**CHEMISTRY**

**Paper 1**

**June 2016**

Time: 2 hours

**JUNE 2016**

**Kenya Certificate of Secondary Education**

**CHEMISTRY**

**PAPER 1**

**M A R K I N G S C H E M E**

1. Consider the diagram below.

a

b

c

 Name the regions labeled a, b, c. **(3 marks)**

 a ***Pale blue zone***

 b ***Green blue zone***

 c ***Almost colourless zone***

2. Some moist iron wool was placed in a test tube and the tube was inverted and set up as shown below.

y cm

x cm

 The apparatus was left for one week. The water level rose and iron wool turned red-brown.

 (i) Write the chemical equation to show the rusting of iron.  **(1 mark)**

 ***4Fe(s) + 302(g) + xH2O 2Fe2O3🞄 xH2O(s)***

(ii) Write the expression for an approximate percentage.  **(1 mark)**

(iii) State two similarities between rusting and combustion.

 (a) ***Both use oxygen***  **(1 mark)**

(b) ***Oxides are formed***  **(1 mark)**

3. Paper chromatography is a method of separating colours or dyes.

What two properties should the components of a mixture have that would make the separation possible. **(2 marks)**

* ***Solubility in the solvents***
* ***Stickiness or absorbility***

4. A student was asked to prepare Lead (II) chloride salt using the following ingredients; Nitric acid, lead (II)oxide and hydrochloric acid. Using ionic equations only explain how the salt can be prepared. **(2 marks)**

***PbO(s) + 2H+(aq) Pb2+(aq) + H2O(l)***

***Pb2+(aq) + 2Cl─(aq) PbCl2(s)***

5. The nitrates of the following metals were heated strongly and observation made accordingly. The nitrate of metal **P** produced the metallic oxide, Nitrogen (IV) oxide and oxygen gas; and that of metal **Q** produced the metallic nitrite and oxygen gas. The nitrate of **R** produced metal **R**, Nitrogen (IV) oxide and oxygen gas. Arrange the metals in order of reactivity beginning with the most reactive. **(2 marks)**

***Q, P, R***

6. A student added barium hydroxide drop wise into a beaker containing dilute sulphuric (VI) acid.

**B**

*x*

*y*

Conc. of ions in solution

 Conductivity

**A**

**C**

 (a) What is the significance of point **B**? **(1 mark)**

 ***The end point.***

 (b) Explain why point **B** does not touch the x-axis? **(1 mark)**

 ***The solution left behind is of a very weak electrolyte.***

(c) Explain what happens between

1. **A** and **B** **(1 mark)**

***Barium ions and sulphate ions are being removed gradually until point B whan they are completely removed.***

1. **B** and **C** **(1 mark)**

***Excess Barium and hydroxide ions are being introduced gradually as all the sulphate and H+ ions have been used up.***

7. In an experiment it was found that 40.0cm3 of 0.2M sodium hydroxide solution just neutralized 0.2g of a dibasic acid **Q**. Calculate the relative molecular mass of acid **Q**.

  **(2 marks)**

 ***2NaOH + H2*X  *Na2*X*(aq) + H2O(l)***

 ***Mole ratio 2 : 1***

 ***100cm3 of NaOH contained 0.2 moles***

 ***∴ No. of moles of a dibasic acid and reacting 0.008 x ½ = 0.004 moles***

 ***0.004 moles weigh 0.2g***

 ***∴ 1 mole will weigh***

 ***= 50g***

 ***∴ RM = = 50g***

8. Give two reasons why during preparation of salt, it is advisable to heat the solution to concentration allowing it to cool in order to crystallize instead of heating to dryness.

  **(2 marks)**

* ***Avoid decomposition of salt***
* ***Avoid loss of water of crystallization***

9. The following is a nuclear equation.

*X*

*y*

233

 91

Ac + a

Pa

1. Calculate the value of

x ***234 ─ 4 = 229***  **( ½ mark)**

y ***91 – 2 = 89*** **( ½ mark)**

1. State two differences between a nuclear reaction and a chemical reaction.

**(2 marks)**

|  |  |  |
| --- | --- | --- |
|  | ***Nuclear reaction*** | ***Chemical reaction*** |
| 1. | ***Unaffected by external forces*** | ***Affected by external forces*** |
| 2. | ***Release large amounts of heat energy*** | ***Heat energy released is much less*** |
| 3. | ***Involves protons and neutrons in nucleus*** | ***Involves electrons*** |

