Solutions and Acid & bases

Printout this handout and take notes on your hard copy while you watch the lecture videos or PPT notes provided to you under Study materials of Module 8.

Module 8; Lecture on Solutions : topics are types of solution, solubility factors, Concentration of solution: quantitative methods to calculate concentrations, Percentage method, molarity and dilution

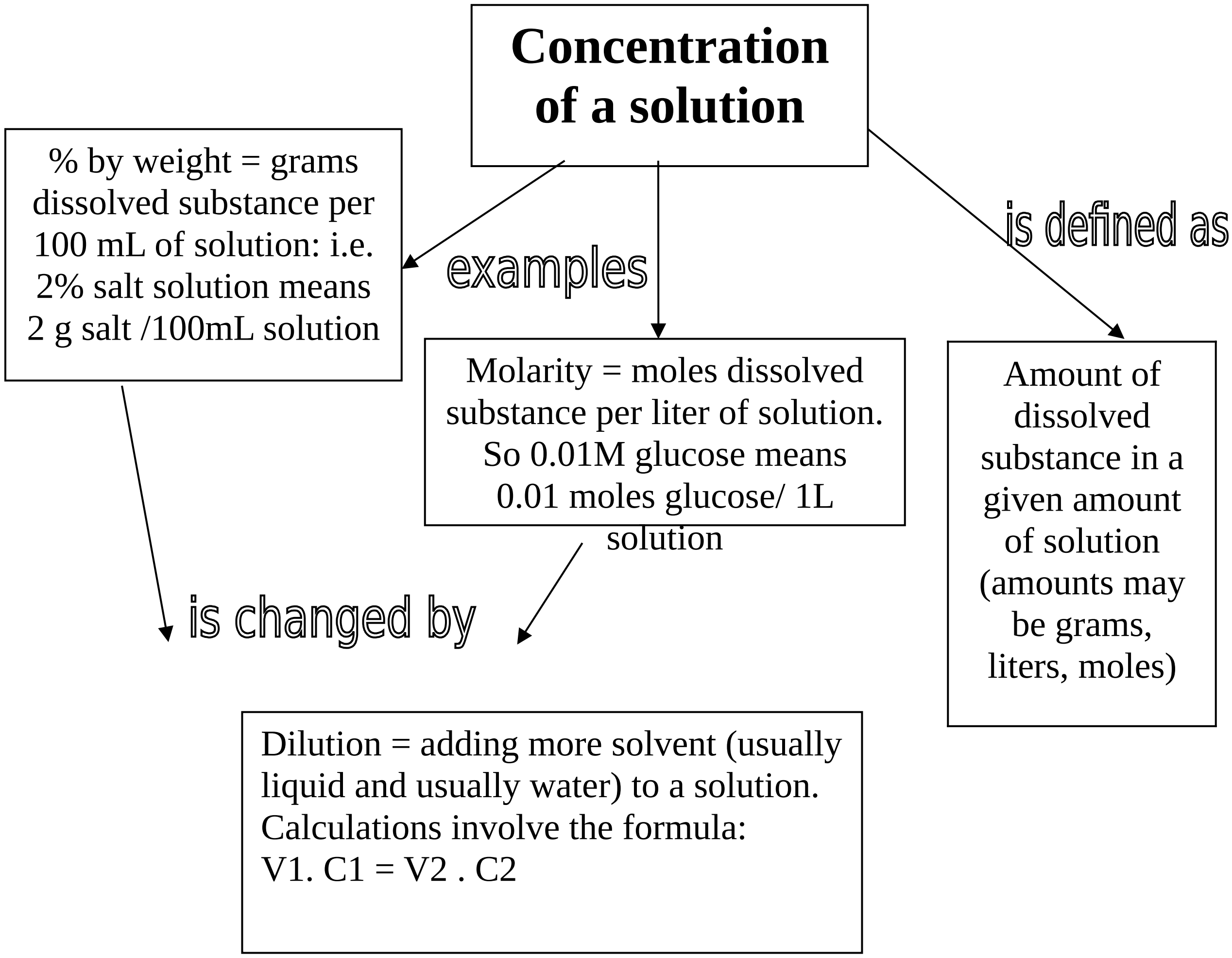
Module 8; Lecture on solutions : topics are Acids, Bases, pH and Buffers:

1. Coke is a solution, a homogenous mixture. In this homogenous mixture, what is the solvent? What are some of the solutes?

2. List some other solutions with which you are familiar.

Concentrations

1. Give examples of some concentrated solutions:
2. How do you dilute any of the above solutions?
3. Put one teaspoon of sugar in a cup of coffee. Put one teaspoon of sugar in a pot of coffee. Which one will taste sweeter (i.e. in which one is the sugar more concentrated?).
4. Pour some coffee from the pot in the above question into a second coffee cup. In which is the sugar more concentrated now – in the coffee pot or the second coffee cup?
5. Compare the three coffees above – the first cup, the coffee pot and the second cup – in which one is the amount of sugar the greatest? In which one is the amount of sugar the least? In which one is the concentration of sugar the greatest? In which one is the concentration of sugar the least?
6. In your own words, describe "concentration".



