

4.1 Multiple-Choice and Bimodal Questions

1) The total concentration of ions in a 0.250 M solution of HCl is _____.

- A) essentially zero.
- B) 0.125 M
- C) 0.250 M
- D) 0.500 M
- E) 0.750 M

Answer: D

Diff: 1

Page Ref: Sec. 4.1

2) A strong electrolyte is one that _____ completely in solution.

- A) reacts
- B) associates
- C) disappears
- D) ionizes

Answer: D

Diff: 2

Page Ref: Sec. 4.1

3) A weak electrolyte exists predominantly as _____ in solution.

- A) atoms
- B) ions
- C) molecules
- D) electrons
- E) an isotope

Answer: C

Diff: 2

Page Ref: Sec. 4.1

4) Which of the following are strong electrolytes?

HCl

$\text{HC}_2\text{H}_3\text{O}_2$

NH_3

KCl

A) HCl, KCl

B) HCl, NH_3 , KCl

C) HCl, $\text{HC}_2\text{H}_3\text{O}_2$, NH_3 , KCl

D) HCl, $\text{HC}_2\text{H}_3\text{O}_2$, KCl

E) $\text{HC}_2\text{H}_3\text{O}_2$, KCl

Answer: A

Diff: 2

Page Ref: Sec. 4.1

5) Which of the following are weak electrolytes?

HCl

$\text{HC}_2\text{H}_3\text{O}_2$

NH_3

KCl

A) HCl , KCl

B) HCl , $\text{HC}_2\text{H}_3\text{O}_2$, NH_3 , KCl

C) $\text{HC}_2\text{H}_3\text{O}_2$, KCl

D) $\text{HC}_2\text{H}_3\text{O}_2$, NH_3

E) HCl , $\text{HC}_2\text{H}_3\text{O}_2$, KCl

Answer: D

Diff: 2

Page Ref: Sec. 4.1

6) What are the spectator ions in the reaction between KOH (aq) and HNO₃(aq)?

- A) K⁺ and H⁺
- B) H⁺ and OH⁻
- C) K⁺ and NO₃⁻
- D) H⁺ and NO₃⁻
- E) OH⁻ only

Answer: C

Diff: 2

Page Ref: Sec. 4.2

7) The net ionic equation for the reaction between aqueous solutions of HF and KOH is _____.

- A) $\text{HF} + \text{KOH} \rightarrow \text{H}_2\text{O} + \text{K}^+ + \text{F}^-$
- B) $\text{HF} + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{F}^-$
- C) $\text{HF} + \text{K}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{KF}$
- D) $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$
- E) $\text{H}^+ + \text{F}^- + \text{K}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{K}^+ + \text{F}^-$

Answer: B

Diff: 2

Page Ref: Sec. 4.2

8) Combining aqueous solutions of BaI₂ and Na₂SO₄ affords a precipitate of BaSO₄. Which ion(s) is/are spectator ions in the reaction?

- A) Ba²⁺ only
- B) Na⁺ only
- C) Ba²⁺ and SO₄²⁻
- D) Na⁺ and I⁻
- E) SO₄²⁻ and I⁻

Answer: D

Diff: 2

Page Ref: Sec. 4.2

9) Which ion(s) is/are spectator ions in the formation of a precipitate of AgCl via combining aqueous solutions of CoCl_2 and AgNO_3 ?

- A) Co^{2+} and NO_3^-
- B) NO_3^- and Cl^-
- C) Co^{2+} and Ag^+
- D) Cl^-
- E) NO_3^-

Answer: A

Diff: 2

Page Ref: Sec. 4.2

10) The balanced net ionic equation for precipitation of CaCO_3 when aqueous solutions of Na_2CO_3 and CaCl_2 are mixed is _____.

- A) $2\text{Na}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{Na}_2\text{CO}_3(\text{aq})$
- B) $2\text{Na}^+(\text{aq}) + 2\text{Cl}^-(\text{aq}) \rightarrow 2\text{NaCl}(\text{aq})$
- C) $\text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{NaCl}(\text{aq})$
- D) $\text{Ca}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{CaCO}_3(\text{s})$
- E) $\text{Na}_2\text{CO}_3(\text{aq}) + \text{CaCl}_2(\text{aq}) \rightarrow 2\text{NaCl}(\text{aq}) + \text{CaCO}_3(\text{s})$

Answer: D

Diff: 3

Page Ref: Sec. 4.2

11) When aqueous solutions of AgNO_3 and KI are mixed, AgI precipitates. The balanced net ionic equation is _____.

- A) $\text{Ag}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{AgI}(\text{s})$
- B) $\text{Ag}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{AgNO}_3(\text{s})$
- C) $\text{Ag}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{AgNO}_3(\text{aq})$
- D) $\text{AgNO}_3(\text{aq}) + \text{KI}(\text{aq}) \rightarrow \text{AgI}(\text{s}) + \text{KNO}_3(\text{aq})$
- E) $\text{AgNO}_3(\text{aq}) + \text{KI}(\text{aq}) \rightarrow \text{AgI}(\text{aq}) + \text{KNO}_3(\text{s})$

Answer: A

Diff: 3

Page Ref: Sec. 4.2

12) When H_2SO_4 is neutralized by NaOH in aqueous solution, the net ionic equation is _____.

- A) $\text{SO}_4^{2-}(\text{aq}) + 2\text{Na}^+(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq})$
- B) $\text{SO}_4^{2-}(\text{aq}) + 2\text{Na}^+(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{s})$
- C) $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
- D) $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{SO}_4^{2-}(\text{aq})$
- E) $2\text{H}^+(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + 2\text{Na}^+(\text{aq})$

Answer: C

Diff: 2

Page Ref: Sec. 4.2

13) The spectator ions in the reaction between aqueous perchloric acid and aqueous barium hydroxide are _____.

- A) OH^- and ClO_4^-
- B) H^+ , OH^- , ClO_4^- , and Ba^{2+}
- C) H^+ and OH^-
- D) H^+ and Ba^{2+}
- E) ClO_4^- and Ba^{2+}

Answer: E

Diff: 3

Page Ref: Sec. 4.2

14) The spectator ions in the reaction between aqueous hydrofluoric acid and aqueous barium hydroxide are _____.

- A) OH^- , F^- , and Ba^{2+}
- B) F^- and Ba^{2+}
- C) OH^- and F^-
- D) Ba^{2+} only
- E) H^+ , OH^- , F^- , and Ba^{2+}

Answer: D

Diff: 2

Page Ref: Sec. 4.2

15) The spectator ions in the reaction between aqueous hydrochloric acid and aqueous ammonia are _____.

- A) H^+ and NH_3
- B) H^+ , Cl^- , NH_3 and NH_4
- C) Cl^- and NH_4^+
- D) H^+ , Cl^- and NH_4^+
- E) Cl^- only

Answer: E

Diff: 2

Page Ref: Sec. 4.2

16) Which of the following are strong acids?

HI

HNO_3

HF

HBr

- A) HF, HBr
- B) HI, HNO_3 , HF, HBr
- C) HI, HF, HBr
- D) HNO_3 , HF, HBr
- E) HI, HNO_3 , HBr

Answer: E

Diff: 3

Page Ref: Sec. 4.3

17) Which hydroxides are strong bases?

Sr (OH)₂

KOH

NaOH

Ba(OH)₂

A) KOH, Ba(OH)₂

B) KOH, NaOH

C) KOH, NaOH, Ba(OH)₂

D) Sr (OH)₂, KOH, NaOH, Ba(OH)₂

E) None of these is a strong base.

Answer: D

Diff: 2

Page Ref: Sec. 4.3

18) A neutralization reaction between an acid and a metal hydroxide produces

_____.

A) water and a salt

B) hydrogen gas

C) oxygen gas

D) sodium hydroxide

E) ammonia

Answer: A

Diff: 2

Page Ref: Sec. 4.3

19) Of the metals below, only _____ will not dissolve in an aqueous solution containing nickel ions.

- aluminum
- chromium
- barium
- tin
- potassium
- A) aluminum
- B) chromium
- C) barium
- D) tin
- E) potassium

Answer: D

Diff: 4

Page Ref: Sec. 4.4

20) Which of these metals is the least easily oxidized?

- Na
- Au
- Fe
- Ca
- Ag
- A) Na
- B) Au
- C) Fe
- D) Ca
- E) Ag

Answer: B

Diff: 3

Page Ref: Sec. 4.4

21) Of the following elements, _____ is the only one that cannot be found in nature in its elemental form.

