Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1092599071

CHEMISTRY **5070/22**

Paper 2 Theory **May/June 2014**

1 hour 30 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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.
Write your answers in the spaces provided in the Question Paper.

Section B
Answer any **three** questions.
Write your answers in the spaces provided in the Question Paper.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 20.

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 **18** printed pages and **2** blank pages.

CAMBRIDGE International Examinations

Section A

Answer **all** the questions in this section in the spaces provided.

The total mark for this section is 45.

A1 Choose from the following gases to answer the questions below.

$CCl F_3$

CH_4

CO

CO_2

H_2

N_2

NH_3

O_2

SO_2

Each gas can be used once, more than once or not at all.

Which gas is

(a) used in making steel,

.....[1]

(b) made by the bacterial decay of vegetable matter,

.....[1]

(c) responsible for ozone depletion in the upper atmosphere,

.....[1]

(d) used to manufacture margarine?

.....[1]

[Total: 4]

A2 Farmers use chemicals to improve crop yield.

Ammonium phosphate, $(NH_4)_3PO_4$, is used as a fertiliser and calcium hydroxide, $Ca(OH)_2$, is used to reduce the acidity of soils.

The relative formula mass of ammonium phosphate is 149.

(a) Calculate the percentage by mass of nitrogen in ammonium phosphate.

percentage = ... % [1]

(b) A farmer adds ammonium phosphate to a field.

He then adds calcium hydroxide to the field because the soil is very acidic.

(i) Calcium hydroxide neutralises the acid in the soil.

Give the ionic equation for this reaction.

.....[1]

(ii) The calcium hydroxide reduces the effectiveness of the ammonium phosphate fertiliser because it reduces the nitrogen content.

Explain why adding calcium hydroxide reduces the nitrogen content.

.....

.....

.....[2]

(c) A sample of ammonium phosphate can be produced by the reaction of aqueous ammonia and phosphoric acid.

$$3NH_3(aq) + H_3PO_4(aq) \longrightarrow (NH_4)_3PO_4(aq)$$

25.0 cm^3 of 1.25 mol/dm^3 phosphoric acid is neutralised by 45.3 cm^3 of aqueous ammonia.

(i) Calculate the concentration, in mol/dm^3, of the ammonia used.

concentration of ammonia = ... mol/dm^3 [3]

(ii) Show, by calculation, that 4.66 g of ammonium phosphate would be produced. Assume that the yield is 100%.
[M_r: $(NH_4)_3PO_4$, 149]

[1]

(iii) In practice, the actual mass of ammonium phosphate produced is 2.93 g.

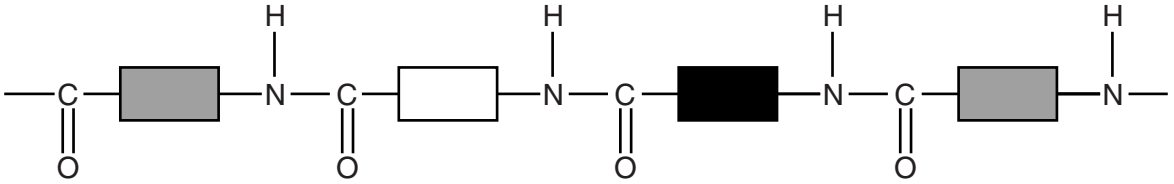
Calculate the percentage yield of ammonium phosphate.

percentage yield = ... % [1]

[Total: 9]

A3 Proteins, carbohydrates and fats are natural macromolecules.

The partial structure of a protein is shown below.



(a) Name the linkage that joins the monomer units in a protein.

..... [1]

(b) Name a synthetic polymer that has the same linkage as a protein.

..... [1]

(c) Proteins are hydrolysed to give a mixture of colourless amino acids.

Describe, with the aid of a labelled diagram, how paper chromatography can be used to identify the amino acids present in a mixture of amino acids.

.....

.....

.....

.....[4]

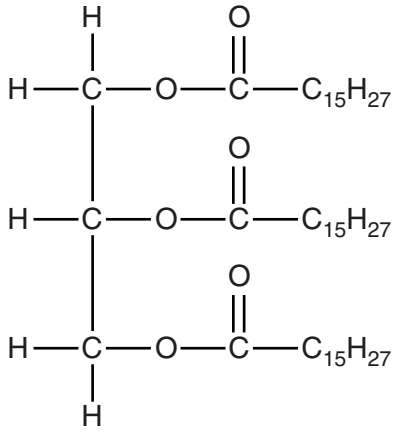
[Turn over

(d) Carbohydrates can be hydrolysed.

Name the class of compound formed when carbohydrates are hydrolysed.

..... [1]

(e) The diagram shows the structure of a simple fat.



