

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. = $64 + (3 \times 28) = 84 = 148$).

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

1) 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.) 1) _____

2) 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 base (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.) 2) _____

3) Equilibrium was established when a mixture of 0.20 mol of NO(g), 0.10 mol of H₂(g), and 0.20 mol of H₂O(g) is placed in a 2.0-L vessel at 400 K. The equilibrium reaction is : 2 NO(g) + 2 H₂(g) \rightleftharpoons N₂(g) + 2 H₂O(g). If at equilibrium [NO] = 0.062 M, then calculate K_p.(8 pts) 3) _____

4) Calculate the mass of Lithium metal produced when molten Lithium Chloride is electrolyzed in a cell with a current of 5.5x10⁴ A flowing for a period of one day. Assume the electrolytic cell is 85% efficient (6 pts.). 4) _____

5) The amount of fissionable material necessary to maintain a chain reactions is called the _____ . (2 pts) 5) _____

6) What is the coordination number of the iron atom in CaNa[Fe(CN)₆] (2 pts.)? 6) _____

7) The most common coordination numbers are _____ (4 pts.). 7) _____

8) 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.)? 8) _____

9) (A) Write the condensed electronic configurations next to each species (eg. [Ar] 3dⁿ) (3 pts./each) and then (B) circle if it is paramagnetic or not (1 pts/each) (total 8 pts.): 9) _____

Cr³⁺ _____ paramagnetic / not paramagnetic

Ag⁺ _____ paramagnetic / not paramagnetic

10) 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) 10) _____

(a) [VCl₆]³⁻

(b) [FeF₆]³⁻ (a high-spin complex)

MULTIPLE CHOICE. On your scantron start from same bubble number as the M/C question number. Choose the one alternative that best completes the statement or answers the question (3 pts each).

11) Which process has $\Delta S > 0$? 11) _____

- A) $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$
- B) $2\text{Hg}(\text{l}) + \text{O}_2(\text{g}) \rightarrow 2\text{HgO}(\text{s})$
- C) $\text{CaO}(\text{s}) + \text{CO}_2(\text{g}) \rightarrow \text{CaCO}_3(\text{s})$
- D) $2\text{Na}_2\text{O}_2(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{NaOH}(\text{aq}) + \text{O}_2(\text{g})$

A) B) C) D)

12) Which combination represents a chemical reaction that is spontaneous at any temperature? 12) _____

- A) $\Delta H < 0$ and $\Delta S < 0$
- B) $\Delta H < 0$ and $\Delta S > 0$
- C) $\Delta H > 0$ and $\Delta S < 0$
- D) $\Delta H > 0$ and $\Delta S > 0$

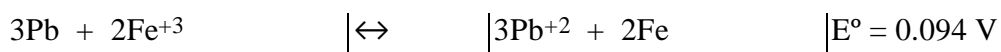
A) B) C) D)

13) Which changes is endothermic? 13) _____

- A) $\text{CO}_2(\text{g}) \rightarrow \text{CO}_2(\text{s})$
- B) $\text{CO}_2(\text{g}) \rightarrow \text{CO}_2(\text{l})$
- C) $\text{CO}_2(\text{s}) \rightarrow \text{CO}_2(\text{g})$
- D) $\text{CO}_2(\text{l}) \rightarrow \text{CO}_2(\text{s})$

A) B) C) D)

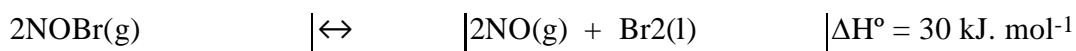
14) Calculate ΔG° for the reaction ($F = 96,480 \text{ C/mol. e}$): 14) _____



- A) -54 kJ
- B) -27 kJ
- C) -18 kJ
- D) -9.0 kJ

A) B) C) D)

15) Which will shift this equilibrium to the reactants? 15) _____



- A) decrease the temperature
- B) decrease the pressure
- C) increase $[\text{NOBr}]$
- D) add a catalyst

A) B) C) D)

16) If the equilibrium constant for a reaction is 1.6×10^{-17} , then

16) _____

- A) at equilibrium $[\text{Reactants}] \gg [\text{Products}]$.
- B) at equilibrium $[\text{Reactants}] \ll [\text{Products}]$.
- C) it takes a long time to reach equilibrium.
- D) equilibrium is reached very rapidly

A)

B)

C)

D)

17) What is the pH of a buffer solution in which the molar concentration of acetic acid is 0.15 M and the molar concentration of the acetate ion is 0.55 M? K_a of acetic acid = 1.8×10^{-5} .

17) _____

- A) 4.74
- B) 5.01
- C) 5.30
- D) 12.93

A)

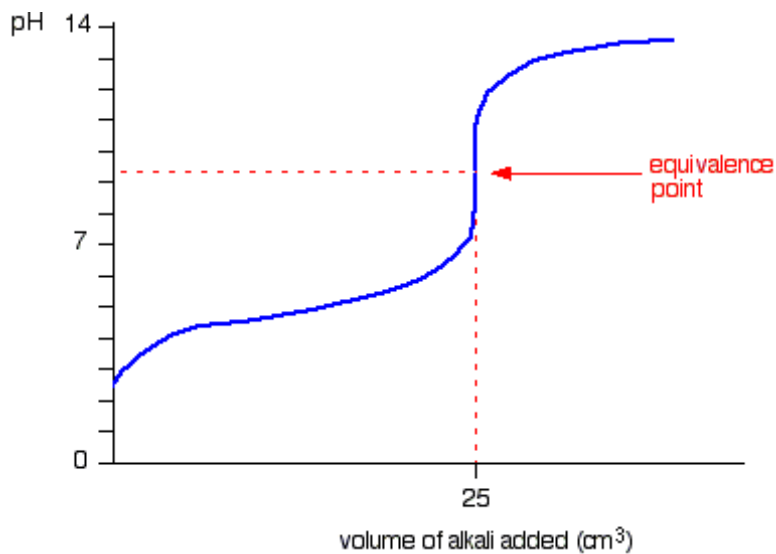
B)

C)

D)

18) What is the approximate pK_a of the weak acid being titrated?

