

Limiting Reagents: For each of the following problems, write the balanced chemical equation, **SHOW ALL WORK** to determine the limiting reactant and **SHOW ALL WORK** to answer the question(s).

1. What mass of precipitate forms when a solution containing 6.24 g of potassium sulfide is reacted with a solution containing 19.2 g barium nitrate?
- 2a) What mass of water forms when solutions containing 3.27 g of hydrochloric acid and 7.62 g of calcium hydroxide are mixed?
b) How much, in grams, of the reactant in excess remains unreacted?
3. If 16.8 grams of copper is placed into a solution containing 25.65 g of silver nitrate, what mass of silver will be produced? (The other product is copper (II) nitrate.)
4. If 19.8 g of ammonium phosphate is mixed in solution with 12.4 g of calcium nitrate, what mass of precipitate is produced?
5. For the reaction $\text{PCl}_3 + \text{Cl}_2 \rightleftharpoons \text{PCl}_5$, 16.0 g of phosphorus trichloride is reacted with 13.2 g of chlorine gas. What is the maximum mass of phosphorus pentachloride that could be produced?
6. In a combustion reaction, 24.3 g of methanol (CH_3OH) was burned in the presence of 14.7 g of oxygen.
 - a) How much, in grams, of the excess reactant was not consumed?
 - b) What mass of water was produced?
7. 42.7 g of solid calcium hydroxide was mixed with 72.6 g of water.
 - a) What mass of product was formed?
 - b) What mass of the reagent in excess was not reacted?
8. Vinegar is a solution that is 5.0% by mass of acetic acid in water (5.0 g acetic acid/100 g of vinegar). If 100.0 g of vinegar is mixed with 15.0 g of baking soda, NaHCO_3 ,
 - a) what mass of gas can be produced?
 - b) what volume of gas at STP would be produced?
9. 37.4 g iron (II) chloride in solution was mixed with 42.3 g potassium permanganate in the presence of acid. The following reaction occurred: $5 \text{FeCl}_2 + \text{KMnO}_4 + 8 \text{HCl} \rightarrow 5 \text{FeCl}_3 + \text{MnCl}_2 + \text{KCl} + 4 \text{H}_2\text{O}$
 - a) What mass of iron (III) chloride was produced?
 - b) How many moles of HCl were required?
 - c) What mass of the excess reactant was not used?

Percent Yield: Write the balanced chemical equation, and **SHOW ALL WORK** to determine the percent yield.
$$\text{Percent yield} = \left(\frac{\text{experimental amount}}{\text{theoretical amount}} \right) \times 100$$

10. In the reaction $2 \text{NH}_3 (\text{g}) \rightarrow 3 \text{H}_2 (\text{g}) + \text{N}_2 (\text{g})$, if 12.0 g of ammonia produced 1.87 g of hydrogen, what was the percent yield?
- 11a) Excess hydrochloric acid was reacted with 8.57 g of calcium carbonate and produced 3.11 g of CO_2 . What was the percent yield?
b) In another experiment, using 9.21 g of calcium carbonate, 1.90 L of CO_2 was collected. What is the percent yield?
12. What is the percent yield of precipitate if a solution containing 33.4 g of sodium phosphate produced 19.6 g of precipitate when reacted with excess aluminum chloride in solution?

