8.7: Properties of Solutions (Exercises)

These are homework exercises to accompany Chapter 8 of the University of Kentucky's LibreText for CHE 103 - Chemistry for Allied Health. Answers are below the questions.

Questions

8.1: Concentrations of Solutions

(click here for solutions)

Q8.1.1

How is a concentrated solution different from a dilute solution?

Q8.1.2

What is the molarity of a solution prepared with 0.75 moles NaCl in 250. mL solution?

Q8.1.3

What is the mass percent of an aqueous solution prepared by dissolving 12.0 g of solute into 40.0 g of water?

Q8.1.4

What is the volume percent of a solution prepared by adding enough water to 200. mL of acetone to make a total volume of 1.60 L?

Q8.1.5

What mass of glucose is in 250.0 mL of solution that is 5.00% by mass? Assume the density of the solution is 1.00 g/mL.

Q8.1.6

For a solution that contains 25.0 g of NaCl in 300.0 mL of water, find each of the following. The density of the water is 1.00 g/mL. Assume the NaCl does not contribute to the **volume** of the solution

a. mass percent
b. mass/volume percent

Q8.1.7

For a solution that contains 15.0 mL of methanol 125 mL of ethanol, find each of the following. The density of methanol is 0.792 g/mL and the density of ethanol is 0.789 g/mL.

a. mass percent
b. mass/volume percent
c. volume percent

Q8.1.8

A saline solution has a mass percent concentration of 10.5%. What mass of NaCl is present in 150.0 mL of the solution? Assume the density of the solution is 1.00 g/mL.

Q8.1.9

Calculate the molarity for each solution.

a. 87.2 g of Na_2SO_4 in enough water to make 500. mL of solution
b. 61.8 g of NH_3 in enough water to make 7.00 L of solution
c. 100. mL of ethanol (C_2H_5OH) in 500. mL of solution (The density of ethanol is 0.789 g/mL.)

Q8.1.10

How many moles of KF are contained in 180.0 mL of a 0.250 M solution?

Q8.1.11

Calculate how many grams of each solute would be required in order to make the given solution.

a. 3.40 L of a 0.780 M solution of iron(III) chloride, $FeCl_3$

b. 60.0 mL of a 4.10 M solution of calcium acetate, $Ca(CH_3COO)_2$

Q8.1.12

What volume of a 0.500 M solution of NaI could be prepared with 113 g of solid NaI?

Q8.1.13

Calculate the molarity of the solutions prepared from the following dilutions.

a. 125 mL of 2.00 M HCl is diluted to a volume of 4.00 L.
b. 1.85 mL of 6.30 M $AgNO_3$ is diluted to a volume of 5.00 mL.

Q8.1.14

What volume of 12 M HCl is required to prepare 6.00 L of a 0.300 M solution?

Q8.1.15

What mass of lead is present in 50.0 mL of solution with a lead concentration of 12 ppm?

Q8.1.16

What mass of mercury is present in 175 mL of solution with a mercury concentration of 25 ppb?

Q8.1.17

What is the concentration, in units of ppm, for a solution that contains 34 g of iron in 365 mL of water?

Q8.1.18

How many equivalents are there in 2.0 moles of the ion of each element below?

a. magnesium
b. aluminum
c. sulfur
d. bromine (Br)
e. cesium (Cs)
f. barium (Ba)

Q8.1.19

How many equivalents are present in 2.50 moles of ions for each of the elements in the previous question?

Q8.1.20

How many moles of Ca^{2+} are given to a patient if they receive 250.0 mL of a solution with a concentration of 132 mEq/L?

Q8.1.21

How many grams of K^+ are given to a patient if they receive 500.0 mL of a solution with a concentration of 98 mEq/L?

Q8.1.22

A solution contains 128 mEq/L of Sr^{2+}. What volume of solution is needed to have a total mass of 3.93 g of strontium ions?

8.2: Chemical Equilibrium

(click here for solutions)

Q8.2.1

What is chemical equilibrium?

Q8.2.2

If the reaction $H_2 + I_2 \rightleftharpoons 2HI$ is at equilibrium, do the concentrations of HI, H_2, and I_2 have to be equal?

