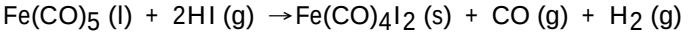
113-2 Semest General Chemistry Final Exam (C)-2025/06/04

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

1) Which element is reduced in the reaction below?

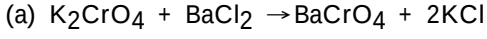


$$Fe(CO)_5\,(l) + 2HI\,(g) \rightarrow Fe(CO)_4I_2\,(s) + CO\,(g) + H_2\,(g)$$

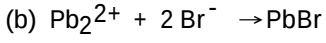
A) H B) Fe C) C D) O E) I

Answer: A

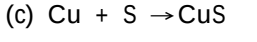
2) Which of the following reactions is a redox reaction?

(a) 

$$K_2CrO_4 + BaCl_2 \rightarrow BaCrO_4 + 2KCl$$

(b) 

$$Pb_2^{2+} + 2\,Br^- \rightarrow PbBr$$

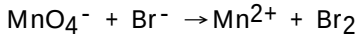
(c) 

$$Cu + S \rightarrow CuS$$

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

Answer: C

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



$$MnO_4^- + Br^- \rightarrow Mn^{2+} + Br_2$$ (acidic solution)

A) 3 B) 1 C) 2 D) 4 E) 5

Answer: C

4) The purpose of the salt bridge in an electrochemical cell is to _____.

A) provide a source of ions to react at the anode and cathode
B) maintain electrical neutrality in the half-cells via migration of ions
C) provide a means for electrons to travel from the anode to the cathode
D) provide oxygen to facilitate oxidation at the anode
E) provide a means for electrons to travel from the cathode to the anode

Answer: B

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

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

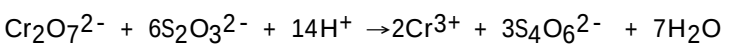
Answer: D

6) One of the differences between a voltaic cell and an electrolytic cell is that in an electrolytic cell, _____.

A) O_2 gas is produced at the cathode
B) an electric current is produced by a chemical reaction
C) oxidation occurs at the cathode
D) electrons flow toward the anode
E) a nonspontaneous reaction is forced to occur

Answer: E

7) _____ is the reducing agent in the reaction below.



$$Cr_2O_7^{2-} + 6S_2O_3^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 3S_4O_6^{2-} + 7H_2O$$

A) $S_2O_3^{2-}$ B) $S_4O_6^{2-}$ C) Cr^{3+} D) H^+ E) $Cr_2O_7^{2-}$

Answer: A

Table 20.1

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

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

A) Br_2

B) I_2

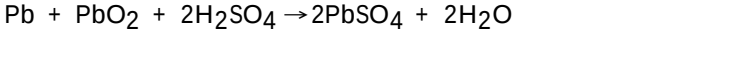
C) Cl_2

D) F_2

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

Answer: D

9) Which substance is the oxidizing agent in the reaction below?



$$Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$$

A) H_2SO_4 B) PbO_2 C) Pb D) $PbSO_4$ E) H_2O

Answer: B

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

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

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

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

Answer: C

11) A reaction that is spontaneous as written _____.
A) is very slow
B) will proceed without outside intervention
C) is also spontaneous in the reverse direction
D) is very rapid
E) has an equilibrium position that lies far to the left

Answer: B

12) Of the following, only _____ is not a state function.
A) q B) S C) T D) H E) E

Answer: A

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

Answer: E

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

Answer: C

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

Answer: C

16) 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) 432 C) 133 D) 1640 E) 1230

Answer: D

17) Given the following table of thermodynamic data,

Substance	$\Delta H_f°$ (kJ/mol)	$S°$ (J/mol · K)
$TiCl_4$ (g)	-763.2	354.9
$TiCl_4$ (l)	-804.2	221.9

complete the following sentence. The vaporization of $TiCl_4$ is _____.