**(Any two)**

10. (a) Distinguish between a strong acid and a concentrated acid. **(1 mark)**

***Strong acid – Highly ionized/dissociated***

***Conc. acid – high molecule concentration per given volume or high solute concentration per given volume.***

1. Giving a reason in each case, identity an acid and a base in the equation.

H3O+(aq) + NH3(g) NH4+(aq) + H2O(l)

Acid: ***H3O+*** **(1 mark)**

Reason: ***Donates H+/proton***  **(1 mark)**

Base: ***NH3*** **(1 mark)**

Reason: ***Accepts a proton***  **(1 mark)**

11. Study the following information and answer the question that follows.

 Heat of hydration of x2+  = -1480 kJ/mol

 Heat of hydration y- = -364 kJ/mol

Lattice energy of XY2 = +2112 kJ/mol

Determine the heat evolved when 31.8g of XY2(s) is dissolved in water to give an infinitely dilute solution. (RAM of Z = 88, Y = 35.5) **(2 marks)**

 ***XY2(s) X2+(g) + 2y─(g)***

 ***DHsoln = DH (latt) + DH hydr.***

 ***= +2112 + (─1480 + 2(─364)***

 ***= +2112 +─2208***

 ***= ─96 kJ/mole***

 ***Molar mass of XY2 is 88 + 71 = 159(g)***

 ***If 159g of XY2 evolve 96 kJ***

 ***∴ 31.8g of XY2 will evolve 31.8 🞪 96***

 ***159***

 ***= 19.2kJ***

12. The apparatus below was set up to show the catalytic oxidation of ammonia.

Water

Hot platinum wire

Gas jar **Y**

Solid **B**

Conc. Ammonia solution

 (a) Write the equation between water and solid **B**. **(1 mark)**

 ***Na2O2(s) + H2O(l) 2NaOH(aq) + H2O(l)***

 (b) State and explain two observations made in gas jar **Y**. **(2 marks)**

1. ***Platinum wire***

***Explanation: Reaction is exothermic***

1. ***Brown fumes/gas can be seen***

***Explanation: Nitrogen (II) oxide formed is oxidized to nitrogen (IV) oxide***

13. (a) You are provided with a nickel rod, copper rod, connecting wires and a U-tube,

potassium nitrate solution, nickel sulphate solution copper sulphate solution and a voltameter. With a well labeled diagram show how you will use the apparatus and materials provided to construct an electrochemical cell. Oxidation potential of the metals are shown below:-

Cu(s) Cu2+ + 2e─ Eϑ = +0.34V

Ni(s) Ni2+ + 2e─ Eϑ = ─0.23V

e

voltameter

Cu

 Ni

Salt bridge containing KNO3(aq)

CuSO4(aq)

NiSO4(aq)

 (b) (i) Give the cell representation of the above cell. **(1 mark)**

  ***Cu(s)/ Cu2+(aq) Ni2+ (aq) Ni(s)***

 (ii) Work out the cell e.m.f of the cell above. **(1 mark)**

 ***E.m.f = EϑRed - Eϑ oxidation***

 ***-0.23 + 0.34***

 ***= +0.11V***

14. The sulphur (IV) oxide can be converted to sulphur (VI) oxide as shown in the equation below.

 2SO2(g) + O2(g) 2SO3(g)

 The energy level diagram for the above reaction is as shown below.

 *x*

Reactants

Energy

 Products

 Reaction y

 (a) What would be the effect of increase in temperature? **(2 marks)**

***Increase in temperature reduces the yield of SO3(g); Since the reaction is oxothermic enhancing decomposition of SO3 and SO2 and O2(g)***

 (b) On the same energy level diagram above sketch the energy level diagram that would be obtained if the reaction is carried out in presence of vanadium (V) oxide.

