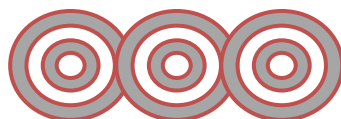




# CHEM 101+103



## First Exam Sample 2

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

**A) 2.2**

**B) 2.8**

**C) 3.6**

**D) 3.9**

**Solution:-**

**Atomic weight for Au = 197 g/mol**

$$n = \frac{N}{N_A} = \frac{1.1 \times 10^{22}}{6.022 \times 10^{23}} = 0.018266 \text{ mol}$$

$$m = n \times M = 0.018266 \times 197 = 3.598 \text{ g}$$

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

- A)  $1.8 \times 10^{23}$     B)  $1.8 \times 10^{24}$     C)  $2.2 \times 10^{23}$     **D)  $2.6 \times 10^{23}$**

**Solution:-**

**1 mol  $(\text{NH}_4)_3\text{PO}_4$  contains 12 mol H**

**M for  $(\text{NH}_4)_3\text{PO}_4 = 149 \text{ g/mol}$**

**mol  $(\text{NH}_4)_3\text{PO}_4 = 5.37/149 = 0.036 \text{ mol}$**

**mol H =  $0.036 \times 12 = 0.5326 \text{ mol}$**

**No. of H atoms =  $n \times N_A$**

**$= 0.5326 \times 6.022 \times 10^{23} = 2.6 \times 10^{23} \text{ atom}$**

**3. How many moles are in 1.0 kg of pure table sugar  $C_{12}H_{22}O_{11}$ ?**

**A) 2.92**

**B) 3.32**

**C) 3.64**

**D) 4.16**

**Solution:-**

**M for  $C_{12}H_{22}O_{11}$  = 342 g/mol**

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

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

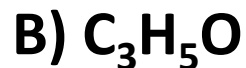
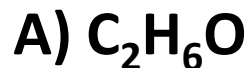
- A) 7.36%      B) 10.64%      C) 8.54%      D) 9.75%**

**Solution:-**

**M for  $\text{Bi}(\text{NO}_3)_3 = 395 \text{ g/mol}$**

$$\text{\%N in } \text{Bi}(\text{NO}_3)_3 = \frac{3 \times 14}{395} \times 100\% = 10.63\%$$

**5. The combustion of 1.031 g of an organic compound that contains only carbon, hydrogen and oxygen produced 2.265 g of CO<sub>2</sub> and 1.236 g of H<sub>2</sub>O. What is the empirical formula of this compound?**



**Solution:-**

$$\text{Gram C} = \frac{2.265}{44} \times 12 = 0.6177 \text{ g}$$

$$\text{Gram H} = \frac{1.236}{18} \times 2 \times 1 = 0.1373 \text{ g}$$

$$\text{Gram O} = 1.031 - (0.6177 + 0.1373) = 0.276 \text{ g}$$

$$\text{mol C} = 0.6177 / 12 = 0.0515 \text{ mol}$$

$$\text{mol H} = 0.1373 / 1 = 0.1373 \text{ mol}$$

$$\text{mol O} = 0.276 / 16 = 0.01725 \text{ mol}$$

**Divide by 0.01725**

**C : H : O    3 : 8 : 1**



**6. An element "X" combines with oxygen to form a compound with formula  $\text{XO}_2$ . 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**

**Solution:-**



$$\text{mol of O}_2 = 3.9/32 = 0.122 \text{ mol}$$

$$\text{mol X} = \text{mol O}_2$$

$$\text{Atomic mass of X} = 6.7/0.122 = 55$$

**7. What is the theoretical yield (in grams) of copper Cu when 18.1 g of NH<sub>3</sub> 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**