Quantitative analysis of Concentration of any solution can be done by many ways such as:

- Molarity,
- Dilution,
- Percentage by mass(m/m%) or Percentage by volume (v/ v%) or mass / volume%, Parts per million or Parts per billion

<u>These are explained in Lecture and PPT Notes</u>

CONCENTRATIONS - Molarity

Define molarity:

#1 What is the concentration in molarity of a 200 mL solution with .5 g NaOH?

Step 1: Convert g to Moles

Step 2: Convert mL to L

Step 3: Use the definition of molarity

#2 To prepare 100 mL of a 2 M NaOH solution, how many grams would you need to weigh out?

Remind yourself what 2 M means:

Set up a conversion:

#3 How many mL of a 1.00 M hydrogen peroxide solution, H_2O_2, can be prepared from 10 g of pure hydrogen peroxide?

Remind yourself what 2 M means:

Set up a conversion:

CONCENTRATIONS – (w/v)%

What is a 1% solution:

What is a 3% solution:

What is a 25% solution:

#1 What is the volume of a 2% salt solution which contains 10 g of salt?

Remind yourself what 2% means:

Set up a conversion:

#2 To prepare 0.100 L of a 6% salt solution, how many grams of salt do you need?

Remind yourself what 6% means:

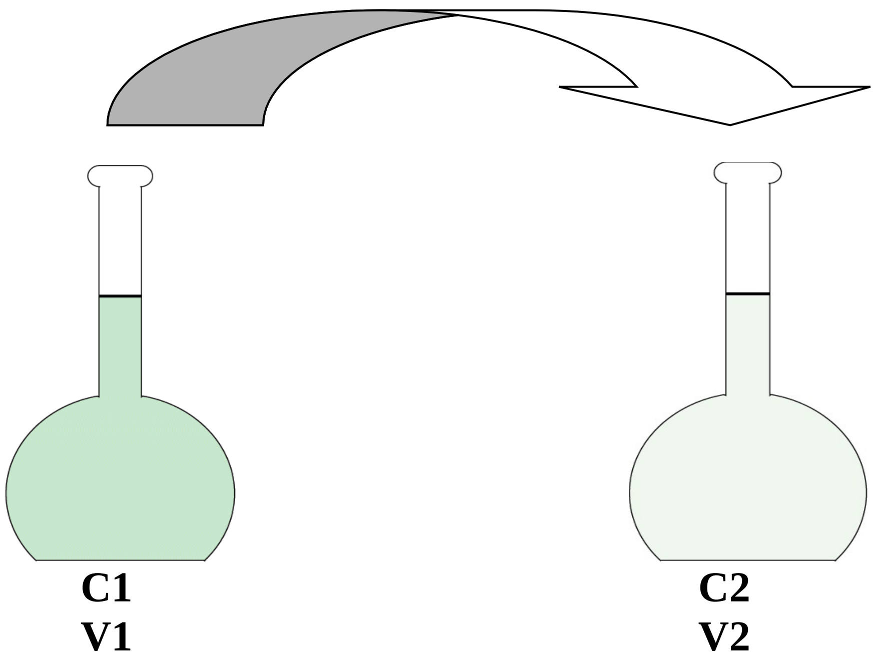
Set up a conversion:

#3 What is the % (m/v) concentration of a solution in which .800 g of solute is dissolved in a 25 mL solution.

Since the definition is grams /100 mL, you need to determine how many grams are in 100 mL. Set up a conversion starting with 100 mL:

DILUTION

Key formula for dilutions: $V_1 C_1 = V_2 C_2$
C_1 is the concentration of the original solution of higher concentration
V_1 is the volume of the original solution used in the dilution
C_2 is the concentration of the solution after dilution
V_2 is the total volume of the solution after dilution



moles of solute concentrated solution = moles of solute of dilute solution

Therefore: C1. V1 = C2 . V2

OR

M1 . V1 = M2. V2

M1 is the concentration of the original solution of higher concentration
V1 is the volume of the original solution used in the dilution
M2 is the concentration of the solution after dilution
V2 is the total volume of the solution after dilution

Now if volume of solvent asked then: **volume of solvent = V2 - V1**

or

Volume of water = volume of solution - volume of solute

#1 How would you dilute a 2 M solution so that you have 100 mL of a .5 M solution.

#2 How would you dilute a 30% solution so that you have 100 mL of a 15% solution.

