KEY

Chemistry: *Stoichiometry – Problem Sheet 2*

Directions: *Solve each of the following problems. Show your work, including proper units, to earn full credit.*

1. ___ $CaCl_2$ + ___ $AgNO_3$ → ___ $Ca(NO_3)_2$ + ___ $AgCl$

How many grams of silver chloride are produced when 45 g of calcium chloride react with excess silver nitrate?

$$x\ \text{g AgCl} = 45\ \text{g CaCl}_2\left(\frac{1\text{mol CaCl}_2}{111\ \text{g CaCl}_2}\right)\left(\frac{2\ \text{mol AgCl}}{1\ \text{mol CaCl}_2}\right)\left(\frac{143.5\ \text{g AgCl}}{1\text{mol AgCl}}\right) = 116\ \text{g AgCl}$$

2. ___ CuO + ___ H_2 → ___ Cu + ___ H_2O

At STP, how many liters of hydrogen are needed to react with 88 g of copper (II) oxide?

$$x\ \text{L H}_2 = 88\ \text{g CuO}\left(\frac{1\text{mol CuO}}{79.5\ \text{g CuO}}\right)\left(\frac{1\text{mol H}_2}{1\text{mol CuO}}\right)\left(\frac{22.4\ \text{L H}_2}{1\text{mol H}_2}\right) = 24.8\ \text{L H}_2$$

3. ___ Na + ___ H_2O → ___ $NaOH$ + ___ H_2

If 3 liters of hydrogen (at STP) are produced in the above reaction, what mass of sodium was used?

$$x\ \text{g Na} = 3\ \text{L H}_2\left(\frac{1\text{mol H}_2}{22.4\ \text{L H}_2}\right)\left(\frac{2\ \text{mol Na}}{1\text{mol H}_2}\right)\left(\frac{23\ \text{g Na}}{1\text{mol Na}}\right) = 6.2\ \text{g Na}$$

4. ___ CH_4 + ___ O_2 → ___ CO_2 + ___ H_2O

What volume of methane is needed to completely react with 500 liters of oxygen?

$$x\ \text{L CH}_4 = 500\ \text{L O}_2\left(\frac{1\text{mol O}_2}{22.4\ \text{L O}_2}\right)\left(\frac{1\text{mol CH}_4}{2\ \text{mol O}_2}\right)\left(\frac{22.4\ \text{L CH}_4}{1\text{mol CH}_4}\right) = 250\ \text{L CH}_4$$

5. ___ CS_2 + ___ O_2 → ___ CO_2 + ___ SO_2

How many molecules of carbon disulfide will react with 4.21 x 10^{19} molecules of oxygen?

$$x\ \text{molecules C}_2\text{S} = 4.21\text{x}10^{19}\ \text{molecules O}_2\left(\frac{1\text{mol O}_2}{6.02\text{x}10^{23}\ \text{molecules O}_2}\right)\left(\frac{1\text{mol CS}_2}{3\ \text{mol O}_2}\right)\left(\frac{6.02\text{x}10^{23}\ \text{molecules CS}_2}{1\text{mol CS}_2}\right) = 1.40\text{x}10^{19}\ \text{molecules CS}_2$$

6. ___ C_2H_6 → ___ C_2H_4 + ___ H_2

If 5.76 x 10^{28} molecules of ethane are broken down, what volume of hydrogen gas is produces at STP?

$$x\ \text{L H}_2 = 5.76\text{x}10^{28}\ \text{molecules C}_2\text{H}_6\left(\frac{1\text{mol C}_2\text{H}_6}{6.02\text{x}10^{23}\ \text{molecules C}_2\text{H}_6}\right)\left(\frac{1\text{mol H}_2}{1\text{mol C}_2\text{H}_6}\right)\left(\frac{22.4\ \text{L H}_2}{1\text{mol H}_2}\right) = 2.14\text{x}10^{6}\ \text{L H}_2$$

7. ___ Fe + ___ H_2O → ___ Fe_3O_4 + ___ H_2

If 67.8 dm^3 of hydrogen are produced at STP, how many atoms of iron were used in the reaction?

$$x\ \text{atoms Fe} = 67.8\ \text{dm}^3\ \text{H}_2\left(\frac{1\text{mol H}_2}{22.4\ \text{dm}^3\ \text{H}_2}\right)\left(\frac{3\ \text{mol Fe}}{4\ \text{mol H}_2}\right)\left(\frac{6.02\text{x}10^{23}\ \text{atoms Fe}}{1\text{mol Fe}}\right) = 1.37\text{x}10^{24}\ \text{atoms Fe}$$