(i) This fat is polyunsaturated.

What is the meaning of the term *polyunsaturated*?

.....

.....

.....[2]

(ii) Describe a chemical test to show that the fat is unsaturated.

name of reagent .....

result of test .....[2]

(iii) Name a synthetic macromolecule that contains the same linkage as fats.

.....[1]

[Total: 12]

A4 Only liquids that contain moving ions can be electrolysed. These liquids are called electrolytes.

(a) Complete the following table which shows the products formed when some liquids are electrolysed using inert graphite electrodes.

electrolyte	ions present in electrolyte	product formed at the positive electrode	product formed at the negative electrode
aqueous copper(II) sulfate	Cu^{2+}, H^+, OH^- and SO_4^{2-}	.....	.....
concentrated aqueous sodium chloride	H^+, Na^+, Cl^- and OH^-	chlorine	hydrogen
molten lead(II) bromide	Pb^{2+} and Br^-	.....	.....

[3]

(b) When concentrated aqueous sodium chloride is electrolysed, chlorine is formed at the positive electrode (anode) and hydrogen at the negative electrode (cathode).

(i) Construct the ionic equation to show the formation of chlorine at the positive electrode.

.....[1]

(ii) Explain why hydrogen is formed at the negative electrode rather than sodium.

.....

.....[1]

(c) Name a metal manufactured by the electrolysis of a molten ionic compound.

.....[1]

[Total: 6]

A5 Haematite, limestone and coke are heated together in a blast furnace in the manufacture of iron.

(a) State why each of the following compounds are needed in a blast furnace.

haematite .....

.....

limestone .....

.....

coke .....

.....[3]

(b) Iron has a high melting point because it has strong metallic bonding.

Describe, using a labelled diagram, metallic bonding.

.....

.....[2]

(c) When iron is made into the alloy steel, the properties of iron are changed.

High carbon steels are stronger than iron but are brittle.

State a property of low carbon steels.

.....[1]

(d) When magnesium powder is added to aqueous iron(II) sulfate, the following reaction occurs.

$$Mg(s) + Fe^{2+}(aq) \longrightarrow Mg^{2+}(aq) + Fe(s)$$

(i) Explain, using electron transfer, why iron(II) ions are reduced in this reaction.

.....

.....[1]

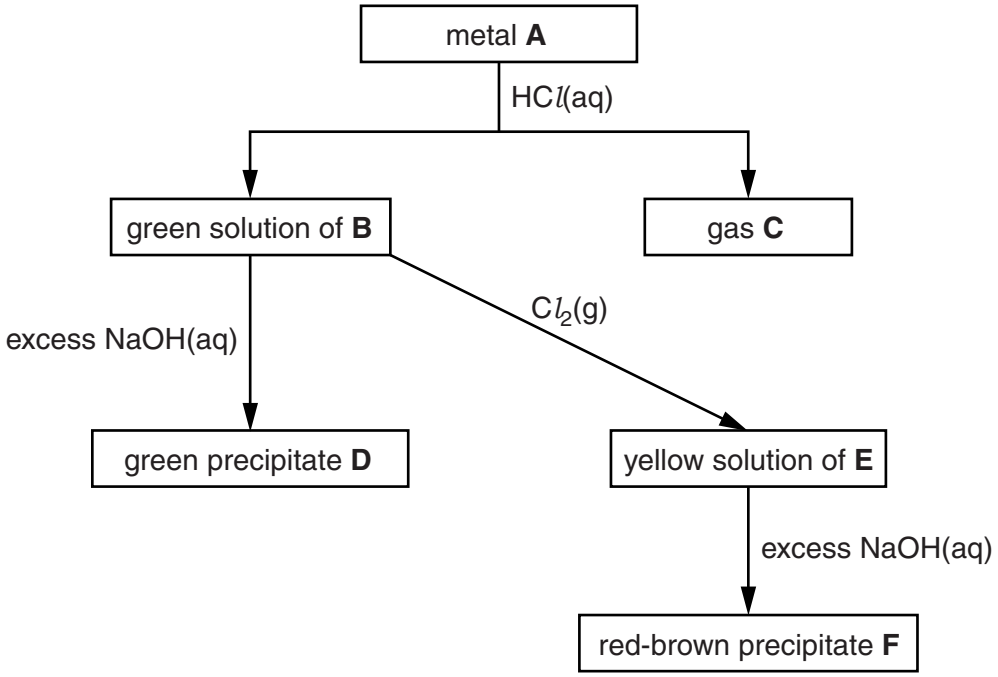
(ii) What would you observe in this reaction?

.....

.....[1]

[Total: 8]

A6 The flow chart shows the reactions of metal **A** and some of its compounds.



