

### Unit 3 Practice Problems (with answers at end)

It is in knowledge as in swimming:  
he who flounders and splashes on the  
surface makes more noise, and attracts  
more attention, than the pearl-diver  
who quietly dives in quest of treasures  
to the bottom.--Washington Irving

#### Stoichiometry

1. Sodium reacts with water to form sodium hydroxide and hydrogen gas. How many grams of  $H_2$  can be produced from 11.5 g of sodium?
2. Hydrochloric acid reacts with calcium hydroxide to produce water and calcium chloride. How many grams of HCl are required to react with 10.0 g of calcium hydroxide?
3. Nitrogen reacts with hydrogen to make ammonia. How many grams of ammonia can be produced from 2.00 g of hydrogen?
4. Potassium chlorate decomposes when heated to give oxygen gas and potassium chloride. How many grams of oxygen gas can be obtained in this way starting with 1.226 g of  $KClO_3$ ?
5. Phosphorus trichloride is made when white phosphorus ( $P_4$ ) reacts with chlorine gas. How many grams of phosphorus are required to produce 5.49 g of phosphorus trichloride?
6. Ethene gas ( $C_2H_4$ ) burns in oxygen to form carbon dioxide and water. How many grams of ethene must be burned to produce 200 g (to the nearest gram) of carbon dioxide?
7. Magnesium metal reacts with sulfuric acid in a displacement reaction. How many grams of hydrogen gas will be produced when 4.05 g of magnesium reacts completely?

Originality is the one thing  
which unoriginal minds cannot  
feel the use of.--John Stuart Mill

#### Limiting reagents in stoichiometry

8. Aluminum and sulfuric acid react in a displacement reaction. If 5.0 g of Al and 45 g of sulfuric acid are used, what mass of hydrogen is collected? What is the limiting reagent?
9. A student prepares hydrogen bromide gas by reacting sodium bromide with phosphoric acid. Sodium phosphate is a by-product. If 24.3 g of sodium bromide is used with 100.0 g of phosphoric acid, how many grams of hydrogen bromide gas can be collected? What is the limiting reagent?

It's what we learn after  
we think we know it all  
that counts.--Kin Hubbard

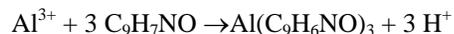
#### Molarity

10. Calculate the Molarity of a solution which contains 49.0 g of phosphoric acid in 2000.0 mL of solution.
11. Calculate the mass of solute in 1.5 L of solution which is 0.240 M in potassium dihydrogen phosphate.
12. How many grams of lead(II) acetate must be used to make 500.0 mL of a solution that is to contain 10 mg/mL of lead(II) acetate? What is the Molarity of the solution?
13. What volume (in Litres) of 0.100 M sodium chloride solution can be prepared from 117 g of the salt?
14. A test solution of aluminum nitrate must be made that is 20.0 g/L in the salt. If 1500.0 mL of the solution is desired, how many grams of the solute must be used? What is the Molarity of the solution? What is the Molarity of nitrate ion in the solution?

### Gravimetric analysis

15. What mass of AgBr is produced when 100.0 mL of 0.150 M AgNO<sub>3</sub> is added to 20.0 mL of 1.00 M NaBr?

16. Aluminum can be determined gravimetrically by reaction with a solution of 8-hydroxyquinoline (C<sub>9</sub>H<sub>7</sub>NO). The net ionic equation is:



A mass of 0.1248 g of Al(C<sub>9</sub>H<sub>6</sub>NO)<sub>3</sub> was obtained by precipitating all of the Al<sup>3+</sup> from a solution prepared by dissolving 1.8571 g of a mineral. What is the mass percent of aluminum in the mineral sample?

Next to being a great poet  
is the power of understanding  
one.--Longfellow

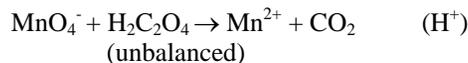
### Acid/Base titration

17. In standardizing an NaOH solution, a student found that 38.46 cm<sup>3</sup> of the base neutralized exactly 32.33 cm<sup>3</sup> of 0.1064 M HCl. Find the concentration (M) of the NaOH.

18. In titrating an H<sub>2</sub>SO<sub>4</sub> solution, it was found that 23.66 cm<sup>3</sup> of 0.2137 M NaOH would neutralize 22.04 cm<sup>3</sup> of the acid. Find the concentration of the H<sub>2</sub>SO<sub>4</sub>.

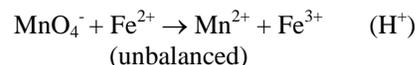
### Redox titration

19. A solution of permanganate is standardized by titration with oxalic acid (H<sub>2</sub>C<sub>2</sub>O<sub>4</sub>). It required 28.97 mL of the permanganate solution to react completely with 0.1058 g of oxalic acid. The unbalanced reaction is:



What is the Molarity of the permanganate solution?

20. A 50.00 mL sample of solution containing Fe<sup>2+</sup> ions is titrated with a 0.0216 M KMnO<sub>4</sub> solution. It required 20.62 mL of the KMnO<sub>4</sub> solution to oxidize all of the Fe<sup>2+</sup> to Fe<sup>3+</sup> ions by the reaction:



What was the concentration of the Fe<sup>2+</sup> solution?

### Answers:

1. 0.50 g
2. 9.86 g
3. 11 g
4. 0.480 g
5. 1.24 g
6. 63.8 g
7. 0.33 g
8. 0.58 g, Al
9. 19.1 g, NaBr
10. 0.250 M
11. 49 g
12. 5.0 g, 0.031 M
13. 20.0 L
14. 30.0 g, 0.0940 M, 0.282 M
15. 2.82 g
16. 0.3947%
17. 0.08944 M
18. 0.1147 M
19. 1.622 x 10<sup>-2</sup> M
20. 4.45 x 10<sup>-2</sup> M