Name_____ Date _____

STUDY GUIDE – CHAPTER 2
MOLECULES AND SOLUTIONS

1) DETERMINE THE CONCENTRATION OF AN AQUEOUS SOLUTION (g/L, mass percent, or ppm)

- A ***solution*** is a homogenous mixture made of a ***solute*** and a ***solvent***. In an ***aqueous*** solution, the solvent is water (substances are dissolved in water).

- The ***concentration*** of a solution measures how ***strong*** a solution is and is given by the following formula:

$$\text{Concentration} = \frac{\text{amount of solute}}{\text{amount of solution}}$$

The amount of solute and solvent can be expressed using different measurement units and therefore the concentration of a solution can be redefined in several different ways.

A) Concentration in ***grams per litre (g/L)***:

$$\text{C}(g/L) = \frac{\text{mass of a solute (g)}}{\text{volume of solution (L)}}$$

Most commonly, a shorter version of this formula is used: $C = \frac{m}{V}$

Example: A solution of 5 g/L sugar concentration will contain 5 g of sugar for every 1 litre or 1000 mL of solution. The concentration of this solution can be written as:

$$\text{C}(g/L) = \frac{5\,\text{g of a solute}}{1\,\text{L of solution}} = 5g/L$$

B) Concentration in ***percent mass/volume***:

$$\%\,\text{m/V} = \frac{\text{mass of a solute(g)}}{100\,\text{mL of solution}}$$

Example: A solution labelled 15 % m/V sodium hydroxide contains 15 g of sodium hydroxide for every 100 mL of solution: The concentration of this solution can be written as:

$$C = \frac{15\,\text{g of sodium hydroxide}}{100\,\text{mL of solution}} = 15\%m/V$$

C) Concentration in ***parts per million(ppm)***:

- It is used when the amount of solute in a solution is extremely small.
- Represents is the ***number of parts*** of solute in ***one million parts of solution***.

$$\mathbf{C}_{(\mathrm{ppm})} = \frac{number\ of\ parts\ of solute}{number\ of\ parts\ of\ solution}$$

Considering that 1 Kg contains one million milligrams and the mass of 1L of water ≈ 1 Kg, concentration in ppm can be written as:

$$1ppm = \frac{1\,\mathrm{mg}}{\mathrm{kg}} = \frac{1\,\mathrm{mg}}{\mathrm{L}}$$

Example: Water in public swimming pools usually contains about 4 ppm of chlorine, to control bacterial growth. This means that for every million parts of water, four parts are chlorine.

$$\mathbf{C}_{(\mathrm{ppm})} = \frac{4\ mg\ chlorine}{1kg\ water} = 4\ ppm$$

SAMPLE QUESTIONS

1) If 30 grams of NaOH are dissolved and then diluted to 2.0 L with water, ***what is the concentration of the solution?*** Express the concentration in g/L. Show all your work.

2) ***What mass of salt is needed to make 300 mL of a 2 g/L solution?*** Express the concentration in g/L. Show all your work.

3) ***What is the volume of a solution with a concentration of 50g/L, for which we are using 10 grams of solute?*** Express the concentration in g/L. Show all your work.

4) ***Find the concentration for each of the following:***

	in g/L	**%m/V**
20 g of NaCl dissolved in 5 L of solution		
2.8 g of NaBr dissolved in 200 mL of solution		
200 mg of KCl dissolved in 75 mL of solution		
0.001 kg of solute in 50 mL of solution		
20 grams of solute in 100 mL of solution		

5) City regulations state that municipal swimming pools must be closed when the concentration of free available residual chlorine is less that 0.3 ppm or greater than 5 ppm. The table below lists the concentrations of free available residual chlorine in water samples taken from four swimming pools. ***Which of these pools has water that complies with these regulations?*** Show all your work.

SWIMMING POOL	CONCENTRATION OF FREE AVAILABLE RESIDUAL CHLORINE
1	0.00003 %(m/V)
2	0.00005 %(m/V)
3	0.0003 g/L
4	0.0061 g/L

1) **Swimming pool 1** - Determine the chlorine concentration in parts per million:

   C_1=

2) **Swimming pool 2** - Determine the chlorine concentration in parts per million:

   C_2 =

3) **Swimming pool 3** - Determine the chlorine concentration in parts per million:

   C_3 =

4) **Swimming pool 4** - Determine the chlorine concentration in parts per million:

   C_4=

Answer: The pools _____ have water that complies with the regulations

6) ***In which of the following situations the best unit for measuring the concentration would be %m/V?***

A) an amount of table salt dissolved in water

B) an amount of salt dissolved in 100 ml of solution

C) the amount of mercury in a bird's blood

D) the amount of alcohol in a bottle of beer

2) *DEFINE THE CONCEPT OF ELECTROLYTE*

- Electrolytes are substances which, when dissolved in water, dissociate to release positive and negative ions and enable an electrical current to pass through.

