Spring 2016 Chem 112 Homework Packet Key

Chem 112 Equilibrium Review
1) D
2) A
3) I) \[
\frac{[\text{NO}_2][\text{O}_2]}{[\text{NO}][\text{O}_3]}
\]

II) \[
[\text{CO}_2]
\]
4) C
5) E; We do not know how the change in temperature affects \( K_c \), therefore we cannot
plug it into the formula that relates \( K_c \) and \( K_p \).
6) B
7) B
8) C
9) A
10) C
11) B

Chem 112 Periodic Trends Review
1) The largest is rubidium. The smallest is krypton.
2) E
3) E
4) D
5) B
6) C
7) Ba < Ca < Al < Si < O
8) D
9) A

Week 1 Kinetics 1
1) E

2) a)
b) 25 kJ/mole
c) higher
3) II, III, V
4) A

\[
\text{Rate} = \frac{\Delta [\text{Fe}_2\text{O}_3]}{\Delta t} = \frac{1}{4} \frac{\Delta [\text{H}_2]}{\Delta t} = \frac{1}{3} \frac{\Delta [\text{Fe}]}{\Delta t} = \frac{1}{4} \frac{\Delta [\text{H}_2\text{O}]}{\Delta t}
\]
5) C
6) C
7) C
8) A
(Kinetics 1 continued)

9) a) rate = k
   b) M/s

c)

d)

Week 2 Kinetics 2

1) A
2) C
3) D
4) A
5) C
6) D
7) B
8) 43.0 kJ/mol
9) D
10) D
11) A
12) A

Week 2 Nuclear 1 Decay and Stability

1) E
2) $^{1}p$ or $^{1}H$
3) C
4) B
5) A
6) C
7) B

8) $^{211}\text{Bi} \rightarrow ^{4}\text{He} + ^{207}\text{TI}$

Week 3 Nuclear 2 Kinetics Energy Fission

1) a. $^{24}\text{Mg}$
   b. $^{113}\text{Cd}$
2) B
3) B
(Week 3 Nuclear 2 Kinetics Energy Fission Continued)

4) E
5) D
6) E
7) B
8) D
9) $2.984 \times 10^{-28}$ kg
10) D
11) B
12) More stable; the binding energy per nucleon of U-238 is greater than the calculated binding energy per nucleon of $1.13 \times 10^{-12}$ Joules for He-4.
13) A
14) C
15) A
16) C
17) E

Week 4 Spontaneity and entropy

1) III only
2) I, II, and IV
3) II and III
4) a. This process is spontaneous above 100 °C.
   b. This process is not spontaneous below 100 °C.
   c. The process is reversible (at equilibrium) at 100°C.
   d. The process is endothermic under all of these conditions.
5) A
6) A
7) E
8) C
9) D
10) C
11) B
12) B
13) a. Predict that $\Delta S$ will be positive (entropy increases from solid to gas).
   \[ \Delta S = 248.5 - 205.0 - 31.88 = +11.6 \text{ J/K-mol} \]
   b. Predict that $\Delta S$ will be negative: 3 moles are converted to 2 moles and there is a gaseous reactant but the products are solids.
   \[ \Delta S = 2(26.78) - 205.0 - 2(32.5) = -216.4 \text{ J/K-mol} \]
   c. Predict that $\Delta S$ will be negative: gas is converted to liquid: entropy will decrease.
   \[ \Delta S = 69.9 - 188.7 = -118.8 \text{ J/K-mol} \]
14) A corresponds to the melting of the pure substance (solid to liquid transition). B corresponds to the evaporation of the pure substance (liquid to gas transition).
15) 124 J mol$^{-1}$ K$^{-1}$
Week 4 Free Energy

