**Avogadro's Number, $N_A$ = 6.022 ◆ $10^{23}$**

**1. [7 points]** What is the empirical formula of magnesium sulfate?

- (a) $Mg_3(SO_4)_2$
- (b) $MgS$
- (c) $MgSO_3$
- (d) $MgSO_4$
- (e) $Mg_2SO_4$

**2. [7 points]** What is the empirical formula of the ionic compound that forms between aluminum and fluorine?

- (a) $AlF_3$
- (b) $Al_2F_3$
- (c) $AlF$
- (d) $AlF_2$
- (e) None of the above

**3. [7 points]** Which statement is <u>false</u>?

- (a) Ionic substances are held together primarily by electrostatic forces
- (b) Ionic substances typically exist as brittle solids
- (c) Ionic substances are always compounds (never elements)
- (d) Ionic substances are typically poor conductors of heat and electricity
- (e) Ionic substances are always white solids

**4. [7 points]** Balance the following reaction and determine the coefficients *a, b, c, d* and *e*. What number do you get when you then sum the coefficients together (*a + b + c + d*)? (*Don't forget the 1's).*

$$a\,NH_3(g) + b\,O_2(g) \rightarrow c\,NO(l) + d\,H_2O(g)$$

- (a) 5
- (b) 9
- (c) 12
- (d) 19
- (e) 21

**5. [7 points]** What is the oxidation state (oxidation number) of sulfur in $H_2SO_3$?

- (a) +2
- (b) +4
- (c) −2
- (d) +3

- (e) +5

**6. [7 points]** Which of the following atoms/ions has 29 protons and 34 neutrons?

- (a) $^{63}Se$
- (b) $^{65}Cu$
- (c) $^{63}Cu$
- (d) $^{34}Cu$
- (e) None of the above

**7. [7 points]** Which of the following atoms/ions has 10 electrons?

- (a) $^{19}F$
- (b) $^{23}Na$
- (c) $^{23}Na^{+}$
- (d) $^{10}B$
- (e) Both (b) and (c)

**8. [7 points]** Which of the following contains the greatest number of <u>oxygen atoms</u>?

- (a) 1.5 moles $O_2$
- (b) 152 g of $Cr_2O_3$
- (c) 152 g of $SnO_2$
- (d) 2.0 L of 0.5 M $NaClO_4$ solution
- (e) 7 $\times$ $10^{23}$ molecules of $CO$

**9. [7 points]** What is the empirical formula of a compound that is 63.2% manganese and 36.8% oxygen by mass?

- (a) $MnO$
- (b) $Mn_2O$
- (c) $Mn_2O_3$
- (d) $Mn_2O_5$
- (e) $MnO_2$

**10. [7 points]** Consider the reaction between carbon monoxide and oxygen to form carbon dioxide. Write a balanced equation for this reaction and use it to determine the number of $CO_2$ molecules that are produced in the reaction between 120 $CO$ molecules and 55 $O_2$ molecules.

- (a) 55 $CO_2$ molecules are produced
- (b) 120 $CO_2$ molecules are produced
- (c) 110 $CO_2$ molecules are produced
- (d) 240 $CO_2$ molecules are produced

- (e) 175 $CO_2$ molecules are produced

**11. [7 points]** Consider the following reaction:

$$4CuO(s) + Zr(s) \rightarrow 2Cu_2O(s) + ZrO_2(s)$$

What type of a reaction is this?

- (a) precipitation
- (b) acid-base
- (c) combustion
- (d) oxidation-reduction
- (e) decomposition

**12. [7 points]** Using the balanced equation from the previous problem determine the exact quantity of zirconium metal (AW = 91.22 g/mol) that is needed to completely convert 6.52 g of copper (II) oxide (FW = 79.55 g/mol) to copper (I) oxide (FW = 143.1 g/mol).

- (a) 3.08 g
- (b) 1.87 g
- (c) 7.48 g
- (d) 1.63 g
- (e) 1.48 g

**13. [7 points]** Which of the following solutions will be the <u>best conductor</u> of electricity (have the highest conductivity)?

- (a) 1.0 M $H_3PO_4$ solution
- (b) 1.0 M $HNO_3$ solution
- (c) 1.0 M $H_3COCH_3$ (dimethyl ether) solution
- (d) 1.0 M $NH_3$ solution
- (e) 1.0 M $HC_2H_3O_2$ solution

**14. [7 points]** What is the molarity of the solution formed by dissolving 81.0 g of sodium nitrate in water to form 1.75 L of solution?

- (a) 1.25 M
- (b) 1.93 M
- (c) 46.3 M
- (d) 0.545 M
- (e) 0.623 M

**15. [7 points]** What is the concentration of the solution which results when 85.0 mL of 0.785 M NaCl solution is mixed with 115 mL of 0.175 M NaCl solution?

