Chem 1020
Mole conversions and stoichiometry worksheet

1. How many Ag atoms are in 2.43 mol Ag atoms?

$$2.43 \text{ mol Ag atoms} \times \frac{6.022\times10^{23} \text{ Ag atoms}}{1 \text{ mol Ag atoms}} = 1.46\times10^{24} \text{ Ag atoms}$$

2. How many Br_2 molecules are in 18.2 mol Br_2 molecules?

$$18.2 \text{ mol } Br_2 \text{ molecules} \times \frac{6.022\times10^{23} \ Br_2 \text{ molecules}}{1 \text{ mol } Br_2 \text{ molecules}} = 1.10\times10^{25} \ Br_2 \text{ molecules}$$

3. 7.53×10^{28} Al atoms is equal to how many mol Al atoms?

$$7.53\times10^{28} \text{ Al atoms} \times \frac{1 \text{ mol Al atoms}}{6.022\times10^{23} \text{ Al atoms}} = 1.25\times10^{5} \text{ mol Al atoms}$$

4. 2.932×10^{17} H_2O molecules is equal to how many mol H_2O molecules?

$$2.932\times10^{17} \ H_2O \text{ molecules} \times \frac{1 \text{ mol } H_2O \text{ molecules}}{6.022\times10^{23} \ H_2O \text{ molecules}} = 4.869\times10^{-7} \text{ mol } H_2O \text{ molecules}$$

5. How many **mol** N atoms are in 8.3 mol HCN?

$$8.3 \text{ mol HCN} \times \frac{1 \text{ mol N atoms}}{1 \text{ mol HCN}} = 8.3 \text{ mol N atoms}$$

6. How many **mol** H atoms are in 2.63 mol CH_2O?

$$2.63 \text{ mol } CH_2O \times \frac{2 \text{ mol H atoms}}{1 \text{ mol } CH_2O} = 5.26 \text{ mol H atoms}$$

7. How many Cl atoms are in 3.63 mol CH_2Cl_2?

$$3.63 \text{ mol } CH_2Cl_2 \times \frac{2 \text{ mol Cl atoms}}{1 \text{ mol } CH_3Cl_2} \times \frac{6.022\times10^{23} \text{ Cl atoms}}{1 \text{ mol Cl atoms}} = 4.37\times10^{24} \text{ Cl atoms}$$

8. How many O atoms are in 6.229 mol $Ca(NO_3)_2$?

$$6.229\ \text{mol Ca(NO}_3\text{)}_2 \times \frac{6\ \text{mol O atoms}}{1\ \text{mol Ca(NO}_3\text{)}_2} \times \frac{6.022\times10^{23}\ \text{O atoms}}{1\ \text{mol O atoms}} = 2.251\times10^{25}\ \text{O atoms}$$

9. How many mol $FeCl_3$ are in 15.3 g $FeCl_3$?

$$\text{Molar mass FeCl}_3 = 55.85 + 3(35.45) = 162.2\ \text{g/mol}$$

$$15.3\ \text{g FeCl}_3 \times \frac{1\ \text{mol FeCl}_3}{162.2\ \text{g FeCl}_3} = 0.0943\ \text{mol FeCl}_3$$

10. How many mol Na_2CO_3 are in 23.5 g Na_2CO_3?

$$\text{Molar mass Na}_2\text{CO}_3 = 2(22.99) + 12.01 + 3(16.00) = 105.99\ \text{g/mol}$$

$$23.5\ \text{g Na}_2\text{CO}_3 \times \frac{1\ \text{mol Na}_2\text{CO}_3}{105.99\ \text{g Na}_2\text{CO}_3} = 0.222\ \text{g Na}_2\text{CO}_3$$

11. What mass is 3.52 mol $NaNO_3$?

$$\text{Molar mass NaNO}_3 = 22.99 + 14.01 + 3(16.00) = 85.00\ \text{g/mol}$$

$$3.52\ \text{mol NaNO}_3 \times \frac{85.00\ \text{g NaNO}_3}{1\ \text{mol NaNO}_3} = 299\ \text{g NaNO}_3$$