Cu
Hg
Au
Ag
Na

- A) Cu
- B) Hg
- C) Au
- D) Ag
- E) Na

Answer: E

Diff: 2

Page Ref: Sec. 4.4

22) Of the following elements, _____ is the most easily oxidized.

oxygen
fluorine
nitrogen
aluminum
gold

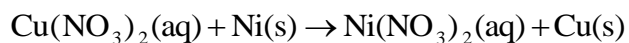
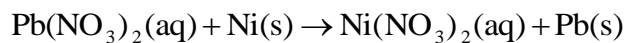
- A) oxygen
- B) fluorine
- C) nitrogen
- D) aluminum
- E) gold

Answer: D

Diff: 3

Page Ref: Sec. 4.4

23) Based on the equations below, which metal is the most active?



- A) Ni
- B) Ag
- C) Cu
- D) Pb
- E) N

Answer: A

Diff: 3

Page Ref: Sec. 4.4

24) When gold dissolves in aqua regia, what is reduced?



- A) H^+
- B) N^{+5}
- C) Cl^-
- D) H_2O
- E) Au

Answer: B

Diff: 4

Page Ref: Sec. 4.5

25) What is the concentration (M) of KCl in a solution made by mixing 25.0 mL of 0.100 M KCl with 50.0 mL of 0.100 M KCl?

- A) 0.100
- B) 0.0500
- C) 0.0333
- D) 0.0250
- E) 125

Answer: A

Diff: 3

Page Ref: Sec. 4.5

26) What is the concentration (M) of CH_3OH in a solution prepared by dissolving 11.7 g of CH_3OH in sufficient water to give exactly 230 mL of solution?

- A) 11.9
- B) 1.59×10^{-3}
- C) 0.0841
- D) 1.59
- E) 11.9×10^{-3}

Answer: D

Diff: 3

Page Ref: Sec. 4.5

27) How many grams of H_3PO_4 are in 175 mL of a 3.5 M solution of H_3PO_4 ?

- A) 0.61
- B) 60
- C) 20
- D) 4.9
- E) 612

Answer: B

Diff: 3

Page Ref: Sec. 4.5

28) What is the concentration (M) of a NaCl solution prepared by dissolving 9.3 g of NaCl in sufficient water to give 350 mL of solution?

- A) 18
- B) 0.16
- C) 0.45
- D) 27
- E) 2.7×10^{-2}

Answer: C

Diff: 3

Page Ref: Sec. 4.5

29) How many grams of NaOH (MW = 40.0) are there in 500.0 mL of a 0.175 M NaOH solution?

- A) 2.19×10^{-3}
- B) 114
- C) 14.0
- D) 3.50
- E) 3.50×10^3

Answer: D

Diff: 3

Page Ref: Sec. 4.5

30) How many grams of CH_3OH must be added to water to prepare 150 mL of a solution that is 2.0 M CH_3OH ?

- A) 9.6×10^3
- B) 4.3×10^2
- C) 2.4
- D) 9.6
- E) 4.3

Answer: D

Diff: 3

Page Ref: Sec. 4.5

31) There are _____ mol of bromide ions in 0.500 L of a 0.300 M solution of AlBr_3 .

- A) 0.150
- B) 0.0500
- C) 0.450
- D) 0.167
- E) 0.500

Answer: C

Diff: 3

Page Ref: Sec. 4.5

32) How many moles of CO^{2+} are present in 0.200 L of a 0.400 M solution of CoI_2 ?

- A) 2.00
- B) 0.500
- C) 0.160
- D) 0.0800
- E) 0.0400

Answer: D

Diff: 3

Page Ref: Sec. 4.5

33) How many moles of K^+ are present in 343 mL of a 1.27 M solution of K_3PO_4 ?

- A) 0.436
- B) 1.31
- C) 0.145
- D) 3.70
- E) 11.1

Answer: B

Diff: 3

Page Ref: Sec. 4.5

34) What are the respective concentrations (M) of Na^+ and SO_4^{2-} afforded by dissolving 0.500 mol Na_2SO_4 in water and diluting to 1.33 L?

- A) 0.665 and 0.665
- B) 0.665 and 1.33
- C) 1.33 and 0.665
- D) 0.376 and 0.752
- E) 0.752 and 0.376

Answer: E

Diff: 4

Page Ref: Sec. 4.5

35) Calculate the concentration (M) of sodium ions in a solution made by diluting 50.0 mL of a 0.874 M solution of sodium sulfide to a total volume of 250.0 mL.

- A) 0.175
- B) 4.37
- C) 0.525
- D) 0.350
- E) 0.874

Answer: D

Diff: 2

Page Ref: Sec. 4.5

36) An aqueous ethanol solution (400 mL) was diluted to 4.00 L, giving a concentration of 0.0400 M. The concentration of the original solution was _____ M.

- A) 0.400
- B) 0.200
- C) 2.00
- D) 1.60
- E) 4.00

Answer: A

Diff: 3

Page Ref: Sec. 4.5

37) The concentration (M) of an aqueous methanol produced when 0.200 L of a 2.00 M solution was diluted to 0.800 L is _____.

- A) 0.800
- B) 0.200
- C) 0.500
- D) 0.400
- E) 8.00

Answer: C

Diff: 2

Page Ref: Sec. 4.5

38) The molarity (M) of an aqueous solution containing 22.5 g of sucrose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) in 35.5 mL of solution is _____.

- A) 0.0657
- B) 1.85×10^{-3}
- C) 1.85
- D) 3.52
- E) 0.104

Answer: C

Diff: 3

Page Ref: Sec. 4.5

39) The molarity (M) of an aqueous solution containing 52.5 g of sucrose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) in 35.5 mL of solution is _____.

- A) 5.46
- B) 1.48
- C) 0.104
- D) 4.32
- E) 1.85

Answer: D

Diff: 3

Page Ref: Sec. 4.5

40) The molarity (M) of an aqueous solution containing 22.5 g of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) in 35.5 mL of solution is _____.

- A) 3.52
- B) 0.634
- C) 0.197
- D) 0.125
- E) 1.85

Answer: A

Diff: 3

Page Ref: Sec. 4.5

41) The molarity of an aqueous solution containing 75.3 g of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) in 35.5 mL of solution is _____.

- A) 1.85
- B) 2.12
- C) 0.197
- D) 3.52
- E) 11.8

Answer: E

Diff: 3

Page Ref: Sec. 4.5

42) How many grams of sodium chloride are there in 55.0 mL of a 1.90 M aqueous solution of sodium chloride?

- A) 0.105
- B) 6.11
- C) 3.21
- D) 6.11×10^3
- E) 12.2

Answer: B

Diff: 3

Page Ref: Sec. 4.5

43) How many grams of sodium chloride are there in 550.0 mL of a 1.90 M aqueous solution of sodium chloride?

- A) 61.1
- B) 1.05
- C) 30.5
- D) 6.11×10^4
- E) 122

Answer: A

Diff: 3

Page Ref: Sec. 4.5

44) The molarity of a solution prepared by diluting 43.72 mL of 1.005 M aqueous $K_2Cr_2O_7$ to 500. mL is _____.

- A) 0.0879
- B) 87.9
- C) 0.0218
- D) 0.0115
- E) 0.870

Answer: A

Diff: 2

Page Ref: Sec. 4.5

45) The molarity of a solution prepared by diluting 43.72 mL of 5.005 M aqueous $K_2Cr_2O_7$ to 500. mL is _____.

- A) 57.2
- B) 0.0044
- C) 0.438
- D) 0.0879
- E) 0.870

Answer: C

Diff: 2

Page Ref: Sec. 4.5

46) The concentration of chloride ions in a 0.193 M solution of potassium chloride is _____.

- A) 0.0643 M
- B) 0.386 M
- C) 0.0965 M
- D) 0.579 M
- E) 0.193 M

Answer: E

Diff: 2

Page Ref: Sec. 4.5

47) The concentration of iodide ions in a 0.193 M solution of barium iodide is _____.

- A) 0.193 M
- B) 0.386 M
- C) 0.0965 M
- D) 0.579 M
- E) 0.0643 M

Answer: B

Diff: 3

Page Ref: Sec. 4.5

48) The concentration of species in 500 mL of a 2.104 M solution of sodium sulfate is _____ M sodium ion and _____ M sulfate ion.

- A) 2.104, 1.052
- B) 2.104, 2.104
- C) 2.104, 4.208
- D) 1.052, 1.052
- E) 4.208, 2.104

Answer: E

Diff: 3

Page Ref: Sec. 4.5

49) When 0.500 mol of $\text{HC}_2\text{H}_3\text{O}_2$ is combined with enough water to make a 300.0 mL solution, the concentration of $\text{HC}_2\text{H}_3\text{O}_2$ is _____ M.

