

112-2 Semester General Chemistry Final Exam (A) -2024/06/12

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) The second law of thermodynamics states that _____.
A) $\Delta E = q + w$
B) $\Delta S = q_{\text{rev}}/T$ at constant temperature
C) for any spontaneous process, the entropy of the universe increases
D) $\Delta H^{\circ}_{\text{rxn}} = \sum n\Delta H^{\circ}_{\text{f}} (\text{products}) - \sum m\Delta H^{\circ}_{\text{f}} (\text{reactants})$
E) the entropy of a pure crystalline substance is zero at absolute zero

Answer: C

- 2) A reversible process is one that _____.
A) must be carried out at low temperature
B) is spontaneous in both directions
C) must be carried out at high temperature
D) can be reversed with no net change in either system or surroundings
E) happens spontaneously

Answer: D

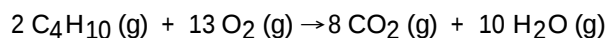
- 3) Which one of the following processes produces a decrease of the entropy of the system?
A) sublimation of naphthalene
B) dissolving oxygen in water
C) dissolving sodium chloride in water
D) explosion of nitroglycerine
E) boiling of alcohol

Answer: B

- 4) ΔS is negative for the reaction _____.
A) $2\text{C} (\text{s}) + \text{O}_2 (\text{g}) \rightarrow 2\text{CO}_2 (\text{g})$
B) $2\text{SO}_2 (\text{g}) + \text{O}_2 (\text{g}) \rightarrow 2\text{SO}_3 (\text{g})$
C) $\text{PbCl}_2 (\text{s}) \rightarrow \text{Pb}^{2+} (\text{aq}) + 2\text{Cl}^{-} (\text{aq})$
D) $\text{NH}_4\text{Cl} (\text{s}) \rightarrow \text{NH}_3 (\text{g}) + \text{HCl} (\text{g})$
E) $\text{H}_2\text{O} (\text{l}) \rightarrow \text{H}_2\text{O} (\text{g})$

Answer: B

- 5) For the reaction



- ΔH° is -125 kJ/mol and ΔS° is +253 J/K · mol. This reaction is _____.
A) spontaneous at all temperatures
B) spontaneous only at low temperature
C) spontaneous only at high temperature
D) nonspontaneous at all temperatures
E) unable to determine without more information

Answer: A

- 6) With thermodynamics, one cannot determine _____.
 A) the speed of a reaction
 B) the temperature at which a reaction will be spontaneous
 C) the direction of a spontaneous reaction
 D) the value of the equilibrium constant
 E) the extent of a reaction

Answer: A

- 7) Consider the reaction:



Given the following table of thermodynamic data,

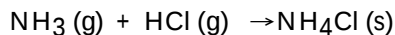
Substance	ΔH_f° (kJ/mol)	S° (J/mol · K)
$\text{CCl}_4(\text{g})$	-106.7	309.4
$\text{CCl}_4(\text{l})$	-139.3	214.4

Determine the normal boiling point of CCl_4 .

- A) 15 °C B) 70 °C C) 83 °C D) 112 °C E) 183 °C

Answer: B

- 8) Consider the reaction:



Given the following table of thermodynamic data,

Substance	ΔH_f° (kJ/mol)	S° (J/mol · K)
$\text{NH}_3(\text{g})$	-46.19	192.5
$\text{HCl}(\text{g})$	-92.30	186.69
$\text{NH}_4\text{Cl}(\text{s})$	-314.4	94.6

determine the lowest temperature (in °C) above which the reaction is nonspontaneous.

- A) 345.0
 B) 432.8
 C) 618.1
 D) 1235
 E) This reaction is spontaneous at all temperatures.

Answer: A

- 9) Which of the following statements is true? (Q: reaction quotient)

- A) If $Q = 0$, the system is at equilibrium
 B) The larger the Q , the larger the ΔG°
 C) If a reaction is spontaneous under standard conditions, it is spontaneous under all conditions
 D) The free-energy change for a reaction is independent of temperature.
 E) If $Q > 1$, $\Delta G > \Delta G^\circ$.

Answer: E

10) The K_{sp} for a very insoluble salt is 4.2×10^{-47} at 298 K. What is ΔG° for the dissolution of the salt in water?

($R = 8.314 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$)

- A) -265 kJ/mol B) -115 kJ/mol C) -2.61 kJ/mol D) +115 kJ/mol E) +265 kJ/mol

Answer: E

11) What is the coefficient of the dichromate ion when the following equation is balanced?



- A) 1 B) 5 C) 3 D) 6 E) 2

Answer: A

12) Which substance is the oxidizing agent in the following reaction?



