Some Review Problems for Exam 3 – Chem 1B

(Note: this selection of problems is NOT comprehensive!)

On this exam, there are many questions involving explanations. These types of questions are not fully represented on this set of review problems. Make sure to study your lecture notes!

1. Is Li^+ a good reducing agent?
2. Predict whether octahedral $Mn(CN)_6^{3-}$ or tetrahedral $FeCl_4^-$ has the greater number of unpaired electrons. Explain and show the d-orbital splitting diagrams. Which would absorb light of the greater wavelength?
3. $Co(CN)_6^{3-}$ $\lambda_{max} = 295$ nm
   $Co(NH_3)_6^{3+}$ $\lambda_{max} = 435$ nm
   $Co(H_2O)_6^{3+}$ $\lambda_{max} = 540$ nm
   Arrange the above ligands in order of increasing ligand field strength. Explain your reasoning.
4. $Ni^{2+} + 2\ e^- \rightarrow Ni$ $E° = -0.25$ V
   Is this spontaneous?
5. If 28.0 % of a sample of silver-112 decays in 1.52 hours, what is the half-life of this isotope?
6. Which is more stable in each of the following pairs? Explain. Predict the type of decay likely for the radioactive isotope.
   a. ^{102}Ag or ^{109}Ag
   b. ^{203}Tl or ^{232}Th
   c. ^{25}Mg or ^{24}Ne
7. Predict the type of radioactive decay for:
   a. ^{6}He
   b. ^{241}Np
8. How would you plate a layer of chromium on an iron object?
9. Balance the following redox reaction. It occurs in basic solution.
   $$P_4 \rightarrow H_2PO_2^- + PH_3$$
10. Balance the following redox reaction. It occurs in acidic solution.
    $$MnO_4^- + C_2O_4^{2-} \rightarrow Mn^{2+} + CO_2$$
    Identify the substance oxidized, the substance reduced, the oxidizing agent, and the reducing agent.
11. An electrochemical cell is assembled. One compartment contains Ag^+ and Ag. The other compartment contains $AgCl_{(s)}$, Cl^-, and Ag.
    a. Which is the anode and which is the cathode? Explain.
    b. Calculate E_{cell} if the first compartment contains Ag^+ at a concentration of 0.75 M and the second compartment contains 0.30 M Cl^-.
    (The K_{sp} of AgCl is 1.8×10^{-10}.)
12. Name or write the formula:
    a. ethylenediaminetetraacetatoferrate (II) ion
    b. $Cr(NH_3)_3Br_3$
    c. $Na_5[Co(H_2O)Cl_2(SO_4)_3]$
    d. dicyanoargentate (I) ion
13. Draw *cis* and *trans* tetraaquadifluorochromium (III) ion.

14. The complex ion $AuCl_4^-$ is diamagnetic. Is this ion tetrahedral or square planar? Explain your answer.
15. Cobalt (II) ion forms both octahedral and tetrahedral complexes. In general, the octahedral complexes are pink, and the tetrahedral complexes are blue. Explain.
16. The compound $Co(NH_3)_5(SO_4)Br$ exists in two forms, one red and one violet. Both forms dissociate in solution to form two ions. Solutions of the red compound form a precipitate of AgBr on addition of $AgNO_3$ solution, but no precipitate of $BaSO_4$ on addition of $BaCl_2$ solution. For the violet compound, just the reverse occurs. From this evidence, indicate the structures of the complex ions in each case, and give the correct name of the each compound. Based on the information given, which is a stronger ligand, bromide ion or sulfate ion?
17. A 1.00-g sample containing ^{32}P and non-radioactive substances has an activity of 5.4 μCi, which is easily detectable. Calculate the mass of ^{32}P present in this sample. The half-life of ^{32}P is 14 days. Based on your answer, comment on why radioactive isotopes are useful in chemical and biological research.
18. Given the following voltaic cell:
    Ag (s) | Ag^+ (saturated Ag_2SO_3) || Fe^{3+} (0.10 M), Fe^{2+} (0.50 M) | Pt $_{(s)}$
    (Pt is an inert electrode.)
    The voltage of the above cell is 0.214 V. Determine the K_{sp} of Ag_2SO_3 from this information.
19. Given the following line structures, draw the Lewis structure, the condensed structural formula, and write the molecular formula for each.

20. Draw the structure of an isomer of each of the above molecules.
21. Draw the condensed structural formula and line structure of decane.
22. For ^{238}U, the half-life is 4.5×10^9 years (to decay to ^{206}Pb). If a sample of rock has a $^{238}U/^{206}Pb$ ratio of 0.77, how long ago did the rock solidify? (Assume that there was no lead-206 originally in the rock sample.)
23. Carbon-14 has a half-life of 5730 years. If a piece of wood has an activity of 14.8 dpm/g C, how old is the wood? (The present-day activity of ^{14}C in living things is 15.3 dpm/ g C.)
24. What is the best oxidizing agent and the best reducing agent in the following list:
    Na, Na^+, Br_2, Br^-, Co, Co^{2+}, Fe, Fe^{2+}, Fe^{3+}, H_3O^+, H_2, Au, Au^{3+}
25. Does solid iron react with acid? Does solid gold react with acid?
26. Given the following skeleton structure, fill in any multiple bonds and lone pairs. Then state the geometry and bond angle around each of the indicated atoms.

27. Predict the half-reactions that would occur at each electrode in the electrolysis of aqueous NaF using copper electrodes. What would you expect to see happening at the anode and at the cathode?

28. a. Calculate the time required to plate out 10.0 g of Cr on an object from a solution of Cr^{3+} with a current of 2.60 amperes.
b. Calculate the maximum work (in kJ) needed to produce 10.0 g of Cr from a solution of Cr^{3+} with an applied voltage of 1.75 volts.

29. Complete the following nuclear equation. This reaction has been used to synthesize the element Unh, which has now been named seaborgium and has the symbol Sg. Include mass number and atomic number for each nucleus.

$$^{249}Cf + \_\_\_\_\_ \rightarrow {}^{263}Unh + 4\ {}^{1}n$$

Must a particle accelerator be used for this reaction? Why or why not?

30. What type of radiation (α, β, or γ) penetrates the furthest?
What type of radiation (α, β, or γ) causes the most damage?

31. Given the following masses:
^{52}Cr nucleus: 51.9273 amu proton: 1.00728 amu neutron: 1.00867 amu
a. Calculate the binding energy and the binding energy per nucleon for chromium-52, in units of kJ/mol.
b. The binding energy of ^{60}Ni is 4.95×10^{10} kJ/mol.
Which nucleus is more stable, ^{52}Cr or ^{60}Ni? How can you tell?

32. Name each of the following compounds.

Some answers:

1. No
2. $FeCl_4^-$, $FeCl_4^-$
3. H_2O, NH_3, CN^-
4. can't tell
5. 3.21 hr
6. Ag-109, Tl-203, Mg-25
7. a. β b. α
11. 0.538 V
14. square planar
16. sulfate is stronger
17. 1.9×10^{-11} g
18. 2.0×10^{-15}
22. 5.4×10^{9} yr
23. 275 yr
24. Au^{3+}, Na
25. yes, no
28a. 5.95 hr
28b. 97.4 kJ
29. ^{18}O, yes
30. γ, α
31a. BE = 4.41×10^{10} kJ/mol, BE/nuc = 8.48×10^{8} kJ/mol
32a. BE/nuc = 8.25×10^{8} kJ/mol, ^{52}Cr is more stable.