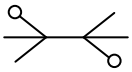
8. ___ $KClO_3$ → ___ KCl + ___ O_2

If 8.65 x 10^{25} molecules of potassium chloride are produced, what mass of oxygen is produced?

$$x\ \text{g O}_2 = 8.65\times10^{25}\ \text{molecules KCl}\left(\frac{1\text{mol KCl}}{6.02\times10^{23}\ \text{molecules KCl}}\right)\left(\frac{3\ \text{mol O}_2}{2\ \text{mol KCl}}\right)\left(\frac{32\ \text{g O}_2}{1\text{mol O}_2}\right) = 6897\ \text{g O}_2$$

9. ___ NaI + ___ Cl_2 → ___ NaCl + ___ I_2

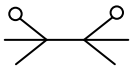
How many molecules of iodine are liberated if 546 g of chlorine react with excess sodium iodide?



$$x \text{ molecules } I_2 = 546 \text{ g } Cl_2 \left(\frac{1 \text{mol } Cl_2}{71 \text{ g } Cl_2}\right)\left(\frac{1 \text{mol } I_2}{1 \text{ mol } Cl_2}\right)\left(\frac{6.02 \times 10^{23} \text{ molecules } I_2}{1 \text{mol } I_2}\right) = 4.63 \times 10^{24} \text{ molecules } I_2$$

10. ___ Cu + ___ $AgNO_3$ → ___ $Cu(NO_3)_2$ + ___ Ag

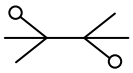
How many grams of silver will be produced if 86 g of copper are used?



$$x \text{ g Ag} = 86 \text{ g CuO}\left(\frac{1 \text{mol Cu}}{63.5 \text{ g Cu}}\right)\left(\frac{1 \text{mol Ag}}{1 \text{mol Cu}}\right)\left(\frac{108 \text{ g Ag}}{1 \text{mol Ag}}\right) = 292 \text{ g Ag}$$

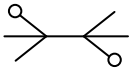
11. ___ $(NH_4)_2SO_4$ + ___ $Ca(OH)_2$ → ___ $CaSO_4$ + ___ NH_3 + ___ H_2O

At STP, how many dm^3 of ammonia are produced by using 26.0 g of calcium hydroxide?



$$x \text{ L } NH_3 = 26.0 \text{ g } Ca(OH)_2 \left(\frac{1 \text{mol } Ca(OH)_2}{74 \text{ g } Ca(OH)_2}\right)\left(\frac{2 \text{ mol } NH_3}{1 \text{mol } Ca(OH)_2}\right)\left(\frac{22.4 \text{ dm}^3 NH_3}{1 \text{mol } NH_3}\right) = 15.7 \text{ dm}^3 NH_3$$

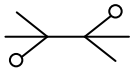
12. ___ NaCl + ___ H_2SO_4 → ___ HCl + ___ Na_2SO_4



If 359 g of sodium chloride are consumed in the reaction, how many molecules of sodium sulfate are produced?

$$x \text{ molecules } Na_2SO_4 = 395 \text{ g NaCl}\left(\frac{1 \text{mol NaCl}}{58.5 \text{ g NaCl}}\right)\left(\frac{1 \text{mol } Na_2SO_4}{2 \text{ mol NaCl}}\right)\left(\frac{6.02 \times 10^{23} \text{ molecules } Na_2SO_4}{1 \text{mol } Na_2SO_4}\right) = 1.85 \times 10^{23} \text{ molecules } Na_2SO_4$$

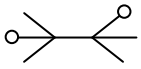
13. ___ $AgCH_3COO$ + ___ Na_3PO_4 → ___ Ag_3PO_4 + ___ $NaCH_3COO$



What mass of $AgCH_3COO$ will react with 4.77 x 10^{26} molecules of sodium phosphate?

$$x \text{ g } AgCH_3COO = 4.77 \times 10^{26} \text{ molecules } Na_3PO_4 \left(\frac{1 \text{mol } Na_3PO_4}{6.02 \times 10^{23} \text{ molecules } Na_3PO_4}\right)\left(\frac{3 \text{ mol } AgCH_3COO}{1 \text{mol } Na_3PO_4}\right)\left(\frac{167 \text{ g } AgCH_3COO}{1 \text{mol } AgCH_3COO}\right) = 3.97 \times 10^5 \text{ g } AgCH_3COO$$