- A) NO_2 B) S C) HNO_3 D) H_2O E) Fe_2S_3

Answer: C

Table 1 Standard reduction potential

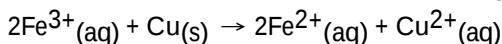
Half Reaction	$E_{\text{red}}^\circ(\text{V})$
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al}(\text{s})$	-1.66
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$	-0.76
$\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Cr}(\text{s})$	-0.74
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.440
$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Ni}(\text{s})$	-0.28
$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.34
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	+0.771
$\text{Sn}^{4+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Sn}^{2+}(\text{aq})$	+0.154

13) At standard state, which of the following reactions will occur spontaneously as written? (E_{red}° Refer Table 1)

- A) $\text{Sn}^{4+}(\text{aq}) + \text{Fe}^{2+}(\text{aq}) \rightarrow \text{Sn}^{2+}(\text{aq}) + \text{Fe}(\text{s})$
B) $\text{Sn}^{4+}(\text{aq}) + \text{Fe}^{3+}(\text{aq}) \rightarrow \text{Sn}^{2+}(\text{aq}) + \text{Fe}^{2+}(\text{aq})$
C) $3\text{Fe}^{2+}(\text{aq}) \rightarrow \text{Fe}(\text{s}) + 2\text{Fe}^{3+}(\text{aq})$
D) $3\text{Fe}(\text{s}) + 2\text{Cr}^{3+}(\text{aq}) \rightarrow 2\text{Cr}(\text{s}) + 3\text{Fe}^{2+}(\text{aq})$
E) $3\text{Sn}^{4+}(\text{aq}) + 2\text{Cr}(\text{s}) \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 3\text{Sn}^{2+}(\text{aq})$

Answer: E

14) Calculate the electromotive force at 298 K generated by a voltaic cell in which the reaction is



When $[\text{Cu}^{2+}] = 0.50 \text{ M}$, $[\text{Fe}^{3+}] = 0.20 \text{ M}$, and $[\text{Fe}^{2+}] = 0.10 \text{ M}$. (E_{red}° Refer Table 1)

- A) -0.358 V B) -0.158 V C) +0.229 V D) +0.431 V E) +0.458 V

Answer: E

15) Based on the values in Table 1, which of these metals could provide cathodic protection to iron: Al, Cu, Ni, Zn?

A) Al and Cu

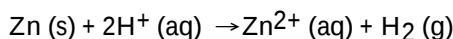
B) Cu and Ni

C) Al and Zn

D) Ni and Zn

Answer: C

16) The standard cell potential (E°) of a voltaic cell constructed using the cell reaction below is 0.76 V:



With $P_{\text{H}_2} = 1.0 \text{ atm}$ and $[\text{Zn}^{2+}] = 1.0 \text{ M}$, the cell potential is 0.66 V. The concentration of H^+ in the cathode compartment is _____ M.

A) 4.9×10^1

B) 1.4×10^{-1}

C) 4.2×10^{-4}

D) 2.0×10^{-2}

E) 1.0×10^{-12}

Answer: D

17) The relationship between the change in Gibbs free energy and the emf of an electrochemical cell is given by _____.

A) $\Delta G = \frac{-E}{nF}$

B) $\Delta G = -nFE$

C) $\Delta G = -nRTF$

D) $\Delta G = \frac{-nF}{ERT}$

E) $\Delta G = \frac{-nF}{E}$

Answer: B

18) A concentration cell is constructed with two $\text{Zn(s)} - \text{Zn}^{2+}(\text{aq})$ half-cells. In one half-cell $[\text{Zn}^{2+}] = 1.35 \text{ M}$, and in the other $[\text{Zn}^{2+}] = 3.75 \times 10^{-4} \text{ M}$. What is the emf generated by the cell and what is the identity of the electrode that is immersed the half-cell in which $[\text{Zn}^{2+}] = 3.75 \times 10^{-4} \text{ M}$?

A) -0.210 V, cathode

B) -0.105 V, anode

C) +0.105 V, anode

D) +0.105 V, cathode

E) +0.210 V, anode

Answer: C

19) Reduction occurs at the _____

A) anode, in both galvanic and electrolytic cells.

B) anode in galvanic cells and cathode in electrolytic cells.

C) cathode, in both galvanic and electrolytic cells.

D) cathode in galvanic cells and anode in electrolytic cells.

Answer: C

20) How many seconds are required to produce 4.00 g of aluminum metal from the electrolysis of molten AlCl_3 with an electrical current of 12.0 A?

A) 1.19×10^3

B) 27.0

C) 9.00

D) 3.57×10^3

E) 2.90×10^5

Answer: D

- 21) Galvanized iron is iron coated with _____.
A) zinc. B) magnesium. C) phosphate. D) chromium. E) iron oxide.

Answer: A

- 22) Transition metals differ from main group metals because transition metals _____.
A) do not react with nonmetals. B) are all the same color.
C) can have multiple oxidation states. D) have very low densities.

Answer: C

- 23) All ligands have _____.
A) negative charges. B) positive charges.
C) at least two atoms. D) at least one lone pair.

Answer: D

- 24) What is the name of the compound $[\text{Rh}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$?
A) Rhodium(III) tetraamminedichloro chloride
B) Tetraammoniadichlororhodium(III) chloride
C) Tetraamminedichlororhodium(III) chloride
D) Tetraamminetrichlororhodium(III)
E) Tetraamminedichlororhodium(II) chloride

Answer: C

- 25) In the coordination compound $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$, the oxidation number of Pt is ____, and its coordination number is ____.
A) +4, 4 B) +2, 4 C) +4, 2 D) +2, 2 E) -4, 2

Answer: B

- 26) Why does Ti^{5+} not exist?
A) Electron affinity is too large.
B) Ionization energy is too small.
C) It produces an ion that is too small in size to be stable.
D) The energy required to remove core electrons is too large.

