Topic 1 Tutorial Questions

Isotopes

1. The isotopes of magnesium and their percentage abundances are :

Isotope	^{24}Mg	^{25}Mg	^{26}Mg
Abundance (%)	78.6	10.1	11.3

   Calculate the relative atomic mass of magnesium.

   [24.3]

2. Calculate the relative atomic mass of gallium given the percentage abundances : ^{69}Ga 60.2% and ^{71}Ga 39.8%. [69.8]

3. Bromine has two isotopes, ^{79}Br and ^{81}Br. At what values of m/z would you expect to find lines in the mass spectrum of bromine, Br_2? (Assume that only 1+ ions are formed). [79, 81, 158, 160, 162]

Mole concept

1. What is the mass of 4 mol of sodium chloride, NaCl? [243 g]

2. How many moles is 37 g of calcium hydroxide, $Ca(OH)_2$? [0.5]

3. 0.004 mole of a substance weighs 1 g. what is the relative molecular mass of compound? [250]

4. Titanium is manufactured by heating titanium(IV) chloride with sodium
   $TiCl_4 + 4Na \rightarrow Ti + 4NaCl$
   What mass of sodium is required to produce 1 tonne of titanium ? [1.92 tonnes]

5. 2.67 g of aluminium chloride was dissolved in water and an excess of silver nitrate solution was added to give a precipitate of silver chloride :
   $AlCl3 + 3AgNO_3 \rightarrow Al(NO_3)_3 + 3AgCl$
   What mass of silver chloride precipitate would be formed? [8.61]

6. Calcium hydroxide is manufactured by heating calcium carbonate strongly to produce calcium oxide, and then adding a controlled amount of water to produce calcium hydroxide :
   $CaCO_3 \rightarrow CaO + CO_2$
   $CaO + H_2O \rightarrow Ca(OH)_2$
   (a) What mass of water would you need to add the calcium oxide produced from 1 tonne of calcium carbonate? [0.18 tonnes]

(b) What mass of calcium hydroxide would you ultimately produce from 1 tonne of calcium carbonate? [0.74 tonnes]

Empirical formula

1. 1.24 g of phosphorus was burnt completely in oxygen to give 2.84 g of phosphorus oxide. Find :
   a) The empirical formula of the oxide, and [P_2O_5]
   b) The molecular formula of the oxide given that 1 mole of the oxide weighs 284 g. [P_4O_{10}]

2. An organic compound contained 66.7% C, 11.1% H, 22.2% O by mass. Its relative molecular mass was 72. Find :
   a) The empirical formula of the compound, and [C_4H_8O]
   b) The molecular formula of the compound. [C_4H_8O]

Avogadro's constant

1. How many water molecules are there in 1 drop of water? Assume 1 drop of water is 0.05 cm^3 and that the density of water is 1 g $cm^{-3.}$ [1.67×10^{21}]

2. Sea water contains about 30 g of ionic sodium chloride in every 1000 cm^3 of water. What volume of sea water contains 10^{20} ion pairs, Na^+Cl^-? [3.007×10^{23}]

3. Which of the following contains the greatest number of stated particles?

   a. Molecules of hydrogen in 1 g of hydrogen gas,
   b. Atoms of helium in 1 g of helium gas,
   c. Atoms of beryllium in 1 g of beryllium.

   [A]

Concentration of solutions

1. What is the minimum volume of 2.00 mol dm^{-3} HCl needed to react with 1.25 g of magnesium carbonate, $MgCO_3$? [14.9 cm^3]

2. When an excess of silver nitrate was added to 10.0 cm^3 of sodium chloride solution, 0.780 g of silver chloride was precipitated. Find the concentration of the sodium chloride solution in g dm^{-3}. [31.8 g dm^{-3}]

3. 25.0 cm^3 of 0.125 mold dm^{-3} sodium hydroxide was neutralized by 17.5 cm^3 of dilute nitric acid of unknown concentration. Calculate the concentration of the nitric acid in mol dm^{-3}.
   [0.179 mol dm^{-3}]

Volume of gasses

1. 20 cm^3 of a hydrocarbon needed 90 cm_3 of oxygen for complete combustion. 60 cm^3 of CO_2 was produced. All volumes were measured at room temperature and pressure. Find the formula of the hydrocarbon.
   [C_3H_6]

2. 10 cm^3 of an unknown hydrocarbon was sparked with 100 cm^3 of oxygen (an excess). When the resulting gases were cooled back to the original room temperature, they had a volume of 75 cm^3. Exposure of the gasses to sodium hydroxide solution reduced the volume to 35 cm^3. Find the formula of the hydrocarbon.
   [C_4H_{10}]

3. 2.76 g of a carbonate, X_2CO_3, was treated with an excess of dilute hydrochloric acid, and the carbon dioxide evolved was collected and measure. 480 cm^3 was produced at room temperature and pressure.
   $X_2CO_3 + 2HCl \rightarrow 2XCl + CO_2 + H_2O$
   Calculate :
   a) The number of moles of X_2CO_3 in the experiment, [0.02]
   b) The mass of 1 mole of X_2CO_3, and [138 g]
   c) The relative atomic mass of X. [39]

Percentage yield

1. A student had to produce some magnesium sulfate crystals, MgSO4.7H2O. He reacted 1.20 g of magnesium with a slight excess of sulfuric acid to give magnesium sulfate solution and later evaporated off to give 9.48 g of crystals. Calculate the percentage yield.
   Making the solution : $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$
   Crystallising the solution : $MgSO_4 + 7H_2O \rightarrow MgSO_4.7H_2O$ [80%]

2. A teacher demonstrated the formation of silicon tetrachloride, $SiCl_4$, by passing dry chlorine over 1.0 g of heated silicon powder until all the silicon had reacted. 3.5 cm^3 of silicon tetrachloride.
   $Si(s) + 2Cl_2(g) \rightarrow SiCl_4(l)$
   [85%]