OCR AS LEVEL CHEMISTRY A

1.1.2 MOLES AND EQUATIONS

1.1.3 ACIDS

TEST

Answer all questions

Max 51 marks

Name ……..
Mark ……../51 ……....% Grade ……

1. In the sixteenth century, a large deposit of graphite was discovered in the Lake District.

People at the time thought that the graphite was a form of lead.

Nowadays, graphite is used in pencils but it is still referred to as 'pencil lead'.

A student decided to investigate the number of carbon atoms in a 'pencil lead'. He found that the mass of the 'pencil lead' was 0.321 g.

(i) Calculate the amount, in mol, of carbon atoms in the student's pencil lead.

Assume that the 'pencil lead' is pure graphite.

answer = ... mol

[1]

(ii) Using the Avogadro constant, N_A, calculate the number of carbon atoms in the student's 'pencil lead'.

number of carbon atoms = ...

[1]

[Total 2 marks]

2. A student reacted 0.438 g of strontium with 200 cm^3 of water.

$$Sr(s) + 2H_2O(l) \rightarrow Sr(OH)_2(aq) + H_2(g)$$

(i) Calculate how many moles of Sr were reacted.

answer ..... mol

[1]

(ii) Calculate the volume, in dm^3, of $H_2(g)$ produced.

answer ..... dm^3

[1]

(iii) Calculate the concentration, in mol dm^{-3}, of the $Sr(OH)_2$ produced.

answer ..... mol dm^{-3}

[1]

[Total 3 marks]

3. Calcium oxide neutralises acids such as nitric acid. A student neutralised 1.50 g of CaO with 2.50 mol dm^{-3} nitric acid, HNO_3. The equation for this reaction is shown below.

$$CaO(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l)$$

(i) How many moles of CaO were reacted?

…… mol

[2]

(ii) Calculate the volume of 2.50 mol dm^{-3} HNO_3 needed to exactly neutralise 1.50 g of CaO.

volume = …… cm^3

[2]

[Total 4 marks]

4. The element strontium forms a nitrate, $Sr(NO_3)_2$, which decomposes on heating as shown below.

$$2Sr(NO_3)_2(s) \rightarrow 2SrO(s) + 4NO_2(g) + O_2(g)$$

A student heats 5.29 g of $Sr(NO_3)_2$ and collects the gas at room temperature and pressure, RTP.

Calculate the volume of gas, in dm^3, obtained by the student at RTP.

(Molar mass of $Sr(NO_3)_2$ = 211.6 g mol^{-1})

answer = ... dm^3

[Total 3 marks]

5. Chlorine can be prepared by reacting concentrated hydrochloric acid with manganese(IV) oxide.

$$4HCl(aq) + MnO_2(s) \rightarrow Cl_2(g) + MnCl_2(aq) + 2H_2O(l)$$

A student reacted 50.0 cm^3 of 12.0 mol dm^{-3} hydrochloric acid with an excess of manganese(IV) oxide.

(i) Calculate how many moles of HCl were reacted.

answer = ... mol

[1]

(ii) Calculate the volume of $Cl_2(g)$ produced, in dm^3.

answer = ... dm^3

[2]

[Total 3 marks]

6. Antimony is found naturally in a number of minerals including stibnite. Stibnite typically contains 5% of Sb_2S_3. Antimony can be obtained by reducing Sb_2S_3 with scrap iron.

$$Sb_2S_3 + 3Fe \rightarrow 2Sb + 3FeS$$

(i) How many moles of Sb_2S_3 are in 500 kg of a typical sample of stibnite containing 5% by mass of Sb_2S_3?

molar mass of Sb_2S_3 = 340 g mol^{-1}; relative atomic mass of Sb = 122

…… mol

[2]

(ii) Calculate the mass of antimony that could be obtained by processing 500 kg of stibnite.

mass = …… kg

[2]

[Total 4 marks]

7. (a) A student carries out a titration to find the concentration of some sulfuric acid.

The student finds that 25.00 cm^3 of 0.0880 mol dm^{-3} aqueous sodium hydroxide, NaOH, is neutralised by 17.60 cm^3 of dilute sulfuric acid, H_2SO_4.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

(i) Calculate the amount, in moles, of NaOH used.

answer = ... mol

[1]

(ii) Determine the amount, in moles, of H_2SO_4 used.

answer = ... mol

[1]

(iii) Calculate the concentration, in mol dm^{-3}, of the sulfuric acid.

answer = ... mol dm^{-3}

[1]

(b) After carrying out the titration in (a), the student left the resulting solution to crystallise. White crystals were formed, with a formula of $Na_2SO_4 \bullet \boldsymbol{x}\ H_2O$ and a molar mass of 322.1 g mol^{-1}.