Q8.2.3

Do the concentrations at equilibrium depend upon how the equilibrium was reached?

Q8.2.4

What does the equilibrium constant tell us?

Q8.2.5

What does it mean if the K_{eq} is > 1?

Q8.2.6

What does it mean if the K_{eq} is < 1?

Q8.2.7

Does the equilibrium state depend on the starting concentrations?

8.3: Le Chatelier's Principle

(click here for solutions)

Q8.3.1

Define Le Chatelier’s principle.

Q8.3.2

List the three factors types of changes that can disturb the equilibrium of a system.

Q8.3.3

How will each change affect the reaction?

$PCl_5(g)$ + heat ⇌ $PCl_3(g) + Cl_2(g)$

a. Addition of PCl_5
b. Addition of Cl_2
c. Removal of PCl_3
d. Increasing temperature
e. Decreasing temperature
f. Decreasing volume

Q8.3.4

How will each change affect the reaction?

$HNO_2(aq) \rightleftharpoons H^+(aq) + NO_2^-(aq)$

a. Removal of HNO_2
b. Addition of HCl (i.e. adding more H^+)
c. Increasing volume
d. Decreasing volume
e. Removal of NO_2^-
f. Addition of OH^- (which will react with and remove H^+)

Q8.3.5

How will each change affect the reaction?

$CO_2(g) + C(s) \rightleftharpoons 2CO(g)\ \Delta H = 172.5\ kJ$

a. Addition of CO_2
b. Removal of CO_2
c. Increasing temperature
d. Decreasing temperature
e. Increasing volume
f. Addition of CO

Q8.3.6

How will each change affect the reaction?

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)\ \Delta H = -9.48\ kJ$

a. Addition of H_2
b. Removal of H_2
c. Increasing temperature
d. Decreasing temperature
e. Increasing volume
f. Decreasing volume

8.4: Osmosis and Diffusion

(click here for solutions)

Q8.4.1

What are some of the features of a semipermeable membrane?

Q8.4.2

Two solutions are separated by a semipermeable membrane. Solution A contains 25.0 g of NaCl in 100.0 mL of water and solution B contains 35.0 g of NaCl in 100.0 mL of water.

a. Which one has a higher concentration?
b. Which way will water molecules flow?
c. Which volume will increase?
d. Which volume will decrease?
e. What will happen to the concentration of solution A?
f. What will happen to the concentration of solution B?

Q8.4.3

What do the prefixes hyper, hypo, and iso mean?

Q8.4.4

Cells are placed in a solution and the cells then undergo hemolysis. What can be said about the relative concentrations of solute in the cell and the solution?

Q8.4.5

Describe the relative concentrations inside and outside a red blood cell when crenation occurs.

Q8.4.6

A saltwater fish is placed in a freshwater tank. What will happen to the fish? Describe the flow of water molecules to explain the outcome.

Q8.4.7

What makes up the "head" region of a phospholipid? Is it hydrophobic or hyrdrophillic?

Q8.4.8

What makes up the "tail" region of a phospholipid? Is it hydrophobic or hyrdrophillic?

8.5: Acid-Base Definitions

(click here for solutions)

Q8.5.1

Which statement below is true? Explain.

a. All Arrhenius bases are also Brønsted-Lowry bases.
b. All Brønsted-Lowry bases are also Arrhenius bases.

Q8.5.2

Classify each of the following as an acid, base, or neither.

a. $LiOH$
b. $HClO_4$
c. CH_3COOH
d. $Sr(OH)_2$
e. CH_4
f. CH_4OH

Q8.5.3

What does it mean to say that a substance is amphoteric?

Q8.5.4

Identify each reactant in the following reactions as an acid or a base according to the Brønsted-Lowry theory.

a. $HIO_3(aq) + H_2O(l) \rightleftharpoons IO_3^-(aq) + H_3O^+(aq)$
b. $F^-(aq) + HClO(aq) \rightleftharpoons HF(aq) + ClO^-(aq)$
c. $H_2PO_4^-(aq) + OH^-(aq) \rightleftharpoons HPO_4^{2-}(aq) + H_2O(l)$
d. $CO_3^{2-}(aq) + H_2O(l) \rightleftharpoons HCO_3^-(aq) + OH^-(aq)$

Q8.5.5

Referring to question 4, identify the conjugate acid-base pairs in each reaction.