Identify, by name, each of the substances.

A .....

B .....

C .....

D .....

E .....

F .....

[Total: 6]

Section B

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

B7 Alkanes are a homologous series of hydrocarbons.

(a) There are two alkanes with the molecular formula C_4H_{10}.

Draw the structures, showing all the atoms and all the bonds, of these two alkanes.

[2]

(b) One of the alkanes with the molecular formula C_4H_{10} is butane.

Butane is used as a fuel.

(i) Construct the equation for the **complete** combustion of butane.

.....[1]

(ii) Describe one problem associated with the **incomplete** combustion of butane.

.....

.....[1]

(c) Butane reacts with chlorine in the presence of ultraviolet radiation.

Write an equation for this reaction.

.....[1]

(d) Nonane, C_9H_{20}, is heated strongly in the presence of a catalyst. Two products are made: an alkane, **G**, and an alkene, **H**.

(i) Name this type of reaction.

.....[1]

(ii) Alkane **G** contains 84% carbon by mass.

Calculate the molecular formula for **G**.

molecular formula ..... [3]

(iii) Suggest a molecular formula for **H**.

.....[1]

[Total: 10]

[Turn over

B8 Butan-1-ol, $CH_3CH_2CH_2CH_2OH$, and ethanol, CH_3CH_2OH, are both alcohols.

Alcohols, such as ethanol, react with sodium to form hydrogen.

$$2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2ONa + H_2$$

(a) Construct the equation to show the reaction of butan-1-ol with potassium.

.....[1]

(b) Describe the chemical test for hydrogen.

.....[1]

(c) A sample containing 0.233 g of an unknown Group I element is added to excess ethanol. The volume of hydrogen gas formed at room temperature and pressure is 400 cm^3.

Calculate the relative atomic mass, A_r, of the Group I element and suggest the identity of the element.

relative atomic mass = ...

identity of the element = ...[4]

(d) Ethanol reacts with ethanoic acid to make an organic compound.

Draw the structure, showing all the atoms and all the bonds, of this organic compound.

[1]

(e) Describe the manufacture of ethanol starting from glucose. Include an equation and the conditions needed.

.....

.....

.....

.....

.....[3]

[Total: 10]

B9 When iron is heated with steam in a sealed container, an equilibrium mixture is obtained.

$$3Fe(s) + 4H_2O(g) \rightleftharpoons 4H_2(g) + Fe_3O_4(s) \qquad \Delta H = +35\,kJ/mol$$

(a) The forward reaction is endothermic. What is the meaning of the term *endothermic*?

.....

.....[1]

(b) Describe and explain what happens to the rate of the forward reaction when the temperature is increased. The pressure remains constant.

.....

.....

.....

.....[2]

(c) Describe and explain what happens, if anything, to the position of equilibrium when the pressure is increased. The temperature remains constant.

.....

.....

.....

.....[2]

(d) Calculate the mass of Fe_3O_4 formed when 2.80 g of iron completely reacts with excess steam.

mass of Fe_3O_4 = ... g [3]

(e) At room temperature iron will rust in moist air.

Describe and explain how galvanising iron prevents rusting.

.....

.....

.....

.....[2]

[Total: 10]

B10 Astatine, At, is an element in Group VII of the Periodic Table.

The table shows some information about two isotopes of astatine.

symbol	number of protons	number of electrons	number of neutrons
$^{210}_{85}At$	.....	.....	.....
$^{211}_{85}At$	.....	.....	.....

(a) (i) Complete the table. [2]

(ii) What is meant by the term *isotopes*?

.....

.....

.....[1]

(b) Astatine forms a diatomic molecule with the same type of bonding as in a chlorine molecule.

Draw the 'dot-and-cross' diagram for an astatine molecule.

Only draw the outer shell electrons.

[1]

(c) Astatine reacts with magnesium to form magnesium astatide, $MgAt_2$, which contains Mg^{2+} and At^- ions.

(i) Describe how a magnesium ion and an astatide ion are formed from a magnesium atom and an astatine atom.

.....

.....

.....

.....[2]

(ii) Predict **two** physical properties of magnesium astatide.

1. .....

2. .....[2]

(d) **(i)** Bromine reacts with aqueous magnesium astatide. Construct the ionic equation for this reaction.

.....[1]

(ii) Explain why astatine does not react with aqueous magnesium iodide.

.....

.....[1]

[Total: 10]

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DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 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	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	244 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	252 Es Einsteinium 99	257 Fm Fermium 100	258 Md Mendelevium 101	259 No Nobelium 102	260 Lr Lawrencium 103

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

Key

a	a = relative atomic mass
X	X = atomic symbol
b	b = atomic (proton) number

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