Sample Exam

1. The atomic mass of nitrogen is 14.007 g. Calculate the % abundances of the two isotopes of nitrogen if their isotopic masses are

Isotopic mass	% abundance
14.0031	
15.001	

2. Analysis shows that a certain ionic solid contains potassium plus one other element, a halogen X. Determine the identity of X from the mass percentages K: 52.4%, X: 47.6%
   What is the empirical formula of the compound?

3. Give the chemical formula for each of the following:
   a. xenon difluoride b. calcium hydrogen sulfite c. dinitrogen tetraoxide

4. Consider the compound, $BaCrO_4$,
   a. Name this compound
   b. Determine its molar mass.
   c. Determine the %Ba in this compound.
   d. How many oxygen atoms are there in 0.50 mol of $BaCrO_4$ molecules
   e. How many grams of $BaCrO_4$ are in part (d) above?

5. Which sets of values are possible?

	Mass Number	Atomic Number	Number of Protons	Number of Neutrons
a	19	42	19	23
b	235	92	92	143
c	53	131	131	79
d	32	15	15	15
e	14	7	7	7
f	40	18	18	40

6. Gold can be dissolved from gold-bearing rock by treating the rock with sodium cyanide in the presence of the oxygen in air.

$$Au\,(s) + NaCN\,(aq) + O_2\,(g) + H_2O\,(\ell) \rightarrow NaAu(CN)_2\,(aq) + NaOH\,(aq)$$

Once the gold is in solution in the form of the $Au(CN)_2^-$ ion, it can be precipitated as the metal according to the following balanced equation:

$$2\,Au(CN)_2^-\,(aq) + Zn\,(s) \rightarrow Zn^{2+}\,(aq) + 2\,Au\,(s) + 4\,CN^-\,(aq)$$

(a) How many moles of NaCN will you need to extract the gold from 1000 kg of rock if the rock is 0.019% gold?

(b) How many kilograms of metallic zinc will you need to recover the gold from the $Au(CN)_2^-$ obtained from the gold in the rock?

(c) If the gold is recovered completely from the rock, and the metal is made into a cylindrical rod 15.0 cm long, what is the diameter of the rod? (The density of gold is 19.3 g cm^{-3}.)

7. Name the following compounds:
   a. $Na_2Cr_2O_7$ b. Cl_2O_7 c. MnO_2 d. $LiHSO_3$
8. Balance the following equations:
   a. $NaHCO_3 + SrCl_2 + NaOH \rightarrow SrCO_3 + NaCl + H_2O$
   b. $Ca(OH)_2 + H_3PO_4 \rightarrow H_2O + Ca_3(PO_4)_2$
   c. $AgNO_3 + H_2SO_4 \rightarrow Ag_2SO_4 + HNO_3$
   d. $Cr + S_8 \rightarrow Cr_2S_3$
9. Indicate which of the following compounds are likely to exist, based on your understanding of the periodic table and the formulas for polyatomic ions:
   Na_3SO_4 BaO KF_3 CaI_2
10. Name and assign oxidation numbers to all elements in the following substances:
    a. $NaMnO_4$ b. $KBrO_3$
11. Nitrogen gas can be prepared in the laboratory by the reaction of ammonia with copper(II) oxide to form nitrogen gas, elemental copper, and water. The reaction will give an 85.0% yield and you want to make 18.4 g of nitrogen gas.
    (a) What mass of ammonia must you start the reaction with?
    (b) What mass of copper(II) oxide do you need if you start with a 37.0% excess?
12. Write net ionic equations for the following reactions:
    (a) $HNO_3\,(aq) + NaHCO_3\,(aq) \rightarrow NaNO_3\,(aq) + CO_2\,(g) + H_2O\,(\ell)$
    (b) $HCl\,(aq) + KOH\,(aq) \rightarrow KCl\,(aq) + H_2O\,(\ell)$
    (c) $NH_4Cl\,(aq) + NaOH\,(aq) \rightarrow NaCl\,(aq) + NH_3\,(g) + H_2O\,(\ell)$
13. A solution is made by mixing 200 mL 0.20 M NaOH with 100 mL 0.10 M HNO_3. Find the number of moles of each ion and its concentration in the solution after reaction is complete.
14. It is found that 22.3 mL of 0.240 M NaOH is required to completely react with a 50.0-mL sample of vinegar, a solution of acetic acid in water. The net ionic equation for the reaction is
    $$HC_2H_3O_2\,(aq) + OH^-\,(aq) \rightarrow C_2H_3O_2^-\,(aq) + H_2O\,(\ell)$$
    Calculate the concentration of acetic acid in the vinegar.
15. What volume of each of the following acids will react completely with 50.00 mL of 0.200 M NaOH?
    (a) 0.100 M HCl (b) 0.0598 M HNO_3 (c) 1.23 M HBr
16. Identify the following reactions as either dissolution, precipitation, redox, or acid-base:
    (a) $N_2O_5\,(g) + 2\,NaOH\,(aq) \rightarrow 2\,NaNO_3\,(aq) + H_2O\,(\ell)$
    (b) $P_4O_{10}\,(s) + 5\,C\,(s) \rightarrow P_4\,(g) + 5\,CO_2\,(g)$
    (c) $3\,Ca(NO_3)_2\,(aq) + 2\,K_3PO_4\,(aq) \rightarrow Ca_3(PO_4)_2\,(s) + 6\,KNO_3\,(g)$
    (d) $(NH_4)_2SO_4\,(aq) + Ba(OH)_2\,(aq) \rightarrow BaSO_4\,(s) + 2\,NH_3\,(g) + 2\,H_2O\,(\ell)$
    (e) $2\,KMnO_4\,(s) \rightarrow K_2MnO_4\,(s) + MnO_2\,(s) + O_2\,(g)$

Sample Exam 1

1. 99.6% with mass 14.0031, 0.4% with mass 15.001
2. KCl
3. a. XeF_2 b. $Ca(HSO_3)_2$ c. N_2O_4
4. a. barium chromate b. 253.321 g/mol c. 54.211% d. 1.2×10^{24} atoms of O e. 1.3×10^{2} g
5. b & e
6. a. 1.9 mol NaCN b. 0.032 kg Zn c. 0.91 cm
7. a. sodium dichromate b. dichlorine heptaoxide c. manganese(II) oxide d. lithium hydrogen sulfite
8. a. 1, 1, 1, 1, 2, 1 b. 3, 2, 6, 1 c. 2, 1, 1, 2 d. 16, 3, 8
9. BaO and CaI_2 could exist
10. a. Na, +1, sodium; Mn, +7, manganese; O, -2, oxygen
    b. K, +1, potassium; Br, +5, bromine; O, -2, oxygen
    In both cases, alkali metals are always +1, oxygen is usually -2, so determine the middle oxidation number by algebraic means.
11. (a) 26.3 g NH_3 (b) 253 g CuO
12. (a) $H^+(aq) + HCO_3^-(aq) \rightarrow CO_2(g) + H_2O(\ell)$
    (b) $H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell)$
    (c) $NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(\ell)$
13. 0.010 mol NO_3^- in sol'n, $[NO_3^-] = 0.033$ M; 0.040 mol Na^+ in sol'n, $[Na^+] = 0.13$ M; 0.030 mol OH^- in sol'n, $[OH^-] = 0.10$ M
14. $[HC_2H_3O_2] = 0.107$ M
15. (a) $V_{HCl} = 0.100$ L (b) $V_{HNO3} = 0.167$ L (c) $V_{HBr} = 8.13 \times 10^{-3}$ L
16. (a) acid-base (b) redox (c) precipitation (d) acid-base (e) redox