12. What mass is 7.326 mol C_2H_4?

$$\text{Molar mass C}_2\text{H}_4 = 2(12.01) + 4(1.008) = 28.052\ \text{g/mol}$$

$$7.326\ \text{mol C}_2\text{H}_4 \times \frac{28.052\ \text{g C}_2\text{H}_4}{1\ \text{mol C}_2\text{H}_4} = 205.5\ \text{g C}_2\text{H}_4$$

13. How many mol H atoms are in 18.2 g NH_3?

$$\text{Molar mass NH}_3 = 14.01 + 3(1.008) = 17.034\ \text{g/mol}$$

$$18.2\ \text{g NH}_3 \times \frac{1\ \text{mol NH}_3}{17.034\ \text{g NH}_3} \times \frac{3\ \text{mol H atoms}}{1\ \text{mol NH}_3} = 3.21\ \text{mol H atoms}$$

14. How many mol O atoms are in 3.52 g MnO_2?

$$\text{Molar mass MnO}_2 = 54.94 + 2(16.00) = 86.94\ \text{g/mol}$$

$$3.52\ \text{g MnO}_2 \times \frac{1\ \text{mol MnO}_2}{86.94\ \text{g MnO}_2} \times \frac{2\ \text{mol O atoms}}{1\ \text{mol MnO}_2} = 0.0810\ \text{mol O atoms}$$

15. How many S atoms are in 2.35 g Al_2S_3?

Molar mass $Al_2S_3 = 2(26.98) + 3(32.06) = 150.14$ g/mol

$$2.35 \text{ g } Al_2S_3 \times \frac{1 \text{ mol } Al_2S_3}{150.14 \text{ g } Al_2S_3} \times \frac{3 \text{ mol S atoms}}{1 \text{ mol } Al_2S_3} \times \frac{6.022 \times 10^{23} \text{ S atoms}}{1 \text{ mol S atoms}} = 2.83 \times 10^{22} \text{ S atoms}$$

16. How many F atoms are in 5.52 g $C_2H_2F_4$?

Molar mass $C_2H_2F_4 = 2(12.01) + 2(1.008) + 4(19.00) = 102.036$ g/mol

$$5.52 \text{ g } C_2H_2F_4 \times \frac{1 \text{ mol } C_2H_2F_4}{102.036 \text{ g } C_2H_2F_4} \times \frac{4 \text{ mol F atoms}}{1 \text{ mol } C_2H_2F_4} \times \frac{6.022 \times 10^{23} \text{ F atoms}}{1 \text{ mol F atoms}} = 1.30 \times 10^{23} \text{ F atoms}$$

17. What mass of O is in 7.56 g H_2O_2?

Molar mass $H_2O_2 = 2(1.008) + 2(16.00) = 34.016$ g/mol

Molar mass O = 16.00 g/mol

$$7.56 \text{ g } H_2O_2 \times \frac{1 \text{ mol } H_2O_2}{34.016 \text{ g } H_2O_2} \times \frac{2 \text{ mol O}}{1 \text{ mol } H_2O_2} \times \frac{16.00 \text{ g O}}{1 \text{ mol O}} = 7.11 \text{ g O}$$

18. What mass of Cl is in 38.2 g PCl_3?

Molar mass $PCl_3 = 30.97 + 3(35.45) = 137.32$ g/mol

Molar mass $Cl = 35.45$ g/mol

$$38.2 \text{ g } PCl_3 \times \frac{1 \text{ mol } PCl_3}{137.32 \text{ g } PCl_3} \times \frac{3 \text{ mol Cl}}{1 \text{ mol } PCl_3} \times \frac{35.45 \text{ g Cl}}{1 \text{ mol Cl}} = 29.6 \text{ g Cl}$$

For the following 6 questions, consider the following balanced chemical equation:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

