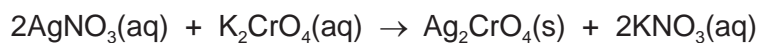
Complete the equation for the reaction at the positive electrode (anode).

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

[3]

[Total: 13]

- 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.



- (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 AgNO₃ 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 AgNO₃ used = [1]

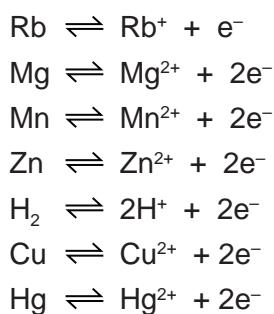
number of moles of Ag₂CrO₄ formed = [1]

mass of one mole of Ag₂CrO₄ = 332 g

mass of Ag₂CrO₄ 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.

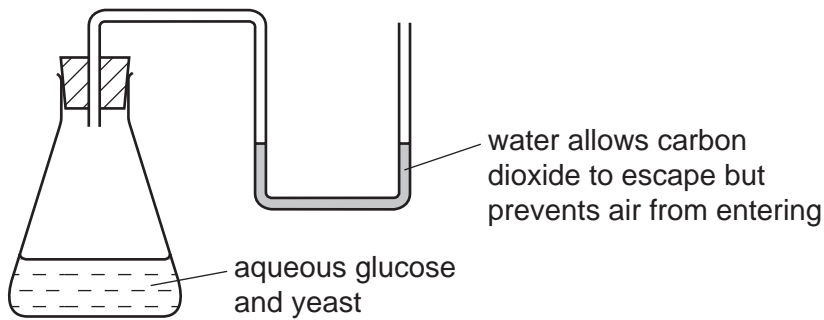
(a) (i) Describe how you could decide from its molecular formula whether a compound is a carbohydrate.

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

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

..... [2]

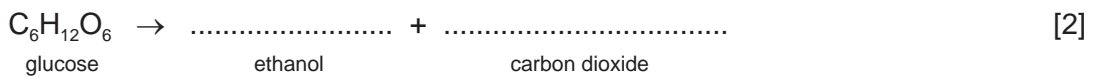
(b) The fermentation of glucose can be carried out in the apparatus shown below. After a few days the reaction stops. A 12% aqueous solution of ethanol has been produced.



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

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

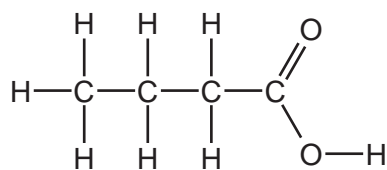
(ii) Complete the equation.



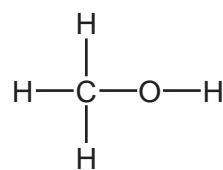
(iii) Why must air be kept out of the flask?

..... [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

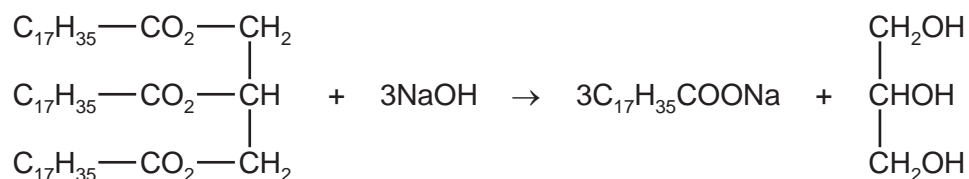


methanol

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

I		Group										VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	IX																																																																						
		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	13 Al Aluminium 13	14 N Nitrogen 7	15 O Oxygen 8	16 F Fluorine 9	17 Ne Neon 10	18 Ar Argon 18	19 K Potassium 19	20 Ca Calcium 20	21 Sc Scandium 21	22 Ti Titanium 22	23 V Vanadium 23	24 Cr Chromium 24	25 Mn Manganese 25	26 Fe Iron 26	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36	37 Rb Rubidium 37	38 Sr Strontium 38	39 Y Yttrium 39	40 Zr Zirconium 40	41 Nb Niobium 41	42 Mo Molybdenum 42	43 Tc Technetium 43	44 Ru Ruthenium 44	45 Rh Rhodium 45	46 Pd Palladium 46	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Sn Tin 50	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54	55 Cs Caesium 55	56 Ba Barium 56	57 La Lanthanum 57	72 Hf Hafnium 72	73 Ta Tantalum 73	74 W Tungsten 74	75 Re Rhenium 75	76 Os Osmium 76	77 Ir Iridium 77	78 Pt Platinum 78	79 Au Gold 79	80 Hg Mercury 80	81 Tl Thallium 81	82 Pb Lead 82	83 Bi Bismuth 83	84 Po Polonium 84	85 At Astatine 85	86 Rn Radon 86	87 Fr Francium 87	88 Ra Radium 88	89 Ac Actinium 89	103 Lr Lawrencium 103	102 No Nobelium 102	101 Md Mendelevium 101	100 Fm Fermium 100	99 Es Einsteinium 99	98 Cf Californium 98	97 Bk Berkelium 97	96 Cm Curium 96	95 Am Americium 95	94 Pu Plutonium 94	93 Np Neptunium 93	92 U Uranium 92	91 Pa Protactinium 91	90 Th Thorium 90	89 Pr Praseodymium 89	88 Ce Cerium 88	87 Pm Promethium 87	86 Sm Samarium 86	85 Eu Europium 85	84 Gd Gadolinium 84	83 Tb Terbium 83	82 Dy Dysprosium 82	81 Ho Holmium 81	80 Er Erbium 80	79 Tm Thulium 79	78 Yb Ytterbium 78	77 Lu Lutetium 77

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

a	X	b
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Key
 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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