A. Selective questions (4 pts each, total 60 pts)

1. Calculate the mass of aluminum that occupies the same volume as 66.7 g of cobalt. The density of cobalt is 8.90 g/cm^3 and the density of aluminum is 2.71 g/cm^3.
   a)　2.77 g ; b) 20.3 g ; c)　1.61×10^2 g ; d) 0.362 g ; e) 0.00457 g

2. How many electrons does the ion $^{59}_{27}Co^{2+}$ have?
   a)　25 ; b)　27 ; c)　29 ; d)　32 ; e)　59

3. A given hydrocarbon is burned in the presence of oxygen gas and is converted completely to water and carbon dioxide. The mole ratio of H_2O to CO_2 is 1.125:1.000. The hydrocarbon could be
   a)　CH_4 ; b)　C_2H_2 ; c)　C_2H_6 ; d)　C_3H_4 ; e)　C_4H_9

4. A student is given a sample in lab that contains <u>one</u> of the ions listed below. After adding a few drops of $AgNO_3$ solution to a portion of the unknown sample, the student got a greyish precipitate. After adding a few drops of $Mg(NO_3)_2$ solution to another portion of the unknown sample, the student got a black precipitate. Based on these observations, the only possible ion in this student's sample is
   a)　Cl^- ; b)　$C_2H_3O_2^-$; c)　F^- ; d)　S^{2-} ; e)　SO_4^{2-} ;

5. A mixture consisting of 0.130 mol N_2, 0.041 mol O_2, 0.100 mol CH_4, and an unknown amount of CO_2 occupies a volume of 8.90 L at 25°C and 1.09 atm pressure. How many moles of CO_2 are there in this sample?
   a)　0.126 mol ; b) 4.46 mol ; c)　2.25 mol ; d)　0.729 mol ; e)　0.397 mol

6. How much heat is released at constant pressure if 48.1 mL of 0.741 M silver (I) nitrate is mixed with 51.4 mL of 0.563 M potassium chloride?
   $AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$; $\Delta H° = -65.5$ kJ
   a)　-48.5 kJ ; b)　-36.9 kJ ; c)　-4.23 kJ ; d)　-1.90 kJ ; e)　-2.33 kJ

7. What is the frequency of a photon having a wavelength of 602.5 nm? ($c = 3.00 \times 10^8$ m/s, $h = 6.63 \times 10^{-34}$ J·s)
   a)　9.09×10^{26} Hz ; b)　3.30×10^{-37} Hz ; c)　4.98×10^{-4} Hz ;
   d)　3.30×10^{-19} Hz ; e)　4.98×10^{14} Hz

8. Rank the following <u>ions</u> in order of increasing first ionization energy: O^{2-}, Mg^{2+}, F^-, Na^+.
   a)　$O^{2-} < Mg^{2+} < F^- < Na^+$; b)　$Mg^{2+} < O^{2-} < Na^+ < F^-$; c)　$O^{2-} < F^- < Na^+ < Mg^{2+}$;
   d)　$Mg^{2+} < Na^+ < F^- < O^{2-}$; e)　$O^{2-} < F^- < Mg^{2+} < Na^+$

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9. Which of the following is the Lewis dot structure for the bromide ion?

   a) $\left[\ddot{Br} \right]^-$; b) $\left[:\ddot{Br}: \right]^+$; c) $\left[\ddot{Br} \right]^+$; d) $\left[:\ddot{Br}: \right]^-$; e) $\left[\dot{Br} \right]^+$

10. Which of the following molecules is nonpolar?

    a) ClF_3 ; b) PF_3 ; c) PF_5 ; d) SF_4 ; e) CH_2F_2

11. Which of the following pure substances has the lowest normal boiling point?

    a) NH_3 ; b) H_2Se ; c) H_2Te ; d) H_2O ; e) H_2S

12. A sulfuric acid solution that is 65.0% H_2SO_4 by mass has a density of 1.55 g/mL at 20°C. What is the molarity of sulfuric acid in the solution?

    a) 3.5 M ; b) 6.9 M ; c) 10.3 M ; d) 12.2 M ; e) 15.7 M
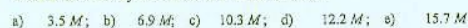
13. A suggested mechanism for the decomposition of ozone is

    $O_3 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} O_2 + O$　　fast equilibrium

    $O + O_3 \xrightarrow{k_2} 2O_2$　　slow step
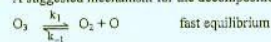
    When the concentration of ozone is doubled and the concentration of oxygen is doubled, the instantaneous rate

    a) remains the same ; b) decreases ; c) increases by a factor of 2
   d) increases by a factor of 4 ; e) increases by a factor of 8.

14. When cobalt chloride is added to pure water, the Co^{2+} ions hydrate. The hydrated form then reacts with the Cl^- ions to set up the equilibrium shown here:

    $$Co(H_2O)_6^{2+} + 4Cl^- \rightleftharpoons CoCl_4^{2-} + 6H_2O$$
    　　　(pink)　　　　　　　(blue)
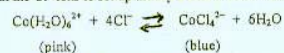
    Which statement describes the change that the system will undergo if silver nitrate is added?

    a) It should become more blue ; b) It should become more pink ; c) Water will be produced ;
    d) The silver ion will react with the $CoCl_4^{2-}$; e) Nothing will change.

15. Which of the following statements is correct concerning the neutralization of sulfurous acid by a strong base?

    $$2OH^-(aq) + H_2SO_3(aq) \rightarrow SO_3^{2-}(aq) + 2H_2O(l)$$
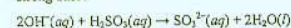
    a) H_2SO_3 is an Arrhenius acid, but not a Brønsted–Lowry acid.
    b) H_2SO_3 is a Brønsted–Lowry acid, but not an Arrhenius acid.
    c) H_2SO_3 is both an Arrhenius acid and a Brønsted–Lowry acid.
    d) H_2SO_3 is neither an Arrhenius acid nor a Brønsted–Lowry acid.
    e) H_2SO_3 is a Lewis base.

B. Please write down the English name (4 pts each, total 20 pts)

1. $MgBr_2$; 2. PbO_2 ; 3. SF_6 ; 4. $(NH_4)_2SO_4$; 5. HNO_3

C. Please define and give the description of the following terms (5 pts each, total 20 pts)

1. Oxidation–Reduction Reaction ; 2. Limiting Reactants ; 3. Orbitals ; 4. Covalent Bonding