- A) 3.33
- B) 1.67
- C) 0.835
- D) 0.00167
- E) 0.150

Answer: B

Diff: 3

Page Ref: Sec. 4.5

50) In a titration of 35.00 mL of 0.737 M H_2SO_4 , _____ mL of a 0.827 M KOH solution is required for neutralization.

- A) 35.0
- B) 1.12
- C) 25.8
- D) 62.4
- E) 39.3

Answer: D

Diff: 3

Page Ref: Sec. 4.6

51) Oxalic acid is a diprotic acid. Calculate the percent of oxalic acid ($\text{H}_2\text{C}_2\text{O}_4$) in a solid given that a 0.7984 g sample of that solid required 37.98 mL of 0.2283 M NaOH for neutralization.

- A) 48.89
- B) 97.78
- C) 28.59
- D) 1.086
- E) 22.83

Answer: A

Diff: 5

Page Ref: Sec. 4.6

52) A 17.5 mL sample of an acetic acid ($\text{CH}_3\text{CO}_2\text{H}$) solution required 29.6 mL of 0.250 M NaOH for neutralization. The concentration of acetic acid was _____ M.

- A) 0.158
- B) 0.423
- C) 134
- D) 6.88
- E) 0.214

Answer: B

Diff: 3

Page Ref: Sec. 4.6

53) A 25.5 mL aliquot of HCl (aq) of unknown concentration was titrated with 0.113 M NaOH (aq). It took 51.2 mL of the base to reach the endpoint of the titration. The concentration (M) of the acid was _____.

- A) 1.02
- B) 0.114
- C) 0.454
- D) 0.113
- E) 0.227

Answer: E

Diff: 4

Page Ref: Sec. 4.6

54) A 31.5 mL aliquot of $\text{HNO}_3(\text{aq})$ of unknown concentration was titrated with 0.0134 M $\text{NaOH}(\text{aq})$. It took 23.9 mL of the base to reach the endpoint of the titration. The concentration (M) of the acid was _____.

- A) 0.0102
- B) 0.0051
- C) 0.0204
- D) 0.227
- E) 1.02

Answer: A

Diff: 4

Page Ref: Sec. 4.6

55) A 31.5 mL aliquot of $\text{H}_2\text{SO}_4(\text{aq})$ of unknown concentration was titrated with 0.0134 M $\text{NaOH}(\text{aq})$. It took 23.9 mL of the base to reach the endpoint of the titration. The concentration (M) of the acid was _____.

- A) 0.0102
- B) 0.00508
- C) 0.0204
- D) 0.102
- E) 0.227

Answer: B

Diff: 4

Page Ref: Sec. 4.6

4.2 Multiple Choice Questions

1) Of the species below, only _____ is not an electrolyte.

- A) HCl
- B) Rb_2SO_4
- C) Ar
- D) KOH
- E) NaCl

Answer: C

Diff: 1

Page Ref: Sec. 4.1

2) The balanced molecular equation for complete neutralization of H_2SO_4 by KOH in aqueous solution is _____.

- A) $2\text{H}^+(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l})$
- B) $2\text{H}^+(\text{aq}) + 2\text{KOH}(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + 2\text{K}^+(\text{aq})$
- C) $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{SO}_4^{2-}(\text{aq})$
- D) $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{KOH}(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{K}_2\text{SO}_4(\text{s})$
- E) $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{KOH}(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{K}_2\text{SO}_4(\text{aq})$

Answer: E

Diff: 1

Page Ref: Sec. 4.2

3) Aqueous potassium chloride will react with which one of the following in an exchange (metathesis) reaction?

- A) calcium nitrate
- B) sodium bromide
- C) lead nitrate
- D) barium nitrate
- E) sodium chloride

Answer: C

Diff: 2

Page Ref: Sec. 4.2

4) Aqueous solutions of a compound did not form precipitates with Cl^- , Br^- , I^- , SO_4^{2-} , CO_3^{2-} , PO_4^{3-} , OH^- , or S^{2-} . This highly water-soluble compound produced the foul-smelling gas H_2S when the solution was acidified. This compound is _____.

- A) $\text{Pb}(\text{NO}_3)_2$
- B) $(\text{NH}_4)_2\text{S}$
- C) KBr
- D) Li_2CO_3
- E) AgNO_3

Answer: B

Diff: 3

Page Ref: Sec. 4.2

5) The net ionic equation for formation of an aqueous solution of NiI_2 accompanied by evolution of CO_2 gas via mixing solid NiCO_3 and aqueous hydriodic acid is _____.

- A) $2\text{NiCO}_3(\text{s}) + \text{HI}(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) + 2\text{Ni}^{2+}(\text{aq})$
- B) $\text{NiCO}_3(\text{s}) + \text{I}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) + \text{Ni}^{2+}(\text{aq}) + \text{HI}(\text{aq})$
- C) $\text{NiCO}_3(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) + \text{Ni}^{2+}(\text{aq})$
- D) $\text{NiCO}_3(\text{s}) + 2\text{HI}(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) + \text{NiI}_2(\text{aq})$
- E) $\text{NiCO}_3(\text{s}) + 2\text{HI}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) + \text{Ni}^{2+}(\text{aq}) + 2\text{I}^-(\text{aq})$

Answer: C

Diff: 4

Page Ref: Sec. 4.2

6) The net ionic equation for formation of an aqueous solution of $\text{Al}(\text{NO}_3)_3$ via mixing solid $\text{Al}(\text{OH})_3$ and aqueous nitric acid is _____.

- A) $\text{Al}(\text{OH})_3(\text{s}) + 3\text{HNO}_3(\text{aq}) \rightarrow 3\text{H}_2\text{O}(\text{l}) + \text{Al}(\text{NO}_3)_3(\text{aq})$
- B) $\text{Al}(\text{OH})_3(\text{s}) + 3\text{NO}_3^-(\text{aq}) \rightarrow 3\text{OH}^-(\text{aq}) + \text{Al}(\text{NO}_3)_3(\text{aq})$
- C) $\text{Al}(\text{OH})_3(\text{s}) + 3\text{NO}_3^-(\text{aq}) \rightarrow 3\text{OH}^-(\text{aq}) + \text{Al}(\text{NO}_3)_3(\text{s})$
- D) $\text{Al}(\text{OH})_3(\text{s}) + 3\text{H}^+(\text{aq}) \rightarrow 3\text{H}_2\text{O}(\text{l}) + \text{Al}^{3+}(\text{aq})$
- E) $\text{Al}(\text{OH})_3(\text{s}) + 3\text{HNO}_3(\text{aq}) \rightarrow 3\text{H}_2\text{O}(\text{l}) + \text{Al}^{3+}(\text{aq}) + \text{NO}_3^-(\text{aq})$

Answer: D

Diff: 4

Page Ref: Sec. 4.2

7) Which of the following is soluble in water at 25 °C?

- A) $\text{Fe}_3(\text{PO}_4)_2$
- B) $\text{Fe}(\text{OH})_2$
- C) $\text{Fe}(\text{NO}_3)_2$
- D) FeCO_3
- E) FeS

Answer: C

Diff: 2

Page Ref: Sec. 4.2

8) Which of the following is insoluble in water at 25 °C?

- A) $\text{Mg}_3(\text{PO}_4)_2$
- B) Na_2S
- C) $(\text{NH}_4)_2\text{CO}_3$
- D) $\text{Ca}(\text{OH})_2$
- E) $\text{Ba}(\text{C}_2\text{H}_3\text{O}_2)_2$

Answer: A

Diff: 4

Page Ref: Sec. 4.2

9) When aqueous solutions of _____ are mixed, a precipitate forms.

- A) NiBr_2 and AgNO_3
- B) NaI and KBr
- C) K_2SO_4 and CrCl_3
- D) KOH and $\text{Ba}(\text{NO}_3)_2$
- E) Li_2CO_3 and CsI

Answer: A

Diff: 2

Page Ref: Sec. 4.2

10) Which one of the following compounds is insoluble in water?

- A) Na_2CO_3
- B) K_2SO_4
- C) $\text{Fe}(\text{NO}_3)_3$
- D) ZnS
- E) AgNO_3

Answer: D

Diff: 1

Page Ref: Sec. 4.2

11) Which combination will produce a precipitate?

