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CHEMISTRY

0971/42

Paper 4 Theory (Extended)

October/November 2018

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 an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, 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.

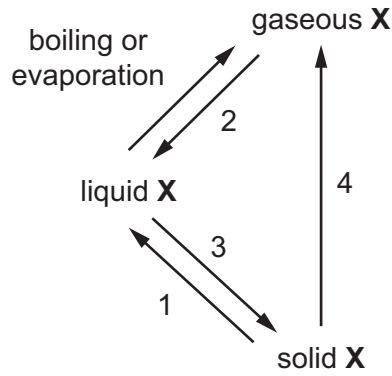
You may lose marks if you do not show your working or if you do not use appropriate units.

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 **13** printed pages and **3** blank pages.

1 Element X can undergo the following physical changes.



(a) (i) Give the scientific name for each of the numbered physical changes.

- 1
- 2
- 3
- 4 [4]

(ii) Explain why the changes shown are physical changes.

..... [1]

(iii) One difference between boiling and evaporation is the rate at which the processes occur. State **one** other difference between boiling and evaporation.

..... [1]

(b) Describe the separation, arrangement and motion of particles of element X in the solid state.

separation

arrangement

motion [3]

(c) Element X is a Group I metal. It burns in air to form an oxide X_2O .

Write a chemical equation for this reaction.

..... [2]

[Total: 11]

2 Magnesium, calcium and strontium are Group II elements.

(a) Complete the table to show the arrangement of electrons in a calcium atom.

shell number	1	2	3	4
number of electrons				

[1]

(b) Describe how the arrangement of electrons in a strontium atom is:

(i) similar to the arrangement of electrons in a calcium atom

.....

(ii) different from the arrangement of electrons in a calcium atom.

.....

[2]

(c) Calcium reacts with cold water to form two products:

- a colourless gas, **P**, which 'pops' with a lighted splint
- a weakly alkaline solution, **Q**, which turns milky when carbon dioxide is bubbled through it.

(i) Name gas **P**.

..... [1]

(ii) Identify the ion responsible for making solution **Q** alkaline.

..... [1]

(iii) Suggest the pH of solution **Q**.

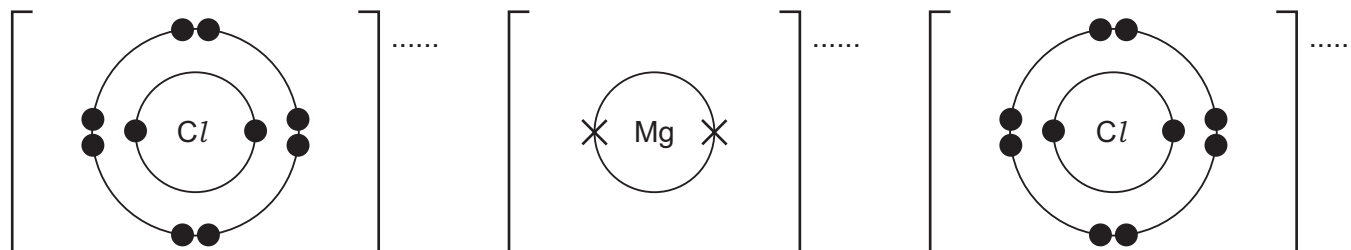
..... [1]

(iv) Write a chemical equation for the reaction of calcium with cold water.

..... [2]

(d) Magnesium reacts with chlorine to form magnesium chloride, MgCl_2 . Magnesium chloride is an ionic compound.

(i) Complete the diagrams to show the electronic structures of the ions in magnesium chloride. Show the charges on the ions.



[3]

(ii) Give **three** physical properties that are typical of ionic compounds such as MgCl_2 .

1

2

3

[3]

(e) Aqueous magnesium chloride is added to aqueous silver nitrate. A white precipitate forms.

Write an **ionic** equation for this reaction. Include state symbols.

..... [2]

[Total: 16]

3 Sulfur is an important element.

(a) Explain how burning fossil fuels containing sulfur leads to the formation of acid rain.

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

(b) Sulfuric acid is manufactured by the Contact process. One step in the Contact process involves a reversible reaction in which sulfur trioxide, SO_3 , is formed.

(i) Write a chemical equation for this reversible reaction. Include the correct symbol to show that the reaction is reversible.

