114-2 Semest General Chemistry Final Exam (B) - 2026/06/10

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

1) Which of the following reactions is a redox reaction?

(a) $K_2CrO_4 + BaCl_2 \rightarrow BaCrO_4 + 2KCl$
(b) $Pb_2^{2+} + 2Br^- \rightarrow PbBr$
(c) $Cu + S \rightarrow CuS$

A) (a) only B) (b) only C) (c) only D) (a) and (c) E) (b) and (c)

Answer: C

2) Which substance is the reducing agent in the following reaction?

$Fe_2S_3 + 12HNO_3 \rightarrow 2Fe(NO_3)_3 + 3S + 6NO_2 + 6H_2O$

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

Answer: D

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

$Fe^{2+} + Cr_2O_7^{2-} \rightarrow Fe^{3+} + Cr^{3+}$ (acidic solution)

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

Answer: E

4) Which transformation could take place at the anode of an electrochemical cell?

A) $O_2 \rightarrow H_2O_2$
B) $CO_2 \rightarrow C_2O_4^{2-}$
C) $NO \rightarrow NO_3^-$
D) $VO_2^+ \rightarrow VO^{2+}$
E) $H_2AsO_4 \rightarrow H_3AsO_3$

Answer: C

5) A voltaic cell is constructed with two silver-silver chloride electrodes, where the half-reaction is

$AgCl(s) + e^- \rightarrow Ag(s) + Cl^-(aq)$ $E° = +0.222$ V

The concentrations of chloride ion in the two compartments are 0.0222 M and 2.22 M, respectively. The cell e is _____ V.

A) 0.118 B) 0.00222 C) 0.232 D) 0.212 E) 22.2

Answer: A

6) How many grams of Cu are obtained by passing a current of 12 A through a solution of $CuSO_4$ for 30 minutes?

A) 28 B) 0.016 C) 14 D) 7.1 E) 3.6

Answer: D

Table 20.1

Half Reaction	E°(V)
F_2 (g) + 2e$^-$ → 2F$^-$ (aq)	+2.87
Cl_2 (g) + 2e$^-$ → 2Cl$^-$ (aq)	+1.359
Br_2 (l) + 2e$^-$ → 2Br$^-$ (aq)	+1.065
O_2 (g) + 4H$^+$ (aq) + 4e$^-$ → 2H_2O (l)	+1.23
Ag^+ + e$^-$ → Ag (s)	+0.799
Fe^{3+} (aq) + e$^-$ → Fe^{2+} (aq)	+0.771
I_2 (s) + 2e$^-$ → 2I$^-$ (aq)	+0.536
Cu^{2+} + 2e$^-$ → Cu (s)	+0.34
2H$^+$ + 2e$^-$ → H_2 (g)	0
Pb^{2+} + 2e$^-$ → Pb (s)	-0.126
Ni^{2+} + 2e$^-$ → Ni (s)	-0.28
Li^+ + e$^-$ → Li (s)	-3.05

7) Which of the halogens in Table 20.1 is the strongest oxidizing agent?

A) Br_2

B) Cl_2

C) F_2

D) I_2

E) All of the halogens have equal strength as oxidizing agents.

Answer: C

Table 20.2

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

8) Which of the following reactions will occur spontaneously as written?

A) 3Fe (s) + 2Cr^{3+} (aq) → 2Cr (s) + 3Fe^{2+} (aq)

B) Sn^{4+} (aq) + Fe^{3+} (aq) → Sn^{2+} (aq) + Fe^{2+} (aq)

C) Sn^{4+} (aq) + Fe^{2+} (aq) → Sn^{2+} (aq) + Fe (s)

D) 3Fe^{2+} (aq) → Fe (s) + 2Fe^{3+} (aq)

E) 3Sn^{4+} (aq) + 2Cr (s) → 2Cr^{3+} (aq) + 3Sn^{2+} (aq)

Answer: E

9) What is the cathode in the hydrogen fuel cell?