1. What mass of precipitate forms when a solution containing 6.24 g of potassium sulfide is reacted with a solution containing 19.2 g barium nitrate? $\text{K}_2\text{S (aq)} + \text{Ba(NO}_3)_2 \text{(aq)} \rightarrow \text{BaS (s)} + 2 \text{KNO}_3 \text{(aq)}$
Limiting reagent: K₂S 9.59 g BaS
- 2a) What mass of water forms when solutions containing 3.27 g of hydrochloric acid and 7.62 g of calcium hydroxide are mixed? $2 \text{HCl (aq)} + \text{Ca(OH)}_2 \text{(aq)} \rightarrow \text{CaCl}_2 \text{(aq)} + 2 \text{H}_2\text{O (l)}$
Limiting reagent: HCl 1.62 g H₂O
- b) How much, in grams, of the reactant in excess remains unreacted? **4.30 g Ca(OH)₂ unreacted**
3. If 16.8 grams of copper is placed into a solution containing 25.65 g of silver nitrate, what mass of silver will be produced? (The other product is copper (II) nitrate.)
 $\text{Cu (s)} + 2 \text{AgNO}_3 \text{(aq)} \rightarrow \text{Cu(NO}_3)_2 \text{(aq)} + 2 \text{Ag (s)}$
Limiting reagent: AgNO₃ 16.29 g Ag
4. If 19.8 g of ammonium phosphate is mixed in solution with 12.4 g of calcium nitrate, what mass of precipitate is produced? $2 \text{(NH}_4)_3\text{PO}_4 \text{(aq)} + 3 \text{Ca(NO}_3)_2 \text{(aq)} \rightarrow \text{Ca}_3\text{(PO}_4)_2 \text{(s)} + 6 \text{NH}_4\text{NO}_3 \text{(aq)}$
Limiting reagent: (NH₄)₂PO₄ 20.6 g Ca₃(PO₄)₂
5. For the reaction $\text{PCl}_3 + \text{Cl}_2 \rightleftharpoons \text{PCl}_5$, 16.0 g of phosphorus trichloride is reacted with 13.2 g of chlorine gas. What is the maximum mass of phosphorus pentachloride that could be produced?
Limiting reagent: PCl₃ 24.3 g PCl₅
6. In a combustion reaction, 24.3 g of methanol (CH₃OH) was burned in the presence of 14.7 g of oxygen.
 $2 \text{CH}_3\text{OH (l)} + 3 \text{O}_2 \text{(g)} \rightarrow 2 \text{CO}_2 \text{(g)} + 4 \text{H}_2\text{O (l)}$ **Limiting Reagent: O₂**
- a) How much, in grams, of the excess reactant was not consumed? **14.6 g CH₃OH unreacted**
- b) What mass of water was produced? **11.0 g H₂O**
7. 42.7 g of solid calcium oxide was mixed with 72.6 g of water.
 $\text{CaO (s)} + \text{H}_2\text{O (l)} \rightarrow \text{Ca(OH)}_2 \text{(aq)}$ **Limiting Reagent: CaO**
- a) What mass of product was formed? **56.4 g Ca(OH)₂**
- b) What mass of the reagent in excess was not reacted? **58.9 g H₂O**
(Shortcut tip: Mass of reactants USED = mass of products formed. Law of Conservation of Matter)
8. Vinegar is a solution that is 5.0% by mass of acetic acid in water (5.0 g acetic acid/100 g of vinegar). If 100.0 g of vinegar is mixed with 15.0 g of baking soda, NaHCO₃, **Limiting Reagent: CH₃COOH**
 $\text{CH}_3\text{COOH} + \text{NaHCO}_3 \text{(s)} \rightarrow \text{NaCH}_3\text{COO (aq)} + \text{CO}_2 \text{(g)} + \text{H}_2\text{O (l)}$
- a) what mass of gas can be produced? **3.4 g CO₂**
- b) what volume of gas at STP would be produced? **1.7 L CO₂**
9. 37.4 g iron (II) chloride in solution was mixed with 42.3 g potassium permanganate in the presence of acid. The following reaction occurred: $5 \text{FeCl}_2 + \text{KMnO}_4 + 8 \text{HCl} \rightarrow 5 \text{FeCl}_3 + \text{MnCl}_2 + \text{KCl} + 4 \text{H}_2\text{O}$
- a) What mass of iron (III) chloride was produced? **47.9 g FeCl₃ Limiting Reagent: FeCl₂**
- b) How many moles of HCl were required? **0.472 moles HCl**
- c) What mass of the excess reagent was not used? **33.0 g KMnO₄**

Percent Yield: Write the balanced chemical equation, and SHOW ALL WORK to determine the percent yield. **Percent yield = $\left(\frac{\text{experimental amount}}{\text{theoretical amount}}\right) \times 100$**

10. In the reaction $2 \text{NH}_3 \text{(g)} \rightarrow 3 \text{H}_2 \text{(g)} + \text{N}_2 \text{(g)}$, if 12.0 g of ammonia produced 1.87 g of hydrogen, what was the percent yield? (theor = 2.1338g) **87.6 % yield for H₂**
- 11a) Excess hydrochloric acid is reacted with 8.57 g of calcium carbonate and produced 3.11 g of CO₂. What was the percent yield? $2 \text{HCl (aq)} + \text{CaCO}_3 \text{(s)} \rightarrow \text{CaCl}_2 \text{(aq)} + \text{CO}_2 \text{(g)} + \text{H}_2\text{O (l)}$
82.5 % yield for CO₂
- b) In another experiment, using 9.21 g of calcium carbonate, 1.90 L of CO₂ was collected. What is the percent yield? **92.2 % yield for CO₂**

12. What is the percent yield of precipitate if a solution containing 33.4 g of sodium phosphate produced 19.6 g of precipitate when reacted with excess aluminum chloride in solution?