1) B
2) D
3) F
4) D
5) B
6) A
7) Both I and II are true.
8) a. +43.2 kJ
   b. −94.8 kJ
9) a. ΔG° = −165.5 kJ. This reaction is spontaneous under standard conditions.
   b. ΔG° = 193.0 kJ. This reaction is not spontaneous under standard conditions.
   c. ΔG° = 215.9 kJ. This reaction is not spontaneous under standard conditions.
10) C
11) A
12) E
13) D
14) D
15) E
16) B
17) E
18) C
19) a. As Pₐ increases, ΔG increases, the reaction will shift to the left, and it will become less spontaneous.
   b. As Pₐ increases, ΔG decreases, the reaction will shift to the right, and it will become more spontaneous.
   c. As Pₐ increases, ΔG increases, the reaction will shift to the left, and it will become less spontaneous.
20) a. $K_{eq} = \frac{1}{[C_2H_2]^2} = 1.5 \times 10^{88}$
   b. $K_{eq} = [Ba^{2+}][SO_4^{2-}] = 1.4 \times 10^{-9}$
   c. $K_{eq} = \frac{[NH_4^+][OH^-]}{[NH_3]} = 1.9 \times 10^{-5}$
21) E
22) −227.9 kJ
**Week 5 Acids and Bases 1 Proton Transfer and Structure**

1. HBr and III. CH₃COOH

2. | Arrhenius base  | Bronsted-Lowry base | Acts as BOTH an Arrhenius and a Bronsted-Lowry base |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>NaOH</td>
<td>NH₃</td>
<td>H₂O</td>
</tr>
<tr>
<td>Ca(OH)₂</td>
<td>O²⁻</td>
<td>OH⁻</td>
</tr>
<tr>
<td></td>
<td>CO₃²⁻</td>
<td></td>
</tr>
</tbody>
</table>

3. D
4. D
5. Bond C will break in aqueous solution. Bond E will break in aqueous solution.
6. A
7. H₂O < H₂S < H₂Se. Bond strength is the most important factor for binary acids (H-X) in the same GROUP. (Bond polarity is the major factor in acid strength for acids in the same row.) The shorter the bond, the stronger the bond, and the weaker the acid. (The H will not dissociate as easily.) Water has the shortest strongest bond and is the weakest acid in this group. The acid with the longest, weakest bond (H₂Se) will be the strongest acid.
8. A
9. E
10. B
11. C
12. E
13. A
14. The protons are produced during the hydrolysis of water. Al³⁺ is a Lewis acid, and forms a bond to a water molecule via the lone pair on oxygen. The high charge on the aluminum ion causes the O-H bond in the bound water to be polarized and weakened. The proton is easily transferred to another water molecule, forming a hydronium ion or hydrated proton.
**Week 6 Acids and Bases 2 Strength pH Kw Acids**

1) C
2) Ions are required for the conduction of electricity, but the concentration of ions in pure water is only $2 \times 10^{-7}$ M at 298K. Pure water is a poor conductor of electricity because water is an electrically neutral molecule that cannot readily exchange electrons. Due to the auto-ionization of water, a sample of “pure” water will have a very low concentration of $H_3O^+$ and $OH^-$, so a large voltage can still produce a current.
3) D
4) A
5) B
6) D
7) A
8) B
9) $pOH = 13.2$
10) B
11) E
12) B
13) D
14) $Br^-, NO_3^-, ClO_3^-, Cl^-$
15) 0.105 M
16) D

<table>
<thead>
<tr>
<th>No.</th>
<th>Question</th>
</tr>
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</table>
| 17 | a. $H_2S \rightleftharpoons H^+ + HS^-$ $K_a = \frac{[H^+][HS^-]}{[H_2S]}$  
  
  b. $HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$ $K_a = \frac{[H^+][CO_3^{2-}]}{[HCO_3^-]}$  
  
  c. $CF_3COOH \rightleftharpoons H^+ + CF_3COO^-$ $K_a = \frac{[H^+][CF_3COO^-]}{[CF_3COOH]}$ |
| 18 | A |
| 19 | C |
| 20 | D |
| 21 | D |
| 22 | D |
| 23 | a) Dilute 0.001 M acetic acid will dissociate more. Adding water to the dissociation equilibrium will shift the system toward the side with more particles; this is an entropy effect. The percent ionization can also be calculated; 0.01 M acetic acid is 4.24% ionized, and 0.001 M acetic acid is 13.4% ionized.  
  