- The only known electrolytes are acids, bases and salts. Their molecules are made up of different ions. When dissolved in water, they release positive and negative ions and allow the conduction of electricity.

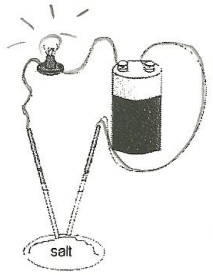
SAMPLE QUESTIONS

1) ***Which one of the following is a correct description of an electrolyte?***

A) A substance that does not conduct electricity because it does not release positive and negative ions when dissolved in water.
B) A substance that conducts electricity because it releases positive and negative ions when dissolved in water.
C) A substance that conducts electricity because it releases ions either that H^+ or OH^- when dissolved in water.
D) A substance that releases H^+ or OH^- and conducts electricity when dissolved in water.

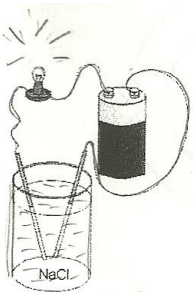
2) ***Which of the following scenarios is scientifically accurate?***

A)



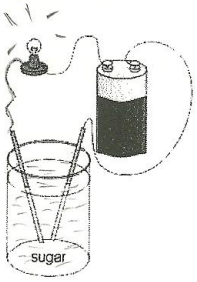
Light bulb lights up

B)



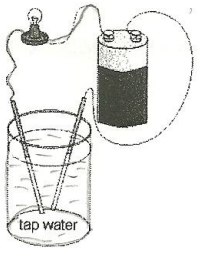
Light bulb lights up

C)



Light bulb lights up

D)



Light bulb does not light up

3) ***Which of the following substances conducts electricity?***

A) A block of salt.
B) Distilled water.
C) A sugar solution.
D) A vinegar solution.

4) ***Which of the following statements IS NOT a correct description of an electrolyte?***

A) The mobile ions that electrolytes release enable the flow of electricity through aqueous solutions.

B) Acids, salts and bases form electrolytes because they release positive and negative ions when dissolved in water.

C) All aqueous solutions conduct electricity because of the presence of mobile positive and negative ions.

D) Electrolytes are substances that conduct electricity when dissolved in water.

5) The science teacher performed a demo during the science class. She poured some distilled water in a beaker and then used an electrical conductivity tester to see if the water conducts electricity. The light bulb stayed off. As soon as she dissolved some powedered NaCl into the beaker, the light turned on.

A) What is the name of the process that allowed the light to go on?

B) ***Why distilled water did not conduct electricity?***

C) Name two other substances that would produce the same effect as NaCl.

6) *DESCRIBE THE PH SCALE (ACIDITY, ALKALINITY, NEUTRALITY, INCREASING AND DECREASING VALUES); DETERMINE THE PH OF A FEW COMMON SUBSTANCES*

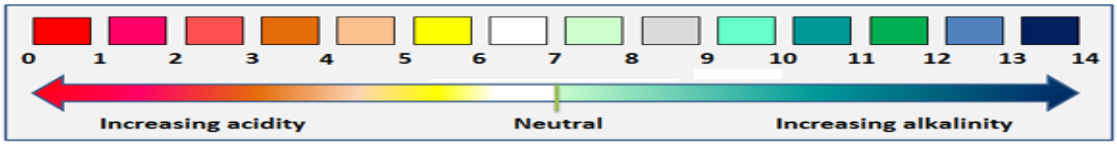
- ***ACIDS*** are substances that release H+ ions in aqueous solutions (when dissolved in water). They neutralize bases. Their pH < 7. The formula for acids is: H - Nonmetal; Ex: HCl

- ***BASES*** are substances that release OH^- ions in aqueous solutions. They neutralize acids. Their pH > 7. The formula for bases is: Metal – OH

- ***SALTS*** are substances that release metal and non-metal ions other than H^+ and OH^- in aqueous solutions. They are one of the products of an acid-base neutralization. Their pH is variable.

- The **pH SCALE** is a number line ranging from 0 to 14; it indicates how acidic or basic a solution is.

