

**CHEM 101+103 FIRST SEMISTER 1431-1432H
FIRST EXAM SOLUTIONS**

1. What is the mass (in grams) of 1.1×10^{22} atom of gold (Au)?

- A) 2.2 B) 2.8 C) 3.6 D) 3.9

SOLUTION

$$m = n \times M = \frac{N}{N_A} \times M = \frac{1.1 \times 10^{22}}{6.022 \times 10^{23}} \times 197 = 3.6 \text{ g}$$

2. How many hydrogen atoms are in 5.37 g of $(\text{NH}_4)_3\text{PO}_4$?

- A) 1.8×10^{23} B) 1.8×10^{24}
C) 2.2×10^{23} D) 2.6×10^{23}

SOLUTION

$$\begin{aligned} & 1 \text{ mol } (\text{NH}_4)_3\text{PO}_4 \text{ contains } 12 \text{ mol H} \\ & \frac{5.37}{149} \text{ mol } (\text{NH}_4)_3\text{PO}_4 \text{ contains } n \text{ mol H} \\ N n &= \frac{0.036 \times 12}{1} = 0.5326 \text{ mol} \\ N &= n \times N_A = 0.5326 \times 6.022 \times 10^{23} = 2.6 \times 10^{23} \text{ atom} \end{aligned}$$

3. How many moles are in 1.0 kg of pure table sugar $\text{C}_{12}\text{H}_{22}\text{O}_{11}$?

- A) 2.92 B) 3.32 C) 3.64 D) 4.16

SOLUTION

$$n = \frac{m}{M} = \frac{1000}{342} = 2.92 \text{ mol}$$

4. The percentage by mass of nitrogen in $\text{Bi}(\text{NO}_3)_3$ is:

- A) 7.36% B) 10.64% C) 8.54% D) 9.75%

SOLUTION

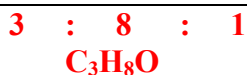
$$N = \frac{\text{mass of element}}{\text{mass of compound}} = \frac{42}{395} \times 100 = 10.6\%$$

5. The combustion of 1.031 g of an organic compound that contains only carbon, hydrogen and oxygen produced 2.265 g of CO_2 and 1.236 g of H_2O . What is the empirical formula of this compound?

- A) $\text{C}_2\text{H}_6\text{O}$ B) $\text{C}_3\text{H}_5\text{O}$ C) $\text{C}_3\text{H}_8\text{O}$ D) CH_2O

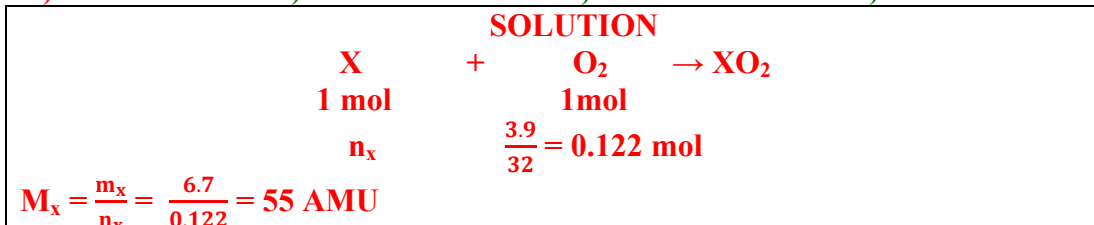
SOLUTION

$$\begin{aligned} C_{\text{mass}} \frac{M_{\text{CO}_2}}{M_C} \times m_{\text{CO}_2} &= \frac{12}{44} \times 2.265 = 0.6177 \text{ g} \\ H_{\text{mass}} \frac{M_H}{M_{\text{H}_2\text{O}}} \times m_{\text{H}_2\text{O}} &= \frac{2}{18} \times 1.236 = 0.1373 \text{ g} \\ C_{\text{mass}} &= M_{\text{compound}} - (C_{\text{mass}} + H_{\text{mass}}) = 1.031 - (0.6177 + 0.1373) = 0.276 \text{ g} \\ C &: H : O \\ \frac{0.6177}{12} &: \frac{0.1373}{1} : \frac{0.276}{16} \\ 0.0515 &: 0.1373 : 0.01725 \end{aligned}$$



6. An element "X" combines with oxygen to form a compound with formula XO_2 . If 6.7 g of this element combines with 3.9 g of oxygen, what is the atomic mass of this element (in a.m.u.)?

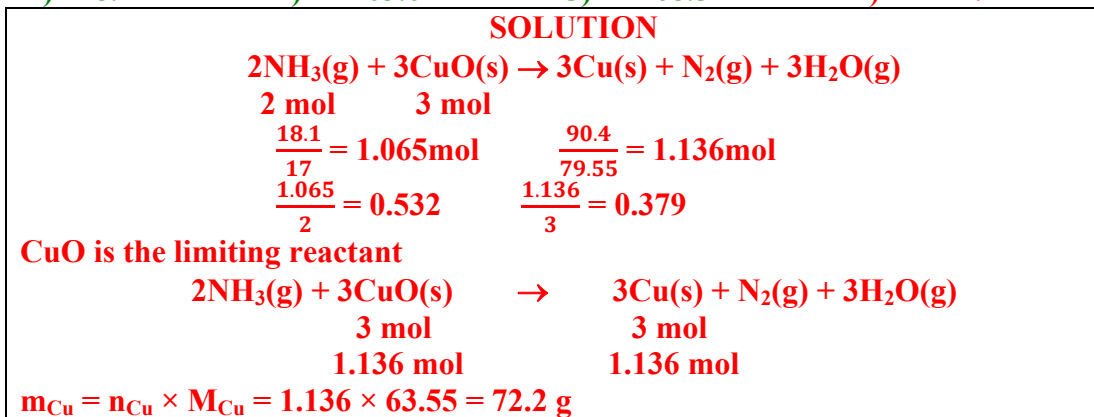
A) 55 B) 40 C) 65 D) 48



7. What is the theoretically yield (in grams) of copper Cu when 18.1 g of NH_3 gas and 90.4 g solid CuO were allowed to react according to:



