Mole Review: Multiple Choice Practice Problems

Fun and exciting note about AP Chem: did anyone mention that you're NOT allowed to use a calculator on the multiple choice portion of the AP Chem test? It's true! <cue applause>

To help you be prepared for the AP test in May, all of your quizzes and tests in AP Chemistry will have two sections: a multiple choice section (no calculator) and a free response section (with a calculator). But don't worry: throughout the year, we're going to teach you lots of tips and tricks to make calculator-free math pHun and delicious.

Guided Practice

1. A single sodium atom has an average mass of 22.99 amu (taken from the periodic table). How does this number relate to a mole of sodium atoms?
   a. One mole of sodium atoms will have a mass of 22.99 amu.
   (b.) One mole of sodium atoms will have a mass of 22.99 grams.
   c. One mole of sodium atoms will have a mass of 22.99 x 6.022 x 10^{23} grams.
   d. You cannot relate the mass of a single sodium atom to the mass of a mole of atoms.

2. How many protons are in 3.50 moles of lithium atoms?

$$3.50 \text{ mol Li} \times \frac{3 \text{ mol p}^+}{1 \text{ mol Li}} \times \frac{6.022 \text{E}23}{1 \text{ mol}}$$

   a. 3.50 b. 10.5 c. 3.50 x (6.022 x 10^{23}) (d.) 10.5 x (6.022 x 10^{23})

3. Which of the following samples contains the largest number of atoms?
   (a.) 3.0 mol of water ~~b.~~ 3.0 g of water ~~c.~~ 3.0 x 10^{22} molecules of nitrogen gas

a.) $3.0 \text{ mol } H_2O \times \frac{3 \text{ mol atoms}}{1 \text{ mol } H_2O} = 9 \text{ mol atoms}$

b.) $3.0 \text{ g } H_2O \times \frac{1 \text{ mol}}{18 \text{ g}} = \frac{1}{9} \approx 0.1 \text{ mol } H_2O < 3 \text{ mol } H_2O$

c.) $3.0\text{E}22 \text{ molec. } N_2 \times \frac{1 \text{ mol } N_2}{6\text{E}23 \text{ molec}} \times \frac{2 \text{ mol atoms}}{1 \text{ mol } N_2}$

$= \frac{3}{6} \times \frac{10^{22}}{10^{23}} \times 2 = \frac{10^{22}}{10^{23}} = 0.1 \text{ mol atoms}$

Independent Practice

4. What volume will 37.8 g of oxygen gas occupy at STP?
   a. 847 L b. 52.9 L (c.) 26.5 L d. 1.69 L

$37.8 \text{ g } O_2 \times \frac{1 \text{ mol}}{32 \text{ g}} \approx \frac{40}{30} = \frac{4}{3} \text{ mol } O_2 \times \frac{22.4 \text{ L}}{1 \text{ mol}} \approx \frac{4 \times 20}{3} = \frac{80}{3} \approx 27 \text{ L}$

STP

5. At 0°C and 1 atm, a 0.25 L container would hold how many grams of carbon monoxide? (The molar mass of carbon monoxide is 28.01 g/mol).
   a. 7.0 g b. 3.2 g (c.) 0.31 g d. 0.011 g

$0.25 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{28.01 \text{ g}}{1 \text{ mol}} \approx \frac{1}{4} \times \frac{1}{22} \times \frac{28}{1} = \frac{7}{22} \approx \frac{1}{3} \text{ g}$

~14 g

6. If you require 13.9 grams of lithium atoms, how many grams of lithium sulfide (Li_2S) would be required?

a. 27.8 g b. 39.1 g (c.) 46.0 g d. 92.0 g

$$14\text{ g Li} \times \frac{1\text{ mol Li}}{7\text{ g Li}} \times \frac{1\text{ mol } Li_2S}{2\text{ mol Li}} \times \frac{47\text{ g } Li_2S}{1\text{ mol } Li_2S} = 47\text{ g}$$

7. Calculate the concentration of a solution prepared by dissolving 11.85 g of solid $KMnO_4$ in enough water to make 750. mL of solution. (The molar mass of $KMnO_4$ is 158.04 g/mol).

(a.) 0.100 M b. 0.0562 M c. 1.00 M d. 0.562 M

$$12\text{ g } KMnO_4 \times \frac{1\text{ mol}}{160\text{ g}} = \frac{12}{16} \times \frac{1}{10} = \frac{0.75}{10} = 0.075\text{ mol}$$

$$M = \frac{0.075\text{ mol}}{0.750\text{ L}} = \frac{7.5E\text{-}2}{7.5E\text{-}1} = \frac{1E\text{-}2}{1E\text{-}1} = 0.1\text{ M}$$

8. How many moles of a gas at 247°C would occupy a volume of 6.4 L at a pressure of 260 mmHg?

(a.) 0.051 mol b. 0.11 mol c. 0.28 mol d. 3.9 mol

$$n = \frac{PV}{RT} = \frac{(260\text{ mmHg})(6.4\text{ L})}{(62.36)(247+273)} = \frac{260 \cdot 6.4}{60 \cdot 520} \approx \frac{250 \cdot 6}{60 \cdot 500} = \frac{1}{20} = 0.05$$

9. How many total ions are contained in 250 mL of a 0.100 M NaCl solution?

a. 1.5×10^{22} ions (b.) 3.0×10^{22} ions 1.5×10^{25} ions b. 3.0×10^{25} ions

$$0.25\text{ L} \times 0.1\text{ M} = 0.025\text{ mol NaCl} \times \frac{2\text{ mol ions}}{1\text{ mol NaCl}} \times \frac{6E23\text{ ions}}{1\text{ mol ions}} = 0.05 \times 6E23$$

(M = mol/L)

$$= 5E\text{-}2 \times 6E23 = 30E21 = 3E22$$

10. What is the molar concentration of $Al(OH)_3$ if a 500. mL solution of $Al(OH)_3$ contains 1.8×10^{24} ions of OH^-?

18E23

a. 0.020 M b. 0.060 M (c.) 2.0 M d. 6.0 M

$$18E23\text{ ions } OH^- \times \frac{1\text{ mol } OH^-}{6E23\text{ ions } OH^-} \times \frac{1\text{ mol } Al(OH)_3}{3\text{ mol } OH^-} = 1\text{ mol } Al(OH)_3$$

$$M = 1\text{ mol}/0.5\text{ L} = \frac{1}{1/2} = 2\text{ M}$$

11. What is the total number of atoms in 123 grams of sulfur trioxide? SO_3

a. 9.25×10^{23} atoms (b.) 3.70×10^{24} atoms c. 5.93×10^{27} atoms d. 2.37×10^{28} atoms

$$123\text{ g } SO_3 \times \frac{1\text{ mol } SO_3}{80\text{ g } SO_3} \times \frac{6E23\text{ molec. } SO_3}{1\text{ mol } SO_3} \times \frac{4\text{ atoms}}{1\text{ molec. } SO_3} \approx 120 \times \frac{1}{80} \times \frac{6E23}{1} \times \frac{4}{1}$$

$32 + 3 \cdot 16$

$$= 36E23 = 3.6E24$$