Q8.5.6

Write the formula of each acid’s conjugate base.

a. HNO_3
b. HSO_3^-
c. H_3AsO_4
d. $HCOOH$
e. HPO_4^{2-}
f. H_2S
g. HS^-
h. HCO_3^-
i. H_2CO_3
j. H_3PO_4
k. $NaHSO_4$

Q8.5.7

Write the formula of each base’s conjugate acid.

a. BrO_3^-
b. NH_3
c. CH_3COO^-
d. HCO_3^-
e. CN^-
f. HPO_4^{2-}
g. HS^-
h. SO_4^{2-}
i. CO_3^{2-}
j. HCO_3^-
k. PH_3

Q8.5.8

Explain why the hydrogen phosphate ion (HPO_4^{2-}) is amphoteric.

8.6: The pH Concept

(click here for solutions)

Q8.6.1

Describe the process by which water self-ionizes, and explain why pure water is considered to be neutral.

Q8.6.2

Indicate whether solutions with the following pH values are acidic, basic, or neutral.

a. pH = 9.4
b. pH = 7.0
c. pH = 5.0

Q8.6.3

How can the pOH of a solution be determined if its pH is known? (Hint: Write a mathematical expression.)

Q8.6.4

Find pH and pOH of each solution.

a. $[H^+] = 2.3 \times 10^{-4}$ M
b. $[H^+] = 8.7 \times 10^{-10}$ M
c. $[OH^-] = 1.9 \times 10^{-9}$ M
d. $[OH^-] = 0.60$ M

Q8.6.5

Find pH and pOH of each solution.

a. $[H^+] = 1.0 \times 10^{-5}$ M
b. $[H^+] = 2.8 \times 10^{-11}$ M
c. $[OH^-] = 1.0 \times 10^{-2}$ M
d. $[OH^-] = 4.4 \times 10^{-9}$ M

Q8.6.6

Determine $[H^+]$ and $[OH^-]$ in aqueous solutions with the following pH or pOH values.

a. pH = 1.87
b. pH = 11.15
c. pH = 0.95
d. pOH = 6.21
e. pOH = 13.42
f. pOH = 7.03

Q8.6.7

You have prepared 1.00 L of a solution with a pH of 5.00. What is the pH of the solution if 0.100 L of additional water is added to it? (Hint: Calculate the moles of H^+ ions present in the solution.)

Q8.6.8

How much water would need to be added to the original solution in question 8 in order to bring the pH to 6.00?

Answers

8.1: Concentrations of Solutions

Q8.1.1

Concentrated solutions have more solute per unit of solvent or solution.

Q8.1.2

$M = \frac{mol\ solute}{L\ soln}$
$M = \frac{0.75\ mol}{0.250\ L}$
$M = 3.0\ M$

Q8.1.3

$mass\ \% = \frac{g\ solute}{g\ soln} \times 100$
$mass\ \% = \frac{12.0\ g}{40.0\ g + 12.0\ g} \times 100$
$mass\ \% = 23.1\ \%$

Remember, the mass of the solution includes both the solute and solvent.

Q8.1.4

$volume\ \% = \frac{L\ solute}{L\ soln} \times 100$
$volume\ \% = \frac{0.200\ L}{1.60\ L} \times 100$
$volume\ \% = 12.5\ \%$

Volumes can also be used in mL (or any other unit) as long as both volumes are in the same unit.

Q8.1.5

Write the concentration in "expanded form" which shows the relationship to then be used in dimensional analysis.

$5.00\ \%\ m/m = \frac{5.00\ g\ glucose}{100\ g\ solution}$

$250.0\ mL\ soln \left(\frac{1.00\ g\ soln}{mL\ soln}\right) \left(\frac{5.00\ g\ glucose}{100\ g\ soln}\right) = 12.5\ g\ glucose$

Q8.1.6

a. $\%\ m/m = \frac{mass\ solute}{mass\ solution} \times 100$
   $\%\ m/m = \frac{25.0\ g}{25.0\ g + 300\ g} \times 100$
   $\%\ m/m = 7.69\ \%$
b. The NaCl does not contribute to the volume of the solution so only the volume of the water is used for the volume fo the solution. Given the density is 1.00 g/mL, the volume of the solution is 300.0 mL.