..... [2]

(ii) State the conditions and name the catalyst used in this reversible reaction.

temperature

pressure

catalyst

[3]

(iii) Describe how the sulfur trioxide formed is converted into sulfuric acid in the next steps of the Contact process.

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

(c) Dilute sulfuric acid is used to make salts known as sulfates.

A method consisting of three steps is used to make zinc sulfate from zinc carbonate.

step 1 Add an excess of zinc carbonate to 20 cm³ of 0.4 mol/dm³ dilute sulfuric acid until the reaction is complete.

step 2 Filter the mixture.

step 3 Heat the filtrate until a saturated solution forms and then allow it to crystallise.

(i) Name a suitable piece of apparatus for measuring 20 cm³ of dilute sulfuric acid in **step 1**.

..... [1]

(ii) State **two** observations which would show that the reaction is complete in **step 1**.

1

2 [2]

(iii) Why is it important to add an excess of zinc carbonate in **step 1**?

..... [1]

(iv) What is meant by the term *saturated solution* in **step 3**?

..... [2]

(v) The equation for the reaction is shown.



Complete the equation by inserting the state symbol for zinc sulfate. [1]

(vi) Name another zinc compound which could be used to make zinc sulfate from dilute sulfuric acid using this method.

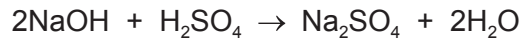
..... [1]

(vii) Suggest why this method would **not** work to make barium sulfate from barium carbonate and dilute sulfuric acid.

..... [1]

- (d) In a titration, a student added 25.0 cm³ of 0.200 mol/dm³ aqueous sodium hydroxide to a conical flask. The student then added a few drops of methyl orange to the solution in the conical flask.

Dilute sulfuric acid was then added from a burette to the conical flask. The volume of dilute sulfuric acid needed to neutralise the aqueous sodium hydroxide was 20.0 cm³.



- (i) What was the colour of the methyl orange in the aqueous sodium hydroxide?

..... [1]

- (ii) Determine the concentration of the dilute sulfuric acid in g/dm³.

- Calculate the number of moles of aqueous sodium hydroxide added to the conical flask.

..... mol

- Calculate the number of moles of dilute sulfuric acid added from the burette.

..... mol

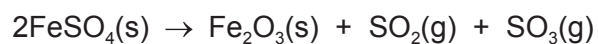
- Calculate the concentration of the dilute sulfuric acid in mol/dm³.

..... mol/dm³

- Calculate the concentration of the dilute sulfuric acid in g/dm³.

..... g/dm³
[4]

(e) Iron(II) sulfate decomposes when heated strongly.



15.20 g of $\text{FeSO}_4(\text{s})$ was heated and formed 4.80 g of $\text{Fe}_2\text{O}_3(\text{s})$.

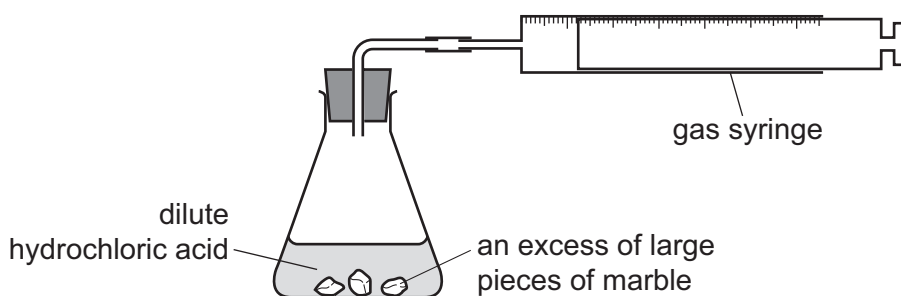
[M_r , $\text{FeSO}_4 = 152$; M_r , $\text{Fe}_2\text{O}_3 = 160$]

Calculate the percentage yield for this reaction.