  b) The concentrated 0.01 M solution has a lower pH of 3.37 (The 0.001 M solution has a pH of 3.87). |
| 24 | A |
| 25 | E |
| 26 | A |
| 27 | D |
| 28 | D |
| 29 | a) $HSO_3^- + H_2O \rightleftharpoons H_3O^+ + SO_3^{2-}$  
  
  b) $HSO_3^- + H_2O \rightleftharpoons OH^- + H_2SO_3$  
  
  c) Amphoteric substances can act as either an acid or a base. |
| 30 | C |
Week 7 Acids and Bases 3 Bases and Salts
1) II. Li⁺, IV. Na⁺, VI. Ca²⁺
2) a. CH₃CH₂NH₂ + H₂O ⇌ CH₃CH₂NH₃⁺ + OH⁻
   \[ K_b = \frac{[OH^-][CH₃CH₂NH₃^+]}{[CH₃CH₂NH₂]} \]
   b. HCO₃⁻ + H₂O ⇌ OH⁻ + H₂CO₃
   \[ K_b = \frac{[OH^-][H₂CO₃]}{[HCO₃^-]} \]
   c. N₃⁻ + H₂O ⇌ HN₃ + OH⁻
   \[ K_b = \frac{[OH^-][HN₃]}{[N₃^-]} \]
3) B
4) C
5) B
6) A
7) E
8) C
9) Acidic Salts, pH < 7 | Basic Salts, pH > 7 | Neutral Salts, pH ~ 7
--- | --- | ---
CH₃NH₂Cl | NaN₃ | KBr
FeBr₃ | CaF₂ | KClO₃
NH₄Br | LiOH | NaNO₃
AlCl₃ | CH₃COOK | SrCl₂
10) a. product: CH₃NH₃OH(aq)
    molecular equation: CH₃NH₃⁺(aq) + OH⁻(aq) ⇌ CH₃NH₃OH(aq)
    net ionic equation: CH₃NH₃⁺(aq) + OH⁻(aq) ⇌ CH₃NH₃OH(aq)
    neutralization lies to the right
b. products: CH₃COOH(aq) + Cl⁻(aq)
    molecular equation: CH₃COO⁻(aq) + HCl(aq) ⇌ CH₃COOH(aq) + Cl⁻(aq)
    net ionic equation: CH₃COO⁻(aq) + H⁺(aq) ⇌ CH₃COOH(aq)
    neutralization lies to the right
c. products: Ca(NO₃)₂(aq) + 2 H₂O(ℓ)
    molecular equation: Ca(OH)₂(aq) + 2 HNO₃(aq) ⇌ Ca(NO₃)₂(aq) + 2 H₂O(ℓ)
    net ionic equation: OH⁻(aq) + H⁺(aq) ⇌ H₂O(ℓ)
    neutralization lies to the right
11) pH = 5.28
12) D
13) D
14) C
15) E
16) salt | strong acid | strong base | weak acid | weak base | spectator | non-electrolyte
--- | --- | --- | --- | --- | --- | ---
Ca(OH)₂⁺ | HNO₃ | Ca(OH)₂ | HCN | CH₃CH₂NH₂ | Br⁻ | CH₃OH
KCl | HBr | NH₂⁻ | NH₃⁺ | S²⁻ | ClO₄⁻ | H₂
CH₃NH₂Br | LiOH | H₃PO₄ | NO₂⁻ | Na⁺ | | | | | |
LiOH⁺ | | | | | | | | | |
* although these are strong bases, they are also ionic compounds (salts)
Week 8 Buffers and Titrations

1) D
2) B
3) C
4) B
5) C
6) D
7) A
8) B
9) A
10) A
11) a. $\text{CN}^-(aq) + \text{H}^+(aq) \rightleftharpoons \text{HCN}(aq)$
    b. $\text{HCN}(aq) + \text{OH}^- \longrightarrow \text{H}_2\text{O}(l) + \text{CN}^-(aq)$
12) a. $[\text{HCO}_3^-]/[\text{H}_2\text{CO}_3] = 17.8$
    b. $[\text{HCO}_3^-]/[\text{H}_2\text{CO}_3] = 12.6$
    c. The pH will increase. Use the equilibria provided in the question, and Le Chatelier’s principle. Exhaling $\text{CO}_2$ shifts the equilibrium to the left, and reduces the concentration of $\text{H}_2\text{CO}_3$ in the blood. This will cause bicarbonate to react with $\text{H}^+$ to form more $\text{H}_2\text{CO}_3$, and the pH will increase as the $\text{H}^+$ decreases.
13) B
14) B
15) C
16) A
17) a. pH < 7
    b. pH < 7
    c. pH = 7
    d. pH > 7
18) D
19) A
20) a. $\text{HB}$ is the weakest acid.
    b. Phenolphthalein is suitable for HA. Alizarin Yellow is suitable for HB.