- A) $\text{NaC}_2\text{H}_3\text{O}_2(\text{aq})$ and $\text{HCl}(\text{aq})$
- B) $\text{NaOH}(\text{aq})$ and $\text{HCl}(\text{aq})$
- C) $\text{AgNO}_3(\text{aq})$ and $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2(\text{aq})$
- D) $\text{KOH}(\text{aq})$ and $\text{Mg}(\text{NO}_3)_2(\text{aq})$
- E) $\text{NaOH}(\text{aq})$ and $\text{HCl}(\text{aq})$

Answer: D

Diff: 3

Page Ref: Sec. 4.2

12) Which combination will produce a precipitate?

- A) NH_4OH (aq) and HCl (aq)
- B) AgNO_3 (aq) and $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$ (aq)
- C) NaOH (aq) and HCl (aq)
- D) NaCl (aq) and $\text{HC}_2\text{H}_3\text{O}_2$ (aq)
- E) NaOH (aq) and $\text{Fe}(\text{NO}_3)_2$ (aq)

Answer: E

Diff: 3

Page Ref: Sec. 4.2

13) With which of the following will the ammonium ion form an insoluble salt?

- A) chloride
- B) sulfate
- C) carbonate
- D) sulfate and carbonate
- E) none of the above

Answer: E

Diff: 1

Page Ref: Sec. 4.2

14) With which of the following will the potassium ion form an insoluble salt?

- A) chloride
- B) sulfate
- C) carbonate
- D) sulfate and carbonate
- E) none of the above

Answer: E

Diff: 1

Page Ref: Sec. 4.2

15) The net ionic equation for the reaction between aqueous sulfuric acid and aqueous sodium hydroxide is _____.

- A) $\text{H}^+(\text{aq}) + \text{HSO}_4^-(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{SO}_4^{2-}(\text{aq})$
B) $\text{H}^+(\text{aq}) + \text{HSO}_4^-(\text{aq}) + 2\text{Na}^+(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + 2\text{Na}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
C) $\text{SO}_4^{2-}(\text{aq}) + 2\text{Na}^+(\text{aq}) \rightarrow 2\text{Na}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
D) $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
E) $2\text{H}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + 2\text{Na}^+(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + 2\text{Na}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$

Answer: D

Diff: 3

Page Ref: Sec. 4.2

16) The net ionic equation for the reaction between aqueous nitric acid and aqueous sodium hydroxide is _____.

- A) $\text{H}^+(\text{aq}) + \text{HNO}_3(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{NO}_3^-(\text{aq})$
B) $\text{HNO}_3(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$
C) $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
D) $\text{HNO}_3(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{NO}_3^-(\text{aq}) + \text{H}_2\text{O}(\text{l})$
E) $\text{H}^+(\text{aq}) + \text{Na}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{Na}^+(\text{aq})$

Answer: C

Diff: 3

Page Ref: Sec. 4.2

17) The reaction between strontium hydroxide and chloric acid produces _____.

- A) a molecular compound and a weak electrolyte
- B) two weak electrolytes
- C) two strong electrolytes
- D) a molecular compound and a strong electrolyte
- E) two molecular compounds

Answer: D

Diff: 3

Page Ref: Sec. 4.3

18) Which one of the following is a diprotic acid?

- A) nitric acid
- B) chloric acid
- C) phosphoric acid
- D) hydrofluoric acid
- E) sulfuric acid

Answer: E

Diff: 2

Page Ref: Sec. 4.3

19) Which one of the following is a triprotic acid?

- A) nitric acid
- B) chloric acid
- C) phosphoric acid
- D) hydrofluoric acid
- E) sulfuric acid

Answer: C

Diff: 2

Page Ref: Sec. 4.3

20) Which one of the following solutions will have the greatest concentration of hydroxide ions?

- A) 0.100 M rubidium hydroxide
- B) 0.100 M magnesium hydroxide
- C) 0.100 M ammonia
- D) 0.100 M beryllium hydroxide
- E) 0.100 M hydrochloric acid

Answer: A

Diff: 3

Page Ref: Sec. 4.3

21) Which one of the following is a weak acid?

- A) HNO_3
- B) HCl
- C) HI
- D) HF
- E) HClO_4

Answer: D

Diff: 1

Page Ref: Sec. 4.3

22) Which of the following are weak acids?

- A) HF , HBr
- B) HI , HNO_3 , HBr
- C) HI , HF
- D) HF
- E) none of the above

Answer: D

Diff: 2

Page Ref: Sec. 4.3

23) A compound was found to be soluble in water. It was also found that addition of acid to an aqueous solution of this compound resulted in the formation of carbon dioxide. Which one of the following cations would form a precipitate when added to an aqueous solution of this compound?

- A) NH_4^+
- B) K^+
- C) Cr^{3+}
- D) Rb^+
- E) Na^+

Answer: C

Diff: 4

Page Ref: Sec. 4.3

24) Which hydroxides are weak bases?

- A) KOH , $\text{Ba}(\text{OH})_2$
- B) $\text{Sr}(\text{OH})_2$, KOH , NaOH , $\text{Ba}(\text{OH})_2$
- C) KOH , NaOH
- D) KOH , NaOH , $\text{Ba}(\text{OH})_2$
- E) None of these is a weak base.

Answer: E

Diff: 2

Page Ref: Sec. 4.3

25) The balanced reaction between aqueous potassium hydroxide and aqueous acetic acid is _____.

- A) $\text{KOH (aq)} + \text{HC}_2\text{H}_3\text{O}_2\text{(aq)} \rightarrow \text{OH}^- \text{(l)} + \text{HC}_2\text{H}_3\text{O}_2^+ \text{(aq)} + \text{K (s)}$
- B) $\text{KOH (aq)} + \text{HC}_2\text{H}_3\text{O}_2\text{(aq)} \rightarrow \text{H}_2\text{O (l)} + \text{KC}_2\text{H}_3\text{O}_2 \text{(aq)}$
- C) $\text{KOH (aq)} + \text{HC}_2\text{H}_3\text{O}_2\text{(aq)} \rightarrow \text{H}_2\text{C}_2\text{H}_3\text{O}_3 \text{(aq)} + \text{K(s)}$
- D) $\text{KOH (aq)} + \text{HC}_2\text{H}_3\text{O}_2\text{(aq)} \rightarrow \text{KC}_2\text{H}_3\text{O}_3 \text{(aq)} + \text{H}_2\text{(g)}$
- E) $\text{KOH (aq)} + \text{HC}_2\text{H}_3\text{O}_2\text{(aq)} \rightarrow \text{H}_2\text{KC}_2\text{H}_3\text{O (aq)} + \text{O}_2\text{(g)}$

Answer: B

Diff: 2

Page Ref: Sec. 4.3

26) The balanced reaction between aqueous nitric acid and aqueous strontium hydroxide is _____.

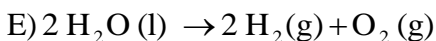
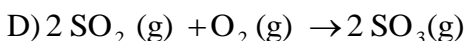
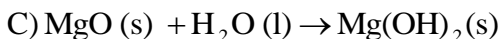
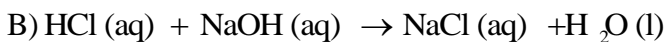
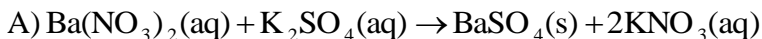
- A) $\text{HNO}_3\text{(aq)} + \text{Sr(OH)}_2\text{(aq)} \rightarrow \text{Sr(NO}_3)_2 \text{(aq)} + \text{H}_2\text{(g)}$
- B) $\text{HNO}_3\text{(aq)} + \text{Sr(OH)}_2\text{(aq)} \rightarrow \text{H}_2\text{O(l)} + \text{Sr(NO}_3)_2 \text{(aq)}$
- C) $\text{HNO}_3\text{(aq)} + \text{SrOH(aq)} \rightarrow \text{H}_2\text{O(l)} + \text{SrNO}_3 \text{(aq)}$
- D) $2\text{HNO}_3\text{(aq)} + \text{Sr(OH)}_2\text{(aq)} \rightarrow 2\text{H}_2\text{O(l)} + \text{Sr(NO}_3)_2 \text{(aq)}$
- E) $2\text{HNO}_3\text{(aq)} + \text{Sr(OH)}_2\text{(aq)} \rightarrow \text{Sr(NO}_3)_2 \text{(aq)} + 2\text{H}_2\text{(g)}$

Answer: D

Diff: 2

Page Ref: Sec. 4.3

27) In which reaction does the oxidation number of oxygen increase?