 **(1 mark)**

15. On complete combustion of a hydrocarbon gas X, 1.32g of carbon (IV) oxide and 0.54g of water. Calculate the empirical formula of X (C = 12.0, H = 1, O = 16.0) **(3 marks)**

 ***1 mole of CO2 weighs 44g***

 ***44g of CO2 contains 12g of c***

 ***∴ 1.32 of CO2 will contain***

 ***= 0.36g of C***

 ***1 mole of H2O weighs 18g***

 ***18g of H2O weigh 18g***

 ***∴ 0.54g of H2O will contain 2 0.54 = 0.06 of H***

 ***18***

 ***Element C H***

 ***Mass 0.36 0.06***

 ***Moles 0.36 0.06***

 ***12 1***

1. ***: 2***

 ***Empirical form = CH2***

16. Calculate the oxidation number of nitrogen in the following species.

 NO2 **(1 mark)**

 ***NO2 = 0***

***N + (-2)2 = O***

 ***n = +4***

 NH4+ **(1 mark)**

 ***NH4 = +1***

 ***N- (+1) = +1***

 ***N + 4 = +1***

 ***N = -3***

17. In an experiment to determine the relative formula mass of gas **P**; the time taken for equal volumes of oxygen and gas **P** under identical conditions of temperature and pressure was measured and the results were shown in the table below. (O = 16.0) **(3 marks)**

|  |  |  |
| --- | --- | --- |
| Gas | Oxygen | P |
| Time in seconds | 20.3 | 30.3 |

 ***=***

2

 ***=***

 ***M2 = 32 30.32***

 ***20.32***

***M2 = 71.92***

18. Using dots and crosses to represent electrons, show bonding in

 (a) Sulphur (IV) oxide  **(1 mark)**

 (b) Structure of an ion illustrated by the formula N3-   **(1 mark)**

3─

🞪🞪

🞪

🞪

 ⦁

🞪⦁

🞪⦁

 🞪

19. Calculate the number of chloride ions in a 250cm3 of 1M solution calcium chloride (Avogadro’s number is 6.0 1023) **(2marks)**

 ***Ca Cl2(aq) Ca2+(aq) + 2Cl─(aq)***

 ***No. of moles of CaCl2 m***

 ***∴ No. of moles of Cl─ ion = 0.25 x 2***

 ***= 0.5m***

 ***∴ No of chloride ions 0.5 x 6.0 x 1023***

 ***= 3.0 x 1023 ions***

20. A compound Y reacts with bromine to form another compound, whose formula is:

 H Br

 CH3 CH2 C C CH3

 Br H

What is the formula and name of the compound Y?  **(2 marks)**

 ***H H H H***

 ***H C C C = C C H Pent-z-ene***

 ***H H H H***

21. Study the diagram below and answer the questions that follow. **(3 marks)**

Gas jar

Dilute

Hydrochloric acid

Clamp

Zinc granules

Liquid **Z**

(a) Write an equation for the reaction between zinc granules and dilute hydrochloric acid. **(1 mark)**

 ***Zn(s) + 2HCl(aq) ZnCl2(aq) + H2(g)***

(b) What property of hydrogen is demonstrated by the method of collection shown on the diagram? **( ½ mark)**

 ***Lighter than air.***

1. Hydrogen gas passed through liquid **Z**. What is the name of liquid **Z** and what is the purpose of liquid **Z**? **(1 mark)**
* ***Conc. sulphuric acid***
* ***Today the gas/Remove water present***
1. Name **one** industrial use of hydrogen. **( ½ mark)**
* ***Used in industrial prep. of NH3(g)***
* ***Used in weather balloon.***

22. Three liquids were mixed together accidentally and this included lubricating oil, kerosene and water. The table below gives information about the properties of the liquids.

|  |  |  |  |
| --- | --- | --- | --- |
| Constituent | Boiling point in 0C | Solubility in water  | Solubility kerosene  |
| Lubricating oil | 350 – 400 | Insoluble | Soluble |
| Kerosene oil | 175 – 250 | Insoluble |  |
| Water | 100 |  | Insoluble |

 Suggest a method you would use to separate the three liquids. **(2 marks)**

* ***Use of a separating funnel to remove water***
* ***Fractional distillation to separate lubricating oil and kerosene.***

23. The diagrams below represent two iron nails with some parts wrapped tightly with zinc strips, respectively.

 **A** Zinc strip Iron nail **B** Copper strip Iron nail

What observations would be made at the exposed points **A** and **B** if the wrapped nails are

left in the open for several months? Explain.

