Additional Calculations on Moles and Molarity

1. These problems refer to dinitrogen oxide (nitrous oxide, N_2O) a gas at STP.

   a) Calculate the mass of 1.00 mole of gas.
   b) Calculate the mass in grams of 1.50 moles of N_2O.
   c) Calculate the number of moles of nitrogen atoms in 2.20g of compound.
   d) Calculate the mass of N_2O which contains 4.00g of oxygen.
   e) Calculate the number of molecules in 4.40g N_2O
   f) Calculate the mass in grams of oxygen combined with 0.50 mole of nitrogen atoms.
   g) Calculate the number of moles of N atoms combined with 1.6g of O.
   h) Calculate number of gram-atoms (moles) of N combined with 0.10 gram-atoms (moles) of 0.
   i) Calculate the volume in liters occupied by 22.0g of N_2O gas at STP.
   j) Calculate the mass of gas in 16.8 litres of N_2O at STP.
   k) Calculate the grams of N in 110 g of N_20.
   1) Calculate the mass percentage of O in the compound.

2. Calculate

   a) the mass percentage of sulfur in sulfur dioxide (SO_2) and
   b) the number of grams of sulfur that could be obtained by decomposing 2000 grams of the oxide.

3. Calculate the mass of water (H_2O) that must be electrolyzed in order to obtain 80.Og of oxygen.

4. An ore sample weighing 8.32g is analyzed for the percentage of chromiurn. All of the chromium is converted to Cr_2O_3 which has a mass of 1.52g. What is the percentage of chromium in the ore?

Questions 5-8 refer to the equation

$$3Ag(s) + 4HNO_3(aq) \rightarrow 3AgNO_3(aq) + NO(g) + 2H_20(l).$$

5. How many moles of NO are produced when 1.5 mole of Ag reacts with excess HNO_3?

6. How many grams of NO are produced when 1.5 mole of Ag reacts with excess HNO_3?

7. How many litres of NO are produced at STP when 162g Ag reacts with excess HNO_3?

8. How many grams of $AgNO_3$ are produced when 154g of Ag reacts with 189g HNO_3?

9. Write word, formula, and net-ionic equations for the precipitation reactions which occur when solutions of these ionic compounds in solutions are mixed. If no reaction occurs write *no reaction.*

   a) iron(III) nitrate + calcium hydroxide.
   b) silver nitrate + sodium sulfide,
   c) potassium sulfate + lead nitrate.
   d) barium iodide + ammonium carbonate,
   e) sodium chromate + silver nitrate.
   f) potassium nitrate + ammonium sulphate.

10. Commercial sulfuric acid is a water solution that has a density of l.84g/mL and is 98.0 percent H_2S04 (m.m. 98.0) by mass. What is the molarity of the solution?

11. What is the molarity of the solution made by dissolving 10.0g of NaOH (mm. 40.0) in 0.200 litres of solution?

12. Calculate the molarity of a solution containing 5.0mg of $BaC1_2$ per mL of solution.

13. Calculate the grams of $BaCI_2$ needed to prepare 200m1 of a 0.500M solution.

14. Concentrated hydrochloric acid has a density of 1.2 g/ml and 36 percent HC1 by mass.

15. What is its molar concentration?

16. The following questions refer to a 0.20M solution of $BaC1_2$.Formula mass of $BaCl_2$ is 208.

    a) Calculate the moles of $BaCl_2$ in 200mL of solution.
    b) Calculate the mg and grams of $BaC1_2$ in the solution.
    c) Calculate the volume in mL that contains 5.0 mmoles of $BaCl_2$.
    d) Calculate the volume in mL that contains 41.6 mg of $BaCI_2$.

17. Three hundred mL of 0.20M HNO_3 solution is added to l00mL of 0.15 M $NaNO_3$ solution. Assume that both compounds are completely dissociated.

18. Find the concentrations of the a)H^+, b)Na^+, c)$N0^-$ ions in the resulting solution.

19. How many mg of $BaC1_2$ are needed to prepare 300mL of a solution containing 1.0 mg. of Ba^{2+} ions per mL of solution?

20. Calculate

    a) the volume of 2.0M $CaC1_2$ that must be used to prepare 1200 mL of 0.80M $CaCl_2$
    b) the volume of water that must be added.

21. What volume in liters of 12.0M HC1 should be added to 3.00 liters of 1.00M HC1 to give 6.00 liters of 6.00M HC1 on dilution with water?

22. Calculate in mL the volume of 0.500M NaOH required to react with 3.0g. acetic acid (m.m. 60.0). The equation is

$$NaOH(aq) + CH_3COOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$$

23. Calculate the number of grams of AgC1 (m.m. 143.5) when 0.200 litres of 0.200M. $AgNO_3$ reacts with an excess of $CaCl_2$. The equation is

$$2AgNO_3\,(aq) + CaCl_2\,(aq) \rightarrow 2AgCl(s) + Ca(NO_3)_2\,(aq)$$

24. Calculate a) the least volume of NaC1 solution required to precipitate all Ag^+ ions as AgCl. and b) the mass of AgC1 formed when an excess of 0.100 M solution of NaCl is added to 0.100 litres of 0.200 M $AgNO_3$.

