71

Candidate Num

General Certificate of Secondary Education
2012

Science: Chemistry

Paper 2
Higher Tier

[G1404]

G1404

FRIDAY 22 JUNE, AFTERNOON

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Write your answers in the spaces provided in this question paper.
Answer **all seven** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 160.
Quality of written communication will be assessed in question **7(c)**.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
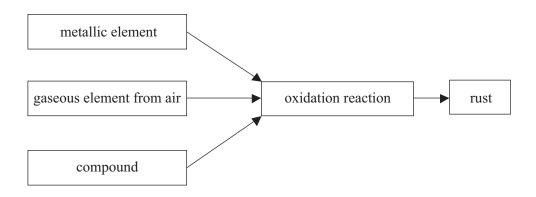A Data Leaflet which includes a Periodic Table of the Elements is provided.

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
Total Marks	

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1 **(a)** The formation of rust is described as an oxidation reaction. The flow chart below shows the formation of rust during which a metallic element reacts with a gaseous element from the air and a compound.

```
┌─────────────────────┐
│   metallic element  │──┐
└─────────────────────┘  │
                         ↘
┌─────────────────────┐   ┌──────────────────┐   ┌────────┐
│gaseous element from air│→│ oxidation reaction│→│  rust  │
└─────────────────────┘   └──────────────────┘   └────────┘
                         ↗
┌─────────────────────┐  │
│      compound       │──┘
└─────────────────────┘
```

(i) Name the metallic element which reacts to form rust.

_____ [1]

(ii) Name the gaseous element from the air which is required for the formation of rust.

_____ [1]

(iii) Name the compound which is required for the formation of rust.

_____ [1]

(iv) Explain what is meant by oxidation.

_____

_____ [1]

(v) Describe the appearance of rust.

_____

_____ [2]

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(b) The reaction of chlorine with hydrogen may be described as both an exothermic reaction and as a reduction.

chlorine + hydrogen → hydrogen chloride

(i) Write a balanced symbol equation for the reaction of chlorine with hydrogen.

_____ [3]

(ii) Explain why chlorine is described as being reduced in this reaction.

_____

_____

_____ [2]

(iii) Describe the colour of the reactants in this reaction.

chlorine _____

hydrogen _____ [2]

(iv) What is meant by the term exothermic?

_____

_____ [1]

(c) Copper(II) carbonate breaks down on heating in an endothermic reaction.

(i) What term is used to describe a reaction in which a substance breaks down on heating?

_____ [2]

(ii) Write a balanced symbol equation for the reaction which occurs when copper(II) carbonate is heated.

_____ [2]

[Turn over

(iii) State the colour change observed when copper(II) carbonate is heated.

_____

_____ [2]

(d) Magnesium reacts with copper(II) sulphate solution. The reaction is described as a redox reaction as both oxidation and reduction are occurring. The balanced symbol equation and ionic equation for the reaction are given below.

Balanced Symbol Equation: $Mg \; + \; CuSO_4 \; \rightarrow \; Cu \; + \; MgSO_4$

Ionic Equation: $\qquad\qquad Mg \; + \; Cu^{2+} \; \rightarrow \; Cu \; + \; Mg^{2+}$

(i) In this reaction, which ion does not undergo any change?

_____ [1]

(ii) What is oxidised in this reaction?

_____ [1]

(iii) Write a half equation for the oxidation process occurring in this reaction.

_____ [3]

(iv) Explain why copper ions are described as being reduced in this reaction.

_____

_____ [2]

7222

2 Pharmaceutical drugs are manufactured and analysed in a specialised chemistry laboratory.

Í 'Dt cpf 'Z 'Rkewt gu'T'Vj kpmuqem

(a) Amyl nitrite is a drug commonly used to treat patients with heart disease.

A sample of amyl nitrite was analysed and found to contain four elements in the following proportions: 72.0 g of carbon, 13.2 g of hydrogen, 16.8 g of nitrogen and 38.4 g of oxygen.

