1. Question | 5070 May-June 2023 P2 V1 Q9

9 Oxides of nitrogen such as nitrogen monoxide, NO, are atmospheric pollutants.

The exhaust gas from a car engine contains 0.00200% by volume of nitrogen monoxide.

(a) Calculate the number of molecules of nitrogen monoxide in 960 dm^3 of exhaust gas at room temperature and pressure.

One mole of any gas contains 6.02×10^{23} molecules.

number of molecules ..... [3]

(b) Nitrogen and oxygen react to make nitrogen monoxide inside a car engine.

Construct the equation for this reaction.

..... [1]

(c) State **one** adverse effect of oxides of nitrogen as pollutants in the air.

..... [1]

(d) Describe how oxides of nitrogen formed in a car engine are removed by a catalytic converter.

.....

..... [1]

(e) The rate of diffusion of nitrogen dioxide, $NO_2(g)$, is less than that of nitrogen monoxide, NO(g), under the same conditions of temperature and pressure.

(i) Explain why the rate of diffusion of $NO_2(g)$ is less than that of NO(g) under the same conditions.

.....

.....

..... [1]

(ii) The rate of diffusion of nitrogen monoxide decreases as the temperature decreases.

Suggest why using ideas about kinetic particle theory.

.....

..... [1]

[Total: 8]

7 **(a)** Dilute hydrochloric acid reacts with aqueous sodium carbonate.

$$2HCl + Na_2CO_3 \rightarrow 2NaCl + H_2O + CO_2$$

A student titrates $20.0\,cm^3$ of $0.0250\,mol/dm^3$ aqueous sodium carbonate with dilute hydrochloric acid using methyl orange as an indicator.

A volume of $15.5\,cm^3$ of dilute hydrochloric acid reacts exactly with the $0.0250\,mol/dm^3$ aqueous sodium carbonate.

Calculate the concentration, in mol/dm^3, of the dilute hydrochloric acid.

concentration of dilute hydrochloric acid ..... mol/dm^3 [3]

(b) **(i)** State the colour of methyl orange in alkaline solution.

..... [1]

(ii) Write the formula of the ion present in aqueous solutions of alkalis.

..... [1]

(c) Calculate the volume, measured at r.t.p., of carbon dioxide produced, in cm^3, when $2.65\,g$ of sodium carbonate reacts with excess hydrochloric acid.

$$2HCl + Na_2CO_3 \rightarrow 2NaCl + H_2O + CO_2$$

volume of carbon dioxide ..... cm^3 [2]

(d) Hydrochloric acid is a strong acid.

Define the term strong in the phrase strong acid.

..... [1]

(e) Oxides of nitrogen contribute to acid rain.

(i) State **one** other adverse effect of oxides of nitrogen.

..... [1]

(ii) Oxides of nitrogen are removed from car exhausts by catalytic converters.

Complete the symbol equation for the reaction that occurs in catalytic converters.

$$2CO + 2NO \rightarrow \text{.....} + \text{.....}$$ [2]

[Total: 11]

3. Question part 1/2 | 5070 Specimen 2023 P2 Q3

3 Salts can be prepared by the reaction of acids with bases or alkalis and also by precipitation reactions.

(a) State the ionic equation for the reaction between an acid and an alkali.

..... [1]

(b) Sodium sulfate is a soluble salt prepared by a titration method using an acid and an alkali.

Identify the acid and the alkali used to prepare sodium sulfate.

acid .....

alkali .....
[1]

(c) Aqueous sodium sulfate is used to prepare barium sulfate in a precipitation reaction.

$$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$$

In an experiment 20.0 cm^3 of 0.550 mol / dm^3 of barium nitrate is added to an excess of sodium sulfate.

(i) State the colour of the precipitate formed in the reaction.

..... [1]

(ii) Calculate the maximum mass of barium sulfate that could be made.

[M_r: $BaSO_4$, 233]

Show your working.

maximum mass of barium sulfate = ... g [2]

(iii) A mass of 1.92 g of dry barium sulfate is obtained.

Calculate the percentage yield of barium sulfate.

percentage yield of barium sulfate = ...% [1]

[Total: 6]

4. Question part 1/2 | 5070 Specimen 2023 P2 Q8

8 Copper reacts with concentrated nitric acid to form copper(II) nitrate.

$$Cu(s) + 4HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$$

(a) State the meaning of (aq).

.....

..... [1]

(b) An excess of copper is added to 25.0 cm^3 of 16.0 mol / dm^3 HNO_3.

Use this information, together with the equation, to calculate the volume of NO_2 formed. The gas volume is measured at room temperature and pressure.

Show your working and state the units.

volume of NO_2 = ... [3]

(c) When heated, $Cu(NO_3)_2$ decomposes to form CuO, NO_2 and O_2.

Construct the symbol equation for this reaction.

..... [1]

(d) To a small sample of $Cu(NO_3)_2(aq)$, a student adds aqueous ammonia drop by drop until it is in excess.

(i) Describe what is observed.

.....

.....

.....

..... [2]

(ii) The student repeats the experiment but adds aqueous sodium hydroxide instead of aqueous ammonia.

Describe what is observed.

.....

..... [1]

[Total: 8]