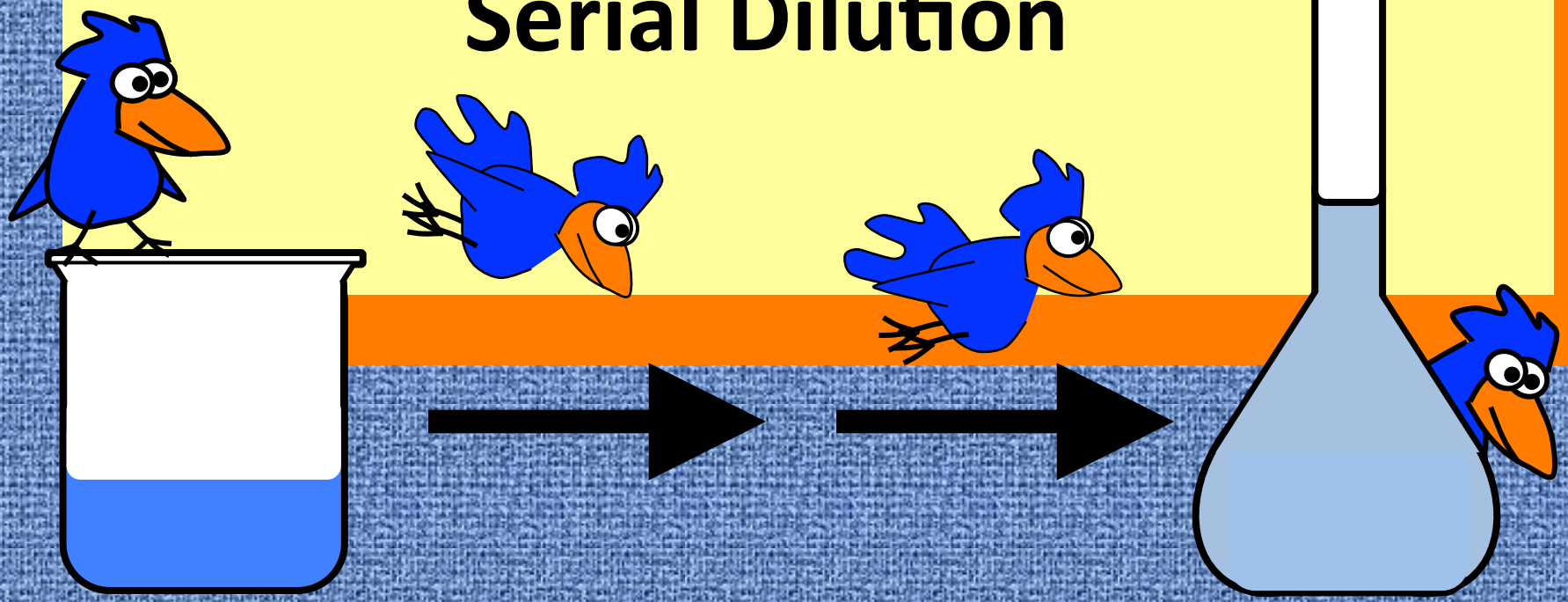
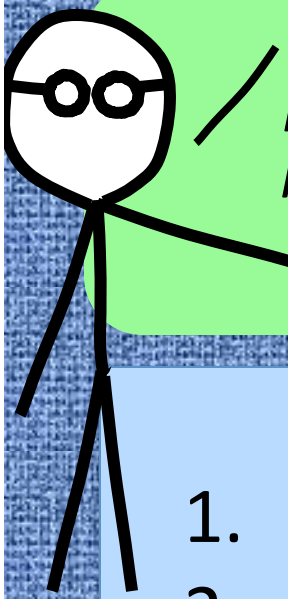
Experiment 7
9 October 2018
Serial Dilution

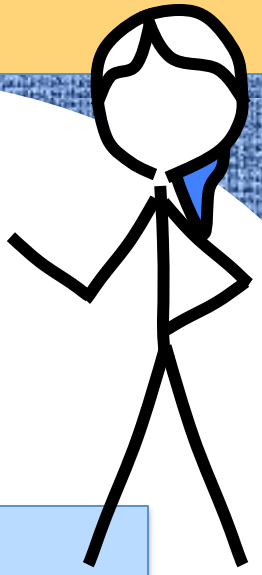


Objective: To prepare a solution of precise molarity using a Mohr pipet.