Molar mass $N_2 = 2(14.01) = 28.02$ g/mol

Molar mass $H_2 = 2(1.008) = 2.016$ g/mol

Molar mass $NH_3 = 14.01 + 3(1.008) = 17.034$ g/mol

19. How many mol NH_3 can be produced from 7.23 mol N_2 (assuming H_2 is in excess)?

$$7.23 \text{ mol } N_2 \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } N_2} = 14.5 \text{ mol } NH_3$$

20. How many mol H_2 must react with 3.26 mol N_2?

$$3.26\ \text{mol N}_2 \times \frac{3\ \text{mol H}_2}{1\ \text{mol N}_2} = 9.78\ \text{mol H}_2$$

21. How many grams of N_2 must react if 25.0 g NH_3 are formed?

$$25.0\ \text{g NH}_3 \times \frac{1\ \text{mol NH}_3}{17.034\ \text{g NH}_3} \times \frac{1\ \text{mol N}_2}{2\ \text{mol NH}_3} \times \frac{28.02\ \text{g N}_2}{1\ \text{mol N}_2} = 20.5\ \text{g N}_2$$

22. How many grams H_2 will react with 15.3 g N_2?

$$15.3\ \text{g N}_2 \times \frac{1\ \text{mol N}_2}{28.02\ \text{g N}_2} \times \frac{3\ \text{mol H}_2}{1\ \text{mol N}_2} \times \frac{2.016\ \text{g H}_2}{1\ \text{mol H}_2} = 3.30\ \text{g H}_2$$

23. If 2.36 g N_2 and 1.52 g H_2 react together, what mass NH_3 can be produced? Which is the limiting reactant?

$$2.36\ \text{g N}_2 \times \frac{1\ \text{mol N}_2}{28.02\ \text{g N}_2} \times \frac{2\ \text{mol NH}_3}{1\ \text{mol N}_2} \times \frac{17.034\ \text{g NH}_3}{1\ \text{mol NH}_3} = \boxed{\mathbf{2.87\ g\ NH_3}}$$

$$1.52\ \text{g H}_2 \times \frac{1\ \text{mol H}_2}{2.016\ \text{g H}_2} \times \frac{2\ \text{mol NH}_3}{3\ \text{mol H}_2} \times \frac{17.034\ \text{g NH}_3}{1\ \text{mol NH}_3} = 8.56\ \text{g NH}_3$$

There is enough N_2 to make 2.87 g NH_3, and there is enough H_2 to make 8.56 g NH_3. **N_2 is the limiting reactant** since it produces the smaller product mass. **2.87 g NH_3 can be produced** (this is the theoretical yield).

24. If 5.32 g N_2 and 15.8 g H_2 react together, what mass NH_3 can be produced? Which is the limiting reactant?

$$5.32\ \text{g N}_2 \times \frac{1\ \text{mol N}_2}{28.02\ \text{g N}_2} \times \frac{2\ \text{mol NH}_3}{1\ \text{mol N}_2} \times \frac{17.034\ \text{g NH}_3}{1\ \text{mol NH}_3} = \boxed{\mathbf{6.47\ g\ NH_3}}$$

$$15.8\ \text{g H}_2 \times \frac{1\ \text{mol H}_2}{2.016\ \text{g H}_2} \times \frac{2\ \text{mol NH}_3}{3\ \text{mol H}_2} \times \frac{17.034\ \text{g NH}_3}{1\ \text{mol NH}_3} = 89.0\ \text{g NH}_3$$

There is enough N_2 to make 6.47 g NH_3 and there is enough H_2 to make 89.0 g NH_3. **N_2 is the limiting reactant** because it makes the smaller product mass. **6.47 g NH_3 can be produced** (this is the theoretical yield).

