Name: Solutions

Part A: Multiple Choice - *Identify the choice that best completes the statement or answers the question. Place your answer in the space provided to the left of each question.* **[16]**

D 1. When an acid reacts with a base, what compounds are formed?
a. a salt only
b. water only
c. metal oxides only
(d.) a salt and water

B 2. What is the formula for phosphoric acid?
a. H_2PO_3
(b.) H_3PO_4
c. HPO_2
d. HPO_4

A 3. Which of the following is a property of an acid?
(a.) sour taste
b. nonelectrolyte
c. strong color
d. unreactive

C 4. The formula of the hydrogen ion is often written as ____.
a. H_2O^+
b. OH^+
(c.) H^+
d. H_4N^+

A 5. Which of these is an Arrhenius base?
(a.) LiOH
b. NH_3
c. $H_2PO_4^-$
d. CH_3COOH

B 6. What is transferred between a conjugate acid-base pair?
a. an electron
(b.) a proton
c. a hydroxide ion
d. a hydronium ion

B 7. A Lewis acid is a substance that can ____.
a. donate a pair of electrons
(b.) accept a pair of electrons
c. donate a hydrogen ion
d. accept a hydrogen ion

B 8. What type of acid is sulfuric acid?
a. monoprotic
(b.) diprotic
c. triprotic
d. none of the above

A 9. Which compound can act as both a Brønsted-Lowry acid and a Brønsted-Lowry base?
(a.) water
b. ammonia
c. sodium hydroxide
d. hydrochloric acid

C 10. In the reaction $CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$, the carbonate ion is acting as a(n) ____.
a. Arrhenius base
b. Arrhenius acid
(c.) Brønsted-Lowry base
d. Brønsted-Lowry acid

B 11. If the hydrogen ion concentration of a solution is $10^{-10}M$, is the solution acidic, alkaline, or neutral?
a. acidic
(b.) alkaline
c. neutral
d. The answer cannot be determined.

D 12. The products of self-ionization of water are ____.
a. H_3O^+ and H_2O
b. OH^- and OH^+
c. OH^+ and H^-
(d.) OH^- and H^+

D 13. In a neutral solution, the $[H^+]$ is ____.
a. $10^{-14}M$
b. zero
c. $1 \times 10^7 M$
(d.) equal to $[OH^-]$

B 14. What is the best description for a solution with a hydroxide-ion concentration of $1 \times 10^{-4}M$?
a. acidic
(b.) basic
c. neutral
d. The answer cannot be determined.

A 15. What is pH?
(a.) the negative logarithm of the hydrogen ion concentration
b. the positive logarithm of the hydrogen ion concentration
c. the negative logarithm of the hydroxide ion concentration
d. the positive logarithm of the hydroxide ion concentration

Remove

C 16. Which of these solutions is the most basic?

a. $[H^+] = 1 \times 10^{-2} M$ 2
b. $[OH^-] = 1 \times 10^{-4} M$ 10
c. $[H^+] = 1 \times 10^{-11} M$ 11
d. $[OH^-] = 1 \times 10^{-13} M$ 1

Part C: Short Answer

Answer each question in the space provided. You must show ALL work to receive points. No points will be given for answers with ONLY a correct numerical response.

1. Calculate the hydrogen-ion concentration $[H^+]$ for an aqueous solution in which $[OH^-]$ is 1×10^{-11} mol/L. Is this solution acidic, basic, or neutral? [2]

$[H^+] = 1 \times 10^{-3} M$ (1)

Remove

Acidic (1)

2. If the pH of a solution is 9, what is the concentration of hydroxide ion? [2]

$9 = -\log [H^+]$

$[H^+] = 10^{-9} M$ (1)

$[OH] = 1 \times 10^{-5} M$ (1)

3. What is the hydrogen-ion concentration in a solution if the pH is 3.7? [2]

$3.7 = -\log [H^+]$

$[H^+] = 10^{-3.7}$ (1)

$[H^+] = 2.0 \times 10^{-4} M$ (1)

