

CANDIDATE
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CHEMISTRY

Paper 2 Theory

5070/22

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.

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.



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, $(\text{NH}_4)_3\text{PO}_4$, is used as a fertiliser and calcium hydroxide, $\text{Ca}(\text{OH})_2$, 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]

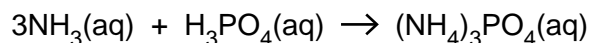
(ii) The calcium hydroxide reduces the effectiveness of the ammonium phosphate fertiliser because it reduces the nitrogen content.

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.



25.0 cm³ of 1.25 mol/dm³ phosphoric acid is neutralised by 45.3 cm³ of aqueous ammonia.

- (i) Calculate the concentration, in mol/dm³, of the ammonia used.

concentration of ammonia = mol/dm³ [3]

- (ii) Show, by calculation, that 4.66 g of ammonium phosphate would be produced. Assume that the yield is 100%.
[*M_r*: (NH₄)₃PO₄, 149]

[1]

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

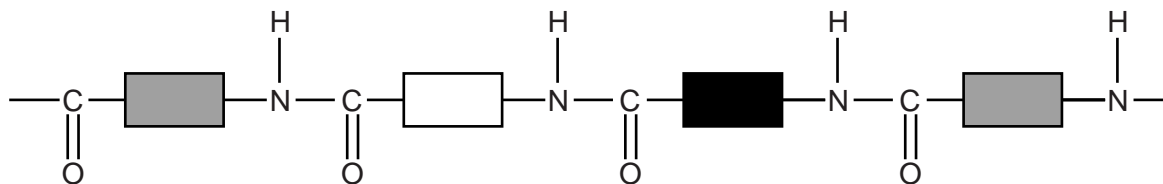
Calculate the percentage yield of ammonium phosphate.

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.

.....

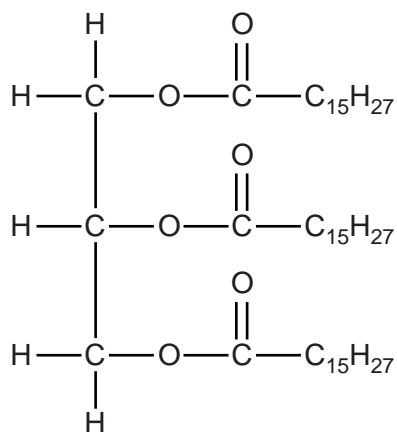
 [4]

(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]

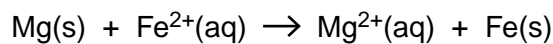
(c) When iron is made into the alloy steel, the properties of iron are changed.

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.



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

.....

.....[1]

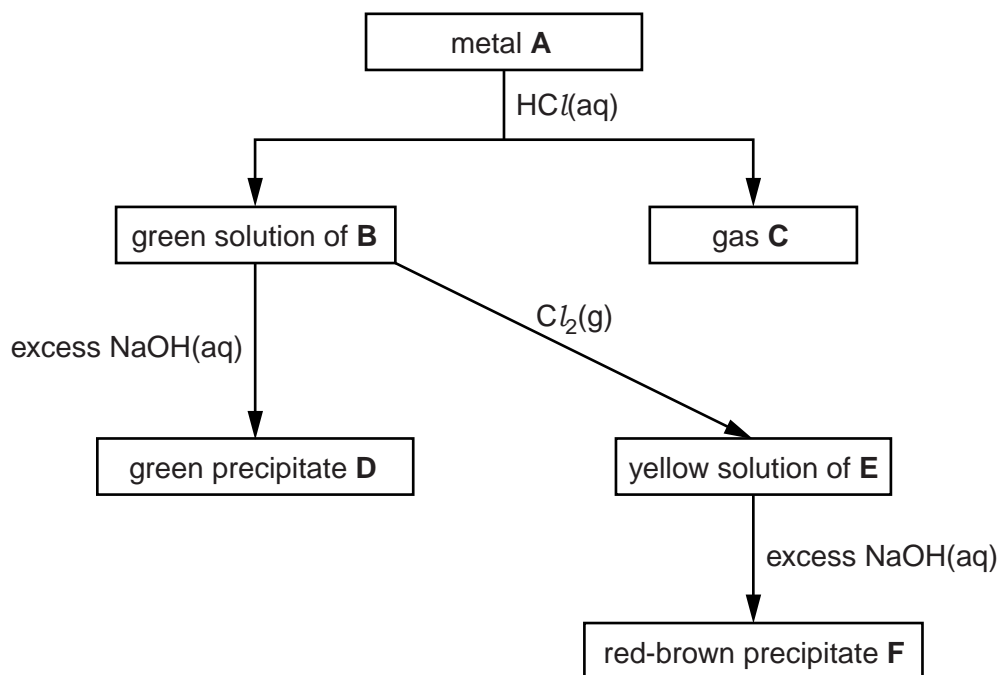
(ii) What would you observe in this reaction?

.....

.....[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]

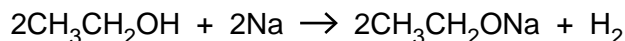
(iii) Suggest a molecular formula for **H**.

.....[1]

[Total: 10]

B8 Butan-1-ol, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$, and ethanol, $\text{CH}_3\text{CH}_2\text{OH}$, are both alcohols.

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



(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 =

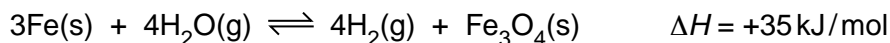
identity of the element =[4]

(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]

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



(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
${}^{210}_{85}\text{At}$
${}^{211}_{85}\text{At}$

(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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