  - Acidic substances have a pH below 7.
  - Basic substances have a pH above 7.
  - Neutral substances have a pH of 7.



SOME EXAMPLES OF COMMON SUBSTANCES AND THEIR pH:

Substance	pH	type
distilled water	7	neutral
tomato juice	4.2	acid
salt water	8.4	base
human blood	7.3 - 7.5	base
floor cleaner	11	base
vinegar	2.8	acid

Substance	pH	type
egg	7.8	base
gastric juice	2.0	acid
lemon	2.8	acid
orange	3.5	acid
bread	5.5	acid
milk	6.5	acid

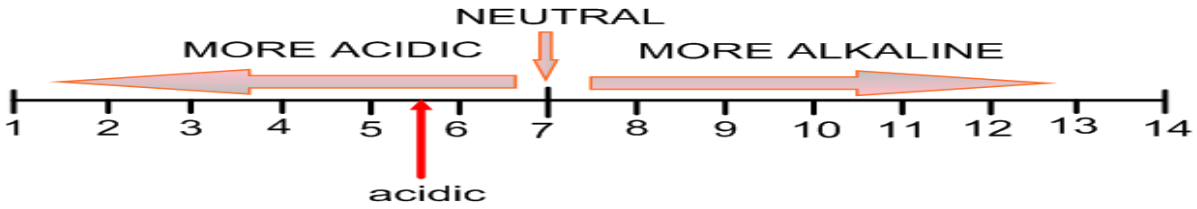
INCREASING AND DECREASING VALUES OF pH

- As you move along the scale ***to the left***, the substances become ***more acidic***. As you move along the scale ***to the right***, the substances become more alkaline (basic).

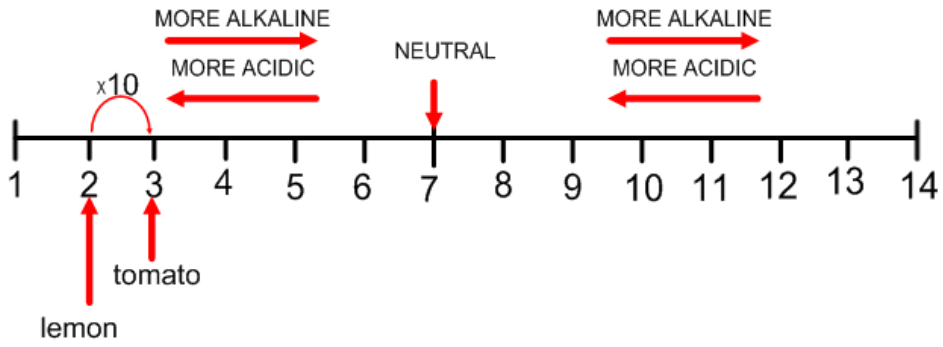
- Every increment on the pH scale represents a factor of 10. As you move to the right, a pH increment of 1 means that the substance is 10 times more alkaline (multiply by ten). As you move to the right, a pH increment of 1 means that the substance is 10 times more alkaline (divide by ten).

Examples:

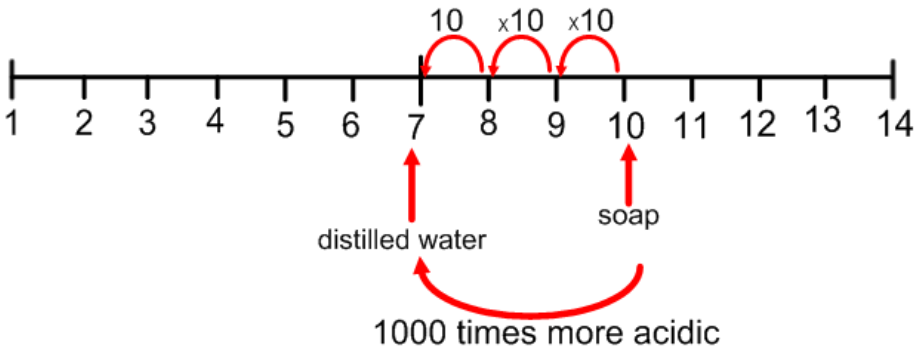
1) A solution with a pH of 5.6 is an acid (pH < 7); a solution with a pH of 11 is a base, since its pH > 7.



2) An apple has a pH of 3, and a lemon has a pH of 2. Therefore, an apple is 10 times more alkaline (basic) than a lemon.



3) Distilled water with a pH of 7 is 1 000 times more acidic than the soap with pH of 10, since every increment on the pH scale represents a factor of 10.