   $\%\ m/v = \frac{mass\ solute}{volume\ solution} \times 100$
   $\%\ m/v = \frac{25.0\ g}{25.0\ mL + 300\ mL} \times 100$
   $\%\ m/v = 8.33\ \%$

Q8.1.7

The parts of this problem require both the volume and mass of solute and solvent. The volume of the solute and solvent are given so first, find the mass of the solute and solvent so all the values are present before we start calculating the concentrations.

$15.0\ mL\ \text{methanol} \left(\frac{0.792\ g}{mL\ \text{methanol}}\right) = 11.9\ g\ \text{methanol}$

$125.0\ mL\ \text{ethanol} \left(\frac{0.789\ g}{mL\ \text{ethanol}}\right) = 98.6\ g\ \text{ethanol}$

a. $\%\ m/m = \frac{mass\ solute}{mass\ solution} \times 100$
   $\%\ m/m = \frac{11.9\ g\ \text{methanol}}{11.9\ g + 98.6\ g} \times 100$
   $\%\ m/m = 10.8\ \%$
b. $\%\ m/v = \frac{mass\ solute}{volume\ solution} \times 100$
   $\%\ m/v = \frac{11.9\ g\ \text{methanol}}{15.0\ mL + 125\ mL} \times 100$
   $\%\ m/v = 8.50\ \%$
c. $\%\ v/v = \frac{volume\ solute}{volume\ solution} \times 100$
   $\%\ v/v = \frac{15.0\ mL\ \text{methanol}}{15.0\ mL + 125\ mL} \times 100$
   $\%\ v/v = 10.7$

Q8.1.8

Write the concentration in "expanded form" which shows the relationship to then be used in dimensional analysis.

$$10.5\ \%\ m/m = \frac{10.5\ g\ \mathrm{NaCl}}{100\ g\ soln}$$

$$150.0\ mL\ soln \left(\frac{1.00\ g\ soln}{mL\ soln}\right)\left(\frac{10.5\ g\ \mathrm{NaCl}}{100\ g\ soln}\right) = 15.8\ g\ \mathrm{NaCl}$$

Q8.1.9

a. $M = \frac{0.614\ mol\ \mathrm{Na_2SO_4}}{0.500\ L\ soln} = 1.23\ M$
b. $M = \frac{3.63\ mol\ \mathrm{NH_3}}{7.00\ L\ soln} = 0.519\ M$
c. $M = \frac{1.71\ mol\ \mathrm{EtOH}}{0.500\ L\ soln} = 3.43\ M$

Q8.1.10

$$0.250\ M = \frac{0.250\ mol\ \mathrm{KF}}{1\ L\ soln}$$

$$180.0\ mL\left(\frac{10^{-3}\ L}{1\ mL}\right)\left(\frac{0.250\ mol\ \mathrm{KF}}{1\ L\ soln}\right) = 0.0450\ mol\ \mathrm{KF}$$

Q8.1.11

a. $3.40\ L\left(\frac{0.780\ mol}{1\ L}\right)\left(\frac{162.2\ g}{mol}\right) = 430.\ g\ \mathrm{FeCl_3}$
b. $60.0\ mL\left(\frac{10^{-3}\ L}{1\ mL}\right)\left(\frac{4.10\ mol}{1\ L}\right)\left(\frac{158.17\ g}{mol}\right) = 38.9\ g\ \mathrm{Ca(CH_3COO)_2}$

Q8.1.12

$$0.500\ M = \frac{0.500\ mol\ \mathrm{NaI}}{1\ L\ soln}$$

$$113\ g\ \mathrm{NaI}\left(\frac{1\ mol}{149.89\ g}\right)\left(\frac{1\ L}{0.500\ mol}\right) = 1.51\ L\ soln$$

