Inorganic Chemistry Questions:

1. Standard reduction potentials are 2.9 V for F_2/F^-, 0.8 V for Ag^+/Ag, 0.5 V for Cu^+/Cu, 0.3 V for Cu^{2+}/Cu, -0.4 V for Fe^{2+}/Fe, -2.7 V for Na^+/Na, and -2.9 V for K^+/K.
    a. Arrange the oxidising agents in order of increasing strength.
    b. Which of these oxidising agents will oxidize Cu under standard state conditions?
2. The standard reduction potential is -1.245 V for the $Zn(OH)_2/Zn$, -2.690 V for $Mg(OH)_2/Mg$, -0.877 V for $Fe(OH)_2/Fe$, -2.30 V for $Al(OH)_3/Al$. Under standard state conditions,
    a. Which is the strongest reducing agent?
    b. Which reducing agent(s) could reduce $Zn(OH)_2$ to Zn?
    c. Which reducing agent(s) could reduce $Fe(OH)_2$ to Fe?
3. The standard reduction potential is -0.76 V for the Zn^{2+}/Zn couple and 1.36 V for the Cl_2/Cl^- couple. Write the equation for the oxidation of Zn by Cl_2. Calculate the potential of this reaction under standard state conditions. Is this a spontaneous reaction?
4. Using the standard reduction potentials given for the appropriate couples, calculate E^0 for each reaction and indicate whether or not each of the reaction described below will be spontaneous under standard state conditions:
    a. E^0 = -0.809 V for $Cd(OH)_2/Cd$ and E^0 = 0.098 V for HgO/Hg
    $$Cd + HgO + H_2O \rightarrow Hg + Cd(OH)_2$$
    b. E^0 = -0.036 V for Fe^{3+}/Fe and E^0 = 0.0000 V for H^+/H_2
    $$2Fe + 6H^+ \rightarrow 2Fe^{3+} + 3H_2$$
    c. E^0 = 1.36 V for Cl_2/Cl^- and E^0 = 1.33 V for $Cr_2O_7^{2-}/Cr^{3+}$
    $$6Cl^- + 14\,H^+ + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 3Cl_2 + 7H_2O$$
    d. E^0 = 0.17 V for SO_4^{2-}/H_2SO_3 and E^0 = 0.96 V for NO^{3-}/NO
    $$3H_2SO_3 + 2NO_3^- \rightarrow 2NO + 4H^+ + H_2O + 3SO_4^{2-}$$
5. Calculate the potential associated with the half-reaction $Co_{(s)} \rightarrow Co^{2+} + 2e^-$, given that the concentration of the cobalt (III) ion is 1 x 10^{-4} M. The standard reduction potential for the Co^{2+}/Co couple is -0.277V.
6. What is the concentration of Ag^+ in a half-cell if the reduction potential of the Ag^+/Ag couple is changed from E^0 = 0.80 V to 0.35 V?
7. The standard reduction potentials for the H^+/H_2 and O_2, H^+/H_2O couples are 0.000 V and 1.229 V respectively. Write the half-reactions, the overall reaction, and calculate E^0 for the reaction
    $$2H_2 + O_2 \rightarrow 2H_2O$$
    Calculate E for the cell when the pressure of H_2 is 5.0 bar and that of O_2 is 0.9 bar.
8. The potential of the cell for the reaction, M + $2H^+$ (1.0 M) $\rightarrow$ H_2 (g, 1.0 bar) + M^{2+} (0.10 M) is 0.500 V. What is the standard reduction potential for the M^{2+}/M couple?

9. Consider the following unbalanced equation: $Hg + Fe^{3+} \rightarrow Hg_2^{2+} + Fe^{2+}$.
    a. Write the ion-electron equations for the half-reactions and the overall cell equation.
    b. Write the shorthand (line) notation for this cell.
    c. The standard reduction potential at 25°C is 0.788 V for Hg_2/Hg and 0.771 V for Fe^{3+}/Fe^{2+}. Find E^0 for the reaction. Is the reaction spontaneous under standard conditions?
    d. When $[Hg_2^{2+}]$ = 0.0010 M, $[Fe^{2+}]$ = -0.10 M, and $[Fe^{3+}]$ = 1.00 M, what is E for the cell?
    e. Is the reaction more, less or identically favourable under these conditions as compared to the standard state conditions?
10. Calculate the value of the equilibrium constant for the reaction: $2K + 2H_2O$ Ý $2K^+ + 2OH^- + H_2$. The standard reduction potential is -2.925 V for K^+/K and -0.8281 V for $H_2O/H_2, OH^+$.
11. Use the following half-reaction and E^0 data at 25°C:

    $PbSO_4 + 2e^- \rightarrow Pb + SO_4^{2-}$ $\quad E^0 = -0.359$ V

    $PbI_2 + 2e^- \rightarrow Pb + 2I^-$ $\quad E^0 = -0.365$ V

    Calculate the equilibrium constant for the reaction.

12. At 25 °C, E^0 = 0.071 V for the reduction of AgBr and 0.799 V for the reduction of Ag^+. Calculate K_{sp} for AgBr.
13. A particular electrochemical cell consists of one half-cell in which a silver wire coated with AgCl dips into a 1 M KCl solution and another half-cell in which a piece of platinum dips into a solution that is 0.1 M in $CrCl_3$, 0.001 M in $K_2Cr_2O_7$, and 1 M HCl. In the cell described, the following reaction takes place: $Ag + Cr_2O_7^{2-} + Cl^- + H^+ \rightarrow AgCl + Cr^{3+} + H_2O$. The standard reduction potentials are 1.33 V and 0.22 V for the $Cr_2O_7^{2-}/Cr^{3+}$ and AgCl/Ag,Cl^- couples, respectively. Write:
    a. The ion-electron equations for the half-reactions for this cell, and the overall cell equation
    b. Determine the standard state potential
    c. Determine the potential of the cell under the above non-standard conditions.
    d. Calculate the equilibrium constant for the reaction.