4. What is the pH of a hydrochloric acid solution with a concentration of 0.01*M*? [1]

$pH = -\log (0.01)$

$pH = 2$

5. What is the pH of a solution that contains 42 grams of hydrobromic acid dissolved in 1.75 litres of water? [3]

$42\ g \times \frac{1\ mol}{81.9119\ g} = 0.5127\ mol\ HBr$ (1) $[HBr] = 0.2929\ M$ (1)

$pH = -\log (0.2929) = 0.53$ (1)

6. What is the pH and pOH of a solution made from adding 550 mL of water to 275 mL of 3.6×10^{-3} M sodium hydroxide? [3]

$M_1V_1 = M_2V_2$

$275 \cdot 3.6 \times 10^{-3} = M_2 (825)$

$M_2 = 1.2 \times 10^{-3} M$ (1)

$pH = 14 - pOH$

$pH = 14 - 2.92$

$pH = 11.08$ (1)

$pOH = -\log [OH]$

$pOH = -\log (1.2 \times 10^{-3})$

$pOH = 2.92$ (1)

7. A swimming pool must have a pH of around 4 for hygienic reasons. How many grams of HCl must be added to a pool with a capacity of 2.5×10^6 litres of water to reach a pH of 4? [3]

$4 = -\log [H^+]$

$[H^+] = 10^{-4} M = [HCl]$ (1)

$\frac{10^{-4}\ mol}{1\ L} \times 2.5 \times 10^6\ L = 250\ mol\ HCl \times \frac{36.4609\ g}{1\ mol} = 9115.225\ g$ (1) (1)

You must add 9100 g of HCl

8. A 0.500*M* solution of a weak acid, H*X*, is only partially ionized. The $[H^+]$ was found to be $4.02 \times 10^{-3} M$. Find the dissociation constant for this acid. [3]

	HX	H^+	X^-
I	0.5	0	0
C	-4.02×10^{-3}	$+4.02 \times 10^{-3}$	
E	0.49598	$+4.02 \times 10^{-3}$	

(1)

$K_a = \frac{[H^+][X^-]}{[HX]}$ (1) $[H^+] = [X^-]$

$K_a = \frac{(4.02 \times 10^{-3})^2}{0.49598} = 3.26 \times 10^{-5}$ (1)

9. What is the pH of a 0.100 M solution of hydrocyanic acid? The K_a for hydrocyanic acid is 6.4×10^{-10}. [3]

$K_a = \frac{[H^+][CN^-]}{[HCN]}$ (1)

$K_a = \frac{[H^+]^2}{[HCN]}$

$6.4 \times 10^{-10} = \frac{[H^+]^2}{0.100}$

$[H^+] = 8.0 \times 10^{-6} M$ (1)

$pH = -\log (8.0 \times 10^{-6})$

$pH = 5.10$ (1)

10. What is the pH of a solution containing 0.025 M HCl and another monoprotic acid that has a concentration of 0.0034 M and a K_a of 1.4×10^{-4}? [4]

$[H^+] = [HCl] + [HX]$ (1)

$= 0.025 + 6.9 \times 10^{-4}$

$= 0.02569$ (1)

$pH = -\log (0.02569)$

$pH = 1.59$ (1)

$K_a = \frac{[H^+][X^-]}{[HX]}$

$1.4 \times 10^{-4} = \frac{[H^+]^2}{0.0034}$ (1)

$[H^+] = 6.9 \times 10^{-4} M$

Part C: Essay

1. How do the three acid-base theories studied in class differ? [3]

Arrhenius - acids contain H^+ and bases OH^- that are present in aqueous solutions

Brønsted-Lowry - acids donate H^+, bases accept H^+

Lewis - acids accept e^- pair, bases donate e^- pair

2. How is strength different from concentration for acids and bases? Give an example. [3]

Strength is how much an acid or base dissociates in water. At equilibrium, strong acids and bases favour products while weak ones favour reactants.

Concentration is about how much acid or base is dissolved in water.

An acid can be strong but dilute. Ex: 0.0001M HCl or weak and concentrated ex: 1.0M CH_3COOH

37

Formulas	$pOH = -\log[OH^-]$
$M_1V_1 = M_2V_2$	$pH = -\log[H^+]$