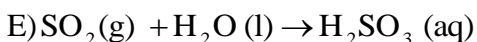
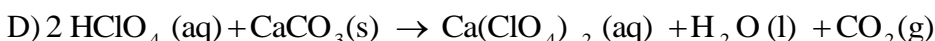
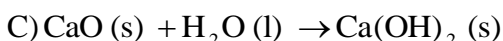
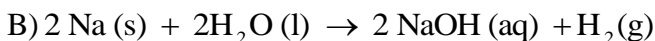
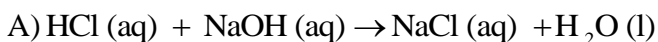


Answer: E

Diff: 3

Page Ref: Sec. 4.4

28) In which reaction does the oxidation number of hydrogen change?

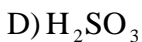
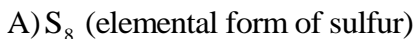


Answer: B

Diff: 3

Page Ref: Sec. 4.4

29) In which species does sulfur have the highest oxidation number?



Answer: E

Diff: 3

Page Ref: Sec. 4.4

30) In which species does nitrogen have the highest oxidation number?

- A) N_2
- B) NH_3
- C) HNO_2
- D) NO_2^-
- E) NaNO_3

Answer: E

Diff: 4

Page Ref: Sec. 4.4

31) Which compound has the atom with the highest oxidation number?

- A) CaS
- B) Na_3N
- C) MgSO_3
- D) $\text{Al}(\text{NO}_2)_3$
- E) NH_4Cl

Answer: C

Diff: 4

Page Ref: Sec. 4.4

32) Of the choices below, which would be the best for the lining of a tank intended for use in storage of hydrochloric acid?

- A) copper
- B) zinc
- C) nickel
- D) iron
- E) tin

Answer: A

Diff: 5

Page Ref: Sec. 4.4

33) Which of these metals will be oxidized by the ions of cobalt?

- A) nickel
- B) tin
- C) iron
- D) copper
- E) silver

Answer: C

Diff: 5

Page Ref: Sec. 4.4

34) Which of these metals will be oxidized by the ions of aluminum?

- A) magnesium
- B) zinc
- C) chromium
- D) iron
- E) nickel

Answer: A

Diff: 5

Page Ref: Sec. 4.4

35) One method for removal of metal ions from a solution is to convert the metal to its elemental form so it can be filtered out as a solid. Which metal can be used to remove aluminum ions from solution?

- A) zinc
- B) cobalt
- C) lead
- D) copper
- E) none of these

Answer: E

Diff: 3

Page Ref: Sec. 4.4

36) Of the reactions below, only _____ is not spontaneous.

- A) $\text{Mg (s)} + 2\text{HCl (aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$
- B) $2\text{Ag (s)} + 2\text{HNO}_3\text{(aq)} \rightarrow 2\text{AgNO}_3\text{(aq)} + \text{H}_2\text{(g)}$
- C) $2\text{Ni (s)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow \text{Ni}_2\text{SO}_4\text{(aq)} + \text{H}_2\text{(g)}$
- D) $2\text{Al (s)} + 6\text{HBr (aq)} \rightarrow 2\text{AlBr}_3\text{(aq)} + 3\text{H}_2\text{(g)}$
- E) $\text{Zn (s)} + 2\text{HI (aq)} \rightarrow \text{ZnI}_2\text{(aq)} + \text{H}_2\text{(g)}$

Answer: B

Diff: 4

Page Ref: Sec. 4.4

37) Based on the activity series, which one of the reactions below will occur?

- A) $\text{Zn (s)} + \text{MnI}_2\text{(aq)} \rightarrow \text{ZnI}_2\text{(aq)} + \text{Mn (s)}$
- B) $\text{SnCl}_2\text{(aq)} + \text{Cu (s)} \rightarrow \text{Sn (s)} + \text{CuCl}_2\text{(aq)}$
- C) $2\text{AgNO}_3\text{(aq)} + \text{Pb (s)} \rightarrow 2\text{Ag (s)} + \text{Pb(NO}_3)_2\text{(aq)}$
- D) $3\text{Hg (l)} + 2\text{Cr(NO}_3)_3\text{(aq)} \rightarrow 3\text{Hg(NO}_3)_2 + 2\text{Cr (s)}$
- E) $3\text{FeBr}_2\text{(aq)} + 2\text{Au (s)} \rightarrow 3\text{Fe (s)} + 2\text{AuBr}_3\text{(aq)}$

Answer: C

Diff: 4

Page Ref: Sec. 4.4

38) Based on the activity series, which one of the reactions below will occur?

- A) $\text{Fe (s)} + \text{ZnCl}_2\text{(aq)} \rightarrow \text{FeCl}_2\text{(aq)} + \text{Zn (s)}$
- B) $\text{Mn (s)} + \text{NiCl}_2\text{(aq)} \rightarrow \text{MnCl}_2\text{(aq)} + \text{Ni (s)}$
- C) $\text{Pb (s)} + \text{NiI}_2\text{(aq)} \rightarrow \text{PbI}_2\text{(aq)} + \text{Ni (s)}$
- D) $\text{SnBr}_2\text{(aq)} + \text{Cu (s)} \rightarrow \text{CuBr}_2\text{(aq)} + \text{Sn (s)}$
- E) None of the reactions will occur.

Answer: B

Diff: 4

Page Ref: Sec. 4.4

39) The net ionic equation for the dissolution of zinc metal in aqueous hydrobromic acid is _____.

- A) $\text{Zn (s)} + 2\text{Br}^- (\text{aq}) \rightarrow \text{ZnBr}_2 (\text{aq})$
- B) $\text{Zn (s)} + 2\text{HBr (aq)} \rightarrow \text{ZnBr}_2 (\text{aq}) + 2\text{H}^+ (\text{aq})$
- C) $\text{Zn (s)} + 2\text{HBr (aq)} \rightarrow \text{ZnBr}_2 (\text{s}) + 2\text{H}^+ (\text{aq})$
- D) $\text{Zn (s)} + 2\text{H}^+ (\text{aq}) \rightarrow \text{Zn}^{2+} (\text{aq}) + \text{H}_2 (\text{g})$
- E) $2\text{Zn (s)} + \text{H}^+ (\text{aq}) \rightarrow 2\text{Zn}^{2+} (\text{aq}) + \text{H}_2 (\text{g})$

Answer: D

Diff: 2

Page Ref: Sec. 4.4

40) Sodium does not occur in nature as Na (s) because _____.

- A) it is easily reduced to Na^-
- B) it is easily oxidized to Na^+
- C) it reacts with water with great difficulty
- D) it is easily replaced by silver in its ores
- E) it undergoes a disproportionation reaction to Na^- and Na^+

Answer: B

Diff: 2

Page Ref: Sec. 4.4

41) Zinc is more active than cobalt and iron but less active than aluminum. Cobalt is more active than nickel but less active than iron. Which of the following correctly lists the elements in order of increasing activity?

- A) $\text{Co} < \text{Ni} < \text{Fe} < \text{Zn} < \text{Al}$
- B) $\text{Ni} < \text{Fe} < \text{Co} < \text{Zn} < \text{Al}$
- C) $\text{Ni} < \text{Co} < \text{Fe} < \text{Zn} < \text{Al}$
- D) $\text{Fe} < \text{Ni} < \text{Co} < \text{Al} < \text{Zn}$
- E) $\text{Zn} < \text{Al} < \text{Co} < \text{Ni} < \text{Fe}$

Answer: C

Diff: 2

Page Ref: Sec. 4.4

42) Oxidation is the _____ and reduction is the _____.

- A) gain of oxygen, loss of electrons
- B) loss of oxygen, gain of electrons
- C) loss of electrons, gain of electrons
- D) gain of oxygen, loss of mass
- E) gain of electrons, loss of electrons

Answer: C

Diff: 2

Page Ref: Sec. 4.4

43) Oxidation and _____ mean essentially the same thing.

- A) activity
- B) reduction
- C) metathesis
- D) decomposition
- E) corrosion

Answer: E

Diff: 2

Page Ref: Sec. 4.4

44) Oxidation cannot occur without _____.

- A) acid
- B) oxygen
- C) water
- D) air
- E) reduction

Answer: E

Diff: 1

Page Ref: Sec. 4.4

45) Which of the following is an oxidation-reduction reaction?

