

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

1) For the reaction: $\text{Mg(s)} + 2 \text{AgNO}_3(\text{aq}) \rightarrow 2 \text{Ag(s)} + \text{Mg(NO}_3)_2(\text{aq})$

Write a voltaic diagram for the reaction.

- A) $\text{Mg(s)} \mid \text{Mg}^{2+} \parallel \text{Ag}^+(\text{aq}) \mid \text{Ag(s)}$
- B) $\text{Ag(s)} \mid \text{Mg}^{2+}(\text{aq}) \parallel \text{Ag}^+(\text{aq}) \mid \text{Mg(s)}$
- C) $\text{Mg(s)} \mid \text{Mg}^{2+} \parallel \text{Ag(s)} \mid \text{Ag}^+(\text{aq})$
- D) $\text{Ag(aq)} \mid \text{Ag(s)} \parallel \text{Mg(s)} \mid \text{Mg}^{2+}(\text{aq})$
- E) $\text{Ag(s)} \mid \text{Ag(aq)} \parallel \text{Mg}^{2+}(\text{aq}) \mid \text{Mg(s)}$

Answer: A

Table 20.1 Selected Standard Electrode Potentials at 25°C

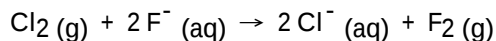
Reaction	E°, V
$\text{Mg}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Mg(s)}$	-2.356
$\text{Fe}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Fe(s)}$	-0.440
$\text{Pb}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Pb(s)}$	-0.125
$2 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow \text{H}_2(\text{g})$	0.0
$\text{Cu}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Cu(s)}$	+0.337
$\text{I}_2(\text{s}) + 2 \text{e}^- \rightarrow 2 \text{I}^-(\text{s})$	+0.535
$\text{Fe}^{3+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	+0.771
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag(s)}$	+0.800
$\text{O}_2(\text{g}) + 4 \text{H}^+(\text{aq}) + 2 \text{e}^- \rightarrow 2 \text{H}_2\text{O}$	+1.229
$\text{Cl}_2(\text{g}) + 2 \text{e}^- \rightarrow 2 \text{Cl}^-(\text{aq})$	+1.358
$\text{F}_2(\text{g}) + 2 \text{e}^- \rightarrow 2 \text{F}^-(\text{aq})$	+2.866

2) (Refer to Table 20.1) Which of the following will oxidize Pb to Pb^{2+} but not Fe^{2+} to Fe^{3+} ?

- A) Ag^+
- B) Cu^{2+}
- C) Mg^{2+}
- D) O_2
- E) Cl_2

Answer: B

3) (Refer to Table 20.1) Calculate the value of ΔG° for the following reaction, in kJ.



- A) -291
- B) +291
- C) -145
- D) 150
- E) +145

Answer: B

4) List the following in order of increasing atomic radius: V, Sc, Fe, Ti

- A) $\text{Fe} < \text{Sc} < \text{Ti} < \text{V}$
- B) $\text{V} < \text{Fe} < \text{Sc} < \text{Ti}$
- C) $\text{Sc} < \text{Ti} < \text{V} < \text{Fe}$
- D) $\text{Ti} < \text{V} < \text{Fe} < \text{Sc}$
- E) $\text{Fe} < \text{V} < \text{Ti} < \text{Sc}$

Answer: E

5) Give the correct name for $[\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2]^+$.

- A) diaquotetrahydroxoiron(III)
- B) tetrahydroxodiaquoferrate(III)
- C) hydrated iron hydroxide
- D) tetraaquadihydroxoiron(III)
- E) tetrawaterdihydroxoiron(III)

Answer: D

6) What is the cell diagram for the spontaneous cell involving the $\text{Cl}_2 \mid \text{Cl}^-$ (1.358 V) and the $\text{Sn}^{2+} \mid \text{Sn}$ (-0.137V) half cells in STP condition?