A) Li B) O_2 C) Pt D) KOH E) H_2

Answer: B

10) The standard cell potential ($E°_{cell}$) of the reaction below is +1.34 V. The value of $\Delta G°$ for the reaction is _____ kJ/mol.

$$3\ Cu\ (s)\ +\ 2\ MnO_4^-\ (aq) + 8H^+\ (aq)\ \rightarrow 3\ Cu^{2+}\ (aq) +\ 2\ MnO_2\ (s)\ +\ 4\ H_2O\ (l)$$

A) +259
B) -259
C) +776
D) -24.3
E) none of the above

Answer: E

11) What two oxidation states are more frequently observed in the first transition series than in the third?
A) +2 and +7 B) +3 and +5 C) +5 and +6 D) +2 and +3 E) +3 and +7

Answer: D

12) What is the most common geometry found in four-coordinate complexes?
A) trigonal bipyramidal
B) square planar
C) tetrahedral
D) icosahedral
E) octahedral

Answer: C

13) The coordination number and oxidation number of the central atom in $[Mn(CO)_4Br_2]$ are _____ and _____, respectively.
A) 6, +2 B) 4, +1 C) 6, +1 D) 5, +2 E) 4, +2

Answer: A

14) A complex of correctly written formula $[Pt(NH_3)_3Br]Br{\cdot}H_2O$ has which set of ligands in its inner coordination sphere?
A) 3 NH_3, 1 Br^--, and 1 H_2O
B) 3 NH_3 and 1 Br^-
C) 3 NH_3 and 2 Br^-
D) 3 NH_3, 2 Br^-, and 1 H_2O
E) 3 NH_3

Answer: B

15) Complexes containing metals with d^{10} electron configurations are typically _____.
A) violet B) green C) blue D) colorless E) yellow

Answer: D

16) Does either or both cis- or trans-$[Mn(en)_2Br_2]$ have optical isomers?
A) trans only
B) cis only
C) both cis and trans
D) neither cis nor trans
E) $[Mn(en)_2Br_2]$ does not exhibit cis-trans isomerism.

Answer: B

17) Based on electron configuration, which is most likely colorless?

A) $[Co(NH_3)_6]^{2+}$

B) $[Cd(NH_3)_4]^{2+}$

C) $[Cr(NH_3)_5Cl]^{2+}$

D) $[Cu(NH_3)_4]^{2+}$

E) $[Ni(NH_3)_6]^{2+}$

Answer: B

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

A) $[Fe(H_2O)_6]^{3+}$ (low spin)

B) $[Co(H_2O)_6]^{3+}$ (low spin)

C) $[Zn(H_2O)_4]^{2+}$

D) $[Fe(H_2O)_6]^{2+}$ (low spin)

E) $[Zn(NH_3)_4]^{2+}$

Answer: A

19) Based on the crystal-field strengths $F^- < CH_2CN < NH_3 < NO_2^- < CN^-$, which Co(III) complex is most likely high-spin?

A) $[Co(CH_3CN)_6]^{3+}$

B) $[Co(NH_3)_6]^{3+}$

C) $[Co(CN)_6]^{3-}$

D) $[CoF_6]^{3-}$

E) $[Co(NO_2)_6]^{3-}$

Answer: D

20) Which substance would be the most soluble in gasoline?

A) water B) $NaNO_3$ C) HCl D) NaCl E) hexane

Answer: E

21) 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—OH B) R—CO—H C) R—CO—R D) R—CO—OH E) R—O—R

Answer: A

22) The following reaction would produce a(n) _____.

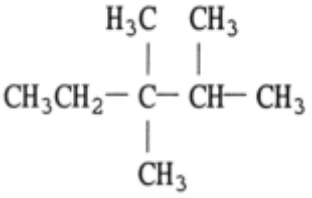
$$R\text{-}OH + R'COOH \rightarrow$$

A) ester B) ether C) alcohol D) aldehyde E) ketone

Answer: A

23) The structure of 2,3-dimethylheptane is _____.