#3 How much water (in mL) must be added to 200 mL of a 1.25 M Sodium chloride (NaCl) solution to decrease its concentration to 0.770 M? (answer; 125 mL

ACIDS and BASES

CALCULATOR PRACTICE

For our Acid/Base section you will need to be able to work with numbers involving exponents and find the log and antilog of numbers. This handout is designed to help you remember (or learn) how to do these mathematical operations.

- ❖ Each calculator can be different in how these types of numbers are entered and in how these functions are carried out. Practice on the calculator you intend to use in assignments and on the exam.

I. Multiplying and Diving Numbers with Exponents

1. The numbers below are expressed in scientific notation. This is a convenient way of expressing very large and very small numbers without using all the zeros. Enter the numbers on your calculator in scientific notation and make sure the display is correct.

   a. 4.5×10^{-6} (this is equal to 0.0000045 but make sure you can enter it in scientific notation, that is using the exponent key on your calculator)

   b. 3.6×10^{7} (this is equal to 36,000,000 but make sure you can enter it in scientific notation, that is using the exponent key on your calculator)

Once you have the first number entered correctly in your calculator then you press either times or divide then enter the second number and press equals. Remember each calculator is a little different. You have to experiment and practice to learn how to use YOUR calculator.

2. Do the following problems.

   a. $(4.5 \times 10^{-6}) \times (1.5 \times 10^{-2}) =$ ______________________

   b. $(5.4 \times 10^{5}) \times (3.9 \times 10^{-3}) =$ ______________________

   c. $(7.7 \times 10^{5}) \times (4.4 \times 10^{3}) =$ ______________________

   d. $(6.9 \times 10^{5}) \div (4.2 \times 10^{-4}) =$ ______________________

   e. $(6.2 \times 10^{-3}) \div (3.2 \times 10^{-5}) =$ ______________________

   f. $(3.8 \times 10^{-4}) \div 18 =$ ______________________

Answers:

a. 6.8×10^{-8}
b. 2.1×10^{3}
c. 3.4×10^{9}
d. 1.6×10^{9}
e. 1.9×10^{2}
f. 2.1×10^{-5}

II. Log and anti log of Numbers

The log of a number expressed in scientific notation can be easily performed on your calculator. Different calculators require the information to be added in different ways. On some you enter the number and then press the log key and on some you have to press the log key first and then enter the number. You may or may not have to use ( ) around your number (including the exponent). You need to figure out how your calculator requires the information to be entered.

3. Find the log of the following numbers:

    a. 200 = ______________________

    b. 0.007 = ______________________

    c. 438 = ______________________

    d. 0.000549 = ______________________

    e. 4.5×10^{-6} = ______________________

    f. 3.7×10^{-11} = ______________________

The inverse log of a number is the reverse of the log (or anti log). On some you enter the number and then press the log key and on some you have to press the log key first and then enter the number. Once again different calculators require the information to be entered in different ways. On some you enter the number and then press the inverse log key and on some you have to press the inverse log key first and then enter the number. The inverse or anti log of a number actually means 10 raised to that number (the number becomes the exponent of 10).

4. Find the inverse or anti log of the following numbers:

    a. 8.2 = ______________________

    b. -2.1 = ______________________

    c. 7.8 = ______________________

    d. -5.2 = ______________________

    e. 7 = ______________________

    f. -4 = ______________________

Answers:

3. a. 2.3 b. -2.2 c. 2.6 d. -3.26 e. -5.34 f. -10.4	4. a. 1.6×10^{8} b. 7.9×10^{-3} c. 6.3×10^{7} d. 6.3×10^{-6} e. 1×10^{7} f. 1×10^{-4}

Measuring the Acidity of Acid/Base Solutions

Consider: H_2CO_3 + H_2O $\leftrightarrow$ HCO_3^- + ________

How strong of an acid is H_2CO_3? To determine this, use a pH meter and measure the concentration of ___________ that forms when H_2CO_3 reacts with H_2O.

WHY?

Because the acidity of a solution is a measure of the $[H_3O^+]$ in the solution. $[H_3O^+]$ is measured in the lab by using a pH meter and the concentration of $[H_3O^+]$ is given on a pH scale. This is a logarithmic scale where

$$\mathbf{pH = -\log [H_3O^+] \qquad and \qquad [H_3O^+] = 10^{-pH}}$$

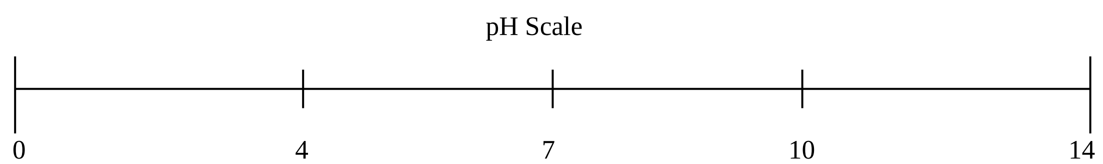
(an inverse log)

If you know the pH of a solution, you can calculate the $[H_3O^+]$. If you know the $[H_3O^+]$, you can calculate the pH.