14. The following reaction takes place in an electrochemical cell: $Sn + 2AgCl \rightarrow SnCl_2 + 2Ag$. For $AgCl/Ag, Cl^-$, $E^0 = 0.2222$ V and for Sn^{2+}/Sn, $E^0 = -0.136$ V.
    a. Determine E^0 for this cell at 25°C.
    b. What is the cell potential, given that the concentration of the $SnCl_2$ is 0.10 M?
    c. What would be the resulting cell potential if the $SnCl_2$ solution were diluted tenfold?
    d. At equilibrium, the cell potential assumes a unique value. What is this value?
    e. From the result in d, calculate the equilibrium constant.
    f. What is the equilibrium concentration of Sn^{2+}?
15. The production of uranium metal from purified uranium dioxide ore consists of the following steps:

$$UO_2 + 4HF \rightarrow UF_4 + 2H_2O$$

$$UF_4 + 2Mg \rightarrow U + 2MgF$$

    a. What is the oxidation number of U in UO_2?
    b. What is the oxidation number of U in UF_4?
    c. What is the oxidation number of U?
    d. Identify the reducing agent
    e. Identify the substance reduced
    f. What current could the second reaction produce if 1.00g of U?
    g. Would 1.00g of Mg be enough to produce 1.00 g of U?

16. A cell is made from Fe^{3+}/Fe and MnO_4^-/Mn^{2+} half cells.
    a. Calculate E^0_{cell} (for Fe^{3+}/Fe: $E^0 = -0.04$ V and MnO_4^-/Mn^{2+}, $E^0 = 1.49$ V)
    b. Write the overall equation
    c. Write the cell notation for the cell (line notation)
    d. Calculate K_c
    e. Calculate E_{cell} when $[Fe^{3+}] = 0.10$ M, $[MnO_4^-] = 0.25$ M, $[Mn^{2+}] = 1.50$ M and pH = 1.67 at 298 K.
17. Determine the standard potential for the following cells. State whether the reaction, as written, could be carried out in a voltaic cell or electrolytic cell. The equations are unbalanced – balance them (in acidic solution)
    a. $Mn + Cr^{3+} \rightarrow Mn^{2+} + Cr$
    b. $NO_3^- + Cl^- \rightarrow NO + Cl_2$

18. A voltaic cell was made with Mn/Mn^{2+} and Cd/Cd^{2+} half-cells and the following conditions: $[Mn^{2+}]$ = 0.090 M and $[Cd^{2+}]$ = 0.060 M.
    a. What is E^0_{cell}?
    b. What is E_{cell} given the above conditions?
    c. What is E_{cell} when $[Cd^{2+}]$ reaches 0.010 M? (What is $[Mn^{2+}]$ under these conditions?)
19. Identify the ligands and give the coordination number and the oxidation number for the central atom or ion in each of the following:
    a. $[Co(NH_3)_2(NO_2)_4]^-$
    b. $[Cr(NH_3)_5Cl]Cl_2$
    c. $K_4[Fe(CN)_6]$
    d. $[Pd(NH_3)_4]^{2+}$
20. Name the following substances:
    a. $K_3[Mn(CN)_6]$
    b. $[Pd(NH_3)_4](OH)_2$
    c. $[Ag(CN)_2]^-$
    d. $[Ag(NH_3)_2]^+$
    e. $K_2[Fe(C_2O_4)_2]\cdot 2H_2O$
    f. $K_3[Co(C_2O_4)_3]\cdot 6H_2O$
    g. $[Cu(NH_3)_4]^{2+}$
    h. $Na[AgI_2]$
    i. $Na_2[PtI_4]$
21. Write formulae for the following:
    a. Diamminedichlorozinc (II)
    b. Tin (IV) hexacyanoferrate (II)
    c. Tetracyanoplatinate (iI) ion
    d. Potassium hexacyanochromate (III)
    e. Tetraammineplatinum (II) ion
    f. Hexaamminenickel (II) bromide
    g. Tetraamminecopper (II) pentacyanohydroxoferrate (III)
22. Give the common oxidation states for chromium, gold, silver, mercury, iron and platinum.
23. Sketch all the possible isomers of $[Co(en)_2(NO_2)_2]$, including optical isomers, in which the en ligands are bidentate. Do not draw different orientations of the same isomer.

24. Give the name and find the ligand field stabilization energy (in terms of Dq) for the following complexes:
    a. $[Cr(NH_3)_6]^{3+}$
    b. $[Cu(NH_3)_4(OH_2)_2]^{2+}$
    c. $[Ti(OH_2)_6]^{3+}$
    d. $[Co(CN)_6]^{3-}$ (low spin)
    e. $[Ni(NH_3)_4Cl_2]$

25. Give the indicated isomers for each of the following coordination compounds and complexes:
    a. Structural formula for the linkage isomer of $[Cr(H_2O)_5(NO_2)]I$
    b. Draw all the possible stereoisomers of the octahedral complex $[Fe(en)(C_2O_4)Br_2]^-$.
    c. Draw all the possible stereoisomers of the square planar complex $[Pt(PPh_3)_2BrCl]$
26. For each of the following sets, indicate the complex you would expect to absorb the shorter wavelength visible light.
    a. $[Fe(NH_3)_6]^{3+}$, $[FeF_6]^{3-}$, $[Fe(CN)_6]$
    b. $[Co(en)_3]^{3+}$, $[Co(o\text{-}phen)_3]^{3+}$. $[Co(NH_3)_6]^{3+}$