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Unit 1 MC Practice

1. 2.500 grams of $\text{MgSO}_4 \cdot x \text{H}_2\text{O}$, a hydrated salt with an unknown water content, is dried in an oven to constant mass until all water has been removed. After drying, the anhydrous salt has a mass of 1.221 grams. How many moles of water are present per mole of hydrated magnesium sulfate? (FW of $\text{MgSO}_4 = 120 \text{ g/mol}$)

a. 1 b. 3 c. 5 **d. 7**

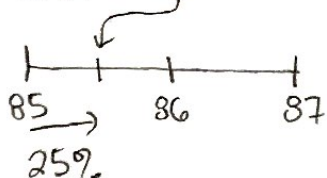
$$2.5 - 1.2 = 1.3 \text{ g H}_2\text{O}$$

$$\left. \begin{array}{l} \text{MgSO}_4: \frac{1.2}{120} = \frac{1.2}{1.2 \text{E}2} = 1 \text{E}-2 \\ \text{H}_2\text{O}: \frac{1.3}{18} \approx \frac{1.2 \text{E}-1}{18} = 0.7 \text{E}-1 = 7 \text{E}-2 \end{array} \right\} \begin{array}{l} = 1 \\ \div 1 \text{E}-2 \\ = \frac{7 \text{E}-2}{1 \text{E}-2} = 7 \end{array}$$

2. Naturally occurring rubidium consists of just two isotopes. One of the isotopes consists of atoms having a mass of 84.912 amu, the other of 86.901 amu. What is the percent natural abundance of the heavier isotope?

a. 15% **b. 28%** c. 37% d. 72%

$$\text{aam (Rb)} = 85.47 \approx 85.5$$



3. When hafnium metal is heated in an atmosphere of chlorine gas, the product of the reaction is found to contain 62.2 percent Hf by mass and 37.4 percent Cl by mass. What is the empirical formula for this compound?

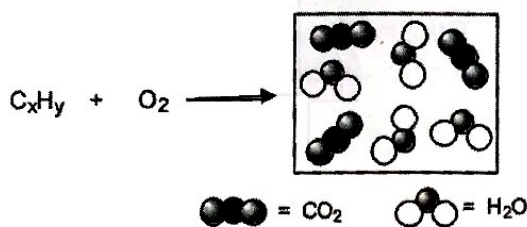
a. Hf_2Cl_3 b. HfCl_2 **c. HfCl_3** d. HfCl_4

$$\left. \begin{array}{l} \text{Hf: } 62.2 / 178.49 \approx \frac{60}{180} = 0.33 \text{ mol} \\ \text{Cl: } 37.4 / 35.45 \approx 1 \text{ mol} \end{array} \right\} \begin{array}{l} = 1 \\ \div 0.33 \\ = 3 \end{array}$$

4. Which of the following represents the correct method for converting 11.0 g of copper metal to the equivalent number of copper atoms?

- a.** $11 \left(\frac{1}{63.55} \right) \left(\frac{6.02 \times 10^{23}}{1} \right)$
 b. $11 \left(\frac{1}{63.55} \right)$
 c. $11 \left(\frac{1}{63.55} \right) \left(\frac{63.55}{6.02 \times 10^{23}} \right)$
 d. $11 \left(\frac{63.55}{1} \right) \left(\frac{6.02 \times 10^{23}}{1} \right)$

5. A hydrocarbon of unknown formula C_xH_y was submitted to combustion analysis: the results are shown in the diagram below. What is the empirical formula of the compound?



$$3 CO_2 \times \frac{1 C}{1 CO_2} = 3 C$$

$$4 H_2O \times \frac{2 H}{1 H_2O} = 8 H$$

- a. CH b. CH_2 c. C_3H_4 d. C_3H_8

$$40 + 2(14 + 3 \cdot 16) = 164 \text{ g/mol}$$

6. How many grams of calcium nitrate, $Ca(NO_3)_2$, contains 48 grams of oxygen atoms?

- a. 82 g b. 120 g c. 190 g d. 320 g

$$48 \text{ g O} \times \frac{1 \text{ mol O}}{16 \text{ g O}} \times \frac{1 \text{ mol } Ca(NO_3)_2}{6 \text{ mol O}} \times \frac{164 \text{ g}}{1 \text{ mol}} = \frac{164}{2} = 82$$

7. If 200.0 mL of 0.60 M $MgCl_2(aq)$ is added to 400. mL of distilled water, what is the concentration of $Mg^{2+}(aq)$ in the resulting solution? (Assume volumes are additive.)