Q8.1.13

a. $C_1V_1 = C_2V_2$
$2.00\ M \cdot 0.125\ L = C_2 \cdot 4.00\ L$
$C_2 = 0.0625\ M$
b. $C_1V_1 = C_2V_2$
$6.30\ M \cdot 1.85\ mL = C_2 \cdot 5.00\ mL$
$C_2 = 2.33\ M$

Q8.1.14

$C_1V_1 = C_2V_2$
$0.300\ M \cdot 6.00\ L = 12\ M\backslash\mathrm{cdotV_2}$
$V_2 = 0.15\ L$

Q8.1.15

$$12\ ppm\ \mathrm{Pb} = \frac{12\ mg\ \mathrm{Pb}}{1\ L\ soln}$$

$$50.0\ mL\left(\frac{10^{-3}\ L}{1\ mL}\right)\left(\frac{12\ mg}{1\ L}\right) = 0.60\ mg\ \mathrm{Pb}$$

Q8.1.16

$$25\ ppb\ \mathrm{Hg} = \frac{25\ \mu g\ \mathrm{Hg}}{1\ L\ soln}$$

$$175\ mL\left(\frac{10^{-3}\ L}{1\ mL}\right)\left(\frac{25\ \mu g}{1\ L}\right) = 4.4\ \mu g\ \mathrm{Hg}$$

Q8.1.17

$$ppm = \frac{mg}{L}$$

$$34\ g\ \mathrm{Fe}\left(\frac{1\ mg}{10^{-3}\ g}\right) = 3.4 \times 10^4\ mg\ \mathrm{Fe}$$

$365\ mL \left(\frac{10^{-3}\ L}{1\ mL}\right) = 0.365\ L$

$ppm = \frac{3.4 \times 10^4\ mg\ \mathrm{Fe}}{0.365\ L} = 9.3 \times 10^4\ ppm\ \mathrm{Fe}$

Q8.1.18

a. $2.0\ mol\ \mathrm{Mg^{2+}} \left(\frac{2\ Eq}{1\ mol}\right) = 4.0\ Eq$
b. $2.0\ mol\ \mathrm{Al^{3+}} \left(\frac{3\ Eq}{1\ mol}\right) = 6.0\ Eq$
c. $2.0\ mol\ \mathrm{S^{2-}} \left(\frac{2\ Eq}{1\ mol}\right) = 4.0\ Eq$
d. $2.0\ mol\ \mathrm{Br^{-}} \left(\frac{1\ Eq}{1\ mol}\right) = 2.0\ Eq$
e. $2.0\ mol\ \mathrm{Cs^{+}} \left(\frac{1\ Eq}{1\ mol}\right) = 2.0\ Eq$
f. $2.0\ mol\ \mathrm{Ba^{2+}} \left(\frac{2\ Eq}{1\ mol}\right) = 4.0\ Eq$

Q8.1.19

a. $2.50\ mol\ \mathrm{Mg^{2+}} \left(\frac{2\ Eq}{1\ mol}\right) = 5.00\ Eq$
b. $2.50\ mol\ \mathrm{Al^{3+}} \left(\frac{3\ Eq}{1\ mol}\right) = 7.50\ Eq$
c. $2.50\ mol\ \mathrm{S^{2-}} \left(\frac{2\ Eq}{1\ mol}\right) = 5.00\ Eq$
d. $2.50\ mol\ \mathrm{Br^{-}} \left(\frac{1\ Eq}{1\ mol}\right) = 2.50\ Eq$
e. $2.50\ mol\ \mathrm{Cs^{+}} \left(\frac{1\ Eq}{1\ mol}\right) = 2.50\ Eq$
f. $2.50\ mol\ \mathrm{Ba^{2+}} \left(\frac{2\ Eq}{1\ mol}\right) = 5.00\ Eq$

Q8.1.20

$250.0\ mL \left(\frac{10^{-3}\ L}{1\ mL}\right) \left(\frac{132\ mEq}{L}\right) \left(\frac{10^{-3}\ Eq}{1\ mEq}\right) \left(\frac{1\ mol\ \mathrm{Ca^{2+}}}{2\ Eq}\right) = 0.0165\ mol\ \mathrm{Ca^{2+}}$