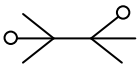
14. ___ HgO → ___ Hg + ___ O_2



What mass of mercury (II) oxide is required to produce 812 liters of oxygen (at STP)?

$$x \text{ g HgO} = 812 \text{ L } O_2 \left(\frac{1 \text{mol } O_2}{22.4 \text{ L } O_2}\right)\left(\frac{2 \text{ mol HgO}}{1 \text{mol } O_2}\right)\left(\frac{216.6 \text{ g HgO}}{1 \text{mol HgO}}\right) = 1.57 \times 10^4 \text{ g HgO}$$

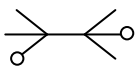
15. ___ Ag_2O → ___ Ag + ___ O_2



How many molecules of silver oxide are needed to produce 445 dm^3 of oxygen (at STP)?

$$x \text{ molecules } Ag_2O = 445 \text{ dm}^3 O_2 \left(\frac{1 \text{mol } O_2}{22.4 \text{ dm}^3 O_2}\right)\left(\frac{2 \text{ mol } Ag_2O}{1 \text{mol } O_2}\right)\left(\frac{6.02 \times 10^{23} \text{ molecules } Ag_2O}{1 \text{mol } Ag_2O}\right) = 2.39 \times 10^{25} \text{ molecules } Ag_2O$$

16. ___ Al + ___ HCl → ___ $AlCl_3$ + ___ H_2



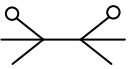
How many liters of hydrogen (at STP) are produced by reacting 3.54 x 10^{24} atoms of aluminum with excess hydrochloric acid?

$$x \text{ L } H_2 = 3.54 \times 10^{24} \text{ atoms Al}\left(\frac{1 \text{mol Al}}{6.02 \times 10^{23} \text{ atoms Al}}\right)\left(\frac{3 \text{ mol } H_2}{2 \text{ mol Al}}\right)\left(\frac{22.4 \text{ L } H_2}{1 \text{mol } H_2}\right) = 198 \text{ L } H_2$$

Answers:

1. 116 g AgCl
2. 24.8 L H_2
3. 6.2 g Na
4. 250 L CH_4
5. 1.40 x 10^{19} molecules CS_2
6. 2.14 x 10^6 L H_2
7. 1.37 x 10^{24} atoms Fe
8. 6897 g O_2
9. 4.63 x 10^{24} molecules I_2
10. 292 g Ag
11. 15.7 dm^3 NH_3
12. 1.85 x 10^{24} molecules
13. 3.97 x 10^5 g $AgCH_3COO$
14. 1.57 x 10^4 g HgO
15. 2.39 x 10^{25} molecules Ag_2O
16. 198 L H_2

Chemistry: *Stoichiometry – Problem Sheet 2* **KEY**



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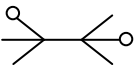

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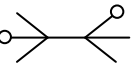
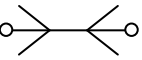
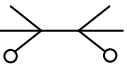


3) $x\ \text{g Na} = 3\ \text{L H}_2\left(\frac{1\text{mol H}_2}{22.4\ \text{L H}_2}\right)\left(\frac{2\ \text{mol Na}}{1\text{mol H}_2}\right)\left(\frac{23\ \text{g Na}}{1\text{mol Na}}\right) = 6.2\ \text{g Na}$

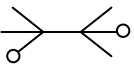


4) $x\ \text{L CH}_4 = 500\ \text{L O}_2\left(\frac{1\text{mol O}_2}{22.4\ \text{L O}_2}\right)\left(\frac{1\text{mol CH}_4}{2\ \text{mol O}_2}\right)\left(\frac{22.4\ \text{L CH}_4}{1\text{mol CH}_4}\right) = 250\ \text{L CH}_4$

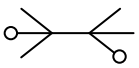


5)

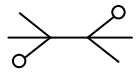
$x\ \text{molecules C}_2\text{S} = 4.21\text{x}10^{19}\ \text{molecules O}_2\left(\frac{1\text{mol O}_2}{6.02\text{x}10^{23}\ \text{molecules O}_2}\right)\left(\frac{1\text{mol CS}_2}{3\ \text{mol O}_2}\right)\left(\frac{6.02\text{x}10^{23}\ \text{molecules CS}_2}{1\text{mol CS}_2}\right) = 1.40\text{x}10^{19}\ \text{m}$



