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# Measurement:

# Basic Lab Techniques

**URL:** <http://mathbench.umd.edu/modules-au/measurement_pipet/page01.htm>

## Learning Outcomes

## After completing this module you should be able to:

## Do some basic conversions, most importantly between milli, micro, nano etc

## Understand how micropipettes (also referred to as pipette, pipetman, micropipetter etc) work and which pipette is ideal to use for any given volume that you want to dispense

## The metric system

How well do you know your metric vocabulary? Below is a list of prefixes used in the metric system, arranged in the order of size. It is a very good idea to familiarise yourself with them as they are the most commonly used notation for many experimental measurements and in daily life!!

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **trillions** | | **billions** | | **millions** | | **thousands** | | **hundreds** | | **tens** | **ones** |
| Tera (1012) | | Giga (109) | | Mega (106) | | Kilo (103) | | hecto ( 102) | | deca (101) | (none) |
|  | |  | |  | |  | |  | |  |  |
| **tenths** | **hundredths** | | **thousandths** | | **millionths** | | **billionths** | | **trillionths** | | |
| deci (0.1 or 10-1) | centi (0.01 or 10-2) | | milli (0.001 or 10-3) | | micro (0.000001 or 10-6) | | Nano (0.000000001 or 10-9) | | pico (0.000000000001 or 10-12) | | |

### Metric Quiz

You already familiarised yourself with the metric system? That's great. Try these questions below to apply that knowledge.

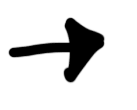
|  |  |  |
| --- | --- | --- |
|  | **Question** | **Answer** |
| **The brain of an elephant can weigh up to 7.5 kilograms.** | What is this in g? | 7500 g |
| **Homo sapiens have a brain volume of about 1350 mL.** | How much is this in litres? | 1.35 L |
| **A mouse brain weighs about 400 milligrams.** | What is this in micrograms? | 400000 micrograms |
| **Prokaryotic ribosomes can have a diameter as small as 20 nm.** | How many micrometres is this? | 0.020 microns |
| **A mitochondrion averages 0.5 micrometres across.** | How much is this in nanometres? | 500 nm |
| **Commander Spock identifies a new strain of bacteria which averages 17.83 micrometres.** | How many nanometres is this? | 17830 nanometres |
| **The nerve cell running the length of a giraffe's neck can measure up to 3100 millimetres.** | How much is this in metres? in micrometres? | 3.1 m, 3100000 microns |

### Here are some simple tips before you attempt the quiz:

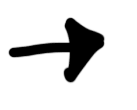
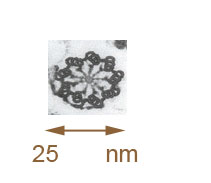
The easiest way to convert metric measurements is to move the decimal place. The metric vocabulary:  
tera – giga – mega – kilo – no prefix – milli – micro – nano – pico

Every time you move to the right on this list, the unit gets smaller (by 3 decimal places), so you need more of them to compensate (move the decimal 3 places to the right).

For example, an ostrich egg can be up to 0.12 metres. What if you need to convert this to millimetres? Since millimetres are smaller than metres, you will need more of them to cover the egg. So, move the decimal 3 places to the right:

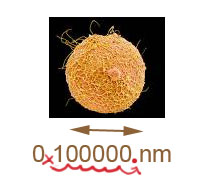
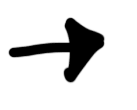
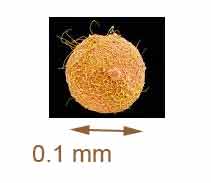


To convert to a larger unit, you need to move the decimal place to the left. For example, a microtubule is 25 nm in diameter. To convert the microtubule length to micrometres, you need to move the decimal 3 places to the left (so that there will be fewer micrometres than nanometres). So,



If you need to convert between two prefixes that are not next to each other (i.e., milli to nano), just add up all the decimal places (in this case, 6 decimal places to the right).

For example, a human egg is 0.1 millimetres in diameter. So, in nanometres, this is:



To summarise, remember that the SMALLER the unit, the MORE of them you need to make the same measurement, so move the decimal in the appropriate direction.

The next section introduces you to the use of a micropipette, which is a very basic instrument used regularly in conducting laboratory experiments. A micropipette allows you to collect and transfer very small amounts of fluid (See image of a pipette below on the left and the ‘tip’ (right image) that you connect to the pipette before dispensing a measured amount of liquid). As we go through this section, you will also see why it is important to familiarise yourself with the metric vocabulary and be able to do conversions that we learnt in the previous section.

## How to select a micropipetter

1. you need to know which pipetman to choose.
2. you need to know how to interpret the numbers on the volume indicator.

There are several standard sizes of pipetman, but this module will focus on 3 commonly used standard sizes called the P20, a P200, and a P1000. They measure up to 20, 200, or 1000 microlitres, respectively. The rule for choosing between them is simple: **use the smallest pipetman you can, but don't exceed the capacity of the pipetman.**

For example, say you need to measure out 25 microlitres of a solution. 25 is too big to fit into a P20, so DON'T DO IT, ok? 20 will fit in a P200 or a P1000, so pick the smaller one. That way you'll get a more precise measurement.

