Chemistry 1220
Practice Problems for Final - Ch 20, 21, 23 Material Only

This practice exam covers only the new material from chapters 20 (20.6-20.9), 21 (21.1-21.4) and 23 (23.1-23.4, only isomerism from 23.4). The actual final is cumulative and covers material from the entire semester.

USEFUL INFORMATION

R = 0.08206 L-atm/mol-K = 8.3145 J/mol-K

$k = 1.38 \times 10^{-23}$ J/K

1 J = 1 C•V, 1 C = 1 A•s, F = 96,485 C/mol e−

$$\Delta G = -nFE \qquad \Delta G^\circ = -nFE^\circ$$

$$E^\circ = \frac{RT}{nF}\ln Q \qquad E^\circ = \frac{0.0592\,V}{n}\log K \quad (at\ 25\,^\circ C)$$

1. A concentration cell is made from two Cr electrodes, one with 0.040 M Cr^{3+} and one with 1.0 M Cr^{3+}. Calculate the voltage (in volts) generated by this concentration cell at 25°C.

$$Cr^{3+}(aq) + 3\,e^- \longrightarrow Cr(s) \quad E° = -0.74\ V$$

A. 0.083 V
B. 0.028 V
C. 0.055 V
D. 0.125 V
E. 0.24 V

2. Given the following balanced reaction equation and standard electrode potentials, what is the concentration (M) of Ag^+ if the emf of the cell is 0.350 V when the concentration of Cu^{2+} is 3.50 M?

$$Cu(s) + 2\,Ag^+(aq) \longrightarrow Cu^{2+}(aq) + 2\,Ag(s)$$

$$Cu^{2+}(aq) + 2\,e^- \longrightarrow Cu(s) \quad E° = +0.337\ V$$
$$Ag^+(aq) + e^- \longrightarrow Ag(s) \quad E° = +0.799\ V$$

A. 0.012 M
B. 0.0045 M
C. 0.20 M
D. 0.00058
E. 0.024 M

3. Consider an electrochemical cell in which the following reaction occurs and predict which changes will increase the cell voltage.

$$2\ Cr^{2+}(aq) + HClO(aq) + H^{+}(aq) \longrightarrow 2\ Cr^{3+}(aq) + Cl^{-}(aq) + H_2O(l)$$

I increase in [HClO]
II increase in size of inert electrodes
III decrease in pH of cell solution

A. I
B. II
C. III
D. I & II
E. I & III
F. II & III

4. Calculate the standard voltage that can be obtained from an ethane-oxygen ($C_2H_6(g)$-$O_2(g)$ fuel cell at 25 °C.

$$C_2H_6(g) + 7/2\ O_2(g) \rightleftarrows 2\ CO_2(g) + 3\ H_2O(\ell) \qquad \Delta G^\circ = -1467\ kJ$$

A. +1.09 V
B. +0.91 V
C. +0.72 V
D. +0.54 V
E. +0.35 V

5. Which of the following is characteristic of the **anode** in an **<u>electrolysis</u>** cell?

A. It is where reduction occurs.
B. It may attract positive ions.
C. It receives electrons from the wire.
D. It may lose weight during electrolysis.
E. It has a negative sign.

6. Using standard electrode potentials, calculate the ΔG° (kJ) for the following electrochemical cell.

Anode	$Hf^{4+}(aq) + 4\ e^- \longrightarrow Hf(s)$	$E^\circ = -1.7000$ V
Cathode	$V^{3+}(aq) + 3\ e^- \longrightarrow V(s)$	$E^\circ = -1.7980$ V

A. +37.8 kJ
B. +113 kJ
C. −9.46 kJ
D. +9.46 kJ
E. −113 kJ

7. Calculate the mass (**kg**) of Li formed by electrolysis of molten LiCl by a current of 6.60×10^4 A flowing for a period of 12.0 h. Assume the cell is 85.0 percent efficient. (atomic weight: Li = 6.941)

A. 126
B. 155
C. 174
D. 205
E. 242

8. By what process does thorium-230 decay to radium-226?

A. gamma emission
B. alpha emission
C. beta emission
D. electron capture
E. positron emission

9. What is the missing product from the following reaction?

$$^{32}_{15}\mathrm{P} \rightarrow {}^{32}_{16}\mathrm{S} + \underline{\quad}$$

A. $^{4}_{2}\mathrm{He}$

B. $^{0}_{-1}\mathrm{e}$

C. $^{0}_{0}\gamma$

D. $^{0}_{1}\mathrm{e}$

E. $^{0}_{1}\mathrm{p}$

10. Radium undergoes alpha decay. The product of this reaction also undergoes alpha decay. What is the product of this second decay reaction?