18) _____



A) 2.6

B) 4.5

C) 9.2

D) 13

A)

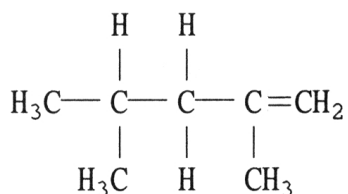
B)

C)

D)

19) What is the name of the compound below?

19) _____



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

20) Of the following, _____ is an exothermic process.

20) _____

- A) freezing
- B) subliming
- C) melting
- D) boiling
- E) All of the above are exothermic.

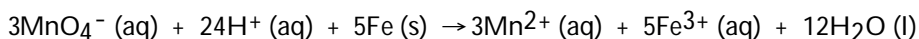
21) For a first-order reaction, a plot of _____ versus _____ is linear.

21) _____

- 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) $[A]_t, t$

22) The half-reaction occurring at the anode in the balanced reaction shown below is _____.

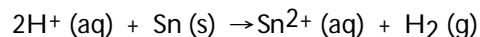
22) _____



- A) $\text{MnO}_4^- (\text{aq}) + 8\text{H}^+ (\text{aq}) + 5\text{e}^- \rightarrow \text{Mn}^{2+} (\text{aq}) + 4\text{H}_2\text{O} (\text{l})$
- B) $\text{Fe} (\text{s}) \rightarrow \text{Fe}^{3+} (\text{aq}) + 3\text{e}^-$
- C) $\text{Fe}^{2+} (\text{aq}) \rightarrow \text{Fe}^{3+} (\text{aq}) + \text{e}^-$
- D) $2\text{MnO}_4^- (\text{aq}) + 12\text{H}^+ (\text{aq}) + 6\text{e}^- \rightarrow 2\text{Mn}^{2+} (\text{aq}) + 3\text{H}_2\text{O} (\text{l})$
- E) $\text{Fe} (\text{s}) \rightarrow \text{Fe}^{2+} (\text{aq}) + 2\text{e}^-$

23) Consider an electrochemical cell based on the reaction:

23) _____



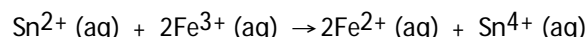
Which of the following actions would not change the measured cell potential?

- 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.

Table 20.2

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

24) The standard cell potential (E°_{cell}) for the voltaic cell based on the reaction below is _____ 24) _____
V.



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

25) Nuclei above the belt of stability can lower their neutron-to-proton ratio by _____ 25) _____

- 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.

26) How many neutrons are emitted when a californium-249 nucleus ($Z=98$) is bombarded with a carbon-12 nucleus to produce a $^{257}_{104}\text{Rf}$ nucleus? 26) _____

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

27) ^{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? 27) _____

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

28) 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 $^{60}_{27}\text{Co}$ nucleus? (The mass of a cobalt-60 nucleus is 59.9338 amu.) _____? 28) _____

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

29) Which one of the following ions cannot form both a high spin and a low spin octahedral complex ion? 29) _____

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

30) Formation of a complex species of M^{n+} metal ion with ligands often _____ 30) _____

- 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

31) A complex that absorbs light at 700 nm will appear _____ 31) _____

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

- 32) Which one of the following substances has three unpaired d electrons? 32) _____
- A) $[\text{Ag}(\text{NH}_3)_2]^+$
 - B) $[\text{Zn}(\text{NH}_3)_4]^{2+}$
 - C) $[\text{Cr}(\text{CN})_6]^{3-}$
 - D) $[\text{V}(\text{H}_2\text{O})_6]^{4+}$
 - E) $[\text{Cu}(\text{NH}_3)_4]^{2+}$

- 33) Which one of the following complexes would most likely have tetrahedral geometry? 33) _____
- A) $[\text{NiCl}_4]^{2-}$
 - B) $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$
 - C) $[\text{Cr}(\text{NH}_3)_6]^{3+}$
 - D) $[\text{Fe}(\text{CN})_6]^{3-}$
 - E) $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$

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

- 34) Under ordinary conditions, a substance will sublime rather than melt if its triple point occurs at a pressure above atmospheric pressure. 34) _____
- 35) The solubility of slightly soluble salts containing basic anions is proportional to the pH of the solution. 35) _____
- 36) Rates of reaction can be positive or negative. 36) _____
- 37) Transition metal complexes are colored because of the energy gap between the d orbitals. 37) _____
- 38) Positron emission causes a decrease of one in the atomic number. 38) _____

MULTIPLE CHOICE. On your scantron start from same bubble number as the M/C question number. Choose the one alternative that best completes the statement or answers the question (3 pts each).

- 39) SURVEY QUESTION: Historically the organic chemistry series 12A/B in Mission College chemistry department has been offered on specific semesters (12A - Fall, 12B - Spring). If you were taking chem 1B during the fall 2017 semester, the next opportunity to enroll in Chem 12A would be the following Fall 2018 semester. If Chem 12A course was offered the next Spring 2018 semester, would you have chosen to enroll in the course? 39) _____
- A) I do not intend to enroll in the organic chemistry courses because my major does not require it
 - B) Yes, I would enroll in Chem 12A during the next spring 2018 semester
 - C) No opinion
 - D) No, I will wait until the following Fall 2018 semester to enroll in Chem 12A