6) $x\ \text{L H}_2 = 5.76\text{x}10^{28}\ \text{molecules C}_2\text{H}_6\left(\frac{1\text{mol C}_2\text{H}_6}{6.02\text{x}10^{23}\ \text{molecules C}_2\text{H}_6}\right)\left(\frac{1\text{mol H}_2}{1\text{mol C}_2\text{H}_6}\right)\left(\frac{22.4\ \text{L H}_2}{1\text{mol H}_2}\right) = 2.14\text{x}10^{6}\ \text{L H}_2$



7) $x\ \text{atoms Fe} = 67.8\ \text{dm}^3\ \text{H}_2\left(\frac{1\text{mol H}_2}{22.4\ \text{dm}^3\ \text{H}_2}\right)\left(\frac{3\ \text{mol Fe}}{4\ \text{mol H}_2}\right)\left(\frac{6.02\text{x}10^{23}\ \text{atoms Fe}}{1\text{mol Fe}}\right) = 1.37\text{x}10^{24}\ \text{atoms Fe}$



8) $x\ \text{g O}_2 = 8.65\times10^{25}\ \text{molecules KCl}\left(\frac{1\text{mol KCl}}{6.02\times10^{23}\ \text{molecules KCl}}\right)\left(\frac{3\ \text{mol O}_2}{2\ \text{mol KCl}}\right)\left(\frac{32\ \text{g O}_2}{1\text{mol O}_2}\right) = 6897\ \text{g O}_2$

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9) $x \text{ molecules } I_2 = 546 \text{ g } Cl_2 \left(\frac{1 \text{mol } Cl_2}{71 \text{ g } Cl_2}\right)\left(\frac{1 \text{mol } I_2}{1 \text{ mol } Cl_2}\right)\left(\frac{6.02 \times 10^{23} \text{ molecules } I_2}{1 \text{mol } I_2}\right) = 4.63 \times 10^{24} \text{ molecules } I_2$

10) $x \text{ g Ag} = 86 \text{ g CuO}\left(\frac{1 \text{mol Cu}}{63.5 \text{ g Cu}}\right)\left(\frac{1 \text{mol Ag}}{1 \text{mol Cu}}\right)\left(\frac{108 \text{ g Ag}}{1 \text{mol Ag}}\right) = 292 \text{ g Ag}$

11) $x \text{ L } NH_3 = 26.0 \text{ g } Ca(OH)_2 \left(\frac{1 \text{mol } Ca(OH)_2}{74 \text{ g } Ca(OH)_2}\right)\left(\frac{2 \text{ mol } NH_3}{1 \text{mol } Ca(OH)_2}\right)\left(\frac{22.4 \text{ dm}^3 NH_3}{1 \text{mol } NH_3}\right) = 15.7 \text{ dm}^3 NH_3$

12)

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13)

$x \text{ g } AgCH_3COO = 4.77 \text{x} 10^{26} \text{ molecules } Na_3PO_4\left(\frac{1 \text{mol } Na_3PO_4}{6.02 \text{x} 10^{23} \text{ molecules } Na_3PO_4}\right)\left(\frac{3 \text{ mol } AgCH_3COO}{1 \text{mol } Na_3PO_4}\right)\left(\frac{167 \text{ g } AgCH_3COO}{1 \text{mol } AgCH_3COO}\right)$

14) $x \text{ g HgO} = 812 \text{ L } O_2\left(\frac{1 \text{mol } O_2}{22.4 \text{ L } O_2}\right)\left(\frac{2 \text{ mol HgO}}{1 \text{mol } O_2}\right)\left(\frac{216.6 \text{ g HgO}}{1 \text{mol HgO}}\right) = 1.57 \times 10^4 \text{ g HgO}$

15)

$x \text{ molecules } Ag_2O = 445 \text{ dm}^3 O_2\left(\frac{1 \text{mol } O_2}{22.4 \text{ dm}^3 O_2}\right)\left(\frac{2 \text{ mol } Ag_2O}{1 \text{mol } O_2}\right)\left(\frac{6.02 \text{x} 10^{23} \text{ molecules } Ag_2O}{1 \text{mol } Ag_2O}\right) = 2.39 \text{x} 10^{25} \text{ molecules } Ag_2O$

16) $x \text{ L } H_2 = 3.54 \times 10^{24} \text{ atoms Al}\left(\frac{1 \text{mol Al}}{6.02 \times 10^{23} \text{ atoms Al}}\right)\left(\frac{3 \text{ mol } H_2}{2 \text{ mol Al}}\right)\left(\frac{22.4 \text{ L } H_2}{1 \text{mol } H_2}\right) = 198 \text{ L } H_2$