Determine the empirical formula of amyl nitrite.
(Relative atomic masses: H = 1; C = 12; N = 14; O = 16)

Empirical formula _____ [5]

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[Turn over

(b) The pharmaceutical drug Eskalith is made from another carbon containing compound. The formula of this compound may be written as X_2CO_3. To determine the identity of X in this compound, a titration was carried out.

3.70 g of solid X_2CO_3 were dissolved in 1000 cm³ of deionised water and mixed thoroughly. 25.0 cm³ of this solution were placed in a conical flask with a few drops of methyl orange indicator. 20.0 cm³ of 0.125 mol/dm³ hydrochloric acid were required to reach the end-point.

(i) Calculate the number of moles of hydrochloric acid used in this titration.

moles _____ [2]

The balanced symbol equation for the reaction is:

$$X_2CO_3 \ + \ 2HCl \ \rightarrow \ 2XCl \ + \ CO_2 \ + \ H_2O$$

(ii) Use the balanced symbol equation to determine the number of moles of X_2CO_3 present in 25.0 cm³ of the solution in the conical flask.

moles _____ [2]

(iii) Calculate the number of moles of X_2CO_3 present in 1000 cm³ of solution.

moles _____ [2]

(iv) Using the initial mass of X_2CO_3 and the answer to **(b) (iii)**, calculate the relative formula mass of X_2CO_3.

relative formula mass _____ [2]

(v) Calculate the relative atomic mass of X and use your Data Leaflet to determine the identity of X.
(Relative atomic masses: C = 12; O = 16)

relative atomic mass _____

identity of X _____ [2]

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[Turn over

(c) Nitrous oxide (N_2O), also known as laughing gas, is commonly used as an anaesthetic in dentistry. Nitrous oxide may be produced by heating a sample of ammonium nitrate, NH_4NO_3. The equation for this reaction is given below.

$$NH_4NO_3(s) \rightarrow 2H_2O(g) + N_2O(g)$$

Calculate the volume of nitrous oxide in dm^3 which can be produced when 2 kg of ammonium nitrate are fully decomposed on heating. (Relative atomic masses: H = 1; N = 14; O = 16; 1 mole of any gas occupies a volume of 24 dm^3 at room temperature and pressure.)

volume of N_2O _____ dm^3 [6]

(d) Nitrous oxide (N_2O) may also be produced by heating ammonia and oxygen in the presence of a catalyst. The equation for this reaction is given below.

$$2NH_3(g) \ + \ 2O_2(g) \ \rightarrow \ N_2O(g) \ + \ 3H_2O(g)$$

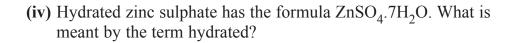**(i)** State Avogadro's Law.

_____

_____

_____ [3]

(ii) Using Avogadro's Law, or otherwise, calculate the volume of ammonia (NH_3) in cm^3, required to produce $70\,cm^3$ of nitrous oxide (N_2O).

volume of NH_3 _____ cm^3 [2]

7222

[Turn over

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3 (a) Acids, bases, alkalis and salts are used in many commonly available household products such as those shown below. One substance found in each is stated.

÷Vj g''hqmqy kpi ''ko ci gu''j cxg''dggp''tgo qxgf ''htqo ''vj ku'r ci g''f wg''vq'' eqr {tki j v'kuuwgu‹'

'"''

É'C''dci ''qh''Dcyj ''Et{uvcn''eqpvckpkpi ''o ci pukwo ''ej nqtkf g0''

É'C''dqwng''qh''O kni'qh''O ci pukc''nks wkf ''eqpvckpkpi ''o ci pukwo ''j {ftqzkf g0''

É'C''ecp''qh''O t''O wueng''Qxgp''Engcpgt''eqpvckpkpi ''uqf kwo ''j {ftqzkf g0''

É'C''dci ''qh''O qquukngt''(''Ncy p''Vqpke''eqpvckpkpi ''|kpe''uwnrj cvg0''

(i) Classify each substance as an acid, base, alkali or salt by placing a tick (✔) in the correct column in the table below. Choose the most common classification for each substance. You may find your Data Leaflet useful in answering this question.