A) spontaneous at all temperatures
B) spontaneous at low temperature and nonspontaneous at high temperature
C) nonspontaneous at all temperatures
D) nonspontaneous at low temperature and spontaneous at high temperature
E) not enough information given to draw a conclusion

Answer: D

18) Which one of the following processes produces a decrease in the entropy of the system?

A) evaporation of liquid ethanol into gaseous ethanol
B) mixing of two gases into one container
C) melting ice to form water
D) freezing of Fe(l) into Fe(s)
E) dissolution of LiOH(s) in water

Answer: D

Use the table below to answer the questions that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25 °C)

Substance	$\Delta H°_f$ (kJ/mol)	$\Delta G°_f$ (kJ/mol)	S (J/K-mol)
Carbon			
C (s, diamond)	1.88	2.84	2.43
C (s, graphite)	0	0	5.69
C_2H_2 (g)	226.7	209.2	200.8
C_2H_4 (g)	52.30	68.11	219.4
C_2H_6 (g)	-84.68	-32.89	229.5
CO (g)	-110.5	-137.2	197.9
CO_2 (g)	-393.5	-394.4	213.6
Hydrogen			
H_2(g)	0	0	130.58
Oxygen			
O_2 (g)	0	0	205.0
H_2O (l)	-285.83	-237.13	69.91

19) The combustion of ethene in the presence of excess oxygen yields carbon dioxide and water:

$$C_2H_4\,(g) + 3O_2\,(g) \rightarrow 2CO_2\,(g) + 2H_2O\,(l)$$

The value of $\Delta S°$ for this reaction is _____ J/K ·mol.

A) -347.6 B) +347.6 C) +140.9 D) -140.9 E) -267.4

Answer: E

20) The equilibrium constant for the following reaction is 3.0×10^8 at 25 °C.

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

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

A) -48 B) 4.1 C) -4.1 D) 22 E) -22

Answer: A

21) How many isomers are possible for C_5H_{12}?

A) 1 B) 4 C) 3 D) 2 E) 10

Answer: C

22) Benzene behaves differently from a hydrocarbon which simply contains three C=C bonds in that the latter would be expected to react much more readily with _____.

A) H_2

B) Br_2

C) Cl_2

D) HCl

E) all of the above

Answer: E

23) Which one of the following is <u>not</u> an alcohol?

A) cholesterol

B) acetone

C) ethylene glycol

D) glycerol

E) ethanol

Answer: B

24) The principal difference between fructose and glucose is that _____.

A) glucose is chiral and fructose is not

B) fructose is a disaccharide and glucose is a monosaccharide

C) fructose is a ketone sugar and glucose is an aldehyde sugar

D) fructose is a monosaccharide and glucose is a disaccharide

E) fructose is chiral and glucose is not

Answer: C

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

A) covalent bonds

B) ester bonds

C) ionic bonds

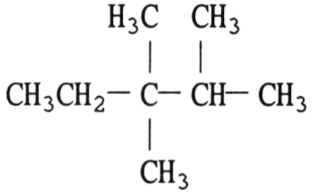
D) hydrogen bonds

E) ion-dipole bonds

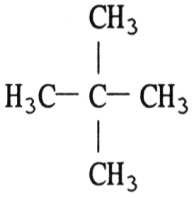
Answer: D

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

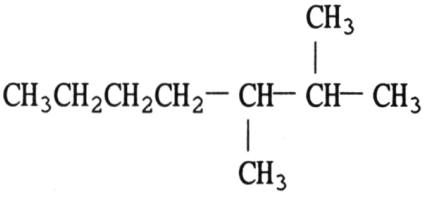
A)



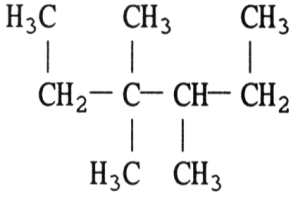
B)



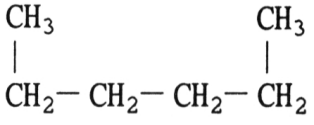
C)



D)



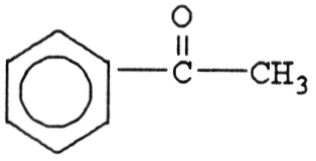
E)



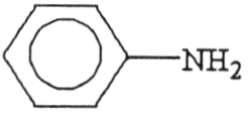
Answer: C

27) Which structure below represents an aldehyde?