Q8.1.21

$500.0\ mL \left(\frac{10^{-3}\ L}{1\ mL}\right) \left(\frac{98\ mEq}{L}\right) \left(\frac{10^{-3}\ Eq}{1\ mEq}\right) \left(\frac{1\ mol\ \mathrm{K^{+}}}{1\ Eq}\right) \left(\frac{39.10\ g}{mol}\right) = 1.92\ g\ \mathrm{K^{+}}$

Q8.1.22

$3.93\ g\ \mathrm{Sr^{2+}} \left(\frac{1\ mol}{87.62\ g}\right) \left(\frac{2\ Eq}{1\ mol}\right) \left(\frac{1\ mEq}{10^{-3}\ Eq}\right) \left(\frac{1\ L}{128\ mEq}\right) = 0.701\ L\ soln$

8.2: Chemical Equilibrium

Q8.2.1

The rate of the forward reaction equals the rate of the reverse reaction.

Q8.2.2

No, the concentrations are constant but the concentrations do not have to be equal.

Q8.2.3

No.

Q8.2.4

The ratio of products and reactants when the system is at equilibrium.

Q8.2.5

More products than reactants are present at equilibrium.

Q8.2.6

More reactants than products present at equilibrium.

Q8.2.7

No. The equilibrium ratio does not depend on the initial concentrations.

8.3: Le Chatelier's Principle

Q8.3.1

Le Chatelier's principle states that a system at equilibrium is disturbed, it will respond in a way to minimize te disturbance.

Q8.3.2

temperature, change in amount of substance, change in pressure through change in volume

Q8.3.3

a. shift right
b. shift left
c. shift right
d. shift right
e. shift left
f. shift left

Q8.3.4

a. shift left
b. shift left
c. no effect
d. no effect
e. shift right
f. shift right

Q8.3.5

a. shift right
b. shift left
c. shift right
d. shift left
e. shift right
f. shift left

Q8.3.6

a. shift right
b. shift left
c. shift left
d. shift right
e. no effect
f. no effect

8.4: Osmosis and Diffusion

Q8.4.1

A semipermeable membrane allows some substances to pass through but not others.

Q8.4.2

Two solutions are separated by a semipermeable membrane. Solution A contains 25.0 g of NaCl in 100.0 mL of water and solution B contains 35.0 g of NaCl in 100.0 mL of water.

a. Solution B
b. $A \rightarrow B$
c. B
d. A

e. increase
f. decrease

Q8.4.3

hyper - higher

hypo - lower

iso - same

Q8.4.4

Cells contain fluid with higher concentration than solution outside the cell.

Q8.4.5

Cells contain fluid with a lower concentration than the solution outside the cell.

Q8.4.6

Water molecules will flow from the tank water into the fish because the fish has a higher concentration of salt. If the fish absorbs too much water, it will die.

Q8.4.7

The "head" region is a phosphate group and it is hydrophillic.

Q8.4.8

The "tail" is a hydrocarbon tail and it is hydrophobic.

8.5: Acid-Base Definitions

Q8.5.1

a. TRUE
b. FALSE - Bronsted-Lowry acid-base definitions are broader.

Q8.5.2

Classify each of the following as an acid, base, or neither.

a. base (contains metal and -OH group)
b. acid (formula starts with H and isn't water)
c. acid (contains -COOH which is carboxylic acid functional group)
d. base (contains metal and -OH group)
e. neither
f. neither (-OH group has to be with metal)

Q8.5.3

Amphoteric substances can act as an acid or base.

Q8.5.4

Identify each reactant in the following reactions as an acid or a base according to the Brønsted-Lowry theory.

a. HIO_3(*aq*) - acid; H_2O(*l*) - base; IO_3^-(*aq*) - base ; H_3O^+(*aq*) - acid
b. F^-(*aq*) - base; HClO(*aq*) - acid; HF(*aq*) - acid; ClO^-(*aq*) - base
c. $H_2PO_4^-$(*aq*) - acid; OH^-(*aq*) - base; HPO_4^{2-}(*aq*) - base; H_2O(*l*) - acid
d. CO_3^{2-}(*aq*) - base; H_2O(*l*) - acid; HCO_3^-(*aq*) - acid; OH^-(*aq*) - base