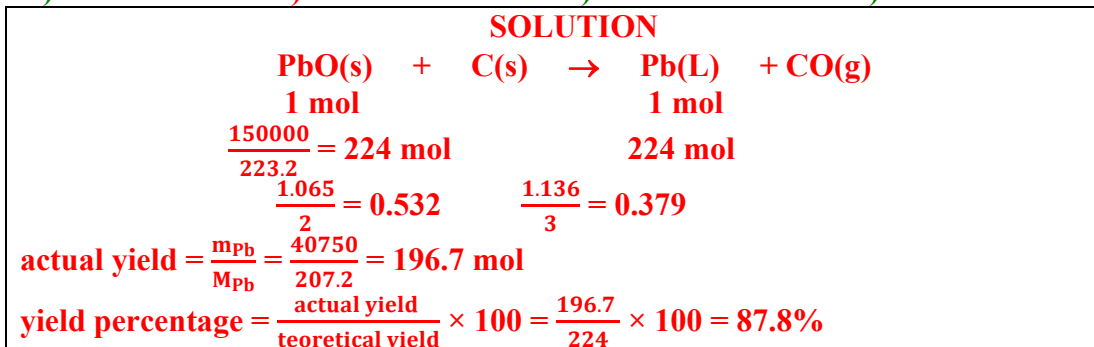
A) 48.7 B) 63.6 C) 68.5 D) 72.2



8. What is the percentage yield of lead (Pb) if 50.00 kg of PbO are reduced by heating with excess carbon and 40.75 kg of lead are produced according to:



A) 75.88% B) 87.79% C) 90.32% D) 94.65%



9. How many milliliter of water must be added to a stock solution of 6.0M HNO_3 in order to prepare 900 mL of 0.5 M HNO_3 by dilution?

- A) 825 B) 850 C) 780 D) 800

SOLUTION

$$M_1 \times V_1 = M_2 \times V_2$$

$$V_1 = \frac{M_2 \times V_2}{M_1} = \frac{0.5 \times 900}{6} = 75 \text{ mL}$$

$$V_{\text{H}_2\text{O}} = V_2 - V_1 = 900 - 75 = 825 \text{ mL}$$

10. What is the percent H_2SO_4 by mass in a 6.0 M H_2SO_4 solution that has a density of 1.34 g/mL?

- A) 27.83% B) 32.74% C) 43.92% D) 78.25%

SOLUTION

$$m_{\text{H}_2\text{O}} = n_{\text{H}_2\text{O}} \times M_{\text{H}_2\text{O}} = 6 \times 18 = 588 \text{ g}$$

$$m_{\text{solution}} = V_{\text{solution}} \times d_{\text{solution}} = 1000 \times 1.34 = 1340 \text{ g}$$

$$\text{H}_2\text{SO}_4\% = \frac{m_{\text{H}_2\text{SO}_4}}{m_{\text{solution}}} \times 100 = \frac{588}{1340} \times 100 = 43.88\%$$

11. A sample of Cl_2 gas occupies a volume of 5.0 L at 25°C and 15.0 atm. What volume (in L) will this sample occupy at STP?

- A) 68.7 B) 52.8 C) 40.6 D) 28.4

SOLUTION

$$M_1 \times V_1 = M_2 \times V_2$$

$$\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2}, V_2 = \frac{P_1 \times V_1 \times T_2}{P_2 \times T_1} = \frac{15 \times 5 \times 273}{1 \times 298} = 68.7 \text{ L}$$

12. A tennis ball has an internal volume of 145 mL and contains 0.366 g of N_2 gas. What will be the pressure (in atm) inside the ball at 25°C ?

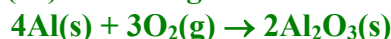
- A) 1.8 B) 2.0 C) 2.2 D) 2.4

SOLUTION

$$M_1 \times V_1 = M_2 \times V_2$$

$$P = \frac{n \times R \times T}{V} = \frac{\frac{m}{M} \times R \times T}{V} = \frac{0.366}{28} \times 0.0821 \times 298 = 2.2 \text{ atm}$$

13. What volume of oxygen gas at STP would be needed to react completely with 20.1 g of aluminum (Al) according to:



- A) 10.8 L B) 12.5 L C) 14.3 L D) 15.5 L

SOLUTION



$$V = \frac{n \times R \times T}{P} = \frac{\frac{m}{M} \times R \times T}{V} = \frac{0.599 \times 0.0821 \times 273}{1} = 12.25 \text{ L}$$

14. What is the molar mass (in $\text{g}\cdot\text{mol}^{-1}$) of a certain gas if its density is 1.57 g/L at 25°C and 1.2 atm?

- A) 71 B) 44 C) 32 D) 28

$$\text{SOLUTION}$$
$$PM = dRT, M = \frac{d \times R \times T}{P} = \frac{1.57 \times 0.0821 \times 298}{1.2} = 32 \text{ g/L}$$

15. What is the root-mean-square speed of a neon Ne atom (in m/s) at 27°C?

- A) 450 B) 498 C) 585 D) 609

$$\text{SOLUTION}$$
$$\sqrt{\bar{U}^2} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3 \times 8.314 \times 300}{0.02018}} = 608.9 \text{ m/s}$$