Empirical Formula Worksheet

Question 1
Explain the difference between empirical and molecular formula

Question 2
Which of the following represent empirical formulas?
C_2H_4, HO, H_2O, PCl_5, CO_2, C_3H_8, H_2O_2, CH_3COOH, CH, C_4H_{10}, N_2H_4, $C_6H_5CH_3$

Question 3
Fill in the table below:

Empirical	Molecular
	$C_6H_{12}O_6$
	CH_4
	$C_2H_8O_2$
	C_3H_9O
CH_2	? (Given molar mass = 56 g mol^{-1})
$C_5H_{12}O$	?(Given molar mass = 88.17 g mol^{-1})

Question 4
A compound has the following composition by mass: C, 0.681 g; H, 0.137 g; O, 0.181 g

    a) Calculate the empirical formula of the compound
    b) If the relative molecular ass of the compound is 88.17, calculate the molecular formula.
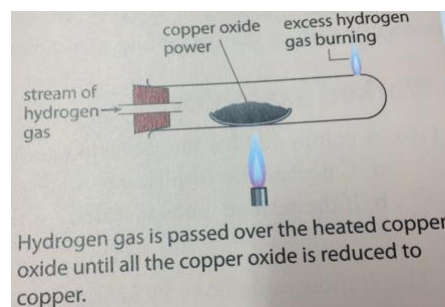
Question 5
If a fluoride of uranium contains 67.62% uranium by mass, what is its empirical formula?

Question 6:
The experimental set-up shown below can be used to determine the empirical formula of copper oxide. The following experimental results were obtained:

copper oxide power — excess hydrogen gas burning
stream of hydrogen gas

Mass of empty dish (g)	24.58
Mass of dish + copper oxide (g)	30.12
Mass of dish + copper after burning (g)	29.00

Calculate the empirical formula of the copper oxide and write an equation for the reaction.

Hydrogen gas is passed over the heated copper oxide until all the copper oxide is reduced to copper.

Question 7
If an oxide of chlorine contains 91.6% chlorine, calculate its empirical formula

Question 8:
An organic compound, B, contains only carbon, hydrogen and oxygen. When 1.46 g of B burns in excess oxygen, 2.79 g of carbon dioxide and 1.71 g of water are formed.
    a) What is the empirical formula of B?
    b) If the relative molecular mass is 92.16, what is the molecular formula of B?

Question 9:
When 4.76 g of an organic compound, **D**, which contains only carbon, hydrogen and oxygen, is burnt in excess oxygen, 10.46 g of carbon dioxide and 5.71 g of water are produced. What is the empirical formula of **D**?

Question 10:
Smog is common in cities throughout the world. One component of smog is PAN (peroxyacylnitrate) which consists of 20.2% C, 11.4% N, 65.9% O and 2.50% H by mass. Determine the empirical formula of PAN, showing your working.

Question 11:
Menthol is an organic compound containing carbon, hydrogen and oxygen.
Complete combustion of 0.1595 g of menthol produces 0.4490 g of carbon dioxide and 0.1840 g of water.

   a) Determine the empirical formula of the compound showing your working.
   b) 0.150 g sample of menthol, when vaporized, had a volume of 0.0337 dm^3 at 150 °C and 100.2 kPa. Calculate its molar mass showing your working.
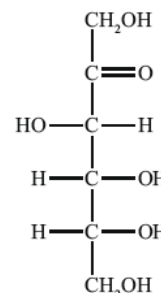
Question 12:
A hydrocarbon has the empirical formula C_3H_7. When 1.17 g of the compound is heated to 85 °C at a pressure of 101 kPa it occupies a volume of 400 cm^3.
   a) Calculate the molar mass of the compound, showing your working.
   b) Deduce the molecular formula of the compound.

Question 13:
The open-chain structure of D-fructose is shown below.

   a) State the names of two functional groups in D-fructose
   b) Deduce the empirical formula of D-fructose
   c) Calculate the % composition by mass of D-fructose
   d) State a balanced equation for the complete combustion of D-fructose

Question 14:
A student decided to determine the molecular mass of a solid monoprotic acid, HA, by titrating a solution of a known mass of the acid.

The following recordings were made.

| Mass of bottle / g ± 0.001 g	1.737
Mass of bottle + acid HA / g ± 0.001 g	2.412

   a) Calculate the mass of the acid and determine its absolute and percentage uncertainty.

   b) This known mass of acid, HA, was then dissolved in distilled water to form a 100.0 cm^3 solution in a volumetric flask. A 25.0 cm^3 sample of this solution reacted with 12.1 cm^3 of a 0.100 $moldm^{-3}$ NaOH solution. Calculate the molar mass of the acid.

   c) The percentage composition of HA is 70.56% carbon, 23.50% oxygen and 5.94% hydrogen. Determine its empirical formula.

   d) From your answers to b and c, determine the molecular formula of the acid, HA.

Question 15:
An organic compound undergoes two different reactions to make products Q and products R.
   a) Draw in what products are formed

Q:
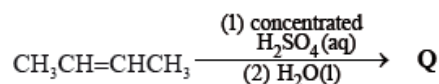
   b) State the structural formula of the organic product formed, **S**, when **Q** is heated under reflux with acidified potassium dichromate(VI).
   c) Apply IUPAC rules to state and name of this product, S.
   d) $CH_3CH=CHCH_3$ can undergo a polymerization reaction. Draw **two** repeating units of the resulting polymer.
   e) Determine the empirical formula of the polymer
   f) Determine its molecular formula given that its molar mass is 156.30 g mol^{-1}.