

Tutorial for calculations worksheet

I. System of measurement: metric

weight: gram
volume: liter
distance: meter

Metric Prefixes

centi: 1×10^{-2}
milli: 1×10^{-3}
micro: 1×10^{-6}

microgram sometimes is written ug; micrometer is sometimes written as um.

nano: 1×10^{-9}
pico: 1×10^{-12}
femto: 1×10^{-15}

II. Solutions

There are several ways that biologists represent the concentration of a solution.

A. Percent

1. by weight: $\frac{\# \text{ g solute}}{\text{total \# g (solute + solvent)}}$

Example: If we want a 10% solution of X in Y, by weight:

10 g of X, and 90 g of Y

$$10 \text{ g X} / 10 \text{ g} + 90 \text{ g} = 10/100=10\%$$

2. by volume: $\frac{\# \text{ ml solute}}{\text{total \# ml (solute + solvent)}}$

10 ml of X, and 90 ml of Y

$$10 \text{ ml X} / 10 \text{ ml} + 90 \text{ ml} = 10/100=10\%$$

3. weight per volume: $\frac{\# \text{ g solute}}{\text{total volume}}$
(in this case you do NOT add the number of g solute to the total volume)

4. volume: volume

Example: If I want a 20:1 solution of alcohol: water, then I need 20 parts alcohol for every 1 part of water.

Therefore, a solution of 20 ml alcohol + 1 ml water would fulfill this requirement (as would a solution of 40 ml alcohol and 2 ml water).

B. Molarity

$$M = \frac{\# \text{ moles solute}}{\# \text{ liters solvent}}$$

1 mole = 6.02×10^{23} atoms = mol. weight in grams
1 mole of NaCl = 58 g

So a 1 M solution of NaCl would be: $\frac{58 \text{ g NaCl}}{1 \text{ liter solution}}$

Example 1: I want a 1M NaCl solution in a final volume of 100 ml. How many grams NaCl do I need?

$$(M)(\text{Volume in liters}) = \# \text{ moles solute}$$

(1) (0.1 L) = 0.1 moles of NaCl are needed

0.1 mol NaCl (58 NaCl/1 mol) = 5.8 g NaCl are needed for this solution.

Example 2: I want 10 ml of a 0.5 M NaCl solution. How many g NaCl do I need?

$$(M) (\text{Vol in liters}) = \# \text{ moles}$$

(0.5) (0.010 L) = 0.005 mol NaCl

0.005 mol (58 g/1 mol) = 0.275 g NaCl

Note: For examples 1 and 2, if you use this formula, you must convert your volume to liters.

Example 3: We want 100 ml of a 0.5M NaCl solution. Instead we have a stock solution of 1 M NaCl. How much of the 1 M stock do we need? How much water do we need?

$$(\mathbf{M\ conc\ stock}) (\mathbf{Vol\ conc\ stock}) = (\mathbf{M\ diluted}) (\mathbf{Vol\ final})$$

$$(1\text{M}) (\text{VOL}) = (0.5\text{M})(100\text{ml})$$

$$\text{VOL} = 50\text{ ml}$$

So we need 50 ml of the stock. How much water do we need?

$$\mathbf{Total\ vol = Vol\ stock + Vol\ water}$$

$$100\text{ ml} + 50\text{ ml} + \text{Vol water}$$

$$\text{Vol water} = 50\text{ ml.}$$

Note: For this formula, and the ones following, you do not need to convert volume to liters.

Example 4: You want 500 ml of a solution that is both 0.5 M NaCl AND 1M MgCl₂.

You have stock solutions that are 5 M NaCl and 3M MgCl₂.

How much of each stock solution do you need? How much water do you need?

For this, you need to calculate each one separately.

First, let's do the NaCl:

$$(\mathbf{M\ conc\ stock}) (\mathbf{Vol\ conc\ stock}) = (\mathbf{M\ final}) (\mathbf{Vol\ final})$$

$$(5) (\text{Vol}) = (0.5)(500)$$

$$\text{Vol of NaCl stock: } 50\text{ ml}$$

Now, let's do the MgCl₂:

$$(\mathbf{M\ conc\ stock}) (\mathbf{Vol\ conc\ stock}) = (\mathbf{M\ final}) (\mathbf{Vol\ final})$$

$$(3) (\text{Vol}) = (1) (500)$$

$$\text{Vol of MgCl}_2\text{ stock: } 166.7\text{ ml}$$

Now, let's calculate how much water we need:

$$\mathbf{Total\ vol = Vol\ stock\ 1 + Vol\ stock\ 2 + vol\ water}$$

$$\text{Vol water} = 283.3$$

Example 5:

You want 500 ml of the following solution:

0.5 M NaCl
1M MgCl₂
2% (weight /volume) potassium permanganate

You have the following stock solutions:

5 M NaCl
3M MgCl₂
solid potassium permanganate

How much of each stock solution do you need? How many grams of potassium permanganate do you need? How much water do you need?

Again, take each one separately:

For the potassium permanganate: you want a 2% solution that is weight /volume. You do not need to know the molecular weight of this compound to calculate this.

$(0.02)(500) = \mathbf{10 \text{ grams potassium permanganate}}$
(percentage) (final volume) = grams needed.

For the NaCl:

$(M \text{ conc stock}) (Vol \text{ conc stock}) = (M \text{ final}) (Vol \text{ final})$
 $(5) (Vol) = (0.5)(500)$

Vol of NaCl stock: 50 ml

For the MgCl₂:

$(M \text{ conc stock}) (Vol \text{ conc stock}) = (M \text{ final}) (Vol \text{ final})$
 $(3) (Vol) = (1) (500)$

Vol of MgCl₂ stock: 166.7 ml

Now, let's calculate how much water we need:
Total vol = Vol stock 1 + Vol stock 2 + vol water
Vol water = 283.3