Substance	acid	base	alkali	salt
magnesium chloride				
magnesium hydroxide				
sodium hydroxide				
zinc sulphate				

[4]

(ii) Sodium hydroxide reacts with sulphuric acid. Write a balanced symbol equation for this reaction.

_____ [3]

(iii) Name the salt produced when magnesium hydroxide reacts with nitric acid.

_____ [1]

(iv) Hydrated zinc sulphate has the formula $ZnSO_4.7H_2O$. What is meant by the term hydrated?

_____

_____ [2]
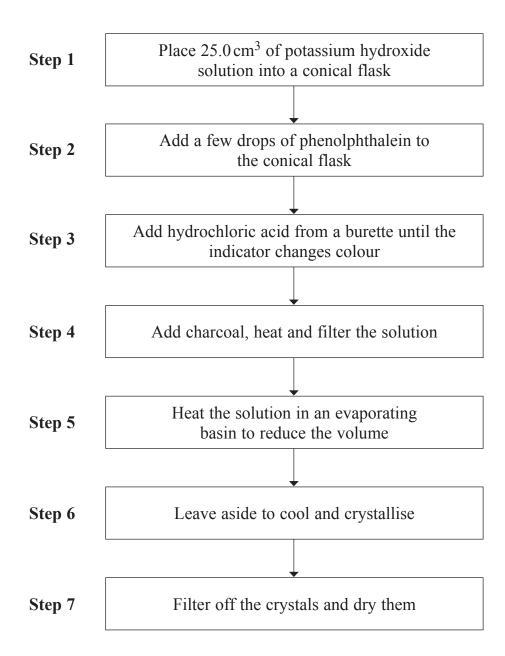
(b) A pure, dry sample of potassium chloride can be prepared by the reaction of potassium hydroxide solution with hydrochloric acid.

The flow chart below explains how this is carried out.

Step 1 — Place $25.0\,cm^3$ of potassium hydroxide solution into a conical flask

Step 2 — Add a few drops of phenolphthalein to the conical flask

Step 3 — Add hydrochloric acid from a burette until the indicator changes colour

Step 4 — Add charcoal, heat and filter the solution

Step 5 — Heat the solution in an evaporating basin to reduce the volume

Step 6 — Leave aside to cool and crystallise

Step 7 — Filter off the crystals and dry them

(i) Name the piece of apparatus required to place 25.0 cm³ of potassium hydroxide solution into the conical flask in **Step 1**.

_____ [1]

(ii) What colour change is observed in **Step 3**?

From _____ to _____ [2]

(iii) What is the purpose of the charcoal in **Step 4**?

_____ [1]

(iv) Draw a labelled diagram of the assembled apparatus used to heat the solution in **Step 5**.

[3]

(v) Explain why crystals form on cooling in **Step 6**.

_____

_____ [1]

(vi) State **one** method which may be used to dry the crystals in **Step 7**.

_____

_____ [1]

[Turn over

(c) The presence of anions in salts can be determined by mixing two solutions and observing the formation of a precipitate and its colour.

(i) What is an anion?

_____ [1]

(ii) What is meant by the term precipitate?

_____

_____ [2]

(iii) Name the solution which is used to test for the presence of sulphate ions.

_____ [1]

(iv) Potassium iodide solution was mixed with silver nitrate solution and a precipitate formed. State the colour of the precipitate.
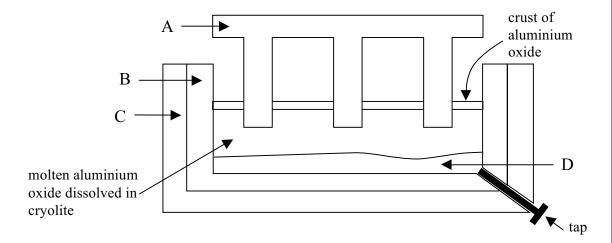
_____ [1]

4 Aluminium is the most abundant metal in the Earth's crust. Aluminium ore is first purified to give aluminium oxide and the metal is then extracted from the aluminium oxide by electrolysis.

