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

1) The gain of electrons by an element is called _____. 1) _____

A) oxidation
B) reduction
C) sublimation
D) fractionation
E) disproportionation

2) _____ is reduced in the following reaction: 2) _____

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

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

3) _____ is the oxidizing agent in the reaction below. 3) _____

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

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

4) Which substance is serving as the reducing agent in the following reaction? 4) _____

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

A) H_2O B) Ni C) $Cr_2O_7^{2-}$ D) Ni^{2+} E) H^+

5) Which substance is the reducing agent in the reaction below? 5) _____

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

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

6) What is the oxidation number of chromium in $Cr_2O_7^{2-}$ ion ? 6) _____

A) +12 B) +14 C) +6 D) +3 E) +7

7) What is the oxidation number of potassium in $KMnO_4$? 7) _____

A) +3 B) 0 C) +1 D) –1 E) +2

8) What is the oxidation number of manganese in the MnO_4^{1-} ion? 8) _____

A) +4 B) +2 C) +7 D) +1 E) +5

9) What is the oxidation number of manganese in MnO_2? 9) _____

A) +2 B) +7 C) +1 D) +4 E) +3

10) _____ electrons appear in the following half–reaction when it is balanced. 10) _____

$$S_4O_6^{2-} \rightarrow 2S_2O_3^{2-}$$

A) 2 B) 4 C) 6 D) 3 E) 1

11) The balanced half–reaction in which chlorine gas is reduced to the aqueous chloride ion is a _____ process. 11) _____

A) two–electron

B) six–electron

C) four–electron

D) one–electron

E) three–electron

12) The balanced half–reaction in which dichromate ion is reduced to chromium metal is a _____ process. 12) _____

A) two–electron

B) six–electron

C) twelve–electron

D) four–electron

E) three–electron

13) The balanced half–reaction in which dichromate ion is reduced to chromium(III) ion is a _____ process. 13) _____

A) three–electron

B) six–electron

C) twelve–electron

D) two–electron

E) four–electron

14) The balanced half–reaction in which sulfate ion is reduced to sulfite ion is a _____ process. 14) _____

A) six–electron

B) one–electron

C) four–electron

D) two–electron

E) three–electron

15) The electrode at which oxidation occurs is called the _____ . 15) _____

A) cathode

B) oxidizing agent

C) reducing agent

D) voltaic cell

E) anode

16) The half–reaction occurring at the anode in the balanced reaction shown below is _____. 16) _____

$$3MnO_4^-\,(aq) + 24H^+\,(aq) + 5Fe\,(s) \rightarrow 3Mn^{2+}\,(aq) + 5Fe^{3+}\,(aq) + 12H_2O\,(l)$$

A) $2MnO_4^-\,(aq) + 12H^+\,(aq) + 6e^- \rightarrow 2Mn^{2+}\,(aq) + 3H_2O\,(l)$

B) $MnO_4^-\,(aq) + 8H^+\,(aq) + 5e^- \rightarrow Mn^{2+}\,(aq) + 4H_2O\,(l)$

C) $Fe\,(s) \rightarrow Fe^{3+}\,(aq) + 3e^-$

D) $Fe^{2+}\,(aq) \rightarrow Fe^{3+}\,(aq) + e^-$

E) $Fe\,(s) \rightarrow Fe^{2+}\,(aq) + 2e^-$

17) In a voltaic cell, electrons flow from the _____ to the _____. 17) _____

A) cathode, anode

B) salt bride, anode

C) anode, cathode

D) anode, salt bridge

E) salt bridge, cathode

18) The reduction half reaction occurring in the standard hydrogen electrode is _____. 18) _____

A) $2H^+\,(aq) + 2OH^- \rightarrow H_2O\,(l)$

B) $O_2\,(g) + 4H^+\,(aq) + 4e^- \rightarrow 2H_2O\,(l)$

C) $2H^+\,(aq, 1M) + Cl_2\,(aq) \rightarrow 2HCl\,(aq)$

D) $H_2\,(g, 1\ atm) \rightarrow 2H^+\,(aq, 1M) + 2e^-$

E) $2H^+\,(aq, 1M) + 2e^- \rightarrow H_2\,(g, 1\ atm)$

19) 1V = _____. 19) _____

A) 1 J/s B) 96485 C C) 1 J/C D) 1 amp • s E) 1 C/J

20) The more _____ the value of $E°_{red}$, the greater the driving force for reduction. 20) _____

A) exothermic

B) extensive

C) endothermic

D) negative

E) positive

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

21) The standard cell potential ($E°_{cell}$) for the voltaic cell based on the reaction below is _____ V. 21) _____