- A) $\text{Cu (s)} + 2\text{AgNO}_3\text{(aq)} \rightarrow 2\text{Ag (s)} + \text{Cu(NO}_3)_2\text{(aq)}$
- B) $\text{HCl (aq)} + \text{NaOH (aq)} \rightarrow \text{H}_2\text{O (l)} + \text{NaCl (aq)}$
- C) $\text{AgNO}_3\text{(aq)} + \text{HCl (aq)} \rightarrow \text{AgCl (s)} + \text{HNO}_3\text{(aq)}$
- D) $\text{Ba(C}_2\text{H}_3\text{O}_2)_2\text{(aq)} + \text{Na}_2\text{SO}_4\text{(aq)} \rightarrow \text{BaSO}_4\text{(s)} + 2\text{NaC}_2\text{H}_3\text{O}_2\text{(aq)}$
- E) $\text{H}_2\text{CO}_3\text{(aq)} + \text{Ca(NO}_3)_2\text{(aq)} \rightarrow 2\text{HNO}_3\text{(aq)} + \text{CaCO}_3\text{(s)}$

Answer: A

Diff: 2

Page Ref: Sec. 4.4

46) Which of the following reactions will not occur as written?

- A) $\text{Zn (s)} + \text{Pb(NO}_3)_2\text{(aq)} \rightarrow \text{Pb (s)} + \text{Zn(NO}_3)_2\text{(aq)}$
- B) $\text{Mg (s)} + \text{Ca(OH)}_2\text{(aq)} \rightarrow \text{Ca (s)} + \text{Mg(OH)}_2\text{(aq)}$
- C) $\text{Sn (s)} + 2\text{AgNO}_3\text{(aq)} \rightarrow 2\text{Ag (s)} + \text{Sn(NO}_3)_2\text{(aq)}$
- D) $\text{Co (s)} + 2\text{AgCl (aq)} \rightarrow 2\text{Ag (s)} + \text{CoCl}_2\text{(aq)}$
- E) $\text{Co (s)} + 2\text{HI (aq)} \rightarrow \text{H}_2\text{(g)} + \text{CoI}_2\text{(aq)}$

Answer: B

Diff: 3

Page Ref: Sec. 4.4

47) Which one of the following is a correct expression for molarity?

- A) mol solute/L solvent
- B) mol solute/mL solvent
- C) mmol solute/mL solution
- D) mol solute/kg solvent
- E) $\mu\text{mol solute/L solution}$

Answer: C

Diff: 3

Page Ref: Sec. 4.5

48) Which one of the following is not true concerning 2.00 L of 0.100 M solution of $\text{Ca}_3(\text{PO}_4)_2$?

- A) This solution contains 0.200 mol of $\text{Ca}_3(\text{PO}_4)_2$.
- B) This solution contains 0.800 mol of oxygen atoms.
- C) 1.00 L of this solution is required to furnish 0.300 mol of Ca^{2+} ions.
- D) There are 6.02×10^{22} phosphorus atoms in 500.0 mL of this solution.
- E) This solution contains 6.67×10^{-2} mol of Ca^{2+} .

Answer: B

Diff: 2

Page Ref: Sec. 4.5

49) A 0.200 M K_2SO_4 solution is produced by _____.

- A) dilution of 250.0 mL of 1.00 M K_2SO_4 to 1.00 L
- B) dissolving 43.6 g of K_2SO_4 in water and diluting to a total volume of 250.0 mL
- C) diluting 20.0 mL of 5.00 M K_2SO_4 solution to 500.0 mL
- D) dissolving 20.2 g of K_2SO_4 in water and diluting to 250.0 mL, then diluting 25.0 mL of this solution to a total volume of 500.0 mL
- E) dilution of 1.00 mL of 250 M K_2SO_3 to 1.00 L

Answer: C

Diff: 3

Page Ref: Sec. 4.5

50) Which solution has the same number of moles of NaOH as 50.00 mL of 0.100M solution of NaOH?

- A) 20.00 mL of 0.200M solution of NaOH
- B) 25.00 mL of 0.175M solution of NaOH
- C) 30.00 mL of 0.145M solution of NaOH
- D) 50.00 mL of 0.125M solution of NaOH
- E) 100.00 mL of 0.0500M solution of NaOH

Answer: E

Diff: 4

Page Ref: Sec. 4.5

51) What are the respective concentrations (M) of Fe^{3+} and I^- afforded by dissolving 0.200 mol FeI_3 in water and diluting to 725 mL?

- A) 0.276 and 0.828
- B) 0.828 and 0.276
- C) 0.276 and 0.276
- D) 0.145 and 0.435
- E) 0.145 and 0.0483

Answer: A

Diff: 4

Page Ref: Sec. 4.5

52) What are the respective concentrations (M) of Cu^{+2} and Cl^- afforded by dissolving 0.200 mol CuCl_2 in water and diluting to 345 mL?

- A) 0.200 and 0.200
- B) 0.580 and 1.16
- C) 0.200 and 0.400
- D) 1.16 and 2.32
- E) 0.580 and 0.290

Answer: B

Diff: 4

Page Ref: Sec. 4.5

53) A tenfold dilution of a sample solution can be obtained by taking _____.

- A) 1 part sample and 9 parts solvent
- B) 1 part sample and 10 parts solvent
- C) 9 parts sample and 1 part solvent
- D) 10 parts sample and 1 part solvent
- E) 99 parts sample and 1 part solvent

Answer: A

Diff: 2

Page Ref: Sec. 4.5

54) Mixing 10.00 mL of an aqueous solution with 10.00 mL of water represents a _____.

- A) crystallization
- B) neutralization
- C) twofold dilution
- D) tenfold dilution
- E) titration

Answer: C

Diff: 2

Page Ref: Sec. 4.5

55) You are given two clear solutions of the same unknown monoprotic acid, but with different concentrations. Which statement is true?

- A) There is no chemical method designed to tell the two solutions apart.
- B) It would take more base solution (per milliliter of the unknown solution) to neutralize the more concentrated solution.
- C) A smaller volume of the less concentrated solution contains the same number of moles of the acid compared to the more concentrated solution.
- D) If the same volume of each sample was taken, then more base solution would be required to neutralize the one with lower concentration.
- E) The product of concentration and volume of the less concentrated solution equals the product of concentration and volume of the more concentrated solution.

Answer: B

Diff: 2

Page Ref: Sec. 4.5

56) A 0.100 M solution of _____ will contain the highest concentration of potassium ions.

- A) potassium phosphate
- B) potassium hydrogen carbonate
- C) potassium hypochlorite
- D) potassium iodide
- E) potassium oxide

Answer: A

Diff: 3

Page Ref: Sec. 4.5

57) Which solution contains the largest number of moles of chloride ions?

- A) 10.0 mL of 0.500M BaCl_2
- B) 4.00 mL of 1.000M NaCl
- C) 7.50 mL of 0.500M FeCl_3
- D) 25.00 mL of 0.400M KCl
- E) 30.00 mL of 0.100M CaCl_2

Answer: C

Diff: 3

Page Ref: Sec. 4.5

58) What volume (mL) of a concentrated solution of sodium hydroxide (6.00 M) must be diluted to 200. mL to make a 1.50 M solution of sodium hydroxide?

- A) 0.0500
- B) 50.0
- C) 45.0
- D) 800.
- E) 0.800

Answer: B

Diff: 2

Page Ref: Sec. 4.5

59) What volume (mL) of a concentrated solution of sodium hydroxide (6.00 M) must be diluted to 200.0 mL to make a 0.880 M solution of sodium hydroxide?

- A) 2.64
- B) 176
- C) 26.4
- D) 29.3
- E) 50.0

Answer: D

Diff: 2

Page Ref: Sec. 4.5

60) What mass (g) of potassium chloride is contained in 430.0 mL of a potassium chloride solution that has a chloride ion concentration of 0.193 M?

- A) 0.0643
- B) 0.0830
- C) 12.37
- D) 0.386
- E) 6.19

Answer: E

Diff: 3

Page Ref: Sec. 4.5

61) What volume (ml) of a 3.45 M lead nitrate solution must be diluted to 450.0 ml to make a 0.990 M solution of lead nitrate?

- A) 129
- B) 109
- C) 101
- D) 56
- E) 45

Answer: A

Diff: 3

Page Ref: Sec. 4.5

62) What mass (g) of barium iodide is contained in 250 mL of a barium iodide solution that has an iodide ion concentration of 0.193 M?

- A) 9.44
- B) 18.9
- C) 0.024
- D) 0.048
- E) 37.7

Answer: A

Diff: 3

Page Ref: Sec. 4.5

63) What mass (g) of AgBr is formed when 35.5 mL of 0.184 M AgNO_3 is treated with an excess of aqueous hydrobromic acid?

- A) 1.44
- B) 1.23
- C) 53.6
- D) 34.5
- E) 188

Answer: B

Diff: 4

Page Ref: Sec. 4.6

64) What mass (g) of CaF_2 is formed when 47.8 mL of 0.334 M NaF is treated with an excess of aqueous calcium nitrate?