SAMPLE QUESTIONS

1) Josie conducts an experiment involving an aqueous solution and gathers the following data: the solution conducts electricity, turns blue litmus paper red and kills germs. ***What could the pH of the substance be?***

a) pH = 2 b) pH =10 c) pH = 7 d) pH=9

2) ***How many times more alkaline is rain water (pH 6) than battery acid (pH 2).***

A) 100 times B) 1000 times C) 10000 times D) 100000 times

3) Calcium carbonate, the active ingredient in *Tums* is used to decrease stomach acidity. Calcium carbonate is 100 times more alkaline that distilled water. ***What is the pH of calcium carbonate?***

A) 7 B) 11 C) 9 D) 0

4) ***Which one of the following compounds can neutralize H_2SO_4 and produce a salt and water?***

A) $MgSO_4$ B) HF C) $Mg(OH)_2$ D) $Mg(OH)_2$

5) The pH of a solution provides information about the nature of that solution. ***Which statement concerning the pH scale is true?***

A) A solution with a pH of 6 is twice as basic as a solution with a pH of 12.
B) A solution with a pH of 6 is twice as acidic as a solution with a pH of 12.
C) A solution with a pH of 11 is 100 times more acidic than a solution with a pH of 9.
D) A solution with a pH of 11 is 100 times more basic than a solution with a pH of 9.

6) ***Which pf the following statements regarding the pH scale IS NOT TRUE?***

A) An increment of 1 towards the right means an increase in acidity by 10 times.
B) An increment of 1 towards the left means an increase in acidity by 10 times.
C) An increment of 10 towards the right means an increase in acidity by 10 times.
D) An increment of 10 towards the right means an increase in acidity by 10 times.

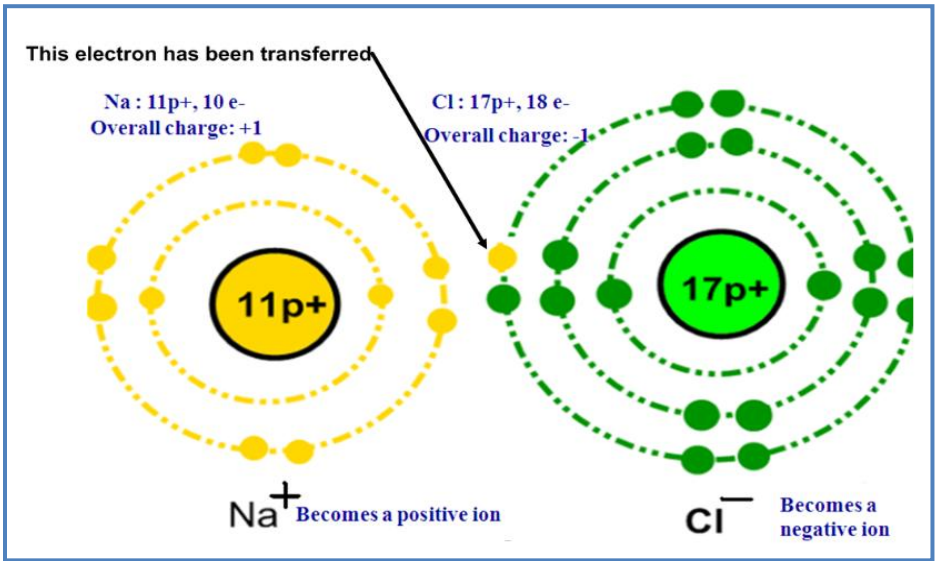
7) DEFINE THE CONCEPT OF ION

- ***Ions*** are particles that carry ***positive (+)*** or ***negative (-)*** charges, because the atoms from which they were formed either ***lost*** or ***gained*** one or more electrons.

Example - the sodium chloride molecule. In a chemical reaction between sodium and chlorine:

- the sodium atom loses an electron and becomes a positive ion (Na^+)
- the chlorine atom gains an electron and becomes a negative ion (Cl^-)

Figure 1 IONS IN THE SODIUM CHLORIDE MOLECULE



When present in aqueous solutions, ions become mobile (free) and able to carry electricity from one electrode to another (they allow electrical conductivity).

SAMPLE QUESTIONS

1) Which of the following sentences is true?

A) There are three types of ions: positive(+), negative(-) and neutral (0)
B) Sodium ions could carry electricity because they have an electrical charge.
C) Positive ions gain protons and negative ions gain electrons.
D) Ions are harmful for humans.