- a. 0.20 M b. 0.30 M c. 0.40 M d. 1.2 M

$$0.2 \text{ L} \times 0.6 \text{ M} = 0.12 \text{ mol } MgCl_2 \times \frac{1 \text{ mol } Mg^{2+}}{1 \text{ mol } MgCl_2} = 0.12 \text{ mol}$$

$$[Mg^{2+}] = \frac{0.12 \text{ mol}}{(0.2 + 0.4) \text{ L}}$$

$$= \frac{0.12}{0.6} = \frac{12 \text{ E}-2}{6 \text{ E}-1} = 2 \text{ E}-1 = 0.2 \text{ M}$$

8. Which IUPAC name/formula combination is **wrong**?

- a. chlorous acid/ $HClO_2$ c. ammonium permanganate/ NH_4MnO_4
 b. dicarbon tetranitride/ C_2N_4 d. copper (II) periodate/ $CuIO_4$

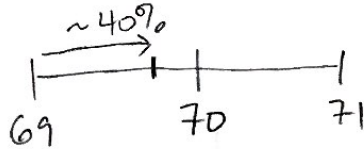
9. Which set of molecules is in order from lowest to highest percent mass of oxygen?

- a. $CH_3OH < CH_3CH_2OH < CH_3CH_2CH_2OH < HOCH_2CH_2OH$
 b. $HOCH_2CH_2OH < CH_3OH < CH_3CH_2OH < CH_3CH_2CH_2OH$
 c. $CH_3CH_2CH_2OH < CH_3CH_2OH < CH_3OH < HOCH_2CH_2OH$
 d. $CH_3CH_2CH_2OH < CH_3CH_2OH < HOCH_2CH_2OH < CH_3OH$

10. Given that there are two naturally occurring isotopes of gallium, ^{69}Ga and ^{71}Ga , the natural abundance of the ^{71}Ga isotope must be approximately:

- a. 25% b. 40% c. 50% d. 71%

$$\text{avg } (Ga) = 69.72$$



11. What pressure (in atm) would be exerted by 76 g of fluorine gas in a 1.50 liter vessel at -37°C ?

- a. 4.1 atm b. 8.2 atm c. 26 atm d. 84 atm

$$76 \text{ g } F_2 \times \frac{1 \text{ mol } F_2}{38 \text{ g } F_2} = 2 \text{ mol} \quad \left. \vphantom{76} \right\} P = \frac{nRT}{V} = \frac{(2 \text{ mol})(0.08206)(-37+273)}{1.5} \approx \frac{2(0.1)(236)}{1.5}$$

12. Which of the following statements is true?

- ✓ I. The molar mass of CaCO_3 is 100.1 g mol^{-1} .
 ✓ II. 50 g of CaCO_3 contains about 9×10^{23} oxygen atoms.
 ✓ III. A 200 g sample of CaCO_3 contains about 2 moles of CaCO_3 .

$$= \frac{(0.1)(472)}{1.5} = \frac{47.2}{3/2} \approx \frac{47.2}{3} \approx 15.2 = 30 \text{ atm}$$

- a. I only b. II only c. I and III only d. I, II, and III

$$\frac{50 \text{ g}}{100 \text{ g/mol}} = 0.5 \text{ mol } \text{CaCO}_3 \times \frac{3 \text{ oxygen}}{1 \text{ CaCO}_3} = 1.5 \text{ mol O} \times 6 \text{ E } 23 = 9 \text{ E } 23 \text{ O atoms}$$

$$\frac{200 \text{ g}}{100 \text{ g/mol}} = 2 \text{ mol } \text{CaCO}_3$$

13. In which of the following compounds is the mass ratio of element X to oxygen closest to 2.5 to 1? (The molar mass of X is 40.0 g/mol .)

