For this unit examination, you must be able to:

- **explain** how the use of indicators, pH paper or pH meters can be used to measure $H_3O^+(aq)$
- **define** Arrhenius (modified) acids as substances that produce $H_3O^+(aq)$ in aqueous solutions and recognize that the definition is limited
- **define** Arrhenius (modified) bases as substances that produce $OH^-(aq)$ in aqueous solutions and recognize that the definition is limited
- **define** neutralization as a reaction between hydronium and hydroxide ions
- **differentiate**, qualitatively, between strong and weak acids and between strong and weak bases on the basis of ionization and dissociation; i.e., pH, reaction rate and electrical conductivity
- **identify** monoprotic and polyprotic acids and bases and compare their ionization/ dissociation
- **design** an experiment to differentiate among acidic, basic and neutral solutions
- **design** an experiment to differentiate between weak and strong acids and between weak and strong bases
- **determine** the pH for a variety of solutions using indicators

Practice Questions

1. Sodium bicarbonate is used medicinally to counteract excess stomach acidity. How many moles of solid sodium bicarbonate would be needed to make 100 mL of a 0.660 mol/L solution suitable for use as an antacid?

A. 0.0660 mol
B. 0.152 mol
C. 66.0 mol
D. 152 mol

$C = \frac{n}{V}$

$0.660 = \frac{n}{0.100}$

Numerical Response

1. What is the molar concentration of a caustic soda (sodium hydroxide) solution if 10 L of concentrated caustic soda solution is diluted to 400 L? The concentration of the stock solution is 19.1 mol/L.

$C_1V_1 = C_2V_2$

$(19.1)(10) = C_2(400)$

$C_2 = 0.4775$

Answer: 0.48 **mol/L**

(Record your **answer rounded to two decimal places** in the numerical response section of your answer sheet.)

2. Which one of the following substances is an Arrhenius acid?

releases H^+

A. $C_6H_{12}(l)$
B. $NH_3(aq)$
C. $HClO_4(aq)$
D. $CO_3^{2-}(aq)$

3. If a nitric acid solution has a hydronium ion concentration of 2.67×10^{-4} mol/L, what is the pH of this solution?

$pH = -\log(2.67 \times 10^{-4})$

A. 2.670
B. 3.272
C. 3.573
D. 8.228

4. A perchloric acid solution has a pH of 1.23. Which row correctly shows the $H_3O^+(aq)$ ion concentration and the pOH, respectively?

$[H_3O^+] = 10^{-1.23}$

Row	$[H_3O^+(aq)]$	pOH
A.	5.9×10^{-2} mol/L	12.77
B.	9.0×10^{-2} mol/L	10.23
C.	1.7×10^{-13} mol/L	11.23
D.	3.5×10^{-3} mol/L	12.77

5. The concentration of the strong base, sodium hydroxide (NaOH), is 5.56×10^{-3} mol/L. Which row shows the pOH and pH of this solution, respectively?

Row	pOH	pH
A.	11.745	2.255
B.	2.255	11.745
C.	0.01799	13.9820
D.	13.9820	0.01799

$[OH^-] = 5.56 \times 10^{-3}$

$pOH = -\log(5.56 \times 10^{-3})$
$= 2.255$

$pH = 11.75$

6. A student wants to determine the pH of a solution of sodium hydroxide. In bromothymol blue, the solution turned blue, in phenolphthalein the solution was pink and in alizarin yellow R, the solution turned orange. What is the approximate pH of the solution?

Bromothymol blue → blue greater 7.6
phenolphthalein → pink greater 10.0
alizarin yellow R → orange ~~less than 10.1~~ between 10.1 - 12.

A. 8.5
B. 9.5
C. 11.0
D. 13.0

7. A student places a magnesium strip into an unknown solution. Bubbles slowly start to appear where the strip is immersed in the solution. The student infers that the unknown solution is most likely:

A. a strong acid
B. a strong base
C. a weak acid
D. a weak base

8. Which one of the following is a polyprotic base?

A. $OH^-(aq)$
B. $PO_4^{3-}(aq)$
C. $HCO_3^-(aq)$
D. $NH_3(aq)$

9. Considering $H_2SO_4(aq)$ and $HSO_4^-(aq)$, which one of the following statements is true?

A. They are both strong acids.
B. They are both diprotic.
C. Given the same volume and concentration, both neutralize the equivalent moles of NaOH.
D. $H_2SO_4(aq)$ acts only as an acid; $HSO_4^-(aq)$ can act as an acid or a base.

1. **Determine** the pH of a 7.53×10^{-4} mol/L calcium hydroxide solution. **(3 marks)**

$Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^-$
7.53×10^{-4} $\quad 2 \times 7.53 \times 10^{-4}$

$pOH = -\log(1.506 \times 10^{-3}) = 2.82$
$pH = 14 - 2.82 = 11.178$

2. **Determine** the hydroxide ion concentration, $OH^-(aq)$, in a solution of shampoo that has a pH of 8.842. **(3 marks)**

$pH = 8.842 \rightarrow pOH = 5.158$
$[OH^-] = 10^{-5.158}$
$= 6.958 \times 10^{-6}$ mol/L