Solutions to Moles Problem Set

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1. Styrene is an organic molecule that is used as a building block for many polymers (like polystyrene). The molecular formula for styrene is C_8H_8.

   a. What is the molecular weight of styrene?

$$MW_C := 12.011 \cdot gm \cdot mole^{-1}$$

$$MW_H := 1.0079 \cdot gm \cdot mole^{-1}$$

$$MW_{styrene} := 8 \cdot MW_C + 8 \cdot MW_H$$

$$MW_{styrene} = 104.151 \cdot gm \cdot mole^{-1}$$

   b. What is the emperical formula of styrene?

C_1H_1

   c. How much does 1.000 mole of styrene weigh?

$$mole_{styrene} := 1 \cdot mole$$

$$mass_{styrene} := mole_{styrene} \cdot MW_{styrene}$$

$$mass_{styrene} = 104.151 \cdot gm$$

   d. How much does 1.54 pmole of styrene weigh?

$$p := 10^{-12} \qquad pmole := p \cdot mole$$

$$mole_{styrene} := 1.54 \cdot pmole$$

$$mole_{styrene} = 1.54 \cdot 10^{-12} \cdot mole$$

$$mass_{styrene} := mole_{styrene} \cdot MW_{styrene}$$

$$mass_{styrene} = 1.604 \cdot 10^{-10} \cdot gm$$

   e. How much many moles in 9.67 kg of styrene?

$$mass_{styrene} := 9.67 \cdot kg$$

$$mass_{styrene} = 9.67 \cdot 10^{3} \cdot gm$$

$$mole_{styrene} := \frac{mass_{styrene}}{MW_{styrene}}$$

$$mole_{styrene} = 92.846 \cdot mole$$

f.How many moles in 84.6 mg of styrene?

$$\text{mass}_{\text{styrene}} := 84.6 \cdot \text{mg}$$

$$\text{mass}_{\text{styrene}} = 0.085 \cdot \text{gm}$$

$$\text{mole}_{\text{styrene}} := \frac{\text{mass}_{\text{styrene}}}{\text{MW}_{\text{styrene}}}$$

$$\text{mole}_{\text{styrene}} = 8.123 \cdot 10^{-4} \cdot \text{mole}$$

g.What is the mass percent of carbon in styrene?

$$\text{fraction}_{\text{C}} := \frac{8 \cdot \text{MW}_{\text{C}}}{\text{MW}_{\text{styrene}}}$$

$$\text{fraction}_{\text{C}} = 0.923$$

$$\text{fraction}_{\text{C}} = 92.258 \cdot \%$$

h.What is the mass percent of hydrogen in styrene?

$$\text{fraction}_{\text{H}} := \frac{8 \cdot \text{MW}_{\text{H}}}{\text{MW}_{\text{styrene}}}$$

$$\text{fraction}_{\text{H}} = 0.077$$

$$\text{fraction}_{\text{H}} = 7.742 \cdot \%$$

i.A barrel of an unknown material is recovered from the Delaware river near a plant that produces polystyrene. It has been suggested that the barrel contains styrene. Results from the elemental analysis of an unknown compound are shown below. Does this support the hypothesis that the barrel contains styrene?

Element	Abundance (%)
Carbon	92.26
Hydrogen	7.74

The elemental composition of the unknown is consistant with the elemental composition of styrene. So it is possible that the unknown is styrene. Note: the experiment does not prove that it is styrene. It just fails to prove that it is not styrene.

j. Further experimentation determines that the molecular weight of this compound is 78.11 grams per mole. What is the molecular formula for the unknown compound?

$$MW_{unk} := 78.11 \cdot gm \cdot mole^{-1}$$

Since this molecular weight is less than the molecular weight of styrene, this is not consitant with the original hypothesis. The unknown is not styrene. It just has the same emperical formula as styrene.

Calculate the "Emperical Mass" of the compound from the emperical formula (C_1H_1).

$$EM := 1 \cdot MW_C + 1 \cdot MW_H$$

$$EM = 13.019 \cdot gm \cdot mole^{-1}$$

Determine the number of emperical formulas in the unknown:

$$\frac{MW_{unk}}{EM} = 6$$

If there are 6 "emperical formulas" in the molecule, the molecuar formula is:

C_6H_6