- A) $\text{Pt} \mid \text{Cl}_2(\text{g}) \mid \text{Cl}^-(\text{aq}) \parallel \text{Sn}^{2+}(\text{aq}) \mid \text{Sn}(\text{s})$
- B) $\text{Sn}(\text{s}) \mid \text{Cl}^-(\text{aq}) \parallel \text{Sn}^{2+}(\text{aq}) \mid \text{Sn}(\text{s})$
- C) $\text{Sn}(\text{s}) \mid \text{Sn}^{2+}(\text{aq}) \parallel \text{Cl}^-(\text{aq}) \mid \text{Cl}_2(\text{g}) \mid \text{Pt}$
- D) $\text{Sn}(\text{s}) \parallel \text{Sn}^{2+}(\text{aq}) \parallel \text{Cl}^-(\text{aq}) \mid \text{Cl}_2(\text{g})$
- E) $\text{Cl}_2(\text{g}) \mid \text{Cl}^-(\text{aq}) \parallel \text{Sn}^{2+}(\text{aq}) \mid \text{Sn}(\text{s})$

Answer: C

7) Write the probable electron configuration for Ti^{2+} .

- A) $[\text{Ar}]3d^2$
- B) $[\text{Ar}]5s^2$
- C) $[\text{Ar}]4s^24d^4$
- D) $[\text{Ar}]4s^13d^5$
- E) $[\text{Ar}]4s^2$

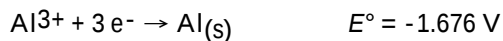
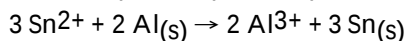
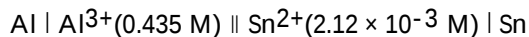
Answer: A

8) Which of the following has the largest molar entropy?

- A) $\text{H}_2(\text{g})$
- B) $\text{I}_2(\text{g})$
- C) $\text{He}(\text{g})$
- D) $\text{Xe}(\text{g})$

Answer: B

9) Determine E_{cell} at 25°C for the following reaction at 25°C:



- A) 1.227 V
- B) 1.611 V
- C) 1.487 V
- D) 1.467 V
- E) 1.562 V

Answer: D

10) The two different compounds $[\text{Cu}(\text{NH}_3)_4][\text{Fe}(\text{CN})_4(\text{H}_2\text{O})_2]$ and $[\text{Cu}(\text{CN})_4]\text{Fe}(\text{NH}_3)_4(\text{H}_2\text{O})_2$ are examples of _____.

- A) coordination isomers
- B) linkage isomers
- C) geometric isomers
- D) ionization isomers
- E) optical isomers

Answer: A

11) Which of the following ions is highest in the spectrochemical series: NO_2^- , NH_3 , Br^- , ox^{2-} , H_2O

- A) ox^{2-}
- B) H_2O
- C) NH_3
- D) Br^-
- E) NO_2^-

Answer: E

12) Choose the INCORRECT statement.

- A) Primary batteries' cell reactions cannot be reversed.
- B) Cells can be joined in series to increase the total voltage.
- C) A concentration cell consists of half cells with identical electrodes but different ion concentrations.
- D) A primary battery is recharged by passing electricity through the battery.
- E) Secondary batteries' cell reaction can be reversed.

Answer: D

13) One mole of electrons has a charge of:

- A) 96,485 C
- B) 6.02×10^{23} A
- C) 1.60×10^{-19}
- D) 96,485 A
- E) 96,485 F

Answer: A

14) A solution of AgNO_3 is electrolyzed by passing 144 A of current for 102 min. What mass of silver plates out?

- A) 5.91×10^4 g
- B) 16.4 g
- C) 6.84 g
- D) 9.13 g
- E) 985 g

Answer: E

15) Write the equation for treatment of Ag with CN^- .

- A) $4 \text{Ag}(\text{s}) + 8 \text{CN}^- + \text{O}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow 4 [\text{AgCN}]^- + 4 \text{CO}(\text{g}) + 4 \text{NH}^+$
- B) $4 \text{Ag}(\text{s}) + 8 \text{CN}^- + \text{O}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow 4 [\text{Ag}(\text{CN})_2]^- + 4 \text{OH}^-$
- C) $4 \text{Ag}(\text{s}) + 2 \text{CN}^- + \text{O}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow 4 \text{AgO}(\text{s}) + 4 \text{CO}(\text{g}) + 4 \text{NH}^-$
- D) $4 \text{Ag}(\text{s}) + 8 \text{CN}^- + \text{O}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow 4 \text{AgO}(\text{s}) + 2 \text{H}_2(\text{g}) + 2 \text{CO} + 6 \text{CN}^-$
- E) $4 \text{Ag}(\text{s}) + 8 \text{CN}^- + \text{O}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow \text{Ag}_3\text{N}(\text{s}) + 4 \text{OH}^- + \text{AgC}_8(\text{s})$

Answer: B

16) Chlorophyll is a green pigment involved in the growth of plants. One type of chlorophyll is a complex. What color of light should plants grow best in?

