NAME \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ INDEX NO. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

SIGNATURE \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DATE \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**233/2**

**CHEMISTRY**

**PAPER 2**

**(THEORY)**

JULY, 2017

**TIME: 2 HOURS**

233/2

CHEMISTRY

PAPER 2

(THEORY)

TIME: 2 HOURS

**INSTRUCTIONS:**

* Write your name, school and index number in the spaces provided above.
* Sign and write the date of the examination in the spaces provided above.
* Answer **ALL** the questions in the spaces provided.
* Mathematical tables and silent electronic calculators may be used.
* All working must be clearly shown where necessary.
* This paper consists of **12** printed pages.
* Candidates should check to ensure that all pages are printed as indicated and no questions are missing.

**FOR EXAMINER’S USE ONLY**

|  |  |  |
| --- | --- | --- |
| **Question** | **Maximum score** | **Candidate’s score** |
| **1** | 12 |  |
| **2** | 12 |  |
| **3** | 8 |  |
| **4** | 12 |  |
| **5** | 15 |  |
| **6** | 12 |  |
| **7** | 9 |  |
| **Total score** | **80** |  |

**1.** Study the table below and answer the questions that follow.

|  |  |  |  |
| --- | --- | --- | --- |
| **Element** | **Atomic number** | **Relative atomic mass** | **Melting point (oC)** |
| Aluminum | 13 | 27.0 |  |
| Calcium | 20 | 40.0 | 850 |
| Carbon | \_\_ | 12.0 | 3730 |
| Hydrogen | \_\_ | 1.0 | - 259 |
| Magnesium | 12 | 24.0 | 650 |
| Neon | \_\_ | 20.0 | - 249 |
| Phosphorous | 15 | 31.0 | 44.2 white  590 red |
| sodium | \_\_ | 23 | 97.8 |

a) Complete the table by filling in the missing atomic numbers. (2 marks)

b) Write the electron arrangement for the following ion. (2 marks)

i) Ca2+

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ii) P3−

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c) What is the melting point of hydrogen in Kelvin? (1 mark)

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d) Which of the allotropes of phosphorous has a higher density? Explain. (2 marks)

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e) The mass numbers of three isotopes of magnesium are 24, 25 and 26.

What is the mass number of the most abundant isotope of magnesium? Explain. (2 marks)

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f) Give the formula of the compound formed between aluminum and carbon. (1 mark)

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g) Explain the difference in the melting points of magnesium and sodium. (2 marks)

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**2.** a) The diagram below shows the Frasch process used for extraction of sulphur.

Use it to answer to answer the questions that follow.



1. Identify X. (1 mark)

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ii) Why is it necessary to use super-heated water in this process? (1 mark)

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iii) State **two** physical properties of sulphur that makes it possible for it to be extracted by this method. (2 marks)

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b) The diagram below shows part of the process in the manufacture of suphuric (VI) acid.

Study it and answer the questions that follow.



i) Write an equation for the formation of sulphur (IV) oxide from sulphur. (1 mark)

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ii) What it the role of concentrated sulphuric (VI) acid in chamber A? (1 mark)

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iii) Name **two** catalysts that can be used in the catalytic chamber B. (1 mark)

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iv) State **two** roles of the heat exchanger. (2 marks)

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c) Explain **one** way in which sulphur (IV) oxide is a pollutant. (1 mark)

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d) What observation will be made when a few drops of concentrated sulphuric (VI) acid are added to crystals of sugar? Explain your answer. (2 marks)

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**3.** a) State **two** factors that should be considered when choosing a fuel for cooking. (2 marks)

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b) The diagram below represents a set-up that was used to determine the molar heat of combustion of ethanol.



During the experiment the data given below was recorded.

Volume of water = 450cm3

Initial temperature of water = 25oC

Final temperature of water = 46.5oC

Mass of ethanol + lamp before burning = 125.5g

Mass of ethanol + lamp after burning = 124.0g

Calculate the:

1. Heat evolved during the experiment.

(Density of water = 1g/cm3 specific heat capacity of water = 4.2Jg−1K−1). (2 marks)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ii) Molar heat of combustion of ethanol (C = 12, O = 16, H = 1). (2 marks)

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c) Write the equation for the complete combustion of ethanol. (1 mark)

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d) The value of the molar heat of combustion of ethanol obtained in b (ii) above is lower than the theoretical value. State **one** source of error in the experiment. (1 mark)

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**4.** a) Crude oil is a source of many compounds that contain carbon and hydrogen only.

i) Name the process used to separate the components of crude oil. (1 mark)

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ii) State **two** physical properties of the above components that determine the separation. (2 marks)

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b) Under certain conditions, Heptane can be converted to two products.