- a. X_3O_2 b. X_2O c. XO_2 d. XO

$$\frac{2.5}{1} = \frac{(\# \text{ of X}) \cdot 40}{(\# \text{ of O}) \cdot 16} \Rightarrow \frac{40}{16} = 2.5 \Rightarrow 1:1 \quad \text{X:O}$$

14. If 87 grams of K_2SO_4 (molar mass 174 g/mol) is dissolved in enough water to make 250 mL of solution, what are the concentrations of the potassium and the sulfate ions?

- | $[\text{K}^+]$ | $[\text{SO}_4^{2-}]$ |
|---|----------------------|
| a. 0.020 M | 0.020 M |
| b. 1.0 M | 2.0 M |
| c. 2.0 M | 1.0 M |
| <input checked="" type="radio"/> d. 4.0 M | 2.0 M |

$$\frac{87 \text{ g}}{174 \text{ g/mol}} = 0.5 \text{ mol } \text{K}_2\text{SO}_4 \quad \left. \vphantom{87} \right\} \begin{array}{c} \text{M} \\ \downarrow \\ [\text{K}_2\text{SO}_4] = \frac{0.5 \text{ mol}}{0.25 \text{ L}} = 2 \text{ M} \end{array}$$

$$2 \text{ M } \text{K}_2\text{SO}_4 \times \frac{2 \text{ K}^+}{1 \text{ K}_2\text{SO}_4} = 4 \text{ M } \text{K}^+$$

15. A compound contains 30.% sulfur and 70.% fluorine by mass. The empirical formula of the compound is:

- a. SF b. SF₂ c. SF₃ d. SF₄

$$S: 30g/32.06 \approx 1 \text{ (but less)}$$

$$F: 70g/19 \approx 4 \text{ (but less)}$$

16. How many carbon atoms are contained in 2.8 g of C₂H₄?

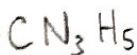
- a. 6.0 x 10²² b. 1.2 x 10²³ c. 3.0 x 10²³ d. 6.0 x 10²³

$$2.8g \text{ C}_2\text{H}_4 \times \frac{1 \text{ mol C}_2\text{H}_4}{28g \text{ C}_2\text{H}_4} \times \frac{2 \text{ C}}{1 \text{ C}_2\text{H}_4} \times \frac{6.023 \text{ atoms}}{1 \text{ mol C}} = (0.1)(2)(6.023) = 1.2 \text{ E } 23 \text{ atoms C}$$

17. Which of the following statements is(are) false?

- I. The % by mass of each element in a compound depends on the amount of the compound.
 II. The mass of each element in a compound depends on the amount of the compound.
 III. The % by mass of each element in a compound depends on the amount of element present in the compound.

- a. I only b. II and III only c. I and II only d. I, II, and III



18. Guanidin, $\text{HNC}(\text{NH}_2)_2$, is a fertilizer. What is the percent by mass of nitrogen in the fertilizer?

- a. 45% b. 55% c. 65% d. 71%

$$\% \text{ N} = \frac{3 \cdot 14}{(12 + 3 \cdot 14 + 5)} \times 100 = \frac{42}{59} \times 100 > \frac{40}{60} \times 100 = \frac{2}{3} \times 100 = 67\%$$

19. How many atoms are in one mole of CH_3OH ? = 6 atoms in 1 molecule

- a. 6.0 b. 6.0 x 10²³ c. 1.2 x 10²⁴ d. 3.6 x 10²⁴

$$1 \text{ mol CH}_3\text{OH} \times \frac{6 \text{ mol of atoms}}{1 \text{ mol CH}_3\text{OH}} \times \frac{6.023 \text{ atoms}}{1 \text{ mol}} = 36 \text{ E } 23 = 3.6 \text{ E } 24 \text{ atoms}$$

20. What is the weight of MgCO₃ (formula weight 84.3 g/mol) found in 100. mL of a 5.0 M solution?

- a. 42 g b. 84 g c. 420 g d. 840 g

$$M = \frac{\text{mol}}{L} \Rightarrow \text{mol} = 5.0 \text{ M} \cdot 0.100 \text{ L} = 0.50 \text{ mol MgCO}_3 \times \frac{84.3 \text{ g}}{1 \text{ mol}} = 42.15 \text{ g}$$

$\Rightarrow \approx 9\%$ oxygen

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21. An oxide of lead contains 90.65% pb by weight. The empirical formula is:

- a. Pb b. PbO c. Pb_3O_4 d. PbO_2

$$\text{Pb: } 91 \text{ g} / 207.2 \text{ g/mol} < 0.5 \text{ mol (but not too much less)}$$

$$\text{O: } 9 \text{ g} / 16 \text{ g/mol} > 0.5 \text{ mol (but not too much more)}$$

22. The mass in grams of 2.6×10^{22} chlorine atoms is:

- a. 0.76 g b. 1.5 g c. 3.2 g d. 4.4 g

$$2.6 \times 10^{22} \text{ Cl atoms} \times \frac{1 \text{ mole Cl}}{6.023 \times 10^{23} \text{ atoms}} \times \frac{35.45 \text{ g}}{1 \text{ mol}} \approx \frac{3 \times 10^{22}}{6.023 \times 10^{23}} \times 35.45$$

$$= 0.5 \times 10^{-1} \times 35.45$$

$$\approx 1.8 \times 10^{-1} = 1.8 \text{ g}$$

23. Identify the INCORRECT statement.

- a. Helium in a balloon: an element c. Tap water: a compound
b. Paint: a mixture d. Mercury in a barometer: an element

24. Which one of the following samples contains the most atoms?

- a. 1 mol of $\text{UF}_6(\text{g})$ c. 1 mol of $\text{CH}_3\text{COCH}_3(\text{l})$
b. 1 mol of $\text{He}(\text{g})$ d. all contain the same number of atoms

7 atoms

10 atoms

1 atom

25. Combustion analysis of 2.400 grams of toluene, an organic solvent, yields 8.023 g CO_2 and 1.877 g H_2O . What is the simplest formula for toluene?

- a. C_4H_7 b. C_7H_4 c. C_7H_8 d. C_8H_7

$$8 \text{ g } \text{CO}_2 \times \frac{1 \text{ mol}}{44 \text{ g}} \times \frac{1 \text{ C}}{1 \text{ CO}_2} < \frac{8}{40} = \frac{1}{5} = 0.2 \text{ mol C}$$

$$1.9 \text{ g } \text{H}_2\text{O} \times \frac{1 \text{ mol}}{18 \text{ g}} \times \frac{2 \text{ H}}{1 \text{ H}_2\text{O}} > (0.1)(2) = 0.2 \text{ mol H}$$

26. The neutral atoms of all of the isotopes of the same element have:

- a. different numbers of protons c. the same number of electrons
b. equal numbers of neutrons d. the same mass number

27. Which one of the following samples contains the most **molecules**?

a. 1 mol of $\text{UF}_6(\text{g})$

c. 1 mol of $\text{CH}_3\text{COCH}_3(\text{l})$

b. 1 mol of $\text{He}(\text{g})$

d. all contain the same number of ~~atoms~~ molecules, oops!

28. Analysis of a sample of a covalent compound showed that it contained 14.4% hydrogen and 85.6% carbon by mass. What is the empirical formula of the compound?

a. CH

b. CH_2

c. CH_3

d. C_2H_3

$$\begin{array}{l} \text{C: } 85.6 \text{ g} / 12 \text{ g/mol} \approx 7 \\ \text{H: } 14.4 \text{ g} / 1.008 \text{ g/mol} \approx 14 \end{array} \left. \vphantom{\begin{array}{l} \text{C: } 85.6 \text{ g} / 12 \text{ g/mol} \approx 7 \\ \text{H: } 14.4 \text{ g} / 1.008 \text{ g/mol} \approx 14 \end{array}} \right] \div 7 \begin{array}{l} = 1 \\ = 2 \end{array}$$

29. What mass of cerussite, PbCO_3 , would contain 35.0 grams of lead?

a. 27.1 g

b. 35.6 g

c. 45.1 g

d. 51.7 g

$$35.0 \text{ g Pb} \times \frac{1 \text{ mol Pb}}{207.2 \text{ g Pb}} \times \frac{1 \text{ PbCO}_3}{1 \text{ Pb}} \times \frac{267.2 \text{ g}}{1 \text{ mol PbCO}_3} \ll \frac{35.300}{200} = 52.5$$