A. Po
B. Rn
C. U
D. Th
E. Hg

11. In the nuclear transmutation represented by, $^{27}_{13}Al$ (n, ?) $^{24}_{11}Na$, what is the emitted particle?

A. an alpha particle
B. a beta particle
C. a gamma photon
D. a proton
E. a neutron

12. Bombardment of ^{238}U with a deuteron ($^{2}_{1}H$) generates ^{237}Np and _____ neutrons.

A. 1
B. 2
C. 3
D. 4
E. 5

13. A freshly prepared sample of curium-243 undergoes 3312 disintegrations per second. After 6.00 yr, the activity of the sample declines to 2755 disintegrations per second. What is the half-life (in yr) of curium-243?

A. 4.99 yr
B. 32.6 yr
C. 7.2 yr
D. 0.765 yr
E. 22.6 yr

14. ^{210}Pb has a half-life of 22.3 years and decays to produce ^{206}Hg. If you start with a 7.50 g of ^{210}Pb, how many grams of ^{206}Hg will you have after 17.5 years?

A. 4.35 g
B. 3.15 g
C. 3.09 g
D. 0.0600 g
E. 1.71 g

15. In which of the following complexes does the transition metal have a d^5 configuration?

A. $PtCl_4^{2-}$
B. $Cu(H_2O)_6^{2+}$
C. $Ni(CO)_4$
D. $Zn(NH_3)_4^{2+}$
E. $Fe(CN)_6^{3-}$

16. Which of the following coordination compounds will form a precipitate when treated with an aqueous solution of $AgNO_3$?

A. $[Cr(NH_3)_3Cl_3]$
B. $[Cr(NH_3)_6]Cl_3$
C. $[Cr(NH_3)Cl](NO_3)_2$
D. $Na_3[Cr(CN)_6]$
E. $Na_3[CrCl_6]$

17. From the following pairs of coordination compounds which pair are linkage isomers?

A. $K_2[NiBr_2Cl_2]$ and $Na_2[NiBr_2Cl_2]$
B. $K_4[Pt(Cl)_2(NCS)_4]$ and $Na_4[Pt(Cl)_4(NCS)_2]$
C. $[Ni(NH_3)_3(H_2O)]Br_2$ and $[Ni(NH_3)_2(H_2O)_2]Cl_2$
D. $K_4[Pt(Cl)_2(SCN)_4]$ and $K_4[Pt(Cl)_2(NCS)_4]$
E. $[Ni(NH_3)_3Br]Cl$ and $[Ni(NH_3)_3Cl]Br$

18. From the following pairs of coordination compounds which pair are coordination-sphere isomers?

A. $K_2[NiBr_2Cl_2]$ and $Na_2[NiBr_2Cl_2]$
B. $K_4[Pt(Cl)_2(NCS)_4]$ and $Na_4[Pt(Cl)_4(NCS)_2]$
C. $[Ni(NH_3)_3(H_2O)]Br_2$ and $[Ni(NH_3)_2(H_2O)_2]Cl_2$
D. $K_4[Pt(Cl)_2(SCN)_4]$ and $K_4[Pt(Cl)_2(NCS)_4]$
E. $[Ni(NH_3)_3Br]Cl$ and $[Ni(NH_3)_3Cl]Br$

19. How many geometric isomers are possible for the complex ion $[Co(NH_3)_3(H_2O)_3]^{3+}$?

A. 4
B. 1
C. 0
D. 2
E. 3

20. Which of the following transition metal complexes can exhibit the phenomenon of optical isomerism?

A. $[Co(NH_3)_4Cl_2]$
B. $[CoCl_6]^{4-}$
C. $[Fe(H_2O)_6]^{3+}$
D. $[Ni(SCN)_3Br_3]^{4-}$
E. $[Mn(C_2O_4)_2Br_2]^{4-}$

21. Which of the following complexes are chiral?

1) $[Cr(en)_2Cl_2]^+$ cis Cl
2) $[Cr(en)_2(NH_3)_2]^{3+}$ trans-NH_3
3) $[Cr(en)_3]^{3+}$
4) $[Cr(en)Cl_2(NH_3)_2]^+$ cis Cl cis NH_3

A. 1, 2, 3
B. 1, 3, 4
C. 2, 3, 4
D. 1, 3
E. 2, 4

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Answers to Practice Problems for New Material Ch 20, 21, 23

1) B
2) E
3) E
4) A
5) D
6) B
7) C
8) B
9) B
10) A
11) A
12) C
13) E
14) C
15) E
16) B
17) D
18) E
19) D
20) E
21) B