(a) What is meant by the term electrolysis?

_____

_____ [2]

(b) Name the ore from which aluminium is extracted.

_____ [1]

(c) The electrolysis of the purified ore is carried out in the Hall-Héroult cell. The diagram below shows the cell used.

(i) Name parts A, B and C, and substance D.

A _____

B _____

C _____
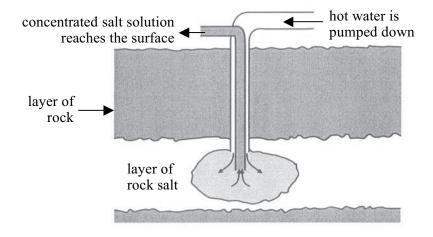
D _____ [4]

(ii) Explain why the aluminium oxide will only conduct electricity when molten.

_____

_____ [2]

[Turn over

(iii) At what temperature does the electrolysis take place?

_____ [1]

(iv) Suggest **one** reason why the aluminium oxide is dissolved in cryolite.

_____ [1]

(v) Name the products formed at the positive and negative electrodes and write half equations for the reactions taking place at each electrode.

	Positive electrode	**Negative electrode**	
Name of product			[2]
Half equation			[6]

(vi) Which electrode must be replaced regularly? Write a balanced symbol equation to explain your answer.

Electrode: _____ [1]

Equation: _____ [2]

(vii) Explain how the aluminium produced in the process is removed from the cell.

_____

_____ [1]

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5 The earth is a rich source of many raw materials. Some of these raw materials, including lignite, are extracted by open-cast mining.

(a) Lignite is a fossil fuel. Describe how lignite is formed.

_____

_____

_____ [3]

(b) Large deposits of lignite have been located near Ballymoney, County Antrim. The advantages and disadvantages associated with mining this lignite were debated in the Northern Ireland Assembly in July 2007.

(i) State **two** advantages for the local community of setting up a lignite mine.

1. _____

_____

2. _____

_____ [2]

(ii) State **two** disadvantages for the local community of setting up a lignite mine.

1. _____

_____

2. _____

_____ [2]

[Turn over

(c) Another method used to extract raw materials from the earth is solution mining. This method is used to extract sodium chloride from the earth.

concentrated salt solution reaches the surface

hot water is pumped down

layer of rock

layer of rock salt

(i) On what physical property of sodium chloride does this process depend?
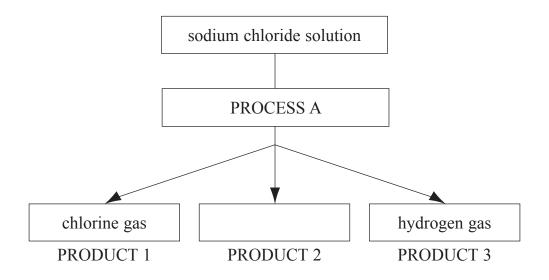
_____ [1]

(ii) Suggest **one** reason why solution mining uses a lot of energy.

_____ [1]

(iii) Suggest **one** negative effect which solution mining has on the environment.

_____ [1]

(d) The chlor-alkali industry uses a substantial percentage of the sodium chloride produced from solution mining. The main process involved is summarised in the diagram below.

```
         ┌─────────────────────────────┐
         │   sodium chloride solution  │
         └─────────────────────────────┘
                       │
         ┌─────────────────────────────┐
         │         PROCESS A           │
         └─────────────────────────────┘
          ╱            │            ╲
 ┌──────────────┐ ┌──────────────┐ ┌──────────────┐
 │ chlorine gas │ │              │ │ hydrogen gas │
 └──────────────┘ └──────────────┘ └──────────────┘
   PRODUCT 1        PRODUCT 2        PRODUCT 3
```

(i) Name Process A.