Week 9 Solubility and Redox

1) C
2) B
3) B
4) C
5) E
6) B
7) a. $\text{CaF}_2(s) \rightleftharpoons \text{Ca}^{2+}(aq) + 2 \text{F}^-(aq)$
    $K_{sp} = [\text{Ca}^{2+}][\text{F}^-]^2$
    b. $\text{BaSO}_4(s) \rightleftharpoons \text{Ba}^{2+}(aq) + \text{SO}_4^{2-}(aq)$
    $K_{sp} = [\text{Ba}^{2+}][\text{SO}_4^{2-}]$
    c. $\text{Ca}_3(\text{PO}_4)_2 \rightleftharpoons 3 \text{Ca}^{2+}(aq) + 2 \text{PO}_4^{3-}(aq)$
    $K_{sp} = [\text{Ca}^{2+}]^3[\text{PO}_4^{3-}]^2$
8) E
9) C
10) A
(Week 9 Solubility and Redox continued)

11) B
12) D
13) A
14) A
15) a. YES, a solid does form (Q > K_{eq})
   b. YES, a solid does form (Q > K_{eq})
16) C
17) C
18) B
19) A
20) E
21) A
22) E
23) D
24) A
25) E
26) a. C_{6}H_{12}O_{6}(s) is oxidized and O_{2} is reduced.
   b. H_{2}O_{2}(aq) is both oxidized and reduced.
   c. NaI(aq) is oxidized and HOCl(aq) is reduced.
   d. This is not an oxidation-reduction reaction.
   e. I_{2}O_{5}(s) is reduced and CO is oxidized.
27) a. Cu(s) is the reducing agent (it is oxidized).
   NO_{3}^{-}(aq) is the oxidizing agent (it is reduced).
   b. Mn^{2+}(aq) is the reducing agent (it is oxidized).
   S_{2}O_{3}^{2-}(aq) is the oxidizing agent (it is reduced).
   c. NH_{3}(aq) is the reducing agent (it is oxidized).
   CuO(s) is the oxidizing agent (it is reduced).
28) a. Cr_{2}O_{7}^{2-}(aq) + 14 H^{+}(aq) + 6 e^{-} → 2 Cr^{3+}(aq) + 7 H_{2}O(ℓ)
   b. Reduction (electrons are reactants)
   c. 6 electrons
29) a. Pb(OH)_{4}^{2-}(aq) → PbO_{2} (s) + 2 H_{2}O(ℓ) + 2 e^{-}
   b. oxidation (electrons are products)
   c. 2 electrons
30) a. Cr(OH)_{3}(aq) + 5 OH^{-}(aq) → CrO_{4}^{2-}(aq) + 4 H_{2}O (ℓ) + 3 e^{-}
   b. oxidation (electrons are products)
   c. 3 electrons
31) I_{2}(s) + 10 HNO_{3}(aq) → 2 HIO_{3}(aq) + 10 NO_{2}(g) + 4 H_{2}O(ℓ)
   I_{2} is oxidized, and HNO_{3}(aq) is reduced.
32) a. S_{2}O_{3}^{2-}(aq) + 4 ClO^{-}(aq) + 2OH^{-}(aq) → 2 SO_{4}^{2-}(aq) + H_{2}O(ℓ) + 4 Cl^{-}(aq)
   b. Mn(OH)_{2}(s) + 4 MnO_{4}^{-}(aq) + 6 OH^{-}(aq) → MnO_{4}^{-}(aq) + 4 MnO_{2}^{2-}(aq) + 4 H_{2}O(ℓ)
33) 2 Cl_{2}(g) + 2 H_{2}O (ℓ) → 2 HClO (aq) + 2 HCl (aq)
   Cl_{2}(g) is both oxidized and reduced. This is an auto-oxidation reaction.
Week 10 Electrochemistry

1) a. The cell will not produce a current because the circuit is not complete. A salt bridge is needed. This provides a means for ions to flow thus completing the circuit and maintaining charge neutrality in the cells.