Answer: D

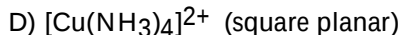
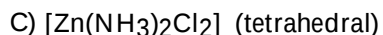
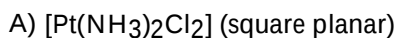
- 27) Why are compounds of Ti(IV) colorless?
A) Ti(IV) has lost half of its valence electrons, and these cannot be excited to higher energy orbitals.
B) Ti(IV) only absorbs light in the infrared region of the spectrum.
C) Ti(IV) has no d electrons, and therefore, no d-d electron transitions can occur in the visible region.
D) Ti(IV) has only one unpaired d electron in the valence shell that can be excited to a higher energy d orbital; the energy gap is not in the visible region.

Answer: **D** 改為**C**

- 28) What property of the porphine ligand makes it possible for chlorophyll to play a role in plant photosynthesis?
A) It has a planar structure that enables the C—H bonds to absorb light in the visible region.
B) The C—C bonds absorb light in the ultraviolet region.
C) It has conjugated double bonds that absorb light in the visible region.
D) It has C—H bonds that absorb light in the infrared region.

Answer: C

29) Which one of the following complexes can exhibit geometrical isomerism?

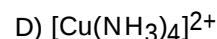
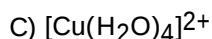
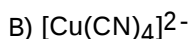


Answer: A

30) Using the following abbreviated spectrochemical series, determine which complex ion is most likely to absorb light in the red region of the visible spectrum.

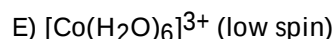
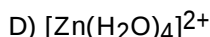
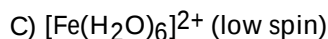
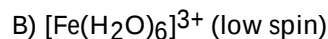
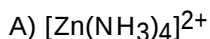
light

small splitting $\text{Cl}^- < \text{H}_2\text{O} < \text{NH}_3 < \text{CN}^-$ large splitting



Answer: A

31) Which one of the following complex ions will be paramagnetic?



Answer: B

32) $\text{C}_{10}\text{H}_{22}$ is the molecular formula of an ____.

A) alkane

B) alkene

C) alkyne

D) aromatic hydrocarbon

Answer: A

33) Which compound does not exist?

A) 1,2,3,4,5,6,7-octaheptaene

B) cis-4-decene

C) cis-2-butane

D) trans-3-hexene

E) 1-propene

Answer: C

34) What product is formed from the hydrogenation of 2-methylpropene?

A) propane

B) butane

C) 2-methylbutane

D) 2-methylpropane

E) 2-methylpropyne

Answer: B

35) Hybridization of the carbon atom indicated by (*) in $\text{CH}_3\text{-}^*\text{CH}_2\text{-CH}_3$, $^*\text{CH}_2=\text{CH}_2$, and $\text{CH}_3\text{-}^*\text{C}\equiv\text{CH}$ is _____, _____, and _____, respectively.

- A) sp , sp^3 , sp^2
- B) sp^3 , sp^2 , sp
- C) sp^3 , sp , sp^2
- D) sp , sp^2 , sp^3
- E) sp^2 , sp^3 , sp

Answer: B

36) How many chiral centers are there in $\text{CH}_3\text{CHClCH}_2\text{CH}_2\text{CHBrCH}_3$?

- A) 4
- B) 3
- C) 1
- D) 2
- E) 0

Answer: D

37) What chemical process is happening when formic acid is converted back to methane?

- A) Reduction
- B) Oxidation
- C) Hydration
- D) Dehydration

Answer: A

38) If each of the following represents an alkane, and a carbon atom is located at each vertex with the proper number of hydrogen atoms also bonded to it, which one is the most reactive?

A)



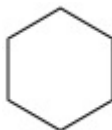
B)



C)



D)



E) They are all equally reactive since they are all alkanes.

Answer: A

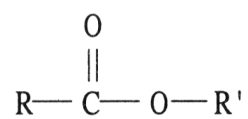
39) Alcohols are hydrocarbon derivatives in which one or more hydrogens have been replaced by a hydroxyl functional group. _____ is the general formula of an alcohol.

- A) R-O-R
- B) R-CO-R
- C) R-CO-H
- D) R-OH
- E) R-CO-OH

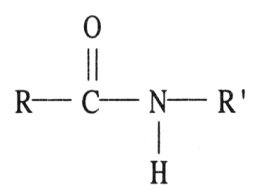
Answer: D

40) Which of the following contains a peptide linkage?

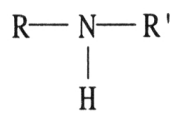
A)



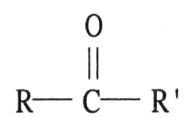
B)



C)



D)



Answer: B