- A) 1.25
- B) 0.472
- C) 2.49
- D) 0.943
- E) 0.623

Answer: E

Diff: 4

Page Ref: Sec. 4.6

65) What volume (mL) of 0.135 M NaOH is required to neutralize 13.7 mL of 0.129 M HCl?

- A) 13.1
- B) 0.24
- C) 14.3
- D) 0.076
- E) 6.55

Answer: A

Diff: 3

Page Ref: Sec. 4.6

66) What volume (L) of 0.250 M HNO_3 is required to neutralize a solution prepared by dissolving 17.5 g of NaOH in 350 mL of water?

- A) 50.0
- B) 0.44
- C) 1.75
- D) 0.070
- E) 1.75×10^{-3}

Answer: C

Diff: 4

Page Ref: Sec. 4.6

67) An aliquot (28.7 mL) of a KOH solution required 31.3 mL of 0.118 M HCl for neutralization. What mass (g) of KOH was in the original sample?

- A) 1.64
- B) 7.28
- C) 0.173
- D) 0.207
- E) 0.414

Answer: D

Diff: 4

Page Ref: Sec. 4.6

68) The point in a titration at which the indicator changes is called the _____.

- A) setpoint
- B) indicator point
- C) standard point
- D) endpoint
- E) volumetric point

Answer: D

Diff: 1

Page Ref: Sec. 4.6

69) Which of the following would require the largest volume of 0.100 M sodium hydroxide solution for neutralization?

- A) 10.0 mL of 0.0500 M phosphoric acid
- B) 20.0 mL of 0.0500 M nitric acid
- C) 5.0 mL of 0.0100 M sulfuric acid
- D) 15.0 mL of 0.0500 M hydrobromic acid
- E) 10.0 mL of 0.0500 M perchloric acid

Answer: A

Diff: 4

Page Ref: Sec. 4.6

70) Which one of the following substances is produced during the reaction of an acid with a metal hydroxide?

- A) H_2
- B) H_2O
- C) CO_2
- D) NaOH
- E) O_2

Answer: B

Diff: 2

Page Ref: Sec. 4.6

71) A 36.3 mL aliquot of 0.0529 M H_2SO_4 (aq) is to be titrated with 0.0411 M NaOH (aq). What volume (mL) of base will it take to reach the equivalence point?

- A) 93.4
- B) 46.7
- C) 187
- D) 1.92
- E) 3.84

Answer: A

Diff: 4

Page Ref: Sec. 4.6

72) A 13.8 mL aliquot of 0.176 M H_3PO_4 (aq) is to be titrated with 0.110 M NaOH (aq). What volume (mL) of base will it take to reach the equivalence point?

- A) 7.29
- B) 22.1
- C) 199
- D) 66.2
- E) 20.9

Answer: D

Diff: 4

Page Ref: Sec. 4.6

73) What volume (mL) of $7.48 \times 10^{-2} \text{M}$ perchloric acid can be neutralized with 115 mL of 0.244 M sodium hydroxide?

- A) 125
- B) 8.60
- C) 188
- D) 750
- E) 375

Answer: E

Diff: 3

Page Ref: Sec. 4.6

74) What volume (mL) of $7.48 \times 10^{-2} \text{M}$ phosphoric acid can be neutralized with 115 mL of 0.244 M sodium hydroxide?

- A) 125
- B) 375
- C) 750
- D) 188
- E) 75.0

Answer: A

Diff: 4

Page Ref: Sec. 4.6

75) _____ is an oxidation reaction.

- A) Ice melting in a soft drink
- B) Table salt dissolving in water for cooking vegetables
- C) Rusting of iron
- D) The reaction of sodium chloride with lead nitrate to form lead chloride and sodium nitrate
- E) Neutralization of HCl by NaOH

Answer: C

Diff: 2

Page Ref: Sec. 4.6

4.3 Short Answer Questions

1) The solvent in an aqueous solution is _____.

Answer: water

Diff: 1

Page Ref: Sec. 4.1

2) What is aqua regia?

Answer: a 3:1 mixture of concentrated hydrochloric and nitric acids

Diff: 3

Page Ref: Sec. 4.4

3) When gold dissolves in aqua regia, into what form is the gold converted?

Answer: AuCl_4^- (aq)

Diff: 3

Page Ref: Sec. 4.5

4) Calculate the concentration (M) of arsenic acid (H_3AsO_4) in a solution if 25.00 mL of that solution required 35.21 mL of 0.1894 M KOH for neutralization.

Answer: 0.08892

Diff: 4

Page Ref: Sec. 4.6

5) How many moles of BaCl_2 are formed in the neutralization of 393 mL of 0.171 M $\text{Ba}(\text{OH})_2$ with aqueous HCl?

Answer: 0.0672

Diff: 4

Page Ref: Sec. 4.6

4.4 True/False Questions

1) $\text{Ca}(\text{OH})_2$ is a strong base.

Answer: True

Diff: 1

Page Ref: Sec. 4.3

2) The compound HClO_4 is a weak acid.

Answer: False

Diff: 2

Page Ref: Sec. 4.3

3) HNO_2 is a strong acid.

Answer: False

Diff: 1

Page Ref: Sec. 4.3

4) The compound NH_4Cl is a weak acid.

Answer: True

Diff: 2

Page Ref: Sec. 4.3

5) Ammonia is a strong base.

Answer: False

Diff: 1

Page Ref: Sec. 4.3

4.5 Algorithmic Questions

1) What is the concentration (M) of sodium ions in 4.57 L of a .398 M Na_3P solution?

Answer: 1.19

Diff: 3

Page Ref: Sec. 4.5

2) What is the concentration (M) of CH_3OH in a solution prepared by dissolving 16.8 g of CH_3OH in sufficient water to give exactly 230 mL of solution?

Answer: 2.28

Diff: 3

Page Ref: Sec. 4.5

3) How many grams of H_3PO_4 are in 265 mL of a 1.50 M solution of H_3PO_4 ?

Answer: 39.0

Diff: 3

Page Ref: Sec. 4.5

4) What is the concentration (M) of a NaCl solution prepared by dissolving 7.2 g of NaCl in sufficient water to give 425 mL of solution?

Answer: 0.29

Diff: 3

Page Ref: Sec. 4.5

5) How many grams of NaOH (MW = 40.0) are there in 250.0 mL of a 0.275 M NaOH solution?

Answer: 2.75

Diff: 3

Page Ref: Sec. 4.5

6) How many grams of CH_3OH must be added to water to prepare 150mL of a solution that is 2.0 M CH_3OH ?

Answer: 9.6

Diff: 3

Page Ref: Sec. 4.5

7) There are _____ mol of bromide ions in 0.900 L of a 0.500M solution of AlBr_3 .

Answer: 1.35

Diff: 3

Page Ref: Sec. 4.5

8) How many moles of Co^{2+} are present in 0.150 L of a 0.200 M solution of CoI_2 ?

Answer: 0.0300

Diff: 3

Page Ref: Sec. 4.5

9) Calculate the concentration (M) of sodium ions in a solution made by diluting 40.0 mL of a 0.474 M solution of sodium sulfide to a total volume of 300 mL.

Answer: 0.126

Diff: 4

Page Ref: Sec. 4.5

10) How many milliliters of a stock solution of 11.1 M HNO_3 would be needed to prepare 0.500 L of 0.500 M HNO_3 ?

A) 0.0444

B) 22.5

C) 2.78

D) 44.4

E) 0.0225

Answer: B

Diff: 3

Page Ref: Sec. 4.5

11) A stock solution of HNO_3 is prepared and found to contain 13.5 M of HNO_3 . If 25.0 mL of the stock solution is diluted to a final volume of 0.500 L, the concentration of the diluted solution is _____ M.

- A) 0.270
- B) 1.48
- C) 0.675
- D) 675
- E) 270

Answer: C

Diff: 3

Page Ref: Sec. 4.5

12) Pure acetic acid ($\text{HC}_2\text{H}_3\text{O}_2$) is a liquid and is known as glacial acetic acid. Calculate the molarity of a solution prepared by dissolving 10.00 mL of glacial acetic acid at 25 °C in sufficient water to give 500.0 mL of solution. The density of glacial acetic acid at 25 °C is 1.05 g/mL.

- A) 1.26×10^3
- B) 21.0
- C) 0.0210
- D) 0.350
- E) 3.50×10^{-4}

Answer: D

Diff: 4

Page Ref: Sec. 4.5

13) A solution is prepared by mixing 50.0 mL of 0.100 M HCl and 10.0 mL of 0.200 M NaCl. What is the molarity of chloride ion in this solution?

