

Chemistry Semester 2 MT 2 Study Guide

Short Answer

Compare and contrast each of the following terms.

1. Arrhenius model and Brønsted-Lowry model
2. acid and conjugate base, conjugate acid-base pair
3. pH and pOH

Problem

4. How would you prepare each of the following solutions? Show your calculations. 1.00 L of a 2.00M aqueous solution of sodium hydroxide (NaOH)
5. How would you prepare each of the following solutions? Show your calculations. 90.0 mL of a 1.20M aqueous solution of sodium oxalate ($\text{Na}_2\text{C}_2\text{O}_4$) from a 2.00M solution of $\text{Na}_2\text{C}_2\text{O}_4$
6. Calculate the pH of a solution with a $[\text{H}^+]$ of 1.0×10^{-4} .
7. What are $[\text{H}^+]$ and $[\text{OH}^-]$ for a solution that has a pH of 3.92?
8. Find the $[\text{H}^+]$, the pOH, and the $[\text{OH}^-]$ of a solution with a pH of 4.20.
9. What is the percent by mass of 92.3 g of potassium fluoride (KF) dissolved in 1000.0 g of water?
10. A 500.0 g-sample of aqueous hydrogen peroxide (H_2O_2) contains 31.50% H_2O_2 by mass. Find the mass of hydrogen peroxide in the solution.
11. If 24.0 mL of methanol (CH_3OH) is dissolved in 48.0 mL of water, determine the percent by volume of methanol in the solution.
12. How would you correctly prepare 125 mL of a 0.30M solution of copper(II) sulfate (CuSO_4) from a 2.00M solution of CuSO_4 ?
13. A 22.0-mL sample of 12M H_2SO_4 is diluted to a volume of 1200.0 mL. What is the molarity of the diluted solution?
14. Copper metal has a specific heat of $0.385 \text{ J/g}\cdot^\circ\text{C}$ and a melting point of 1083°C . Calculate the amount of heat required to raise the temperature of 22.8 g of copper from 20.0°C to 875°C .
15. How many degrees of temperature rise will occur when a 25.0-g block of aluminum absorbs 10.0 kJ of heat? The specific heat of aluminum is $0.897 \text{ J/g}\cdot^\circ\text{C}$.
16. What is the molarity of a KOH solution if 25.0 mL of it is neutralized by 31.7 mL of a 0.100M nitric acid solution?

Chemistry Semester 2 MT 2 Study Guide Answer Section

SHORT ANSWER

- ANS:
Both are models of acids and bases. An Arrhenius acid contains ionizable hydrogen atoms, and the bases contain hydroxide groups. A Brønsted-Lowry acid donates H^+ , and a base accepts H^+ .
- ANS:
A conjugate acid is the result of the acceptance of an H^+ by a Brønsted-Lowry base, and a conjugate base is the result of an H^+ being donated by a Brønsted-Lowry acid. A conjugate acid-base pair consists of two substances related to each other by the donating and accepting of a single hydrogen ion.
- ANS:
pH is the negative logarithm of the $[H^+]$, and the pOH is the negative logarithm of the $[OH^-]$. $pH + pOH = 14$.