The acid/base strength of solutions can be compared by looking at the pH of the solutions. The pH scale goes from 0-14. The middle of the pH scale, pH = 7, is considered neutral (neither acidic nor basic). pHs lower than 7 are acidic and pHs greater than 7 are basic. The lower the pH, the stronger the acid strength of the solution. On the basic side of the scale, the higher the pH, the more basic the solution is.

Practice Problem:

Label the following pH scale with the following: basic, acidic, neutral



__________ __________ __________

Practice Problems:

Do the following problems on calculating pH and $[H_3O^+]$:

a. If $[H_3O^+] = 10^{-7}$ M, what is the pH?

Start with the formula:
Then plug in the numbers:
Then solve this on your calculator.

b. If pH = 3, what is $[H_3O^+]$?

c. Find the pH of a urine sample if $[H_3O^+]$ is 8.9×10^{-6} M.

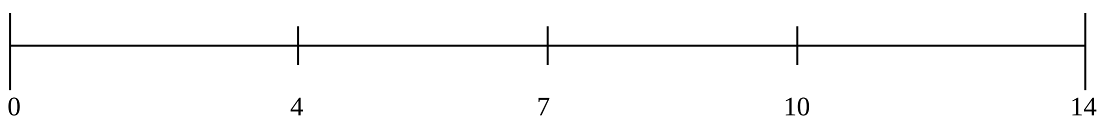
d. Find the $[H_3O^+]$ in the bloodstream where pH = 7.4.

e. Find the pH of seawater with a $[H_3O^+]$ of 5.3×10^{-9} M.

f. Find the $[H_3O^+]$ in lake water where pH = 6.4.

g. Fill in the $[H_3O^+]$ for the pHs of 4, 7 and 10 on the pH scale below.

pH Scale



$[H_3O^+]$ = __________ __________ __________

h. What happens to $[H_3O^+]$ as the pH increases?

____

i. Is the acidity of the solution increasing or decreasing as the pH increases?

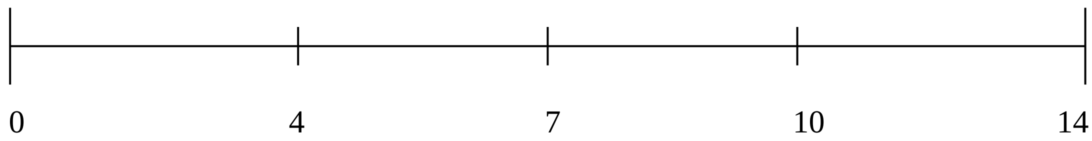
____

Answers:

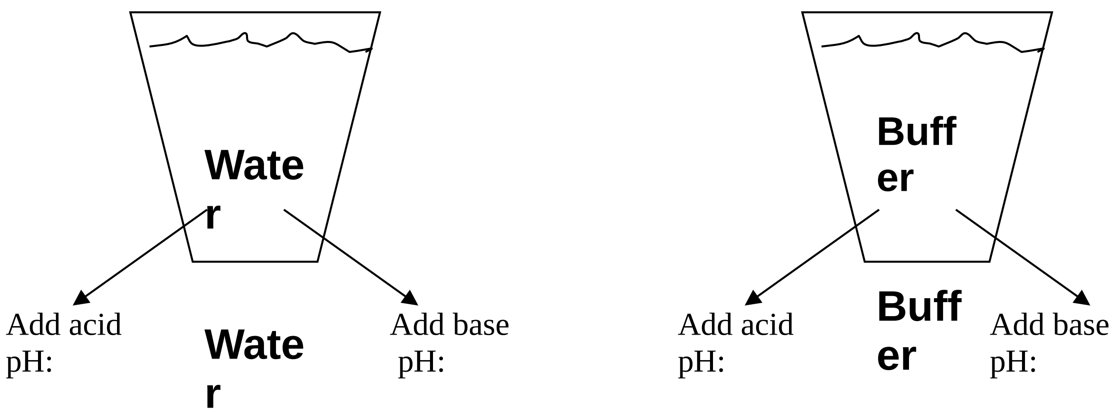
b) .001 M *c) pH = 5.05* *d) 3.98×10^{-8} M* *e) 8.28* *f) 3.98×10^{-7} M*

pH SCALE and Buffers

Indicate where neutral, acidic and basic are on the pH scale below:



What does a buffer do?



What is a buffer?

A buffer is a solution that contains two components. It contains an ________________ to neutralize any ____________ that gets added and a _________________ to neutralize any ________________ that is added. Your blood is a buffer; the acid/base pair in your blood prevents your blood's pH from changing much from its normal pH of 7.4.