

Example Molarity Calculations

Example 1: You have 2 moles of a compound dissolved in 1 litre of water. What is the molarity of the solution?

Using the equation above:

$$M = m / v$$

Where:

$$\begin{aligned} M &= \text{molar (M)} \\ m &= \text{moles} = 2 \text{ moles} \\ v &= \text{volume (litre)} = 1 \text{ l} \end{aligned}$$

Hence:

$$M = 2 / 1 = 2 \text{ Molar}$$

So the answer is, 2 Molar, or 2 M

Example 2: You have 2 moles of a compound dissolved in 0.5 l of water. What is the molarity of the solution?

Again, using the equation:

$$M = m / v$$

Where:

$$\begin{aligned} M &= \text{molar (M)} \\ m &= \text{moles} = 2 \text{ moles} \\ v &= \text{volume (litre)} = 0.5 \text{ l} \end{aligned}$$

Hence:

$$M = 2 / 0.5 = 4 \text{ Molar}$$

So the answer is, 4 Molar, or 4 M.

Example 3: You have 2 moles of a compound dissolved in 250 ml of water. What is the molarity of the solution?

This example also uses equation again, but in this case you must remember to convert the 250 ml to litres. There are 1,000 ml in 1 litre, so 250 ml is $250 / 1000 = 0.25 \text{ l}$.

$$M = m / v$$

Where:

$$\begin{aligned} M &= \text{molar (M)} \\ m &= \text{moles} = 2 \text{ moles} \\ v &= \text{volume (litre)} = 250 \text{ ml} = 0.25 \text{ l} \end{aligned}$$

Hence:

$$M = 2 / 0.25 = 8 \text{ Molar}$$

So the answer is, 8 Molar, or 8 M

Example 4: You have 2 g of a compound with a molecular weight of 2 dissolved in 1 l of water. What is the molarity of the solution?

This calculation is a slight change from above as you now have a number of grams of a compound of a known molecular weight.

There are two approaches that can be taken to find the answer. One approach just works with the idea that the molecular weight of a compound dissolved in 1 litre of water is a one molar solution, whilst the other uses a formula to get the answer.

Approach 1:

First, calculate the number of moles of the compound present. For that we need equation introduced in the "What is a Mole?" lecture earlier in this course:

$$m = g / MW$$

Where:

m = moles

g = mass in grams = 2 g

MW = molecular weight (grams per mole) = 2

Hence we have:

$$m = 2 / 2 = 1 \text{ mole}$$

This 1 mole is in 1 l. To convert this to molar we need equation from above:

$$M = m / v$$

Where:

M = molar (M)

m = moles = 1 moles

v = volume (litre) = 1 l

Hence:

$$M = 1 / 1 = 1 \text{ Molar}$$

So the answer is, 1 Molar, or 1 M

Approach 2:

The alternative approach is just to use equation:

$$M = g / (MW \times v)$$

Where:

M = molar (M)

g = mass in grams = 2 g

MW = molecular weight (grams per mole) = 2

v = volume (litre) = 1 l

Hence we get:

$$M = 2 / (2 \times 1) = 2 / 2 = 1 \text{ Molar}$$

So, the answer is 1 M.

Although approaches 1 and 2 above work, and approach 2 seems to be shorter and easier, there is always the danger with approach 2 that you may forget the equation, whereas with approach 1 if you remember the principles you can construct the equation.

Example 5: You have 1 g of a compound with a molecular weight of 2 dissolved in 1 l of water. What is the molarity of the solution?

This is the same calculation as in Example 4, but with different numbers.

Approach 1:

First, calculate the number of moles of the compound present. For that we need the equation:

$$m = g / MW$$

Where:

m = moles

g = mass in grams = 1 g

MW = molecular weight (grams per mole) = 2 g/mol

Hence we have:

$$m = 1 / 2 = 0.5 \text{ mole}$$

This 0.5 mole is in 1 l. To convert this to molar we need the following equation:

$$M = m / v$$

Where:

M = molar (M)

m = moles = 0.5 moles

v = volume (litre) = 1 l

Hence:

$$M = 0.5 / 1 = 0.5 \text{ Molar}$$

So the answer is, 0.5 Molar, or 0.5 M

Approach 2:

The alternative approach is to use the equation:

$$M = g / (MW \times v)$$

Where:

M = molar (M)

g = mass in grams = 1 g

MW = molecular weight (grams per mole) = 2 g/mol

v = volume (litre) = 1 l

Hence we get:

$$M = 1 / (2 \times 1) = 1 / 2 = 0.5 \text{ Molar}$$

So, the answer is 0.5 M.

Approach 2:

The alternative approach is to use the equation:

$$M = g / (MW \times v)$$

Where:

M = molar (M)

g = mass in grams = 1 g

MW = molecular weight (grams per mole) = 2 g/mol

v = volume (litre) = 1 l

Hence we get:

$$M = 1 / (2 \times 1) = 1 / 2 = 0.5 \text{ Molar}$$

So, the answer is 0.5 M.