- A) 0.183
- B) 8.57
- C) 3.50

- D) 0.0500
- E) 0.117

Answer: E

Diff: 3

Page Ref: Sec. 4.5

12) A solution is prepared by dissolving 23.7 g of CaCl_2 in 375 g of water. The density of the resulting solution is 1.05 g/mL. The concentration of CaCl_2 is _____% by mass.

- A) 5.94
- B) 6.32
- C) 0.0632
- D) 0.0594
- E) 6.24

Answer: A

Diff: 3

Page Ref: Sec. 13.4

13) The concentration of urea in a solution prepared by dissolving 16 g of urea in 39 g of H_2O is _____% by mass. The molar mass of urea is 60.0 g/mol.

- A) 29
- B) 41
- C) 0.29
- D) 0.41
- E) 0.48

Answer: A

Diff: 3

Page Ref: Sec. 13.4

14) The concentration of nitrate ion in a solution that contains 0.900 M aluminum nitrate is _____ M.

- A) 0.900
- B) 0.450
- C) 0.300

- D) 2.70
- E) 1.80

Answer: D

Diff: 3

Page Ref: Sec. 13.4

15) The concentration of KBr in a solution prepared by dissolving 2.21 g of KBr in 897 g of water is _____ molal.

- A) 2.46
- B) 0.0167
- C) 0.0207
- D) 2.07×10^{-5}
- E) 0.0186

Answer: C

Diff: 3

Page Ref: Sec. 13.4

16) The concentration of lead nitrate ($\text{Pb}(\text{NO}_3)_2$) in a 0.726 M solution is _____ molal. The density of the solution is 1.202 g/mL.

- A) 0.476
- B) 1.928
- C) 0.755
- D) 0.819
- E) 0.650

Answer: C

Diff: 5

Page Ref: Sec. 13.4

17) The concentration of a benzene solution prepared by mixing 12.0 g C_6H_6 with 38.0 g CCl_4 is _____ molal.

- A) 4.04
- B) 0.240
- C) 0.622

- D) 0.316
- E) 0.508

Answer: A

Diff: 4

Page Ref: Sec. 13.4

18) A solution is prepared by dissolving 15.0 g of NH_3 in 250.0 g of water. The density of the resulting solution is 0.974 g/mL. The mole fraction of NH_3 in the solution is _____.

- A) 0.0640
- B) 0.0597
- C) 0.940
- D) 0.922
- E) 16.8

Answer: B

Diff: 4

Page Ref: Sec. 13.4

19) A solution is prepared by dissolving 15.0 g of NH_3 in 250.0 g of water. The density of the resulting solution is 0.974 g/mL. The molarity of NH_3 in the solution is _____.

- A) 0.00353
- B) 0.882
- C) 60.0
- D) 3.24
- E) 3.53

Answer: D

Diff: 4

Page Ref: Sec. 13.4

20) A solution is prepared by dissolving 23.7 g of CaCl_2 in 375 g of water. The density of the resulting solution is 1.05 g/mL. The concentration of Cl^- in this solution is _____ M.

- A) 0.214
- B) 0.562
- C) 1.12
- D) 1.20
- E) 6.64×10^{-2}

Answer: C

Diff: 4

Page Ref: Sec. 13.4

21) A solution is prepared by dissolving 23.7 g of CaCl_2 in 375 g of water. The density of the resulting solution is 1.05 g/mL. The concentration of CaCl_2 in this solution is _____ molal.

- A) 0.214
- B) 0.569
- C) 5.70
- D) 63.2
- E) 1.76

Answer: B

Diff: 4

Page Ref: Sec. 13.4

22) The concentration of HCl in a solution that is prepared by dissolving 5.5 g of HCl in 200 g of $\text{C}_2\text{H}_6\text{O}$ is _____ molal.

- A) 27.5
- B) 7.5×10^{-4}
- C) 3.3×10^{-2}
- D) 0.75
- E) 1.3

Answer: D

Diff: 3

Page Ref: Sec. 13.4

23) The concentration (M) of HCl in a solution prepared by dissolving 5.5 g of HCl in 200 g of $\text{C}_2\text{H}_6\text{O}$ is _____ M. The density of the solution is 0.79 g/mL.

- A) 21
- B) 0.93
- C) 0.58
- D) 6.0×10^{-4}
- E) 1.72

Answer: C

Diff: 3

Page Ref: Sec. 13.4

24) The mole fraction of He in a gaseous solution prepared from 4.0 g of He, 6.5 g of Ar, and 10.0 g of Ne is _____.

- A) 0.60
- B) 1.5
- C) 0.20
- D) 0.11
- E) 0.86

Answer: A

Diff: 3

Page Ref: Sec. 13.4

25) The mole fraction of urea (MW = 60.0 g/mol) in a solution prepared by dissolving 16 g of urea in 39 g of H_2O is _____.

- A) 0.58
- B) 0.37
- C) 0.13
- D) 0.11
- E) 9.1

Answer: D

Diff: 3

Page Ref: Sec. 13.4

26) The concentration of urea (MW = 60.0 g/mol) in a solution prepared by dissolving 16 g of urea in 39 g of H₂O is _____ molal.

- A) 96
- B) 6.8
- C) 0.68
- D) 6.3
- E) 0.11

Answer: B

Diff: 3

Page Ref: Sec. 13.4

27) The molarity of urea in a solution prepared by dissolving 16 g of urea (MW = 60.0 g/mol) in 39 g of H₂O is _____ M. The density of the solution is 1.3 g/mL.

- A) 0.11
- B) 3.7
- C) 6.8
- D) 6.3
- E) 0.16

Answer: D

Diff: 3

Page Ref: Sec. 13.4

28) What is the molarity of sodium chloride in solution that is 13.0% by mass sodium chloride and that has a density of 1.10 g/mL?

- A) 143
- B) 2.45
- C) 2.56
- D) 2.23
- E) 1.43×10^{-2}

Answer: B

Diff: 4

Page Ref: Sec. 13.4

29) The concentration of sodium chloride in an aqueous solution that is 2.23 M and that has a density of 1.01 g/mL is _____% by mass.

- A) 2.21
- B) 7.83
- C) 45.3
- D) 12.9
- E) 10.1

Answer: D

Diff: 4

Page Ref: Sec. 13.4

14) A solution is prepared by adding 1.60 g of solid NaCl to 50.0 mL of 0.100 M CaCl_2 . What is the molarity of chloride ion in the final solution? Assume that the volume of the final solution is 50.0 mL.

- A) 0.747
- B) 0.647
- C) 0.132
- D) 0.232
- E) 0.547

Answer: A

Diff: 4

Page Ref: Sec. 4.5

15) Calculate the number of grams of solute in 500.0 mL of 0.189 M KOH.

- A) 148
- B) 1.68
- C) 5.30×10^3
- D) 5.30
- E) 1.68×10^{-3}

Answer: D

Diff: 2

Page Ref: Sec. 4.5

16) What is the molarity of a NaOH solution if 28.2 mL of a 0.355 M H_2SO_4 solution is required to neutralize a 25.0-mL sample of the NaOH solution?

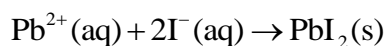
- A) 0.801
- B) 0.315
- C) 0.629
- D) 125
- E) 0.400

Answer: A

Diff: 4

Page Ref: Sec. 4.6

17) Lead ions can be precipitated from aqueous solutions by the addition of aqueous iodide:



Lead iodide is virtually insoluble in water so that the reaction appears to go to completion. How many milliliters of 3.550 M HI(aq) must be added to a solution containing 0.700 mol of $\text{Pb}(\text{NO}_3)_2$ to completely precipitate the lead?

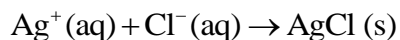
- A) 2.54×10^{-3}
- B) 394
- C) 197
- D) 0.197
- E) 0.394

Answer: B

Diff: 4

Page Ref: Sec. 4.6

18) Silver ions can be precipitated from aqueous solutions by the addition of aqueous chloride:



Silver chloride is virtually insoluble in water so that the reaction appears to go to completion. How many grams of solid NaCl must be added to 25.0 mL of 0.366 M AgNO_3 solution to completely precipitate the silver?

- A) 9.15×10^{-3}
- B) 1.57×10^{-4}
- C) 0.535
- D) 0.157
- E) 6.39×10^3

Answer: C

Diff: 4

Page Ref: Sec. 4.6

19) How many milliliters of 0.132 M HClO_4 solution are needed to neutralize 50.00 mL of 0.0789 M NaOH?

- A) 0.521
- B) 0.0120
- C) 83.7
- D) 0.0335
- E) 29.9

Answer: E

Diff: 3

Page Ref: Sec. 4.6