25. Calculate

    a) the mass of $BaSO_4$ (m.m. 233) formed when excess 0.200M Na_2SO_4 solution is added to 0.500 liters of 0.500M $BaC1_2$ solution
    b) the minimum volume of Na_2SO_4 needed to precipitate the Ba^{2+} ions from the $BaC1_2$ solution.

26. a sample of potassium chloride mixed with potassium nitrate weighs 0.500 g. The sample is dissolved and an excess of AgNO3 is added to the solution. The resulting precipitate, AgC1, when dried weighs 0.750g. What is the percentage of KCI in the original mixture?

27. A silver-copper alloy having a mass of 0.500 g. is dissolved in HNO_3 and the Ag^+ ions are precipitated as AgCl. What is the percentage of silver in the alloy if the dried precipitate has a mass of 0.598 g?

28. Balance these skeleton equations

a) $Al(s) + O_2(g) \rightarrow A1_2O_3\,(s)$

b) $Al(s) + Fe_2O_3(s) \rightarrow Al_2O_3(s) + Fe(s)$

c) $KC1O_4(s) \rightarrow KC1(s) + O_2(g)$

d) $Ca(OH)_2(aq) + HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l)$

e) $Cr_2(SO_4)_3(aq) + NaOH(aq) \rightarrow Cr(OH)_3(aq) + Na_2SO_4(aq)$

f) $Cu(s) + AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + Ag(s)$

g) $CH_4(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$

h) $C_3H_6(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$

i) $SiO_2(s) + HF(aq) \rightarrow SiF_4(g) + H_2O(l)$

j) $MgO(s) + H_3PO_4(aq) \rightarrow Mg_3(PO_4)_2(aq) + H_2O(l)$

k) $PbO_2(s) \rightarrow PbO(s) + O_2(g)$

1) $NaBr(aq) + Cl_2(g) \rightarrow NaCl(aq) + Br_2(l)$

m) $Sb_2S_3(s) + HCI(aq) \rightarrow H_3SbC1_6(aq) + H_2S(g)$

29. Write net ionic equations for these precipitation reactions when solutions containing these solutes are mixed. If no reaction occurs, write *no reaction*.

a) potassium hydroxide + aluminum chloride
b) silver nitrate + calcium iodide
c) sodium nitrate + ammonium chloride
d) barium chloride + sodium phosphate
e) antimony(III) chloride + sodium sulfide
f) ammonium oxalate + calcium nitrate
g) lead nitrate + potassium chromate
h) barium nitrate + ammonium carbonate
i) bismuth(III) nitrate + potassium sulfide
j) iron(III) sulfate + calcium hydroxide

30. Balance these equations. It is not necessary to write the number 1 as a coefficient.

a) $Na(s) + Cl_2(g) \rightarrow NaCI(s)$
b) $Ca(s) + Br_2(l) \rightarrow CaBr_2(s)$
c) $Al(s) + O_2(g) \rightarrow A1_2O_3(s)$
d) $C(s) + O_2(g) \rightarrow CO_2(g)$

e) $P_4(s) + C1_2(g) \rightarrow PCI_5(s)$

f) $SO_2(g) + O_2(g) \rightarrow SO_3(g)$

h) $A1_4C_3(s) + H_2O(l) \rightarrow Al(OH)_3(s) + CH_4(g)$

i) $Fe_3O_4(s) + H_2(g) \rightarrow Fe(s) + H_2O(g)$

j) $KClO_3(s) \rightarrow KCl(s) + O_2(g)$

k) $HgO(s) \rightarrow Hg(l) + O_2(g)$

Answers:

1. a)44.0g. b)66.0 g. c)0.100 mole N atoms, d)11.0g, e)6.02 x 10^{22} molecules, f) 4.0g, g) 0.20 mole N atoms, h)0.20g atoms N. i)11.2 litres N_2O , j)33.0g, k)70.0g, 1)36.4 %
2. a)50.0 % sulfur, b)1000g sulfur. 3. 90.0g. 4. 12.5 % 5. 0.50. 6. 15g. 7. 11.2 liters. 8. 242g.
10. 18.4 M. 11. 1.25 M.12. 0.024 M. 13. 20.8g. 14. 12 M.
15. a)4.0 x 10 millimoles, b)8.3 x 10^3 mg and 8.3g, c)25 mL, d)1.0 mL
16. a)0.15 M, b)0.038 M, c)0.19 M. 17. 455mg. 18. a)480 mL, b)720 mL 19. 2.75 liters
20. 100 ml 21. 5.74g. 22. a) 0.200 liters. b) 2.87g. 23. a) 58.2g., b) 1.25 liters 24. 78% 25.