

ChemActivity 28

The Mole Concept

Model: The Elephant and the Methane Molecule

One elephant has one trunk and four legs.

One methane molecule, CH_4 , contains one carbon atom and four hydrogen atoms.

$$1 \text{ amu} = 1.6606 \times 10^{-24} \text{ g}$$

$$1 \text{ dozen} = 12 \text{ items}$$

$$1 \text{ mole} = 6.022 \times 10^{23} \text{ items} = \text{Avogadro's Number}$$

Critical Thinking Questions

1. How many trunks are found in one dozen elephants? Give your answer in terms of a number (such as 17 or 3.25×10^{15} trunks).
2. How many legs are found in one dozen elephants? Give your answer in terms of a number (such as 17 or 3.25×10^{15} legs).
3. How many carbon atoms are found in one dozen methane, CH_4 , molecules? Give your answer in terms of a number (such as 17 or 3.25×10^{15} C atoms).
4. How many hydrogen atoms are found in one dozen methane molecules? Give your answer in terms of a number (such as 17 or 3.25×10^{15} H atoms).
5. How many trunks are found in one mole of elephants?
6. How many legs are found in one mole of elephants?

7. How many carbon atoms are found in one mole of methane molecules?
8. How many hydrogen atoms are found in one mole of methane molecules?
9. Calculate the average mass (in amu) of one methane molecule (to 0.01 amu).
10. Based on your answer to CTQ 9, calculate the mass (in grams) of one mole of methane molecules (to 0.01 g).
11. Use a grammatically correct English sentence to describe how the mass in amu of one molecule of a compound is related to the mass in grams of one mole of that compound.

Exercises

Unless otherwise stated, calculate all mass values in grams.

1. What is the mass of 1.00 mole of Cu?
2. What is the mass of 1.00 mole of sodium(I) fluoride, NaF?
3. Consider a 1.00 carat diamond (pure C) that has a mass of 0.200 grams. How many carbon atoms are present in this diamond? Give your answer in terms of a number (such as 17 or 3.25×10^{15} C atoms) and as a number of moles of C atoms.
4. Consider 1.00 mole of dihydrogen gas, H_2 . How many dihydrogen molecules are present? How many hydrogen atoms are present? What is the mass of this sample?
5. Ethanol has a molecular formula of CH_3CH_2OH . What is the mass of 1.000 moles of ethanol? What is the average mass of one molecule of ethanol?
6. What is the mass of 0.5623 moles of ethanol, CH_3CH_2OH ?

7.
 - a) How many moles of ethanol are present in a 100.0 g sample of ethanol?
 - b) How many moles of each element (C, H, O) are present in a 100.0 g sample of ethanol?
 - c) How many grams of each element (C, H, O) are present in a 100.0 g sample of ethanol?
8. How many moles of carbon dioxide, CO_2 , are present in a sample of carbon dioxide with a mass of 254 grams?
9. How many moles of O atoms are present in a 254 g sample of carbon dioxide?
10. How many carbon atoms are found in 0.500 g of glycine, $\text{H}_2\text{NCH}_2\text{COOH}$?
11. Indicate whether each of the following statements is true or false, and explain your reasoning.
 - a) One mole of NH_3 weighs more than one mole of H_2O .
 - b) There are more carbon atoms in 48 grams of CO_2 than in 12 grams of diamond (a form of pure carbon).
 - c) There are equal numbers of nitrogen atoms in one mole of NH_3 and one mole of N_2 .
 - d) The number of Cu atoms in 100 grams of Cu(s) is the same as the number of Cu atoms in 100 grams of copper(II) oxide, CuO .
 - e) The number of Ni atoms in 100 moles of Ni(s) is the same as the number of Ni atoms in 100 moles of nickel(II) chloride, NiCl_2 .
 - f) There are more hydrogen atoms in 2 moles of NH_3 than in 2 moles of CH_4 .
12. Use grammatically correct sentences to describe how to calculate the number of H atoms in "z" moles of NH_3 .