- A) red
- B) cyan
- C) blue
- D) yellow
- E) green

Answer: A

17) What is the correct IUPAC name for $\text{K}_3[\text{Co}(\text{NO}_2)_6]$?

- A) tripotassiumhexanitritocobalt(III)
- B) potassium hexanitritocobaltate(III)
- C) potassium hexanitratocobalt(III)
- D) tripotassiumhexanitritocobalt(0)
- E) potassium hexanitritocobalt(III)

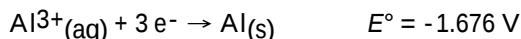
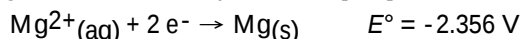
Answer: B

18) In the cation $[\text{CoCl}_2(\text{en})_2]^+$, the oxidation state of cobalt and its coordination number, respectively, are _____.

- A) +2 and six
- B) -3 and two
- C) -4 and six
- D) +4 and four
- E) +3 and six

Answer: E

19) Will magnesium metal displace Al^{3+} [1M] ion from an aqueous solution?



- A) Yes, since E°_{cell} is negative.
- B) No, since E°_{cell} is negative.
- C) Yes, since E°_{cell} is positive.
- D) No, the reverse reaction is spontaneous.
- E) No, the system is at equilibrium.

Answer: C

20) What is the approximate pH of the H^+/H_2 electrode compartment through which H_2 gas is bubbled at a pressure of 1.00 atm if this electrode, when coupled with a $\text{Ni}/(0.10 \text{ M}) \text{Ni}^{2+}$ electrode, forms a galvanic cell having an initial potential of 0.10 V? [The discharge reaction involves oxidation of nickel to Ni^{2+} . Ni^{2+}/Ni (-0.257 V)]

- A) 3.65
- B) 2.15
- C) 3.15
- D) 4.65
- E) 6.15

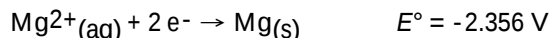
Answer: C

21) Which of the following magnetic/geometric descriptions is most likely for the $[\text{ZnCl}_4]^{2-}$ ion?

- A) diamagnetic/tetrahedral
- B) diamagnetic/octahedral
- C) paramagnetic/tetrahedral
- D) paramagnetic/square planar
- E) diamagnetic/square planar

Answer: A

22) For the reaction: $\text{Mg}(\text{s}) + \text{AgNO}_3(\text{aq}) \rightarrow \text{Ag}(\text{s}) + \text{Mg}(\text{NO}_3)_2(\text{aq})$



Determine ΔG° .

- A) 609.0 kJ/mol
- B) -300.3 kJ/mol
- C) -304.5 kJ/mol
- D) -609.0 kJ/mol
- E) 304.5 kJ/mol

Answer: D

23) $[\text{CuCl}_4]^{2-}$ absorbs light in the blue part of the visible spectrum, thereby appearing to have the color _____.

- A) yellow B) blue C) green D) purple E) cyan

Answer: A

24) Write the correct formula for tetrachloroplatinate (II) ion.

- A) $[\text{PtCl}_4]^{2-}$ B) $[\text{PtCl}_3]^- \text{Cl}^-$ C) $[\text{PtCl}_2]_4^{2+}$ D) $[\text{Pt}_4\text{Cl}]^-$ E) PtCl_3Cl

Answer: A

25) What mass of manganese dioxide (MnO_2), from pyrolusite ore, is required for production of 25 kg of potassium permanganate (KMnO_4) by a process which is 78% efficient?

- A) 32 kg B) 18 kg C) 29 kg D) 25 kg E) 14 kg

Answer: B

26) List the following in order of increasing density: Ti, Pd, Nb, Pt

- A) $\text{Ti} < \text{Pt} < \text{Pd} < \text{Nb}$
B) $\text{Ti} < \text{Nb} < \text{Pd} < \text{Pt}$
C) $\text{Nb} < \text{Ti} < \text{Pt} < \text{Pd}$
D) $\text{Pd} < \text{Nb} < \text{Ti} < \text{Pt}$
E) $\text{Pt} < \text{Pd} < \text{Nb} < \text{Ti}$

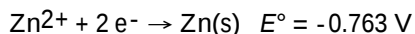
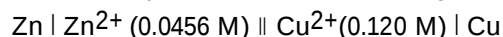
Answer: B

27) Which is most probably the ground state electron configuration for the iron(III) ion?