Example 6: You have 1 g of a compound with a molecular weight of 2 dissolved in 0.5 l of water. What is the molarity of the solution?

Approach 1:

First, calculate the number of moles of the compound present. For that we need the equation:

$$m = g / MW$$

Where:

m = moles

g = mass in grams = 1 g

MW = molecular weight (grams per mole) = 2 g/mol

Hence we have:

$$m = 1 / 2 = 0.5 \text{ mole}$$

This 0.5 mole is in 0.5 l. To convert this to molar we need the equation:

$$M = m / v$$

Where:

M = molar (M)

m = moles = 0.5 moles

v = volume (litre) = 0.5 l

Hence:

$$M = 0.5 / 0.5 = 1 \text{ Molar}$$

So the answer is, 1 Molar, or 1 M

Approach 2:

The alternative approach is just to use the equation:

$$M = g / (MW \times v)$$

Where:

M = molar (M)

g = mass in grams = 1 g

MW = molecular weight (grams per mole) = 2 g/mol

v = volume (litre) = 0.5 l

Hence we get:

$$M = 1 / (2 \times 0.5) = 1 / 1 = 1 \text{ Molar}$$

So, the answer is 1 M.

Example 7: *You have 1 g of a compound with a molecular weight of 2 dissolved in 250 ml of water. What is the molarity of the solution?*

Again, this is just like the examples above, but with the added complication that the volume is now expressed in millilitres (ml) as opposed to litres (l). In this case the first thing you need to do is convert the millilitres (ml) to litres (l).

1 litre is 1,000 ml, so 250 ml is 250 / 1000 l, which is 0.25 l.

Approach 1:

First, calculate the number of moles of the compound present. For that we need the equation:

$$m = g / MW$$

Where:

m = moles

g = mass in grams = 1 g

MW = molecular weight (grams per mole) = 2 g/mol

Hence we have:

$$m = 1 / 2 = 0.5 \text{ mole}$$

This 0.5 mole is in 0.25 l. To convert this to molar we need the equation:

$$M = m / v$$

Where:

M = molar (M)

m = moles = 0.5 moles

v = volume (litre) = 0.25 l

Hence:

$$M = 0.5 / 0.25 = 2 \text{ Molar}$$

So the answer is, 2 Molar, or 2 M

Approach 2:

The alternative approach is just to use the equation:

$$M = g / (MW \times v)$$

Where:

M = molar (M)

g = mass in grams = 1 g

MW = molecular weight (grams per mole) = 2 g/mol

v = volume (litre) = 0.25 l

Hence we get:

$$M = 1 / (2 \times 0.25) = 1 / 0.5 = 2 \text{ Molar}$$

So, the answer is 2 M.

Molarity Calculations Summary

In these lessons we looked at how to calculate the molarity of the solution, and also the different ways for expressing molarity. For example, expressing the molarity as a whole number and using a prefix such as μ or m in front of the large M for molarity, or expressing in the scientific notation form of, for example, $\times 10^{-3}$.

The ideas and calculations may at first glance appear simple, but they are used again and again in the lab, therefore it is critical that you gain a full understanding. Molarity is an important concept and is one that needs to be understood as it is a 'cornerstone' of lab research and without a basic understanding of moles and molarity research is not possible.

Molarity is a measure of concentration. That is all it is, it is the number of moles of something per litre of solution.

A 1 Molar (1 M) solution can be described as:

1 mole of a compound made up to a 1 litre solution

So, expressed as an equation this means that:

$$M = m / v$$

Where:

M = molarity (M)

m = moles

v = volume (litre)

From the equation in the lecture on moles we know that:

$$m = g / MW$$

Where:

m = moles

g = mass in grams

MW = molecular weight (grams per mole)

So this mean we can substitute for m in the first equation we get:

$$M = m / v$$

As $m = g / MW$, then we get

$$M = (g / MW) / v$$

Which is:

$$M = g / (MW \times v)$$

Where:

M = molarity (M)

g = mass in grams

MW = molecular weight (grams per mole)

v = volume (litre)

In the lab you may be asked to make up a certain volume of a solution at a given molarity. For this you need to rearrange the above equation so that you can solve for grams (g).

Given the equation:

$$M = g / (MW \times v)$$

then a rearrangement for g gives:

$$M \times (MW \times v) = g$$

And tidying up we get:

$$g = M \times MW \times v$$

Where:

g = mass in grams

M = molarity (M)

MW = molecular weight (grams per mole)

v = volume (litre)

You could use the above equations to calculate molarity, but if you remember that:

the molecular weight of a compound dissolved in 1 litre of water is a one molar solution

then you have molarity covered, and you can quickly and easily derive the equations.