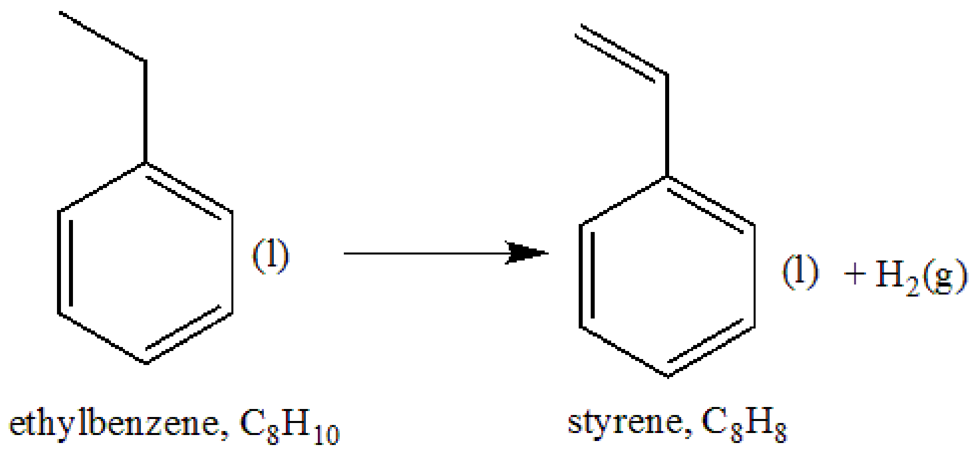
Chem1B, Spring15, MC, FinalTest   Name________________________________

Read the questions carefully to understand it, before answering on the question paper. Write clearly and concisely. **Write set-up equation, then put the raw numbers with units before doing your calculation**. Use the reverse side of your answer paper as scratch. Ask your instructor if you don't understand anything. A periodic table & some formulas are on the back. (Total pts.= 85 + (3*21=) 63 = 148).

SHORT ANSWER. To get full points, show all your work in details with set up equation and units.

1) Styrene is produced by catalytic dehydrogenation at high temperatures based on the reaction below. Calculate the $\Delta_rG°$ (kJ/mol) and the equilibrium constant, K, at 25°C (6 pts.). Is the reaction spontaneous at 25°C using the following information in the table below (2 pts.) (Total 8 pts.)?   1) ______________



	ethylbenzene (l)	styrene (l)	hydrogen (g)
$\Delta_fH°(kJmol^{-1})$	-12.5	103.8	0
$S°(Jmol^{-1}K^{-1})$	255	238	130.6

2) Calculate the pH of a 0.075M acetic acid (CH_3COOH) solution. For your calculation show what happens in a stepwise fashion, with ICE chart if necessary . ($K_a = 1.8 \times 10^{-5}$) (6 pts.) 2) ______________

3) In SF_3^+ calculate the total number of valence electrons (2 pts.), draw the Lewis structure (3 pts.) and write the hybridization of the central atom (2 pts.) (Total 7 pts). 3) ______________

4) The molecule 2-chloro-4-methylhexane, the product, is made by addition of HCl to an alkene, the reactant . Write a balanced chemical equation using condensed or skeleton structures of the reactants (3 pts.) and products (3 pts.) for this reaction. Also name the reactant (3 pts.) (10 pts. tot.). 4) ______________

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5) 250mL of a buffer of pH 12.25 was made by dissolving Na_2HPO_4 and Na_3PO_4 in water. A buffer constitutes a weak acid and its conjugate base. Which is the acid here (1 pts.) and which is the conjugate (1 pts.). Write the formula you would use to calculate the pH of the buffer (1 pt.). If the concentration of Na_3PO_4 is 0.4 M, what mass (in grams) of Na_2HPO_4 is present in that 250mL buffer. ($K_{a3} = 4.2 \times 10^{-13}$) (8 pts.) 5) ______________

6) Equilibrium was established when a mixture of 0.20 mol of NO(g), 0.10 mol of H_2(g), and 0.20 mol of H_2O(g) is placed in a 2.0-L vessel at 400 K. The equilibrium reaction is : 2 NO(g) + 2 H_2(g) $\longleftrightarrow$ N_2(g) + 2 H_2O(g). If at equilibrium [NO] = 0.062 *M*, then calculate K_p.(8 pts) 6) ______________