(i) What term is given to the '$\bullet \boldsymbol{x}\ H_2O$' part of the formula?

.....

[1]

(ii) Using the molar mass of the crystals, calculate the value of ***x***.

answer = ...

[2]

[Total 6 marks]

8. Epsom salts can be used as bath salts to help relieve aches and pains.

Epsom salts are crystals of hydrated magnesium sulfate, $MgSO_4 \cdot \boldsymbol{x}H_2O$.

A sample of Epsom salts was heated to remove the water. 1.57 g of water was removed leaving behind 1.51 g of anhydrous $MgSO_4$.

(i) Calculate the amount, in mol, of anhydrous $MgSO_4$ formed.

amount = ... mol

[2]

(ii) Calculate the amount, in mol, of H_2O removed.

amount = ... mol

[1]

(iii) Calculate the value of $\boldsymbol{x}$ in $MgSO_4 \cdot \boldsymbol{x}H_2O$.

$\boldsymbol{x}$ = ...

[1]

[Total 4 marks]

9. Rubidium forms an ionic compound with silver and iodine. This compound has a potential use in miniaturised batteries because of its high electrical conductivity.

The empirical formula of this ionic compound can be calculated from its percentage composition by mass: Rb, 7.42%; Ag, 37.48%; I, 55.10%.

(i) Define the term *empirical formula*.

.....

.....

.....

[1]

(ii) Calculate the empirical formula of the compound.

[2]

[Total 3 marks]

10. A student reacted 1.44 g of titanium with chlorine to form 5.70 g of a chloride **X**.

(i) How many moles of Ti atoms were reacted?

[1]

(ii) How many moles of C*l* atoms were reacted?

[2]

(iii) Determine the empirical formula of **X**.

[1]

(iv) Construct a balanced equation for the reaction between titanium and chlorine.

.....

[1]

[Total 5 marks]

11. A small amount of solid magnesium oxide, MgO, was reacted with excess dilute hydrochloric acid.

(i) Define an acid.

.....

[1]

(ii) Write a balanced equation for this reaction.

.....

[1]

[Total 2 marks]

12. Both calcium carbonate, $CaCO_3$, and calcium oxide, CaO, are white solids.

Dilute hydrochloric acid, HC*l*, can be used to identify whether a sample of white solid is $CaCO_3$ or CaO.

(i) Write equations, including state symbols, for the reaction of HC*l* with $CaCO_3$ and the reaction of HC*l* with CaO.

.....

.....

[3]

(ii) How would observation of the reactions with hydrochloric acid allow the identification of the white solid?

$CaCO_3$ .....

.....

CaO .....

.....

[1]

[Total 4 marks]

13. A student carries out experiments using acids, bases and salts.

Calcium nitrate, $Ca(NO_3)_2$, is an example of a salt.

The student prepares a solution of calcium nitrate by reacting dilute nitric acid, HNO_3, with the base calcium hydroxide, $Ca(OH)_2$.

(i) Why is calcium nitrate an example of a salt?

.....

.....

[1]

(ii) Write the equation for the reaction between dilute nitric acid and calcium hydroxide. Include state symbols.

.....

[2]

(iii) Explain how the hydroxide ion in aqueous calcium hydroxide acts as a base when it neutralises dilute nitric acid.

.....

.....

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[1]

[Total 4 marks]

14. Ammonium compounds such as ammonium sulfate, $(NH_4)_2SO_4$, can be used as fertilisers.

(i) Write a balanced equation to show how ammonium sulfate could be formed by the reaction between aqueous ammonia and sulfuric acid.

.....

[1]

(ii) Ammonium sulfate is an example of a salt formed when an acid is neutralised by a base.

Explain what is meant by the term *salt*.

.....

.....

[1]

(iii) Why is ammonia acting as a base in this neutralisation?

.....

.....

[1]

(iv) What is the relative formula mass of $(NH_4)_2SO_4$?

Give your answer to **one** decimal place.

.....

[1]

[Total 4 marks]