PROBLEM

- ANS:
Molarity = moles of solute/liters of solution
 $2.00M NaOH = 2.00 \text{ mol NaOH}/1.00 \text{ L of solution}$
 $(2.00 \text{ mol NaOH})(40.00 \text{ g NaOH}/1 \text{ mol NaOH}) = 80.00 \text{ g NaOH}$
Add 80.00 g of NaOH to a 1-L volumetric flask. Add distilled water to the flask to completely dissolve the NaOH. Carefully add additional distilled water to bring the solution up to the 1-L calibration line.
- ANS:
 $M_1V_1 = M_2V_2$
 $V_1 = V_2(M_2/M_1) = (90.0 \text{ mL})(1.20M/2.00M) = 54.0 \text{ mL}$
Add 54.0 mL 2.00M $Na_2C_2O_4$ to a graduated cylinder. Carefully add distilled water to bring the solution up to the 90.0-mL calibration line.
- ANS:
 $pH = -\log[H^+] = -\log(1.0 \times 10^{-4})$, $pH = -\log(0 + (-4)) = 4.00$
- ANS:
 $[H^+] = \text{antilog}(-3.92) = 1.2 \times 10^{-4}M$; $[OH^-] = 1.0 \times 10^{-14}/1.2 \times 10^{-4}$
 $= 8.3 \times 10^{-11}M$
- ANS:
 $[H^+] = \text{antilog}(-4.20) = 6.3 \times 10^{-5}M$, $pOH = 14.00 - 4.20 = 9.80$,
 $[OH^-] = 1.0 \times 10^{-14}/6.3 \times 10^{-5} = 1.6 \times 10^{-10}M$
- ANS:
mass of solution =
mass of solute + mass of solvent
mass of solution = $1000.0 \text{ g} + 92.3 \text{ g} = 1092.3 \text{ g}$
Percent by mass = $\frac{\text{mass of solute}}{\text{mass of solution}} \times 100\%$
 $= \left(\frac{92.3 \text{ g}}{1092.3 \text{ g}}\right)(100\%)$
Percent by mass = 8.45%

10. ANS:

$$\text{Percent by mass} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100\%$$

Mass of solute

$$= \frac{\text{percent by mass}}{100\%} \times \text{mass of solution}$$

$$= \left(\frac{31.50\%}{100\%} \right) (500.0 \text{ g})$$

$$\text{mass of solute} = 157.5 \text{ g (H}_2\text{O}_2)$$

11. ANS:

volume of solution =

volume of solute + volume of solvent

$$\begin{aligned} \text{volume of solution} &= 24.0 \text{ mL} + 48.0 \text{ mL} \\ &= 72.0 \text{ mL} \end{aligned}$$

$$\text{Percent by volume} = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100\%$$

$$= \left(\frac{24.0 \cancel{\text{ mL}}}{72.0 \cancel{\text{ mL}}} \right) (100\%)$$

$$\text{Percent by volume} = 33.3\%$$

12. ANS:

$$M_1V_1 = M_2V_2$$

$$V_1 = V_2 \frac{M_2}{M_1} = (125 \text{ mL}) \left(\frac{0.30M}{2.00M} \right) = 19 \text{ mL}$$

Dilute 19 mL 2.00M CuSO₄ solution to 125 mL with water.

13. ANS:

$$M_1V_1 = M_2V_2$$

$$M_2 = M_1 \frac{V_1}{V_2} = (12M) \left(\frac{22.0 \cancel{\text{ mL}}}{1200.0 \cancel{\text{ mL}}} \right)$$

$$= 0.22M \text{ H}_2\text{SO}_4$$

14. ANS:

$$q = c \times m \times \Delta T$$

$$q = 0.385 \cancel{\text{ J/g}^\circ\text{C}} \times 22.8 \cancel{\text{ g}} \times (875^\circ\text{C} - 20.0^\circ\text{C}) \times$$

$$\frac{1 \text{ kJ}}{1000 \cancel{\text{ J}}} = 7.51 \text{ kJ}$$

15. ANS:

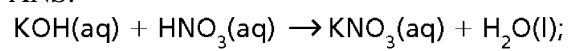
$$q = c \times m \times \Delta T$$

$$\Delta T = \frac{q}{c \times m}$$

$$(T_{\text{final}} - T_{\text{initial}}) = 10\,000 \cancel{\text{ J}} (25.0 \cancel{\text{ g}} \times$$

$$0.897 \cancel{\text{ J/g}^\circ\text{C}}) = 446^\circ\text{C}$$

16. ANS:



$$0.0317 \text{ L HNO}_3 \times 0.100 \text{ mol HNO}_3 / \text{L HNO}_3$$

$$= 3.17 \times 10^{-3} \text{ mol HNO}_3;$$

$$\text{mol HNO}_3 : \text{mol KOH} = 1:1,$$

$$\text{so } 3.17 \times 10^{-3} \text{ mol HNO}_3 : 3.17 \times 10^{-3} \text{ mol KOH};$$

$$3.17 \times 10^{-3} \text{ mol KOH} / 0.0250 \text{ L KOH} = 0.127\text{M}$$