7) The amount of fissionable material necessary to maintain a chain reactions is called the __________ . (2 pts) 7) ______________

8) What is the coordination number of the iron atom in $CaNa[Fe(CN)_6]$ (2 pts.)? 8) ______________

9) The most common coordination numbers are __________ (4 pts.). 9) ______________

10) Calculate the nuclear binding energy (Joules/Nucleon) of Helium-4 nucleus . (Given: Mass of a helium nucleus = 4.0015 amu; Mass of a proton = 1.00728 amu; Mass of a neutron = 1.00866 amu; Mass of an electron: 5.4858 x 10-4 amu). (8 pts.) 10) ______________

11) Strontium-90 is a byproduct in nuclear reactors fueled by the radioisotope uranium-235. The half-life of strontium-90 is 28.8 yr. What percentage of a strontium-90 sample remains after 70.0 yr (8 pts.)? 11) ______________

12) Calculate the mass of Lithium metal produced when molten Lithium Chloride is electrolyzed in a cell with a current of 5.5×10^4 A flowing for a period of one day. Assume the electrolytic cell is 85% efficient (6 pts.). 12) ______________

13) Write d electron configuration of the metal ion (2 pts.), draw the crystal-field energy-level diagrams (to the right of the formula, 1 pt.) and show the placement of electrons (1 pts.) for the following complexes: (2 x 4 = 8 pts. total) 13) ____________

(a) $[VCl_6]^{3-}$

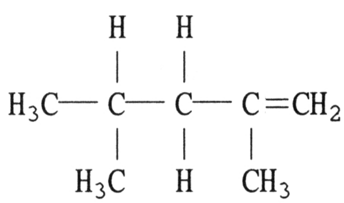
(b) $[FeF_6]^{3-}$ (a high-spin complex)

MULTIPLE CHOICE. On your scantron start from line 14 to answer the questions. Choose the one alternative that best completes the statement or answers the question (3 pts each).

14) The electron-domain geometry of a sulfur-centered compound is trigonal bipyramidal. The hybridization of the central nitrogen atom is _________. 14) ______

A) sp B) sp^3d^2 C) sp^2 D) sp^3d E) sp^3

15) What is the name of the compound below? 15) ______



A) 2,4-methylbutene
B) 2,4-ethylbutene
C) 2,4-dimethyl-1-pentene
D) 2,5-dimethylpentane
E) 2,4-dimethyl-4-pentene

16) For a first-order reaction, a plot of _________ versus _________ is linear. 16) ______

A) t, $\frac{1}{[A]_t}$ B) $\frac{1}{[A]_t}$, t C) ln $[A]_t$, $\frac{1}{t}$ D) ln $[A]_t$, t E) $[A]_t$, t

17) What change will be caused by addition of a small amount of HCl to a solution containing fluoride ions and hydrogen fluoride? 17) ______

A) The concentration of fluoride ions will increase as will the concentration of hydronium ions.
B) The concentration of hydronium ions will increase significantly.
C) The concentration of fluoride ion will decrease and the concentration of hydrogen fluoride will increase.
D) The concentration of hydrogen fluoride will decrease and the concentration of fluoride ions will increase.
E) The fluoride ions will precipitate out of solution as its acid salt.

18) Formation of solutions where the process is endothermic can be spontaneous provided that __________. 18) ______

A) the solvent is water and the solute is a gas
B) they are accompanied by another process that is exothermic
C) they are accompanied by an increase in disorder
D) the solvent is a gas and the solute is a solid
E) they are accompanied by an increase in order

19) The half-reaction occurring at the anode in the balanced reaction shown below is __________. 19) ______

$$3MnO_4^- (aq) + 24H^+ (aq) + 5Fe (s) \rightarrow 3Mn^{2+} (aq) + 5Fe^{3+} (aq) + 12H_2O (l)$$

A) $MnO_4^- (aq) + 8H^+ (aq) + 5e^- \rightarrow Mn^{2+} (aq) + 4H_2O (l)$
B) $Fe (s) \rightarrow Fe^{3+} (aq) + 3e^-$
C) $Fe^{2+} (aq) \rightarrow Fe^{3+} (aq) + e^-$
D) $2MnO_4^- (aq) + 12H^+ (aq) + 6e^- \rightarrow 2Mn^{2+} (aq) + 3H_2O (l)$
E) $Fe (s) \rightarrow Fe^{2+} (aq) + 2e^-$