Q8.5.5

a. HIO_3/IO_3^- and H_3O^+/H_2O
b. HF/F^- and $HClO/ClO^-$
c. $H_2PO_4^-/HPO_4^{2-}$ and H_2O/OH^-
d. HCO_3^-/CO_3^{2-} and H_2O/OH^-

Q8.5.6

a. NO_3^-
b. SO_3^{2-}
c. $H_2AsO_4^-$
d. $HCOO^-$ (the H that is removed comes from the carboxylic acid functional group)
e. PO_4^{3-}
f. HS^-
g. S^{2-}
h. CO_3^{2-}
i. HCO_3^-
j. $H_2PO_4^-$
k. Na_2SO_4 or $NaSO_4^-$

Q8.5.7

Write the formula of each base's conjugate acid.

a. $HBrO_3$
b. NH_4^+
c. CH_3COOH
d. H_2CO_3
e. HCN
f. $H_2PO_4^-$
g. H_2S
h. HSO_4^-
i. HCO_3^-
j. H_2CO_3
k. PH_4^+

Q8.5.8

HPO_4^{2-} can act as a base and accept a proton to form $H_2PO_4^-$ and it can act as an acid and donate a proton to form PO_4^{3-}.

8.6: The pH Concept

Q8.6.1

$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$

It's neutral because there are equal amounts of H^+ and OH^-.

Q8.6.2

Indicate whether solutions with the following pH values are acidic, basic, or neutral.

a. basic
b. neutral
c. acidic

Q8.6.3

pH + pOH = 14

Q8.6.4

a. pH = 3.64; pOH = 10.36
b. pH = 9.06; pOH = 4.94
c. pOH = 8.72; pH = 5.28
d. pOH = 0.22; pH = 13.78

Q8.6.5

a. pH = 5.00; pOH = 9.00

b. pH = 10.55; pOH = 4.94
c. pOH = 8.72; pH = 5.28
d. pOH = 0.22; pH = 13.78

Q8.6.6

a. $[\mathrm{H}^+] = 1.3 \times 10^{-2}\ M, [\mathrm{OH}^-] = 7.4 \times 10^{-13}\ M$
b. $[\mathrm{H}^+] = 7.1 \times 10^{-12}\ M, [\mathrm{OH}^-] = 1.4 \times 10^{-3}\ M$
c. $[\mathrm{H}^+] = 0.11\ M, [\mathrm{OH}^-] = 8.9 \times 10^{-14}\ M$
d. $[\mathrm{OH}^-] = 6.2 \times 10^{-7}\ M, [\mathrm{H}^+] = 1.6 \times 10^{-8}\ M$
e. $[\mathrm{OH}^-] = 3.8 \times 10^{-14}\ M, [\mathrm{H}^+] = 0.26\ M$
f. $[\mathrm{OH}^-] = 9.3 \times 10^{-8}\ M, [\mathrm{H}^+] = 1.1 \times 10^{-7}\ M$

Q8.6.7

Given pH = 5.00, we know $[\mathrm{H}^+] = 1.0 \times 10^{-5}\ M$ which means $M = \frac{1.0 \times 10^{-5}\ mol\ \mathrm{H}^+}{1.00\ L}$.

If 0.100 L of water is added to 1.00 L, then the volume changes to 1.10 L but the moles of H^+ does not change. The molarity can be calclulated with the same number of moles and the new volume.

$$M = \frac{1.0 \times 10^{-5}\ mol\ \mathrm{H}^+}{1.00 + 0.100\ L}$$
$$M = 9.1 \times 10^{-6}\ M$$

$$pH = 5.04$$

Q8.6.8

How much water would need to be added to the original solution in question 8 in order to bring the pH to 6.00?

To get to pH = 6.00, we need $[\mathrm{H}^+] = 1.0 \times 10^{-6}\ M$.

Use the dilution formula to calculate the total volume of solution.

$$C_1V_1 = C_2V_2$$
$$1.0 \times 10^{-5}\ M \cdot 1.00\ L = 1.0 \times 10^{-6}\ M \cdot V_2\ V_2 = 10.\ L$$

The total volume is 10. L so 9 L needs to be added to the original 1 L solution.