A)



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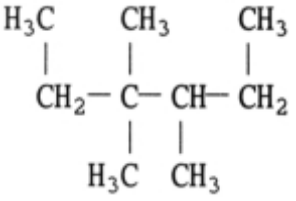

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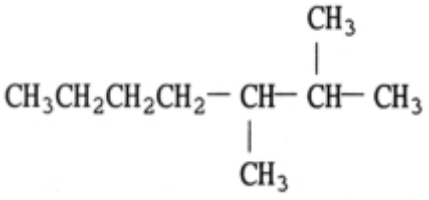

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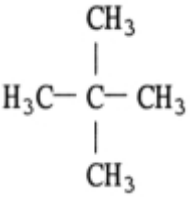

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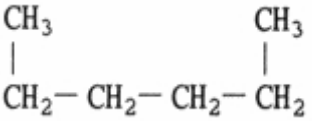


Answer: C

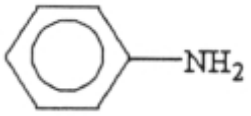
24) How many chiral centers are there in $CH_3CHClCH_2CH_2CHBrCH_3$?

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

Answer: E

25) Which structure below represents a ketone?

A)



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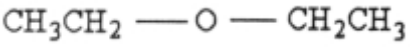

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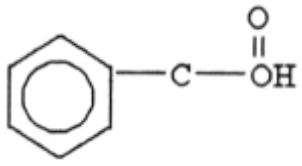
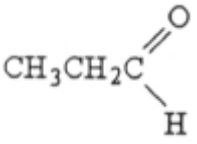


D)



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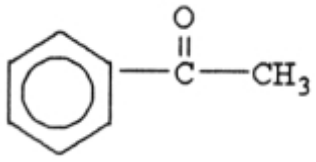


Answer: E

26) Sugars are examples of what type of molecule?

A) carbohydrates
B) amino acids
C) proteins
D) salts
E) nucleic acids

Answer: A

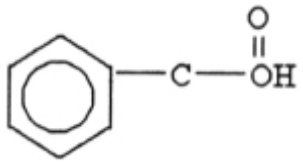
27) The double helix of DNA is stabilized mainly by _____.

A) hydrogen bonds
B) covalent bonds
C) ionic bonds
D) ion-dipole bonds
E) ester bonds

Answer: A

28) Which structure below represents an amine?

A)



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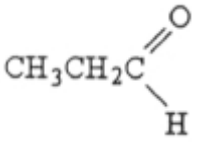

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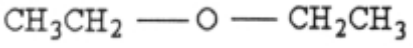

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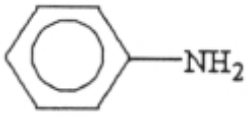
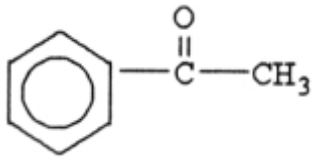


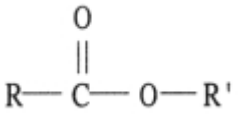
E)



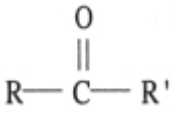
Answer: D

29) Which of the following contains a peptide linkage?

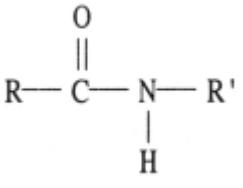
A)



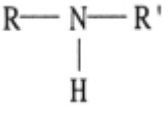
B)



C)



D)



E) none of the above

Answer: C

30) The first law of thermodynamics can be given as _____.
A) $\Delta E = q + w$
B) for any spontaneous process, the entropy of the universe increases
C) $\Delta H°_{rxn} = \sum n\Delta H°_f$ (products) - $\sum m\Delta H°_f$ (reactants)
D) $\Delta S = q_{rev}/T$ at constant temperature
E) the entropy of a pure crystalline substance at absolute zero is zero
Answer: A

