Worksheet 12.4
Empirical and molecular formula calculations

NAME: **CLASS:**

INTRODUCTION

The **empirical formula** of a compound is defined as the simplest whole-number ratio of atoms of different elements in the compound.
The **molecular formula** of a compound is defined as the actual number of atoms of different elements covalently bonded in a molecule, and is a whole-number multiple of the empirical formula.
The **percentage composition** of a compound can be determined from its formula or from experimental mass proportion data.

No.	Question	Answer
1	Titanium oxide, TiO_2, is widely used as a pigment in high-quality artists' paints due to its brilliant white colour. Determine the percentage composition of TiO_2.	
2	An oxide of sulfur contains 60% oxygen. Determine the empirical formula of the oxide.	
3	A group 1 metal chloride contains 47.6% chlorine. What is the formula of this ionic compound?	
4	Write empirical formulas for each of the following compounds: **a** CH_4 **b** N_2H_4 **c** $C_2H_4O_2$	

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5	A molecule has an empirical formula C_2H_4O and a relative molecular mass of 88. What is its molecular formula?	
6	0.300 mole of a sample of a hydrocarbon is found to have a mass of 24.6 g. If the empirical formula of the compound is C_3H_5, determine its molecular formula.	
7	A student is given a 2.486 g sample of a purple crystalline solid. Upon analysis it is found to consist of potassium (0.614 g), manganese (0.863 g) and oxygen (1.006 g). Determine the empirical formula of the compound.	
8	A compound undergoes analysis to establish the following elemental composition: carbon: 40.0% hydrogen: 6.67% oxygen: 53.3% If the compound, known as a carbohydrate, has a molecular mass of approximately 60, determine both its empirical and molecular formulas.	

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The **empirical formula** of a compound is defined as the simplest whole-number ratio of atoms of different elements in the compound.
The **molecular formula** of a compound is defined as the actual number of atoms of different elements covalently bonded in a molecule, and is a whole-number multiple of the empirical formula.
The **percentage composition** of a compound can be determined from its formula or from experimental mass proportion data.

No.	Question	Answer
1	Titanium oxide, TiO_2, is widely used as a pigment in high-quality artists' paints due to its brilliant white colour. Determine the percentage composition of TiO_2.	$TiO_2 = 47.87 + (16 \times 2)$ $= 79.87$ Ti = 59.9% O = 40.1%
2	An oxide of sulfur contains 60% oxygen. Determine the empirical formula of the oxide.	SO_3 $32 + (16 \times 3)$ 48/80
3	A group 1 metal chloride contains 47.6% chlorine. What is the formula of this ionic compound?	KCl = 74.55 Cl 47.6%
4	Write empirical formulas for each of the following compounds: **a** CH_4 **b** N_2H_4 **c** $C_2H_4O_2$	CH_4 NH_2 CH_2O.

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5	A molecule has an empirical formula C_2H_4O and a relative molecular mass of 88. What is its molecular formula?	$C_2H_4O = (12\times2)+4+16$ $= 44$ $C_4H_8O_2$
6	0.300 mole of a sample of a hydrocarbon is found to have a mass of 24.6 g. If the empirical formula of the compound is C_3H_5, determine its molecular formula.	$n = \frac{m}{Mr}$ $0.3 = \frac{24.6}{Mr}$ Mr 82 $C_3H_5 = 41$ C_6H_{10}
7	A student is given a 2.486 g sample of a purple crystalline solid. Upon analysis it is found to consist of potassium (0.614 g), manganese (0.863 g) and oxygen (1.006 g). Determine the empirical formula of the compound.	K Mn O $\frac{0.614}{39.1}$ $\frac{0.863}{54.94}$ $\frac{1.006}{16}$ 0.0157 0.0157 0.06287 0.0157 0.0157 0.0157 1 1 4 $KMnO_4$
8	A compound undergoes analysis to establish the following elemental composition: carbon: 40.0% hydrogen: 6.67% oxygen: 53.3% If the compound, known as a carbohydrate, has a molecular mass of approximately 60, determine both its empirical and molecular formulas.	C H O $\frac{40}{12}$ $\frac{6.67}{1}$ $\frac{53.3}{16}$ 3.33 6.67 3.33 1 2 1 M_f $C_{10}H_{20}O_{10}$ $300 \div 6 = 5$ Mf $C_2H_4O_2$ Ef $= CH_2O$