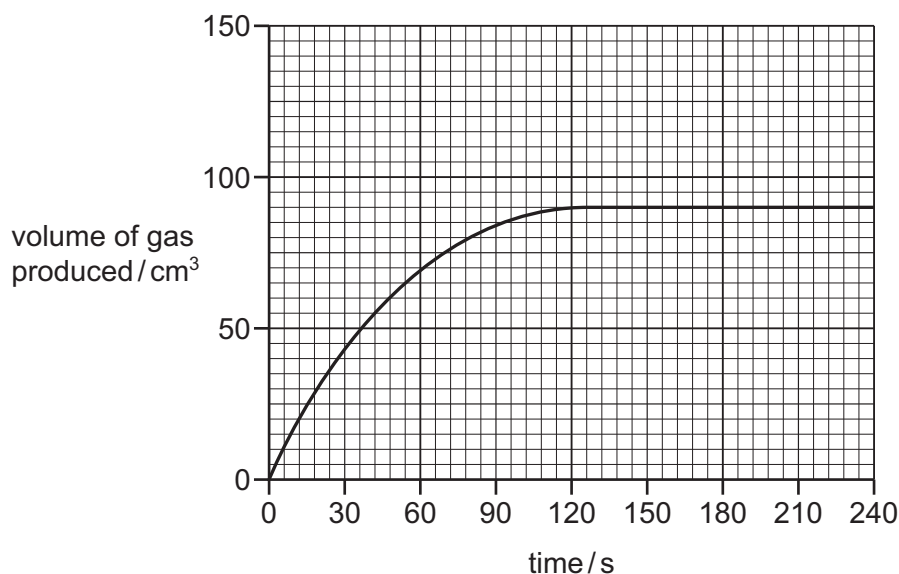
..... % [3]

[Total: 26]

- 4 A student investigated the progress of the reaction between dilute hydrochloric acid, HCl , and an excess of large pieces of marble, CaCO_3 , using the apparatus shown.



- (a) A graph of the volume of gas produced against time is shown.



- (i) How does the shape of the graph show that the rate of reaction decreased as the reaction progressed?

.....
 [1]

- (ii) Why did the rate of reaction decrease as the reaction progressed?

..... [1]

- (iii) After how many seconds did the reaction finish?

..... s [1]

- (b) The experiment was repeated using the same mass of smaller pieces of marble. All other conditions were kept the same.

Draw a graph **on the grid** to show the progress of the reaction using the smaller pieces of marble. [2]

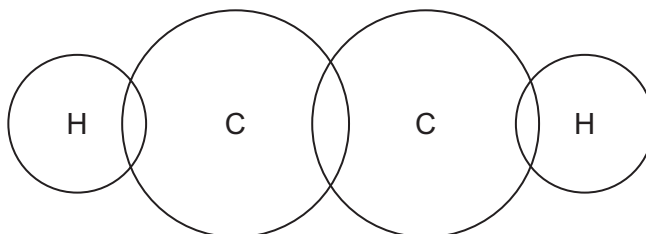
- 5 Alkynes are a homologous series of unsaturated hydrocarbons. All members contain a $C\equiv C$ triple bond.

(a) Complete the table showing information about the first **three** alkynes.

formula	C_2H_2	C_3H_4	
structure	$H-C\equiv C-H$	$H-C\equiv C-CH_3$	$H-C\equiv C-CH_2-CH_3$
name	ethyne		butyne

[2]

- (b) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ethyne, $H-C\equiv C-H$. Show outer shell electrons only.



[2]

(c) Compounds in the same homologous series have the same general formula.

- (i) Give **two** other characteristics of members of a homologous series.

1

2

[2]

- (ii) Use the information in the table in (a) to deduce the general formula of alkynes.

..... [1]

(d) Alkynes are unsaturated.

Describe a test for unsaturation.

test

result

[2]

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The Periodic Table of Elements

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Li lithium 7	Be beryllium 9	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20	Na sodium 23	Mg magnesium 24	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40	K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59	Cu copper 64	Zn zinc 65	Ga gallium 70	Ge germanium 73	As arsenic 75	Se selenium 79	Br bromine 80	Kr krypton 84	Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium —	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106	Ag silver 108	Cd cadmium 112	In indium 115	Sn tin 119	Sb antimony 122	Te tellurium 128	I iodine 127	Xe xenon 131	Cs caesium 133	Ba barium 137	La lanthanum 139	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium —	At astatine —	Rn radon —	Fr francium —	Ra radium —	Ac actinium —	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —	Cn copernicium —	Fl flerovium —	Lv livermorium —	Uu ununoctium —	Og oganeson —																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids

actinoids

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