31) When a system is at equilibrium, _____.
A) the forward process is spontaneous but the reverse process is not
B) the forward and the reverse processes are both spontaneous
C) both forward and reverse processes have stopped
D) the process is not spontaneous in either direction
E) the reverse process is spontaneous but the forward process is not
Answer: D

32) The thermodynamic quantity that expresses the degree of disorder in a system is _____.
A) entropy
B) enthalpy
C) bond energy
D) heat flow
E) internal energy
Answer: A

33) Which one of the following is always positive when a spontaneous process occurs?
A) $\Delta H_{universe}$
B) $\Delta S_{universe}$
C) $\Delta S_{surroundings}$
D) ΔS_{system}
E) $\Delta H_{surroundings}$
Answer: B

34) Which one of the following correctly indicates the relationship between the entropy of a system and the number of different arrangements, W, in the system?
A) $S = \frac{k}{W}$ B) $S = Wk$ C) $S = k\ \ln W$ D) $S = kW$ E) $S = \frac{W}{k}$
Answer: C

35) ΔS is positive for the reaction _____.
A) $H_2O\ (l) \rightarrow H_2O\ (s)$
B) $CaO\ (s) + CO_2\ (g) \rightarrow CaCO_3\ (s)$
C) $N_2\ (g) + 3H_2\ (g) \rightarrow 2NH_3\ (g)$
D) $Ag^+\ (aq) + Cl^-\ (aq) \rightarrow AgCl\ (s)$
E) $2SO_3\ (g) \rightarrow 2SO_2\ (g) + O_2\ (g)$
Answer: E

36) For the reaction

$$C_2H_6\,(g) \rightarrow C_2H_4\,(g) + H_2\,(g)$$

$\Delta H°$ is +137 kJ/mol and $\Delta S°$ is +120 J/K · mol. This reaction is _____.

A) spontaneous only at low temperature
B) spontaneous only at high temperature
C) nonspontaneous at all temperatures
D) spontaneous at all temperatures

Answer: B

37) Consider the reaction:

$$Ag^+\,(aq) + Cl^-\,(aq) \rightarrow AgCl\,(s)$$

Given the following table of thermodynamic data,

Substance	$\Delta H_f°$ (kJ/mol)	S° (J/mol · K)
Ag^+ (aq)	105.90	73.93
Cl^- (aq)	-167.2	56.5
AgCl (s)	-127.0	96.11

determine the temperature (in °C) above which the reaction is nonspontaneous under standard conditions.

A) 150 B) 1230 C) 133 D) 1640 E) 432

Answer: D

38) The normal boiling point of $C_2Cl_3F_3$ is 47.6 °C and its molar enthalpy of vaporization is 27.49 kJ/mol. What is the change in entropy in the system in J/K when 24.1 grams of $C_2Cl_3F_3$ vaporizes to a gas at the normal boiling point?

A) -4.19 B) 27.5 C) 4.19 D) 11.0 E) -11.0

Answer: D

39) Phosphorous and chlorine gases combine to produce phosphorous trichloride:

$$P_2\,(g) + 3Cl_2\,(g) \rightarrow 2PCl_3\,(g)$$

$\Delta G°$ at 298 K for this reaction is -642.9 kJ/mol. The value of ΔG at 298 K for a reaction mixture that consists of 1.5 atm P_2, 1.6 atm Cl_2, and 0.65 atm PCl_3 is _____.

A) -3.88×10^3 B) -7.28×10^3 C) -44.2 D) -649.5 E) -708.4

Answer: D

40) The equilibrium constant for the following reaction is 3.5×10^8 at 25 °C.

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$$

The value of $\Delta G°$ for this reaction is _____ kJ/mol.

A) -4.1 B) -22 C) 4.1 D) 22 E) -49

Answer: E