\[ \text{b. } \text{Cu}^{2+}(aq) + 2 \text{e}^- \rightarrow \text{Cu(s)} \quad E^\circ_{\text{cell}} = 0.337 \text{ V} \]
\[ \text{Al(s)} \rightarrow \text{Al}^{3+}(aq) + 3 \text{e}^- \quad E^\circ_{\text{cell}} = 1.66 \text{ V} \]

c. The copper electrode is the cathode. The aluminum electrode is the anode.

d. Current flows from the anode (where electrons are produced) to the cathode where electrons are consumed. Electrons flow through the wire from the Al electrode to the Cu electrode.

ea. The copper electrode is the cathode. The aluminum electrode is the anode.

d. Current flows from the anode (where electrons are produced) to the cathode where electrons are consumed. Electrons flow through the wire from the Al electrode to the Cu electrode.

e. The anions flow from the salt bridge to the anodic compartment. The cations in the salt bridge flow from the salt bridge to the cathodic compartment. The copper cations flow from the electrolyte solution to the copper cathode. The aluminum cations are produced at the aluminum anode and go into the electrolyte solution.

\[ \text{f. } 3 \text{Cu}^{2+}(aq) + 2 \text{Al(s)} \rightarrow 3 \text{Cu(s)} + 2 \text{Al}^{3+}(aq) \]

There are 6 electrons transferred.

g. \( E^\circ_{\text{cell}} = 1.997 \text{ V} \)

2) A

3) A

4) a. 0.294 V

5) 1.43 V

6) a. \( 3 \text{I}_3^- (aq) + 2 \text{Au(s)} + 8 \text{Br}^- (aq) \rightarrow 9 \text{I}^- (aq) + 2 \text{AuBr}_4^- (aq) \quad E^\circ_{\text{cell}} = 1.378 \text{ V} \]

b. \( \text{Ni(s)} + \text{Sn}^{2+} (aq) \rightarrow \text{Ni}^{2+} (aq) + \text{Sn(s)} \quad E^\circ_{\text{cell}} = 0.144 \text{ V} \)

7) B

8) C

9) A

10) a. \( \text{Ag}^+ (aq) + 2 \text{e}^- \rightarrow \text{Ag(s)} \quad E^\circ = 0.799 \text{ V} \]

\[ \text{Cr(s)} \rightarrow \text{Cr}^{3+}(aq) + 3 \text{e}^- \quad E^\circ = 0.74 \text{ V} \]

\[ 3 \text{Ag}^+ (aq) + \text{Cr(s)} \rightarrow 3 \text{Ag(s)} + \text{Cr}^{3+}(aq) \]

b. The silver electrode is the cathode (where reduction occurs). The chromium electrode is the anode (where oxidation occurs).

c. Ag will be deposited on the cathode so the silver anode will increase in mass.

The chromium anode will dissolve, form ions, and decrease in mass.

d. \( E^\circ_{\text{cell}} = 0.799 \text{ V} + 0.74 \text{ V} = 1.539 \text{ V} \)

11) a. \( \text{Al}^{3+} \)

b. \( \text{NO}_3^- (aq) \)

c. \( \text{I}_2(s) \)

12) B

13) B

14) D

15) a. Mn is +7, Br is +5, Cr is +6

b. \( \text{MnO}_4^- (aq) + 8 \text{H}^+(aq) + 5 \text{e}^- \rightarrow \text{Mn}^{2+}(aq) + 4 \text{H}_2\text{O}(l) \quad E^\circ_{\text{red}} = 1.51 \text{ V} \]

\[ \text{BrO}_3^- (aq) + 12 \text{H}^+(aq) + 10 \text{e}^- \rightarrow \text{Br}_2(l) + 6 \text{H}_2\text{O}(l) \quad E^\circ_{\text{red}} = 1.52 \text{ V} \]

\[ \text{Cr}_2\text{O}_7^{2-}(aq) + 14 \text{H}^+(aq) + 6 \text{e}^- \rightarrow 2 \text{Cr}^{3+}(aq) + 7 \text{H}_2\text{O}(l) \quad E^\circ_{\text{red}} = 1.33 \text{ V} \]

Yes, atoms in high oxidation states are easily reduced.
(Week 10 Electrochemistry continued)