Here's an analogy. Say you need to measure ½ litre of milk. Which would you rather use, a one-litre jug, or a five-litre bucket? Right, the one-litre jug. Pick the smallest measuring device that will hold the quantity needed.

Oh, yeah, then get the right tip. In most cases, this part is easy because they're colour-coded to the plunger on the pipette :

* Yellow plunger = yellow (or clear) tip.
* Blue plunger = blue tip.

Not exactly rocket science, but can have serious consequences on your results if you get them wrong!

### Which Tip is Which?

|  |  |
| --- | --- |
| Questions | Answer |
| Some superfast glucometres require as much as 25 microlitres of blood. Which pipetman would you use to measure this amount? | P200. 25 microlitres won't fit in a P20, so you have to use the P200 |
| Part of the process of making glucose test strips for diabetes involves pipetting 210 microlitres of glucose oxidase into the reactive mixture. Which pipetman should be used for this purpose? | P1000. 210 microlitres won't fit in a P200, so you have to use the P1000 |
| People with diabetes need to measure their blood sugar using a glucometre which requires a sample of up to 12 microlitres of blood. Which pipetman could you use to measure this amount? | P20. 12 microlitres will fit in any pipette, but the P20 will give you the most accurate measurement |
| Diabetic rats produce approximately 0.443 millilitres of saliva per half hour. If you wanted to measure this amount in a pipetman, which one should you choose? | P1000. Didn’t get this one right? Remember your conversions - 0.443 millilitres is 443 microlitres, which has to go in the P1000 micropipette |

## How to read a pipetman

You now know which pipettes to use for which volume range, but how do you actually adjust your pipette to get the right amounts you want. Clearly, there is a display and adjustment for this on any pipette. Each pipetman has a three-digit volume indicator, but the (slightly) tricky part is that the digits mean different things depending on whether you're looking at a P20, a P200, or a P1000.   
•  On a P20, the most you can measure is 20, so the top digit is 10s of microlitres.  
•  On a P200, the most you can measure is 200, so the top digit is 100s of microlitres.   
•  On a P1000, the most you can measure is 1000, so the top digit is 1000s of microlitres (remember that a 1000 microlitre is also the same as 1 millilitre).

This means, incidentally, that the top number on the number dial can only be set to a few digits. On a P20 or a P200, it can only be set to 0 or 1. On a P1000, you have to leave it at 0. If you "overload" the number, you won't actually cause any explosions, but you will damage the calibration of the pipette.

**Picky But Important Note:** the top digit of a P20 or P200 CAN be a "2", but only if the other digits are zero. In other words, a reading of "200" is ok, but not "201". Likewise, a reading of "1000" is ok on the P1000, but not "1001".

**Another picky note**: some pipets read from left to right instead of top to bottom. If yours does, lucky you!

### What each of the following mean:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| P20   |  | | --- | | 1 | | 3 | | 2 | | P20   |  | | --- | | 1 | | 3 | | 2 | | P20   |  | | --- | | 1 | | 3 | | 2 | | P20   |  | | --- | | 0 | | 3 | | 0 | | P20   |  | | --- | | 0 | | 3 | | 0 | | P20   |  | | --- | | 0 | | 3 | | 0 | |
| 13.2 microlitres | 132 microlitres | DON'T DO THIS | 3.0 microlitres | 30 microlitres | 300 microlitres |

## Your turn

|  |  |  |  |
| --- | --- | --- | --- |
| to measure 12 microlitres for a glucometers | to measure 25 microlitres for a superfast glucometer | to measure 180 microlitres of glucose oxidase for a glucose test strip | to measure 0.44 millilitres of saliva produced by a diabetic rat |
| P20 | P20 | P20 | P20 |
| Volume:   |  | | --- | | 1 | | 2 | | 0 | | Volume:   |  | | --- | | 0 | | 2 | | 5 | | Volume:   |  | | --- | | 1 | | 8 | | 0 | | Volume:   |  | | --- | | 0 | | 4 | | 4 | |

## Summary

Metric System:

* The prefixes you really need to know: kilo, milli, micro, nano
* Move the decimal place 3 to the right to go to a smaller prefix (i.e., milli to micro)
* Move the decimal place 3 to the left to go to a larger prefix (i.e., nano to micro)

The Micropipetters:

* P20 -- max 20 microlitres -- top digit is tens (can only be set to 0 or 1#)
* P200 -- max 200 microlitres -- top digit is hundreds (can only be set to 0 or 1^)
* P1000 -- max 1000 microlitres -- top digit is thousands (can only be set to 0\*)

#Or 2 if the other digits are set to zero – which will then be a volume of 20 microlitres.

^Or 2 if the other digits are set to zero – which will then be a volume of 200 microlitres.

\*Or 1 if the other digits are set to zero -- which will then be a volume of 1000 microlitres.

## Learning Outcomes

As you have completed this module you should now be able to:

## Do some basic conversions, most importantly between milli, micro, nano, etc.

## Understand how micropipettes (also referred to as pipette, pipetman, micropipetter, etc.) work and which pipette is ideal to use for any given volume that you want to dispense.