The formula of one of the products is C3H8.

i) Write the formula of the other product. (1 mark)

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ii) Determine a simple chemical reaction to show the difference between the two products formed in b(i) above. (2 marks)

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c) Butyne C4H6 is another compound found in crude oil. One mole of butyne was reacted with one mole of hydrogen chloride gas and a product P1 was formed. P1 was then reacted with excess hydrogen gas to form P2. Draw the structure of P1 and P2. (2 marks)

d) The set up below was used to prepare and collect ethene gas.

Study it and answer the questions that follow.



1. Name substance T. (1 mark)

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ii) Give the property of ethene that allows it to be collected as shown in the set-up. (1 mark)

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e) One of the reactions undergone by ethene is addition polymerization.

Give the name of the polymer and **one** disadvantage of the polymer it forms. (2 marks)

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Disadvantage \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**5.** a) The standard electrode potentials for the elements chloride and magnesium are:

Cl2 (aq) + 2e− → 2Cl− (aq) Eθ = +1.36V

Mg2+ (aq) + 2e− → Mg(s) Eθ = –2.36V

1. Which one for the two elements will act as an oxidizing agent? Explain your choice. (2 marks)

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ii) Calculate the electromotive force of a cell where the overall reaction is:

Cl2 (aq) + Mg (s) → MgCl2 (aq) (1 mark)

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b) The table below gives the standard electrode potentials for divalent metals represented by the letters P, Q, R and S (not their symbols of elements). Use it to answer the question that follow.

Metal Eθ (volts)

P +1.50

Q +0.44

R +0.34

S –0.76

i) Which one of the metals cannot be displaced from a solution of its ions by any other metals in the table? Explain. (2 marks)

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ii) Metals P and Q were connected to from a cell as shown in the diagram below.



I. On the diagram label the metals P and Q and indicate the ions in solution. (2 marks)

II. Write equations (half equations) of the reactions taking place at the electrodes.

Electrode P (1 mark)

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Electrode Q (1 mark)

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III. State **two** functions of the salt bridge. (2 marks)

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IV. What must be observed about the choice of a salt bridge? (1 mark)

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iii) A metallic couple of the metal S and Z produced a voltage of +1.71volts.

(Assume that S has the higher negative electrode potential)

I. Calculate the standard electrode potential (S.E.P) for metal Z. (1 mark)

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II. Arrange the metals P, Q, R and Z in their decreasing order of reactivity. (2 marks)

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**6.** a) Define the term solubility. (1 mark)

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b) In an experiment to determine the solubility of two salts X and Y at different temperatures, a candidate recorded her observations as shown below.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Temperature (oC) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
| Solubility of X in g/100g of H2O | 14.3 | 17.4 | 20.7 | 25.0 | 28.5 | 33.3 | 40.0 | 47.0 | 55.0 | 64.0 |
| Solubility of Y in g/100g of H2O | 25.0 | 27.5 | 30.0 | 32.5 | 35.0 | 37.6 | 40.1 | 42.4 | 45.0 | 48.0 |

 On the same axes plot the solubility curves of X and Y against temperature. (5 marks)

c) From the graph determine;

i) Solubility of X and Y at 47oC.

Solubility of X. (½ mark)

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Solubility of Y. (½ mark)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ii) The temperature at which the two salts have the same solubility in water. (1 mark)

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d) If 60g of X is dissolved in 100g of water and heated to 90oC, calculate the amount of salt that crystallized out if cooled to 20oC. (1 mark)

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e) State what would happen if a mixture of salt X in 100g of water and 30g of Y in 100g of water were cooled from 90oC to 70oC. (2 marks)

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f) State **one** application of solubility. (1 mark)

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**7.** In an experiment, a piece of magnesium ribbon was cleaned with steel wool. 2.4g of the clean magnesium ribbon was placed in crucible and completely burnt in oxygen.

After cooling, the product weighed 4.0g.

a) Explain why it is necessary to clean the magnesium ribbon. (1 mark)

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b) What observation was made in the crucible after burning? (1 mark)

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c) Why was there an increase in mass? (1 mark)

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d) Write the equation for the reaction which took place in the crucible. (1 mark)

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e) The product in the crucible was shaken with water and filtered.

Explain the observation which was made when blue and red litmus papers were dropped into the filtrate. (2 marks)

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f) Calculate the volume of oxygen gas used during the burning.

(O = 16, molar volume of gas = 24000cm3 at room temperature) (3 marks)

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