Cambridge O Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

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

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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.

$$CClF_3$$

$$CH_4$$

$$CO$$

$$CO_2$$

$$H_2$$

$$N_2$$

$$NH_3$$

$$O_2$$

$$SO_2$$

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.

$$3NH_3(aq) + H_3PO_4(aq) \longrightarrow (NH_4)_3PO_4(aq)$$
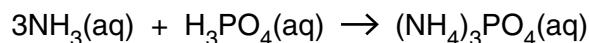
25.0 cm^3 of 1.25 mol/dm^3 phosphoric acid is neutralised by 45.3 cm^3 of aqueous ammonia.

(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$_4$)$_3$PO$_4$, 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.
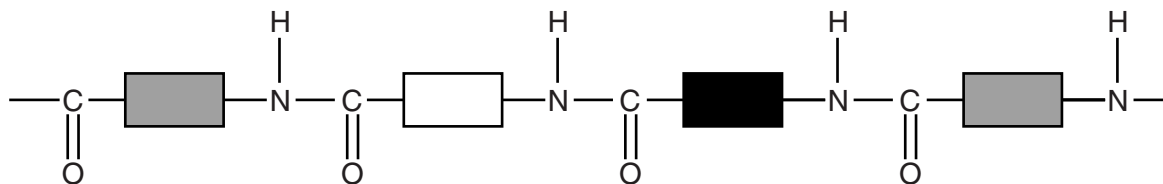
(a) Name the linkage that joins the monomer units in a protein.

.... [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.
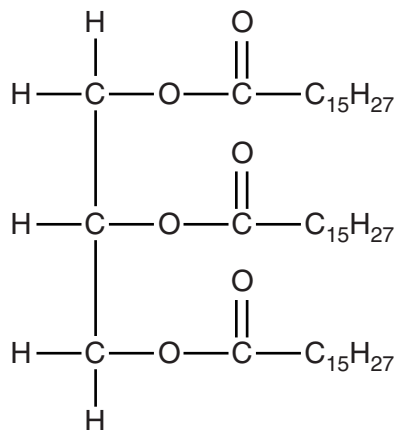
(i) This fat is polyunsaturated.

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.

$$Mg(s) \ + \ Fe^{2+}(aq) \ \rightarrow \ Mg^{2+}(aq) \ + \ Fe(s)$$
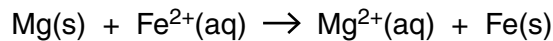
(i) Explain, using electron transfer, why iron(II) ions are reduced in this reaction.

....

....[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.

```
                          ┌─────────────────┐
                          │    metal A      │
                          └─────────────────┘
                                   │ HCl(aq)
            ┌──────────────────────┴──────────────────────┐
            ▼                                              ▼
  ┌─────────────────────┐                        ┌─────────────────┐
  │ green solution of B │                        │    gas C        │
  └─────────────────────┘                        └─────────────────┘
       │              \ Cl₂(g)
       │               \
 excess NaOH(aq)        \
       │                 \
       ▼                  ▼
┌──────────────────┐   ┌─────────────────────┐
│green precipitate D│   │ yellow solution of E │
└──────────────────┘   └─────────────────────┘
                                │ excess NaOH(aq)
                                ▼
                       ┌─────────────────────────┐
                       │ red-brown precipitate F │
                       └─────────────────────────┘
```
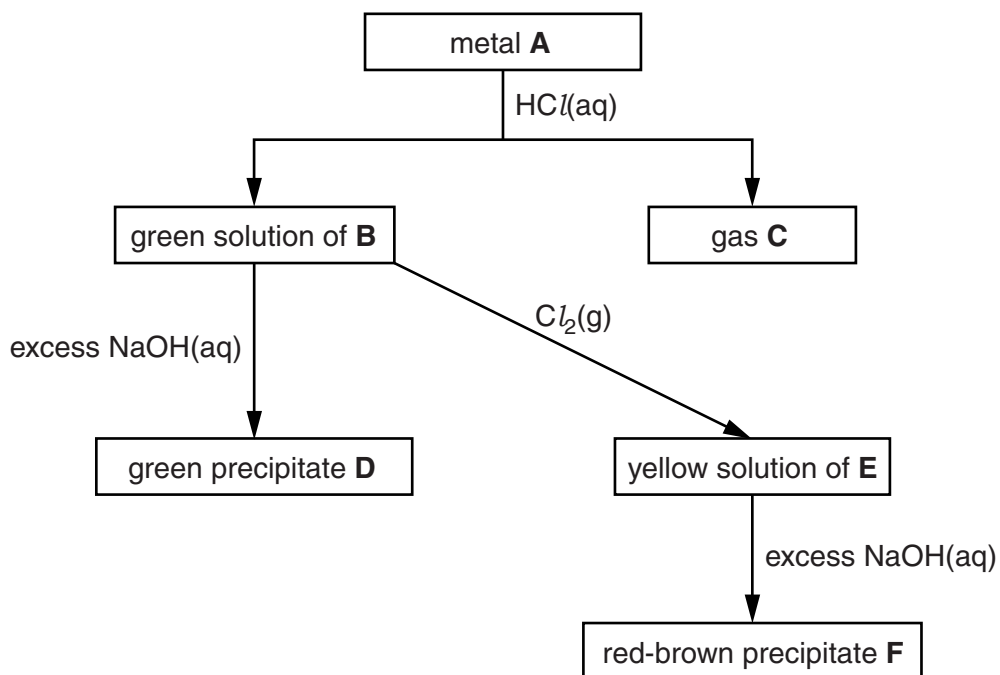
Identify, by name, each of the substances.

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]

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.

$$2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2ONa + H_2$$
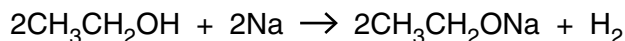
(a) Construct the equation to show the reaction of butan-1-ol with potassium.

....[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.

$$3Fe(s) + 4H_2O(g) \rightleftharpoons 4H_2(g) + Fe_3O_4(s) \qquad \Delta H = +35\,kJ/mol$$
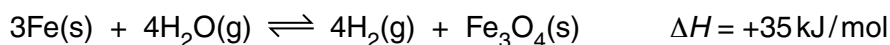
(a) The forward reaction is endothermic. What is the meaning of the term *endothermic*?

....

....[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	II		III	IV	V	VI	VII	0
								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	(transition elements)	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		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		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							

Transition elements:

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
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
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
227 **Ac** Actinium 89 †									

H Hydrogen 1

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

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

Key

a
X
b

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

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

5070/22/M/J/14