- A) $[\text{Ar}]4s^0 3d^5$
B) $[\text{Ar}]4s^0 3d^3 3p^3$
C) $[\text{Ar}]4s^2 3d^3$
D) $[\text{Ar}]4s^0 4p^5$
E) $[\text{Ar}]4s^1 3d^4$

Answer: A

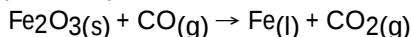
28) What is the cell potential for the following cell at 25°C?



- A) 1.094 V B) 1.115 V C) 1.129 V D) 1.088 V E) 1.106 V

Answer: B

29) The simplified equation for the reduction of iron ore is:



When it is balanced, the coefficients are _____.

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

Answer: D

30) Write the electron configuration for Fe^{2+} .

- A) $[\text{Ar}]3d^6$ B) $[\text{Ar}]4s^2 3d^4$ C) $[\text{Ar}]5s^2$ D) $[\text{Ar}]4s^2 4p^4$ E) $[\text{Ar}]4s^1 4p^1$

Answer: A

31) Choose the INCORRECT statement.

- A) Metals can be protected by cathodic protection.
- B) Cathodic protection is attaching a more active metal to the protected metal.
- C) Corrosion of metals is an oxidation reduction process.
- D) Rust is a form of corrosion.
- E) The active metal is called a sacrificial cathode.

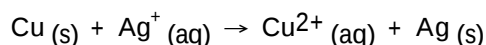
Answer: E

32) Which of the following complexes has no geometric isomers?

- A) $[\text{Co}(\text{NH}_3)_2\text{F}_4]^-$
- B) $[\text{Co}(\text{NH}_3)_4\text{F}_2]^+$
- C) $[\text{Co}(\text{NH}_3)_3\text{F}_3]$
- D) $[\text{Pt}(\text{NH}_3)_4\text{F}_2]$
- E) $[\text{Pt}(\text{NH}_3)\text{F}_5]^{-3}$

Answer: E

33) Which of the following species is reduced in the reaction shown below?



- A) $\text{H}_2\text{O (l)}$
- B) Cu (s)
- C) $\text{Ag}^+ \text{ (aq)}$
- D) Ag (s)
- E) $\text{Cu}^{2+} \text{ (aq)}$

Answer: C

34) Give the correct name for $[\text{Fe}(\text{CN})_6]^{4-}$.

- A) iron hexacyanide
- B) hexacyanoferrate(III)
- C) hexacyanide iron(II)
- D) hexayanoiron(II)
- E) hexacyanoferrate(II)

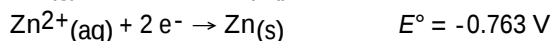
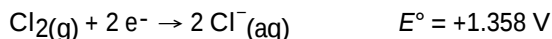
Answer: E

35) Which of the following ions is highest in the spectrochemical series: en, I^- , SCN^- , OH^- , CN^-

- A) en
- B) SCN^-
- C) I^-
- D) OH^-
- E) CN^-

Answer: E

36) For the following voltaic cell, determine the $[\text{Cl}^-]$ when $P_{\text{Cl}_2} = 0.500 \text{ atm}$, $[\text{Zn}^{2+}] = 1.77 \times 10^{-2} \text{ M}$, and $E_{\text{cell}} = 2.250 \text{ V}$. The half-reactions at 25°C are:



- A) 0.0939 M
- B) $2.32 \times 10^{-3} \text{ M}$
- C) $5.48 \times 10^{-6} \text{ M}$
- D) 0.0352 M
- E) 0.0296 M

Answer: D

37) Which two of the following half-reactions will combine to give the galvanic cell with the highest cell potential?

- 1) $2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$ $E^\circ = 0$
- 2) $\text{Pb}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Pb}(\text{s})$ $E^\circ = -0.125\text{ V}$
- 3) $\text{I}_2(\text{s}) + 2\text{e}^- \rightarrow 2\text{I}^-(\text{aq})$ $E^\circ = +0.535\text{ V}$
- 4) $\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$ $E^\circ = -0.763\text{ V}$

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

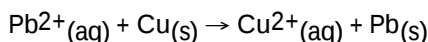
Answer: C

38) A compound has the empirical formula $\text{CoCl}_3 \cdot 5\text{NH}_3$. One mole of it yields two moles of silver chloride when treated with silver nitrate. Ammonia is not removed by treatment with concentrated sulfuric acid. A reasonable formula for the compound is _____.