16) \[ \Delta G = -2.70 \text{ kJ mol}^{-1}, K_{eq} = 2.98 \]
17) \[ \Delta G = 24.3 \text{ kJ mol}^{-1}, K_{eq} = 5.46 \times 10^{-5} \]
18) D
19) B
20) B
21) a. \( E_{\text{cell}} \) will increase.
b. No change in \( E_{\text{cell}} \).
   \( E_{\text{cell}} \) will decrease.
22) a. 1.076V
    b. \( E_{\text{cell}} = 1.068 \text{ V} \)
    c. \( E_{\text{cell}} = E^{\circ}_{\text{cell}} = 1.076 \text{ V} \)
    d. \( E_{\text{cell}} = 0.829 \text{ V} \)
23) A
24) E
25) B
26) A
27) B
28) A

Week 11 Batteries, Electrolysis, Work

1) C
2) B
3) 239 g
4) a. Li(s) is the anode; Ag(s) is the cathode.
    b. \( E_{\text{cell}} \) at 37 °C will be 3.5 V because all reactants and products are solids (Q = 1).
5) a. The oxidation reactions and potentials for Mg and Fe are:
   \[ \text{Mg}(s) \rightarrow \text{Mg}^{2+}(aq) + 2 \text{e}^- \quad E^{\circ} = 2.37 \text{ V} \]
   \[ \text{Fe}(s) \rightarrow \text{Fe}^{2+}(aq) + 2 \text{e}^- \quad E^{\circ} = 0.440 \text{ V} \]
   This works because Mg has a higher oxidation potential.
   The overall reaction and cell potential would be:
   \[ \text{Mg}(s) + \text{Fe}^{2+}(aq) \rightarrow \text{Mg}^{2+}(aq) + \text{Fe}(s) \quad E^{\circ} = 1.93 \text{ V} \]
   b. The oxidation reactions and potentials for Mg and Pb are:
   \[ \text{Mg}(s) \rightarrow \text{Mg}^{2+}(aq) + 2 \text{e}^- \quad E^{\circ} = 2.37 \text{ V} \]
   \[ \text{Pb}(s) \rightarrow \text{Pb}^{2+}(aq) + 2 \text{e}^- \quad E^{\circ} = 0.126 \text{ V} \]
   This works because Mg has a higher oxidation potential.
   The overall reaction and cell potential would be:
   \[ \text{Mg}(s) + \text{Pb}^{2+}(aq) \rightarrow \text{Mg}^{2+}(aq) + \text{Pb}(s) \quad E^{\circ} = 2.24 \text{ V} \]
6) B
7) No, it will not provide a long-term solution. Steel will promote the further corrosion of brass because Zn has a higher oxidation cell potential than Fe.
8) C
9) a. Reduction: \( \text{Mg}^{2+} + 2 \text{e}^- \rightarrow \text{Mg}(s) \), Oxidation: \( 2 \text{Cl}^- \rightarrow \text{Cl}_2(g) + 2 \text{e}^- \)
   b. \( \text{Mg}^{2+} + 2 \text{Cl}^- \rightarrow \text{Mg}(s) + \text{Cl}_2(g) \)
   c. \( E^{\circ} = -3.73 \text{ V} \)
(Week 11 Batteries, Electrolysis, Work continued)

10) a. \( Li(\ell) \) will be the product at the cathode, \( Cl_2(g) \) will be the product at the anode.
b. See the figure below:

```
\[
\text{Power supply}
\text{anode}
\text{cathode}
\]
\[
LiCl(\ell)
\]
```

11) B
12) E
13) E
14) \( H_2O(\ell) \) will be reduced at the cathode and the product will be \( H_2(g) \). \( E^o = -0.83 \text{ V} \)
\( \Gamma(aq) \) will be oxidized at the anode and the product will be \( I_2(s) \). \( E^o = -0.536 \text{ V} \)