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

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

22) The standard cell potential ($E°_{cell}$) for the voltaic cell based on the reaction below is _____ V. 22) _____

$$Cr\ (s) + 3Fe^{3+}\ (aq) \rightarrow 3Fe^{2+}\ (aq) + Cr^{3+}\ (aq)$$

A) +1.57 B) –1.45 C) +1.51 D) +3.05 E) +2.99

23) The standard cell potential ($E°_{cell}$) for the voltaic cell based on the reaction below is _____ V. 23) _____

$$2Cr\ (s) + 3Fe^{2+}\ (aq) \rightarrow 3Fe\ (s) + 2Cr^{3+}\ (aq)$$

A) –0.16 B) +3.10 C) +0.83 D) +2.80 E) +0.30

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

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

A) +1.94 B) –0.59 C) +0.89 D) –1.02 E) +2.53

25) The relationship between the change in Gibbs free energy and the emf of an electrochemical cell is given by _____. 25) _____

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

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

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

D) $\Delta G = -nFE$

E) $\Delta G = -nRTF$

26) The standard cell potential ($E°_{cell}$) of the reaction below is +0.126 V. The value of $\Delta G°$ for the reaction is _____ kJ/mol. 26) _____

$$Pb\ (s) + 2H^+\ (aq) \rightarrow Pb^{2+}\ (aq) + H_2\ (g)$$

A) −24 B) +24 C) −12 D) +12 E) −50

27) The standard cell potential ($E°_{cell}$) for the reaction below is +0.63 V. The cell potential for this reaction is _____ V when [Zn^{2+}] = 1.0 M and [Pb^{2+}] = 2.0×10^{-4} M. 27) _____

$$Pb^{2+}\ (aq) + Zn\ (s) \rightarrow Zn^{2+}\ (aq) + Pb\ (s)$$

A) 0.74 B) 0.41 C) 0.85 D) 0.63 E) 0.52

28) The standard cell potential ($E°_{cell}$) for the reaction below is +1.10 V. The cell potential for this reaction is _____ V when the concentration of [Cu^{2+}] = 1.0×10^{-5} M and [Zn^{2+}] = 1.0 M. 28) _____

$$Zn\ (s) + Cu^{2+}\ (aq) \rightarrow Cu\ (s) + Zn^{2+}\ (aq)$$

A) 0.95 B) 1.25 C) 1.10 D) 0.80 E) 1.40

29) The lead–containing reactant(s) consumed during recharging of a lead–acid battery is/are _____. 29) _____

A) PbO_2 (s) only

B) Pb (s) only

C) $PbSO_4$ (s) only

D) both PbO_2 (s) and $PbSO_4$ (s)

E) both Pb (s) and PbO_2 (s)

30) Galvanized iron is iron coated with _____. 30) _____

A) zinc.

B) chromium.

C) phosphate.

D) magnesium.

E) iron oxide.

31) Corrosion of iron is retarded by _____. 31) _____

A) the presence of salts

B) low pH conditions

C) high pH conditions

D) both the presence of salts and high pH conditions

E) both the presence of salts and low pH conditions

32) How many minutes will it take to plate out 2.19 g of chromium metal from a solution of Cr^{3+} using a current of 35.2 amps in an electrolyte cell _____ ? 32) _____

A) 17.3 B) 115 C) 346 D) 1.92 E) 5.77

33) What current (in A) is required to plate out 1.22 g of nickel from a solution of Ni^{2+} in 1.0 hour _____ ? 33) _____

A) 65.4 B) 2.34 C) 1.11 D) 12.9 E) 4.01×10^3

34) How many grams of Ca metal are produced by the electrolysis of molten $CaBr_2$ using a current of 30.0 amp for 10.0 hours _____ ? 34) _____

A) 22.4 B) 448 C) 0.0622 D) 112 E) 224

35) How many grams of CuS are obtained by passing a current of 12 A through a solution of $CuSO_4$ for 15 minutes _____ ? 35) _____

A) 3.6 B) 7.1 C) 14 D) 1.8 E) 0.016

36) How many seconds are required to produce 1.0 g of silver metal by the electrolysis of a $AgNO_3$ solution using a current of 30 amps _____ ? 36) _____

A) 3.7×10^{-5} B) 60 C) 3.2×10^3 D) 30 E) 2.7×10^4

37) How many grams of copper will be plated out by a current of 2.3 A applied for 25 minutes to a 0.50–M solution of copper(II) sulfate _____ ? 37) _____

A) 0.019 B) 2.2 C) 0.036 D) 1.1 E) 1.8×10^{-2}

1) B
2) D
3) C
4) B
5) D
6) C
7) C
8) C
9) D
10) A
11) A
12) C
13) B
14) D
15) E
16) C
17) C
18) E
19) C
20) E
21) A
22) C
23) E
24) C
25) D
26) A
27) E
28) A
29) C
30) A
31) C
32) E
33) C
34) E
35) A
36) D
37) D