30. Which IUPAC name/formula combination is **wrong**?

a. phosphoric acid / H_3PO_4

c. iron (III) hydroxide / $\text{Ca}(\text{OH})_3$

b. nitrogen monoxide / NO

d. sodium hypobromite / NaBrO

31. The simplest formula for an oxide of nitrogen that is 36.8 percent nitrogen by weight is:

a. N_2O

b. NO

c. N_2O_3

d. NO_2

$$\begin{array}{l} \text{N: } 36.8 \text{ g} / 14 \approx 2.5 \\ \text{O: } 63.2 \text{ g} / 16 \approx 4 \end{array} \left. \vphantom{\begin{array}{l} \text{N: } 36.8 \text{ g} / 14 \approx 2.5 \\ \text{O: } 63.2 \text{ g} / 16 \approx 4 \end{array}} \right] \div 2.5 \begin{array}{l} = 1 \\ = 1.6 \end{array} \left. \vphantom{\begin{array}{l} = 1 \\ = 1.6 \end{array}} \right] \times 2 \begin{array}{l} \approx 2 \\ \approx 3 \end{array}$$

32. How many aluminum atoms are there in 3.50 g of Al_2O_3 ?

a. 2.07×10^{22}

b. 2.07×10^{23}

c. 4.13×10^{22}

d. 4.13×10^{23}

$$3.50 \text{ g Al}_2\text{O}_3 \times \frac{1 \text{ mol Al}_2\text{O}_3}{102 \text{ g Al}_2\text{O}_3} \times \frac{6.022 \text{E}23}{1 \text{ mol}} \times \frac{2 \text{ Al}^{3+}}{1 \text{ Al}_2\text{O}_3} \approx \frac{7.6 \text{E}23}{1 \text{E}2} = 42 \text{E}21 = 4.2 \text{E}22$$

$$\Rightarrow 1 \text{ mol} = 22.4 \text{ L} \Rightarrow 1 \text{ L} \approx \frac{1}{22.4} \text{ mol} \times \frac{70 \text{ g Cl}_2}{1 \text{ mol Cl}_2} = 3.1 \text{ g Cl}_2$$

33. The density of chlorine gas at STP, in grams per liter, is approximately:

- a. 1.3 **b. 3.2** c. 4.5 d. 6.2

34. A container with volume 71.9 mL contains water vapor at a pressure of 10.4 atm and a temperature of 465°C. How many grams of the gas are in the container?

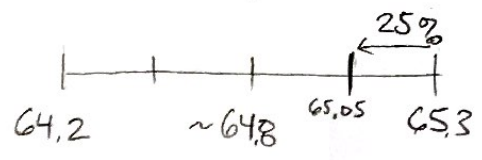
- a. 0.129 g **b. 0.222 g** c. 0.363 g d. 0.421 g

$$n = \frac{PV}{RT} = \frac{(10.4 \text{ atm})(0.0719 \text{ L})}{(0.08206 \text{ L atm / mol K})(738 \text{ K})} \approx \frac{(10)(0.07)}{(0.1)(700)} = \frac{0.7}{70} = \frac{7 \times 10^{-1}}{7 \times 10^1} = 10^{-2} \text{ mol} \times 18.016 \frac{\text{g}}{\text{mol}} = 0.18 \text{ g}$$

35. What is the atomic weight of a hypothetical element consisting of two isotopes, one with mass = 64.23 amu (26.0%), and one with mass = 65.32 amu? (% ab = 74%)

- a. 64.8 amu b. 64.8 amu **c. 65.0 amu** d. 65.3 amu

$$a_{\text{am}} = (64.23)(0.26) + (65.32)(0.74)$$



36. The mass of element X found in 1.00 mole of each of four different compounds is 28.0 g, 42.0 g, 56.0 g, and 70.0 g, respectively. The possible atomic weight of X is:

- a. 8.00 **b. 14.0** c. 28.0 d. 38.0

only common multiple is 14!

37. Consider the species, ⁷²Zn, ⁷⁵As, and ⁷⁴Ge. These species have:

- a. the same number of electrons c. the same number of protons
b. the same number of neutrons d. the same mass number

38. Which of the following includes all of the following that are chemical changes and not physical changes?

- ✗ I. freezing of water
- ✓ II. dropping a piece of iron into hydrochloric acid (H₂ is produced)
- ✓ III. burning a piece of wood
- ✓ IV. emission of light by a kerosene lamp (b/c burning is)

- a. I and IV only b. II and III only **c. II, III, and IV only** d. I, II, and III only