Table 20.2

Half-reaction	E° (V)
$Cr^{3+} (aq) + 3e^- \rightarrow Cr (s)$	-0.74
$Fe^{2+} (aq) + 2e^- \rightarrow Fe (s)$	-0.440
$Fe^{3+} (aq) + e^- \rightarrow Fe^{2+} (s)$	+0.771
$Sn^{4+} (aq) + 2e^- \rightarrow Sn^{2+} (aq)$	+0.154

20) The standard cell potential ($E°_{cell}$) for the voltaic cell based on the reaction below is __________ V. 20) ______

$$Sn^{2+} (aq) + 2Fe^{3+} (aq) \rightarrow 2Fe^{2+} (aq) + Sn^{4+} (aq)$$

A) +0.46 B) -0.46 C) +1.39 D) +0.617 E) +1.21

21) Consider an electrochemical cell based on the reaction: 21) ______

$$2H^+ (aq) + Sn (s) \rightarrow Sn^{2+} (aq) + H_2 (g)$$

Which of the following actions would not change the measured cell potential?

A) increasing the tin (II) ion concentration in the anode compartment
B) lowering the pH in the cathode compartment
C) increasing the pressure of hydrogen gas in the cathode compartment
D) addition of more tin metal to the anode compartment
E) Any of the above will change the measured cell potential.

22) Nuclei above the belt of stability can lower their neutron-to-proton ratio by __________. 22) ______

A) gamma emission
B) beta emission
C) positron emission
D) electron capture
E) Any of the above processes will lower the neutron-to-proton ratio.

23) How many neutrons are emitted when a californium-249 nucleus (Z=98) is bombarded with a carbon-12 nucleus to produce a $^{257}_{104}Rf$ nucleus? 23) _______

A) one B) four C) zero D) three E) two

24) ^{131}I has a half-life of 8.04 days. Assuming you start with a 1.53 mg sample of ^{131}I, how many mg will remain after 13.0 days? 24) _______

A) 0.835 B) 0.268 C) 0.422 D) 0.499 E) 0.440

25) The mass of a proton is 1.00728 amu and that of a neutron is 1.00867 amu. What is the mass defect (in amu) of a $^{60}_{27}Co$ nucleus? (The mass of a cobalt-60 nucleus is 59.9338 amu.) __________.? 25) _______

A) 27.7830 B) 0.4827 C) 0.0662 D) 0.5489 E) 0.5405

26) Which one of the following ions <u>cannot</u> form both a high spin and a low spin octahedral complex ion? 26) _______

A) Cr^{3+} B) Cr^{2+} C) Mn^{3+} D) Co^{2+} E) Fe^{3+}

27) Formation of a complex species of M^{n+} metal ion with ligands often __________. 27) _______

A) reduces availability of the free M^{n+} ions in solution
B) may cause changes in the ease with which M^{n+} is reduced or oxidized
C) alters original physical properties of M^{n+}
D) "masks" original chemical properties of both the M^{n+} ion and the ligands
E) all of the above

28) A complex that absorbs light at 700 nm will appear __________. 28) _______

A) yellow B) violet C) red D) orange E) green

29) Which one of the following substances has three unpaired d electrons? 29) _______

A) $[Ag(NH_3)_2]^+$
B) $[Zn(NH_3)_4]^{2+}$
C) $[Cr(CN)_6]^{3-}$
D) $[V(H_2O)_6]^{4+}$
E) $[Cu(NH_3)_4]^{2+}$

30) Which one of the following complexes would most likely have tetrahedral geometry? 30) _______

A) $[NiCl_4]^{2-}$
B) $[Pt(NH_3)_2Cl_2]$
C) $[Cr(NH_3)_6]^{3+}$
D) $[Fe(CN)_6]^3$
E) $[Co(H_2O)_6]^{2+}$

TRUE/FALSE. Circle 'A' if the statement is true and 'B' if the statement is false (3 pts each).

31) The solubility of slightly soluble salts containing basic anions is proportional to the pH of the solution. 31) ______

32) Rates of reaction can be positive or negative. 32) ______

33) Transition metal complexes are colored because of the energy gap between the d orbitals. 33) ______

34) Positron emission causes a decrease of one in the atomic number. 34) ______