For the following 6 questions, consider the following balanced chemical equation:

$$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$$

Molar mass C_2H_2 = 2(12.01) + 2(1.008) = 26.036 g/mol
Molar mass O_2 = 2(16.00) = 32.00 g/mol
Molar mass CO_2 = 12.01 + 2(16.00) = 44.01 g/mol
Molar mass H_2O = 2(1.008) + 16.00 = 18.016 g/mol

25. How many mol of CO_2 can be formed if 8.26 mol C_2H_2 react (assuming excess O_2)?

$$8.26 \text{ mol } C_2H_2 \times \frac{4 \text{ mol } CO_2}{2 \text{ mol } C_2H_2} = 16.5 \text{ mol } CO_2$$

26. How many mol C_2H_2 will react with 20.3 mol O_2?

$$20.3 \text{ mol } O_2 \times \frac{2 \text{ mol } C_2H_2}{5 \text{ mol } O_2} = 8.12 \text{ mol } C_2H_5$$

27. How many g of H_2O can be formed if 36.2 g C_2H_2 react (assuming excess O_2)?

$$36.2 \text{ g } C_2H_2 \times \frac{1 \text{ mol } C_2H_2}{26.036 \text{ g } C_2H_2} \times \frac{2 \text{ mol } H_2O}{2 \text{ mol } C_2H_2} \times \frac{18.016 \text{ g } H_2O}{1 \text{ mol } H_2O} = 25.0 \text{ g } H_2O$$

28. How many g O_2 will react with 12.2 g C_2H_2?

$$12.2 \text{ g } C_2H_2 \times \frac{1 \text{ mol } C_2H_2}{26.036 \text{ g } C_2H_2} \times \frac{5 \text{ mol } O_2}{2 \text{ mol } C_2H_2} \times \frac{32.00 \text{ g } O_2}{1 \text{ mol } O_2} = 37.5 \text{ g } O_2$$

29. If 2.l3 g C_2H_2 and 3.63 g O_2 react, how many grams CO_2 can be formed? Which is the limiting reactant?

$$2.13 \text{ g } C_2H_2 \times \frac{1 \text{ mol } C_2H_2}{26.036 \text{ g } C_2H_2} \times \frac{4 \text{ mol } CO_2}{2 \text{ mol } C_2H_2} \times \frac{44.01 \text{ g } CO_2}{1 \text{ mol } CO_2} = 7.20 \text{ g } CO_2$$

$$3.63 \text{g } O_2 \times \frac{1 \text{ mol } O_2}{32.00 \text{ g } O_2} \times \frac{4 \text{ mol } CO_2}{5 \text{ mol } O_2} \times \frac{44.01 \text{ g } CO_2}{1 \text{ mol } CO_2} = \boxed{\mathbf{3.99 \text{ g } CO_2}}$$

There is enough C_2H_2 to make 7.20 g CO_2 and there is enough O_2 to make 3.99 g CO_2. **O_2 is the limiting reactant** since it produces the smaller product mass. **3.99 g CO_2 can be produced** (this is the theoretical yield).

30. If 6.26 g C_2H_2 and 22.35 g O_2 react, how many grams H_2O can be formed? Which is the limiting reactant?

$$6.26\text{ g } C_2H_2 \times \frac{1\text{ mol } C_2H_2}{26.036\text{ g } C_2H_2} \times \frac{2\text{ mol } H_2O}{2\text{ mol } C_2H_2} \times \frac{18.016\text{ g } H_2O}{1\text{ mol } H_2O} = \boxed{\mathbf{4.33\text{ g } H_2O}}$$

$$22.35\text{ g } O_2 \times \frac{1\text{ mol } O_2}{32.00\text{ g } O_2} \times \frac{2\text{ mol } H_2O}{5\text{ mol } O_2} \times \frac{18.016\text{ g } H_2O}{1\text{ mol } H_2O} = 5.03\text{ g } H_2O$$

There is enough C_2H_5 to make 4.33 g H_2O and there is enough O_2 to make 5.03 g H_2O. **C_2H_2 is the limiting reactant** because it produces the smaller product mass. **4.33 g H_2O can be produced** (this is the theoretical yield).