_____ [1]

(ii) Write the chemical formula for Product 2.

_____ [1]

(iii) State **one** use of each of the gaseous products.

chlorine: _____

hydrogen: _____ [2]

6 On 14th April 2010 the volcano Eyjafjallajökull erupted in Iceland, creating an ash cloud which was dangerous for aircraft and led to the closure of many airports for about ten days.

Í "kUqenr j q\q"l"Vj kpmvqem

A large number of gases were released into the atmosphere from the volcano. These volcanic gases included carbon dioxide, hydrogen and hydrogen chloride.

(a) Complete the table below to describe the tests used to identify each of these gases in the laboratory, and state the result of a positive test for each gas.

Gas	Test	Result of positive test	
carbon dioxide			[2]
hydrogen			[2]
hydrogen chloride			[4]

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(b) Sulphur dioxide is also emitted when a volcano erupts. It is a pollutant gas which reacts with water in the air to form acid rain.

(i) Write a balanced symbol equation for the reaction of sulphur dioxide with water.

_____ [2]

(ii) State **two** harmful effects of acid rain on the environment.

1. _____

_____

2. _____

_____ [2]

(c) Volcanic ash contains many different minerals and can be used in cosmetics including skin scrubs. Some skin scrubs, such as the one shown below, contain sugar to give roughness.

=Cp'ko ci g''qh'O CE''Xqrecpke''Cuj ''Gzhqrkcvqt''j cu'dggp''tgo qxgf htqo ''vj ku'r ci g''f wg''vq''eqr { tki j v''kuuwgu0»

(i) Describe the appearance of sugar.

_____ [2]

[Turn over

(ii) State **three** observations you would make when concentrated sulphuric acid is added to sugar.

_____

_____

_____ [3]

(d) Iron compounds are added to many cosmetics to give colour. Iron compounds may contain the iron(II) ion or the iron(III) ion. The presence of these ions in solution may be detected by adding ammonia solution.

(i) Complete the table to show what would be observed when ammonia solution is added to a solution of iron(II) ions and to a solution of iron(III) ions.

	Result of a positive test when ammonia solution is added
iron(II) ion	
iron(III) ion	

[4]

(ii) Write an ionic equation for the reaction of iron(II) ions with ammonia solution.

_____ [3]

7 Hydrogen peroxide, H_2O_2, decomposes very slowly to produce water and oxygen.

(a) Draw a labelled diagram of the assembled apparatus used to carry out this reaction and measure the volume of oxygen produced every minute. Include all apparatus required.

[4]

[Turn over

(b) The rate of decomposition of hydrogen peroxide may be increased by adding 1 g of manganese(IV) oxide (manganese dioxide) to the solution. The manganese(IV) oxide acts as a catalyst.

(i) Explain what you understand by the term catalyst.

_____

_____

_____ [3]

(ii) What mass of manganese(IV) oxide will be recovered at the end of the reaction?

_____ [1]

(iii) Catalysts are important in many industrial processes. Complete the table below.

Industrial Process	Catalyst used	Balanced symbol equation for the catalysed reaction	
The Haber Process	iron		[3]
The Contact Process		$2SO_2 \ + \ O_2 \ \rightarrow \ 2SO_3$	[1]
Production of Nitric acid	platinum/ rhodium		[3]

(c) Another method of increasing the rate of decomposition of hydrogen peroxide is to increase the temperature of the solution. Explain, in terms of particles, how increasing the temperature of the solution increases the rate of reaction.

_____

_____

_____

_____

_____

_____

_____ [3]

Quality of written communication   [2]

(d) In the Haber Process, a pressure of 250 atmospheres is used even though a higher yield of ammonia can be obtained at a higher pressure. Suggest **two** reasons why a higher pressure is not used in the process.

1. _____

_____

_____

2. _____

_____

_____ [2]

THIS IS THE END OF THE QUESTION PAPER

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