



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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CANDIDATE
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.

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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.

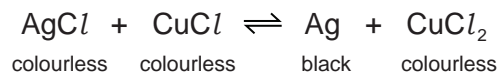
Use o to represent an electron from a fluorine atom.

[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?

.....

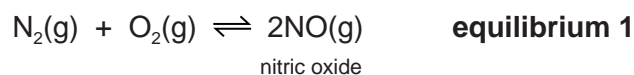
.....

..... [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.

.....NO₂ + O₂ + →HNO₃ [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, 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]

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]

- (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).

.....

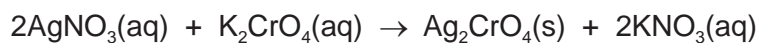
Complete the equation for the reaction at the positive electrode (anode).

..... 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]

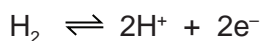
number of moles of Ag₂CrO₄ formed = [1]

mass of one mole of Ag₂CrO₄ = 332 g

mass of Ag₂CrO₄ formed = g [1]

[Total: 11]

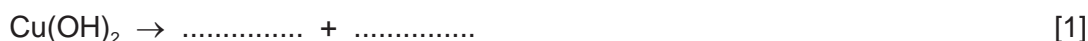
- 6 The following reactivity series shows both familiar and unfamiliar elements in order of decreasing reactivity. Each element is represented by a redox equation.



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.

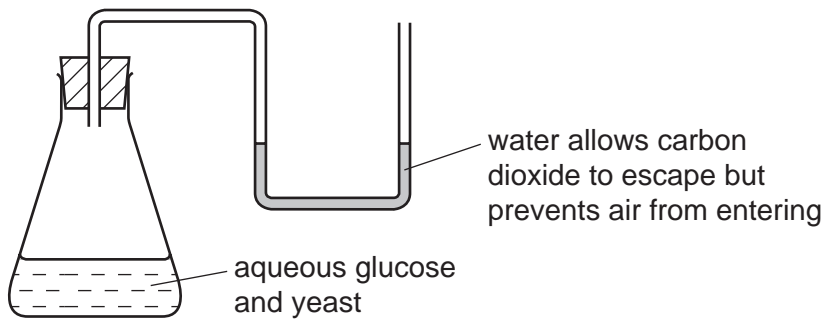
(a) (i) Describe how you could decide from its molecular formula whether a compound is a carbohydrate.

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

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

..... [2]

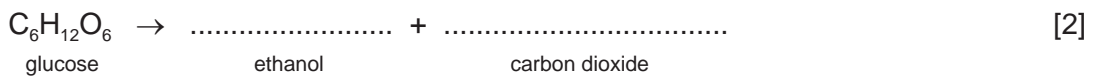
(b) The fermentation of glucose can be carried out in the apparatus shown below. After a few days the reaction stops. A 12% aqueous solution of ethanol has been produced.



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

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

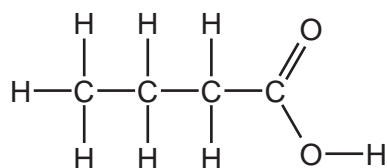
(ii) Complete the equation.



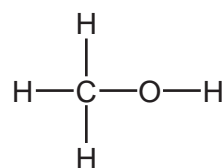
(iii) Why must air be kept out of the flask?

..... [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

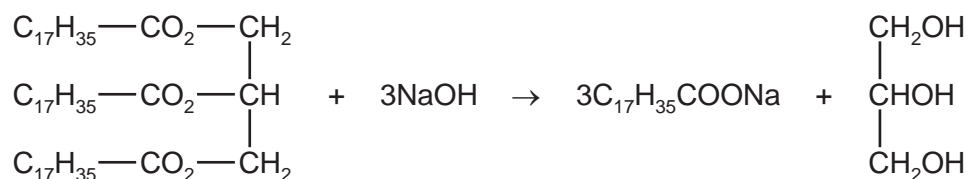


methanol

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

Group		Period											
		I	II	III	IV	V	VI	VII	0				
1		2											
1		2											
7	9	4	2										
3	4	2											
23	24	2											
11	12	2											
39	40	2											
19	20	2											
85	88	2											
37	38	2											
133	137	2											
55	56	2											
87	88	2											
226	227	2											
89	89	2											
†	†	2											
*58-71 Lanthanoid series		2											
†90-103 Actinoid series		2											
Key		2											
a		2											
X		2											
b		2											
a = relative atomic mass		2											
X = atomic symbol		2											
b = proton (atomic) number		2											
140	141	144	141	150	152	157	159	162	165	167	169	173	175
58	59	60	59	62	63	64	65	66	67	68	69	70	71
232	238	238	91	94	95	96	97	98	99	100	101	102	103
90	92	92	91	94	95	96	97	98	99	100	101	102	103
Ce	Pr	Nd	Pr	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Th	Pu	Np	Cm	Bk	Cf	Es	Fm	Md	No	Lr
Thorium	Protactinium	Uranium	Thorium	Plutonium	Neptunium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Lawrencium
90	91	92	90	94	93	96	97	98	99	100	101	102	103

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

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