- (a) 0.434 M

- (b) 0.480 M
- (c) 3.43 M
- (d) 0.365 M
- (e) None of the above

**16. [7 points]** Which of the following is a molecular substance?

- (a) Ag
- (b) $F_2$
- (c) $CaF_2$
- (d) Ar
- (e) None of the above

**17. [7 points]** Which of the following reactions would you expect to produce a gaseous product?

- (a) $MgCO_3(s) + HCl(aq)$ ➔
- (b) $NaOH(aq) + H_3PO_4(aq)$ ➔
- (c) $Na_2CO_3(aq) + CuCl_2(aq)$ ➔
- (d) $AgNO_3(aq) + HNO_3(aq)$ ➔
- (e) None of the above reactions will produce a gaseous product

**18. [7 points]** In each of the following instances two solutions are mixed together. Which reaction(s) will lead to the formation of a precipitate?

- (a) potassium bromide solution + barium hydroxide solution
- (b) hydrochloric acid solution + barium hydroxide solution
- (c) magnesium nitrate solution + sodium hydroxide solution
- (d) ammonium chloride solution + iron (II) nitrate solution
- (e) None of the above reactions will lead to formation of a precipitate

**19. [7 points]** Which of the following is not an oxidation-reduction reaction?

- (a) $CH_4(g) + 2O_2(g)$ ➔ $2H_2O(l) + CO_2(g)$
- (b) $2AgNO_3(aq) + Fe(s)$ ➔ $2Ag(s) + Fe(NO_3)_2(aq)$
- (c) $AgNO_3(aq) + NaCl(aq)$ ➔ $AgCl(s) + NaNO_3(aq)$
- (d) $Mg(s) + 2HCl(aq)$ ➔ $H_2(g) + MgCl_2(aq)$
- (e) $4Fe(s) + 3O_2(g)$ ➔ $2Fe_2O_3(s)$

For the next three problems consider the two solutions (A and B) below.

**Solution A**
Solute = NaI
Volume = 50.0 mL
Concentration = 2.5 M

**Solution B**
Solute = $Pb(NO_3)_2$
Volume = 100.0 mL
Concentration = 0.75 M

**20. [7 points]** How many nitrate ions are present in solution B?

- (a) 4.5 ◆ $10^{22}$ $NO_3^-$ ions
- (b) 9.0 ◆ $10^{22}$ $NO_3^-$ ions
- (c) 6.0 ◆ $10^{23}$ $NO_3^-$ ions
- (d) 7.5 ◆ $10^{24}$ $NO_3^-$ ions
- (e) None of the above

**21. [7 points]** If you mix the two solutions together what quantity of lead (II) iodide precipitate will be formed (assume 100% yield)?

- (a) 35 g
- (b) 58 g
- (c) 46 g
- (d) 29 g
- (e) 70 g

**22. [7 points]** After mixing the two solutions together and separating out the precipitate which ions will be present in the resulting solution?

- (a) $NO_3^-$, $Na^+$ and $I^-$
- (b) $Pb^{2+}$, $Na^+$ and $I^-$
- (c) $Pb^{2+}$, $NO_3^-$ and $I^-$
- (d) $Pb^{2+}$, $NO_3^-$ and $Na^+$
- (e) $NO_3^-$ and $Na^+$

**23. [7 points]** Which of the following reactants will be capable of oxidizing chromium metal to $Cr^{3+}$ ions?

- (a) NaCl solution
- (b) HCl solution
- (c) $SnCl_2$ solution
- (d) $ZnCl_2$ solution
- (e) Both (b) HCl and (c) $SnCl_2$ solutions

**24. [7 points]** Which of the following represents the <u>balanced net ionic equation</u> for the reaction between phosphoric acid and calcium hydroxide?

- (a) $HPO_4$ (aq) + $CaOH$(aq) ➔ $H_2O$(l) + $CaPO_4$(aq)
- (b) $H^+$ (aq) + $OH^-$(aq) ➔ $H_2O$(l)
- (c) $H_3PO_4$ (aq) + $Ca(OH)_2$(aq) ➔ $H_2O$(l) + $Ca_3(PO_4)_2$(aq)
- (d) $2H_3PO_4$ (aq) + $3Ca(OH)_2$(aq) ➔ $6H_2O$(l) + $Ca_3(PO_4)_2$(aq)
- (e) $H_3PO_4$ (aq) + $3OH^-$(aq) ➔ $3H_2O$(l) + $PO_4^{3-}$ (aq)

**25. [7 points]** What volume of 5.00 M HCl solution will be needed to neutralize 87.5 mL of 3.00 M $Sr(OH)_2$ solution?

- (a) 105 mL
- (b) 53.0 mL
- (c) 87.5 mL
- (d) 292 mL
- (e) None of the above