**Solution:-**

$$\text{mol NH}_3 = 18.1/17 = 1.065 \text{ mol}$$

$$\text{mol CuO} = 90.4/79.55 = 1.136 \text{ mol}$$

**Stoichiometric ratio**

$$\text{NH}_3 \text{ mol} = 1.065/2 = 0.532$$

$$\text{CuO mol} = 1.136/3 = 0.379$$

**CuO is the limiting reactant**

$$\text{So, mol Cu}/3 = \text{mol CuO}/3$$

$$\text{mol of Cu} = 1.136$$

$$\text{mass Cu} = 1.136 \times 63.55 = 72.2 \text{ g}$$



**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%**

**Solution:-**

$$\text{M PbO} = 223.2 \text{ g/mol}$$

$$\text{mol PbO} = 50000/223.2 = 224 \text{ mol}$$

$$\text{mol PbO} = \text{mol Pb produced}$$

$$\text{mass Pb} = 224 \times 207.2 = 46412.8 \text{ g}$$

$$\% \text{yield} = \frac{40750}{46412.8} \times 100\% = 87.799\%$$

**9. How many milliliter of water must be added to a stock solution of 6.0 M HNO<sub>3</sub> in order to prepare 0.90 L of 0.5 M HNO<sub>3</sub> by dilution?**

**A) 825**

**B) 850**

**C) 780**

**D) 800**

**Solution:-**

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

$$6 \times V_1 = 0.5 \times 0.9$$

$$V_1 = 0.5 \times 0.9 / 6 = 0.075 \text{ L}$$

$$V_{\text{H}_2\text{O}} = 0.9 - 0.075 = 0.825 \text{ L} = 825 \text{ mL}$$

**10.** What is the percent  $\text{H}_2\text{SO}_4$  by mass in a 6.0 M of 1.0 L  $\text{H}_2\text{SO}_4$  solution that has a density of 1.34 g/mL?

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

**Solution:-**

$$\text{mol H}_2\text{SO}_4 = 6 \times 1 = 6 \text{ mol}$$

$$\text{mass H}_2\text{SO}_4 = 6 \times 98 = 588 \text{ g}$$

$$\text{mass of solution} = 1000 \times 1.34 = 1340 \text{ g}$$

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

**11.** A sample of  $\text{Cl}_2$  gas occupies a volume of 5.0 L at  $25^\circ\text{C}$  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:-**

**STP;  $0^\circ\text{C}$  (273 K) and 1 atm**

$$P_1 V_1 / T_1 = P_2 V_2 / T_2$$

$$V_2 = 15 \times 5 \times 273 / 298 \times 1 = 68.7 \text{ L}$$

**12.** A tennis ball has an internal volume of 145 mL and contains 0.366 g of N<sub>2</sub> 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:-**

$$P = nRT / V$$

$$\text{mol N}_2 = 0.366 / 28 = 0.0131 \text{ mol}$$

$$P = 0.0131 \times 0.0821 \times 298 / 0.145 = 2.2 \text{ atm}$$

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

$$4\text{Al(s)} + 3\text{O}_2\text{(g)} \rightarrow 2\text{Al}_2\text{O}_3\text{(s)}$$

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

**Solution:-**

$$\text{mol Al} = 20.1 / 26.98 = 0.745 \text{ mol}$$

$$\text{mol Al} / 4 = \text{mol O}_2 / 3$$

$$\text{mol O}_2 = 0.745 \times 3 / 4 = 0.559 \text{ mol}$$

$$PV = nRT$$

$$V = 0.559 \times 0.08206 \times 273 / 1 = 12.5 \text{ L}$$

**14.** What is the molar mass (in g.mol<sup>-1</sup>) of a certain gas if its density is 1.57g/L at 25°C and 1.2 atm?

A) 71

B) 44

**C) 32**

D) 28

**Solution:-**

$$\mathcal{M} = \frac{d R T}{P}$$

$$= \frac{1.57 \times 0.0821 \times 298}{1.2} = 32 \text{ L}$$

**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

**Solution:-**

$$u = \sqrt{\frac{3RT}{\mathcal{M}}}$$

$$= \sqrt{\frac{3 \times 8.314 \times 300}{0.02018}} = 608.9 \text{ m/s}$$