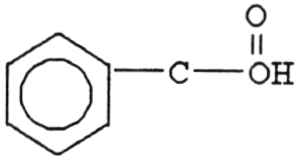
A)



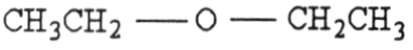
B)



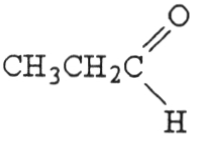
C)



D)



E)



Answer: E

28) Sugars are examples of what type of molecule?

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

Answer: A

29) Which of the following compounds does <u>not</u> contain a C=O bond?

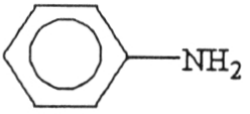
A) alcohols
B) carboxylic acids
C) esters
D) aldahydes
E) none of the above

Answer: A

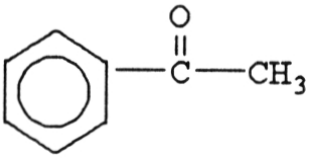
30) Which structure below represents an ether?

A)

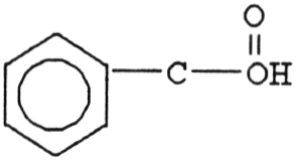
B)



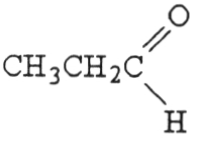
C)



D)



E)



Answer: A

31) Which one of the following species is paramagnetic?

A) Ag^+ B) Cr^{3+} C) Zn D) Ca E) Cu^+

Answer: B

32) The coordination number of cobalt in $CoCl_3 \cdot 6NH_3$ is _____.

A) 2 B) 3 C) 4 D) 6 E) 8

Answer: D

33) Which of the following complexes has a coordination number of 6?

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

B) $[Ag(NH_3)_2]^+$

C) $[Pt(NH_3)_2Cl_2]$

D) $[Co(en)_2Cl_2]^+$

E) None of these complexes has coordination number 6.

Answer: D

34) Which of the following is a polydentate ligand?
A) chloride ion
B) hydroxide ion
C) oxalate ion
D) ammonia
E) water

Answer: C

35) 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, 2 Br^-, and 1 H_2O
C) 3 NH_3
D) 3 NH_3 and 2 Br^-
E) 3 NH_3 and 1 Br^-

Answer: E

36) Isomers whose ligands can bind directly to a metal or be outside the lattice are called _____.
A) linkage isomers
B) geometric isomers
C) coordination sphere isomers
D) optical isomers
E) rotational isomers

Answer: C

37) A metal complex absorbs light mainly at 420 nm. What is the color of the complex?
A) yellow B) red C) purple D) orange E) green

Answer: A

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

Answer: E

39) Based on the crystal-field strengths $Cl^- < F^- < H_2O < NH_3 < H_2NC_2H_4NH_2$, which octahedral Ti (III) complex below has its d-d electronic transition at shortest wavelength?
A) $[Ti(H_2NC_2H_4NH_2)_3]^{3+}$
B) $[TiF_6]^{3-}$
C) $[Ti(NH_3)_6]^{3+}$
D) $[Ti(H_2O)_6]^{3+}$
E) $[TiCl_6]^{3-}$

Answer: A

40) The coordination sphere of a complex consists of _____.

A) the ligands
B) the central metal ion and the ligands bonded to it
C) coordination and steric numbers
D) the primary and secondary valencies
E) the central metal ion only

Answer: B