Observation at **A**. ***Clean nail*** **( ½ mark)**

Explanation: ***Zinc reacts and protects iron zinc / is higher in the electrochemical***

 **( ½ mark)**

Observation at **B**. ***Rust/brown***  **( ½ mark)**

Explanation: ***Iron more reactive than copper/Higher than copper in the reactivity series*** **( ½ mark)**

24. RCOO─ Na+ and RC6H5SO3─ Na+, represent two cleansing agents where R is a long hydrocarbon chain.

(a) Write the formulae of the salts that would be formed when each of these cleansing agents is added to water containing calcium ions.  **(1 mark)**

* ***(RCOO)2 Ca***
* ***(RC6H5SO3)2 Ca***

(b) Explain how the solubilities of the calcium ions in (a) above affect the cleansing properties of each of the cleansing agents.  **(2 marks)**

***The first, cleansing ability was affected because the carboxylate ion responsible for cleaning is removed by the calcium ion responsible for cleaning is removed by the calcium ion forming an insoluble salt.***

***At the 2nd case, it forms soluble salt and so there is no effect as the sulphate ion free to cleanse.***

25. The grid below represents part of the periodic table. Study it and answer the questions that follow. The letters are not the actual symbols.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  | **Q** |  |  |  |  |
| **W** |  |  | **Y** |  |  | **R** | **S** |  |
| **T** |  |  |  |  |  | **K** | **U** |  |
| **V** |  |  |  |  |  |  | **Z** |  |

(a) Hydrogen can be placed in group I or group VII. Explain. **(1 mark)**

* ***Hydrogen reacts by losing one electron like group I elements to form H.***
* ***Hydrogen can react to gain an electron like group 7 elements to form H.***

(b) Write the formula of the compound formed between element **Y** and **R**. **(1 mark)**

***Y2R3***

 (c) How does the atomic radii of **T** and **K** compare. Explain. **(1 mark)**

***It is smaller than T; because K has more protons in the nucleus than T. There is therefore a greater pull in the K than T to the nucleus.***

26. Dilute sulphuric (VI) acid reacts with aqueous sodium hydroxide to form a salt. Give the formula and name of the anion in the salt.

 Name: ***Sulphur ion***  **(1 mark)**

 Formula: ***SO4***2─ **(1 mark)**

27. The molecular formula of a hydrocarbon is C6 H14. The hydrocarbon can be converted into two other hydrocarbons as shown by the equation below.

 C6 H14 X + C3 H8

1. Name and draw the possible structure of formula of x.

Name: ***Propene*** **(1 mark)**

Structure: **(1 mark)**

 ***H H H***

 ***H C C = C***

 ***H H H***

1. State and explain the observation that would be made if a few drops of bromine water were added to sample of x. **(1 mark)**

***Bromine is decolourised because sample x is unsaturated/has a double bond.***

28. The diagram below is of the apparatus used to measure the volumes of reacting gases.

**SYRINGE A**

 **SYRINGE B**

**TAP**

50cm3 of Oxygen

50cm3 of Nitrogen monoxide

Now, Nitrogen (II) oxide reacts with oxygen to form only one gaseous product. In the above experiment, 5.0cm3 portions of oxygen were pushed from syringe **B** into syringe **A**. After each addition, the tap was closed and after cooling, the total volume of gases remaining was measured. The results are shown below.

(a) What is observed in syringe **A** during the experiment? Explain using a chemical equation. **(1 mark)**

***Observation – Brown fumes of NO2 gas*** *( ½ mark)*

***Explanation – 2NO(g) + O2(g) 2NO2(g)*** *( ½ mark)*

(b) Determine from the graph above.

1. the total volume of gases when the reaction is complete.  **( ½ mark)**

***75.0cm3***

1. the volume of oxygen which reacts with 50cm3 of nitrogen monoxide.

 **(½ mark)**

 ***25.0cm3***

(c) Using the results to (b) (i) and (ii) determine the formula of the gaseous product formed.  **(1 mark)**

 ***NO(g) + O2(g) NxOy***

 ***50 25 50***

 ***2 : 1 : 2***

 ***2NO + O2 2NxOy***

 ***For x 2N = 2Nx***

 ***x = 1***

 ***For y 25y = 50***

 ***Y = 2***

***∴ N1O2 ⇒ NO2***

29. A condensation polymer formed by loss of water molecules has the following structure.

 O O

 ‖ ‖

 CH2 CH2CH2CH2

n

1. State **two** advantages of using natural polymers over synthenic ones. **(2 marks)**
* ***Biodegradable***
* ***More durable***

***Synthetic polymers are flammable producing poisonous gases/Natural polymers less flammable.***

1. Draw the structure of the monomer.  **(1 mark)**

 ***O***

***H O CH2 CH2 C OH***