15) C
16) B
17) C
18) E
19) C
20) E

---

Week 12 MO Theory

1) B
2) D
3) B
4) C
5) D
6) G

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Week 13 Transition Metals

1) a. Fe
   \[ \text{[Ar]} \ 4s^2 \ 3d^6 \]
   Co
   \[ \text{[Ar]} \ 4s^2 \ 3d^7 \]
   Ni
   \[ \text{[Ar]} \ 4s^2 \ 3d^8 \]
   Ti
   \[ \text{[Ar]} \ 4s^2 \ 3d^2 \]
b. Fe^{2+}
   \[ \text{[Ar]} \ 3d^6 \]
   Cr^{2+}
   \[ \text{[Ar]} \ 3d^7 \]
   Ni^{2+}
   \[ \text{[Ar]} \ 3d^8 \]
   Ti^{2+}
   \[ \text{[Ar]} \ 3d^2 \]

2) a. Zn^{2+}
   \[ \text{[Ar]} \ 3d^{10}, \text{zero unpaired electrons.} \]
b. Co^{3+}
   \[ \text{[Ar]} \ 3d^6, 4 \text{ unpaired electrons.} \]
c. Mo^{3+}
   \[ \text{[Kr]} \ 4d^3, 3 \text{ unpaired electrons.} \]
d. Cu^{2+}
   \[ \text{[Ar]} \ 3d^9, 1 \text{ unpaired electron.} \]
(Week 13 Transition Metals continued)
3)  
   a. Pd$^{2+}$ [Kr] 4d$^8$, 2 unpaired electrons.
   b. Au$^{3+}$ [Xe] 4f$^1$ 5d$^8$, 2 unpaired electrons.
   c. Ti$^{4+}$ [Ar] 3d$^0$, no unpaired electrons.
   d. Fe$^{3+}$ [Ar] 3d$^5$, 5 unpaired electrons.
4)  
   a. CN = 6, charge on the complex = −1, oxidation state of the metal = 3+
   b. CN = 6, charge on the complex = −3, oxidation state of the metal = 3+
   c. CN = 4, charge on the complex = −2, oxidation state of the metal = 2+
   d. CN = 4, charge on the complex = +2, oxidation state of the metal = 2+
   e. CN = 4, charge on the complex = −1, oxidation state of the metal = 3+
5)  
   a. CN = 6, charge on the complex = −1, oxidation state of the metal = 3+
   b. CN = 6, charge on the complex = −3, oxidation state of the metal = 3+
   c. CN = 4, charge on the complex = −2, oxidation state of the metal = 2+
   d. CN = 4, charge on the complex = +2, oxidation state of the metal = 2+
   e. CN = 4, charge on the complex = −1, oxidation state of the metal = 3+
6)  
   a. CN = 6, charge on the complex = −1, oxidation state of the metal = 3+
   b. CN = 4, charge on the complex = −2, oxidation state of the metal = 2+
   c. CN = 4, charge on the complex = 0, oxidation state of the metal = 2+
   d. CN = 4, charge on the complex = +1, oxidation state of the metal = 3+
   e. CN = 6, charge on the complex = −1, oxidation state of the metal = 3+
7)  
   E
8)  
   B
9)  
   C
10)  
   E
11)  
   E
12)  
   D
13)  
   B
14)  
   A
15)  
   A
16)  
   B
17)  
   B
18)  
   E
19)  
   a. orange
   b. violet
   c. green
20)  
   A
21)  
   Solution II will have the largest crystal field splitting.
       Solution I will have the smallest.
22)  
   Solution II will have the smallest crystal field splitting.
       Solution III will have the largest.
23)  
   a. $\Delta_o = 3.06 \times 10^{-19}$ J
   b. 184 kJ mol$^{-1}$
24)  
   A
25)  a. 5 electrons, 5 unpaired electrons

b. 5 electrons, 1 unpaired electron

c. 4 electrons, 4 unpaired electrons

26)  B

Week 14 Materials, Solids, Electrical
1)  D
2)  E
3)  D
4)  A
5)  E
6)  B
7)  D
8)  E
9)  A
10)  B
11)  D
12)  B
13)  A
14)  D

(ALLOYS)
15)  D
16)  E
17)  E

Polymers
1)  B
2)  D
3)  A
4)  C
5)  A
6)  B
7)  monomer I matches polymer A
   monomer II matches polymer B
8) E
9) C
10) A
11) E
12) A
13) a. There is an ester functional group. Esters are formed via condensation reaction, so this must be a condensation polymer.
   b. Esters are formed via the condensation reaction of an alcohol and a carboxylic acid. The monomers will have both of these functional groups. The two monomers are drawn below:

   ![Structure of monomers](image-url)