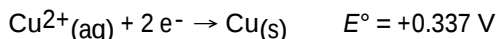
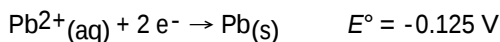
- A) $[\text{Co}(\text{NH}_3)_5]\text{Cl}_3$
- B) $\text{CoCl}_3 \cdot 5\text{NH}_3$
- C) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$
- D) $[\text{Co}(\text{NH}_3)_4\text{Cl}]\text{Cl}_2 \cdot \text{NH}_3$
- E) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl} \cdot \text{NH}_3$

Answer: C

39) Determine E°_{cell} at 25°C for the following reaction:



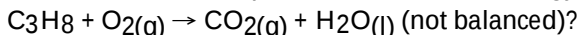
The half-reactions are:



- A) 0.462 V B) -0.462 V C) -0.212 V D) 0.424 V E) 0.212 V

Answer: B

40) What is the standard cell potential if the Gibbs energy is -2108 kJ in the reaction:



- A) 1.092 V B) -1.092 V C) 21.85 V D) 10.92 V E) -10.92 V

Answer: A

41) Ligands approaching in a tetrahedral pattern cause some orbitals to be raised in energy. How many orbitals are on the lower energy level?

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

Answer: B

42) Choose the correct shape, weak or strong field, and number of unpaired electrons for $[\text{Co}(\text{ox})_3]^{4-}$.

- A) tetrahedral, strong, 3
- B) octahedral, strong, 5
- C) square planar, strong, 3
- D) tetrahedral, weak, 3
- E) octahedral, weak, 3

Answer: E

- 43) Of the following complex ions: $[\text{CoCl}(\text{NH}_3)_5]^{2+}$, $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Co}(\text{en})_3]^{3+}$, $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$, one appears pink, two are yellow, and one blue. Which is blue?
- A) both $[\text{Co}(\text{en})_3]^{3+}$ and $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
 - B) $[\text{Co}(\text{NH}_3)_6]^{3+}$
 - C) $[\text{Co}(\text{en})_3]^{3+}$
 - D) $[\text{CoCl}(\text{NH}_3)_5]^{2+}$
 - E) $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$

Answer: E

- 44) The correct name for $[\text{Ag}(\text{NH}_3)_2]^+$ is _____.

- A) silver ammoniate
- B) silver amide
- C) silver nitride
- D) silver(I) diammine ion
- E) diamminesilver(I)ion

Answer: E

- 45) $[\text{Fe}(\text{CN})_6]^{4-}$ has how many unpaired electrons?

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

Answer: D

- 46) The net formation constant for tetraamminezinc(II) is 4.1×10^8 . What would be the approximate potential of the galvanic cell symbolized below?



- A) 1.02 V
- B) 0.76 V
- C) 0.00 V
- D) 0.51 V
- E) 0.25 V

Answer: E

- 47) In the group of elements Cr, Ni, Sn, Pt, Ti, the one which is a main group element is _____.

- A) Sn
- B) Ni
- C) Ti
- D) Cr
- E) Pt

Answer: A

- 48) Which complex ion possesses the largest number of unpaired electrons?

- A) $\text{Cr}(\text{NH}_3)_6^{2+}$
- B) $\text{Fe}(\text{H}_2\text{O})_6^{3+}$
- C) $\text{Cu}(\text{NH}_3)_4^{2+}$
- D) CoCl_4^{2-}
- E) $\text{Mn}(\text{CN})_6^{4-}$

Answer: B

- 49) What is the free Ag^+ concentration of 0.020 M Ag^+ solution mixed with an equal volume of 2.0 M NH_3 ? K_f for $[\text{Ag}(\text{NH}_3)_2]^+$ is 1.6×10^7 .

- A) 2.0×10^{-14}
- B) 3.1×10^{-10}
- C) 6.5×10^{-10}
- D) 6.3×10^{-8}
- E) 1.3×10^{-10}

Answer: C

- 50) When 100 mL each of 2.0×10^{-4} M Ca^{2+} and 2.0×10^{-2} M F^{-} are mixed, what is the remaining Ca^{2+} ion concentration and is precipitation complete? The solubility product constant of CaF_2 is 5.3×10^{-9} .
- A) 5.4×10^{-5} , no
 - B) 5.6×10^{-4} , no
 - C) 1.7×10^{-6} , yes
 - D) 4.3×10^{-7} , no
 - E) 1.7×10^{-8} , yes

Answer: A