Today we will learn to prepare a solution of precise molarity – a skill used by any chemist worth beans.

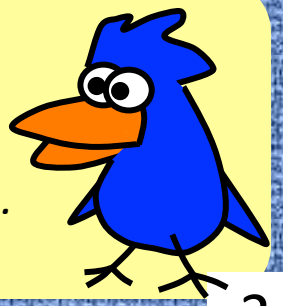
And it all comes down to properly using the Mohr pipet.



Overview:

1. The Mohr pipet in review
2. Using the dilution formula, $M_cV_c = M_dV_d$
3. Planning the job
4. Procedure
5. Your lab report

The blue solution we are working with today is erioglaucine disodium salt, ($C_{37}H_{34}N_2Na_2O_9S_3$) – a.k.a. FD&C Blue No. 1 or – or (are you ready for this?).... blue food coloring!



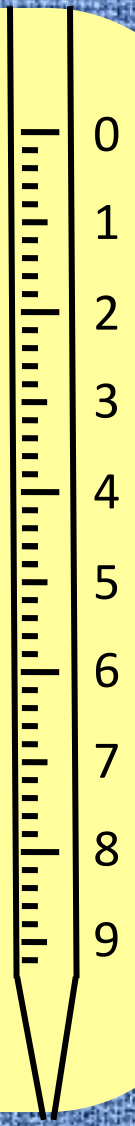
1. The Mohr pipet in review

By now you've watched the Mohr pipet YouTube video.

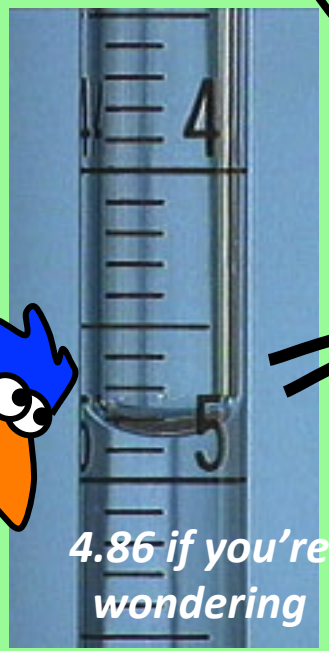
We always start with the thing filled to the 0 mark.

And then deliver to the calculated volume.

The rest is extra.



Reading the volume is tricky. The numbers get bigger going down.



4.86 if you're wondering

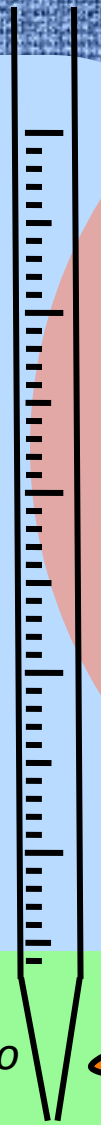
Pipet image credit: allpipettes.com/Use-Mohr-Pipettes.html

1. The Mohr pipet in review

Suppose we wanted 4.86 mL. Start with it filled to the 0 mark.

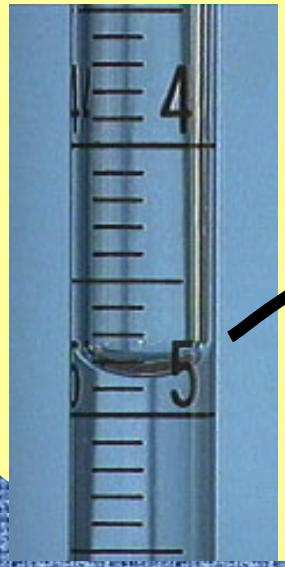
… and deliver the solution down to 4.86 mL

… and the rest goes back in the beaker.



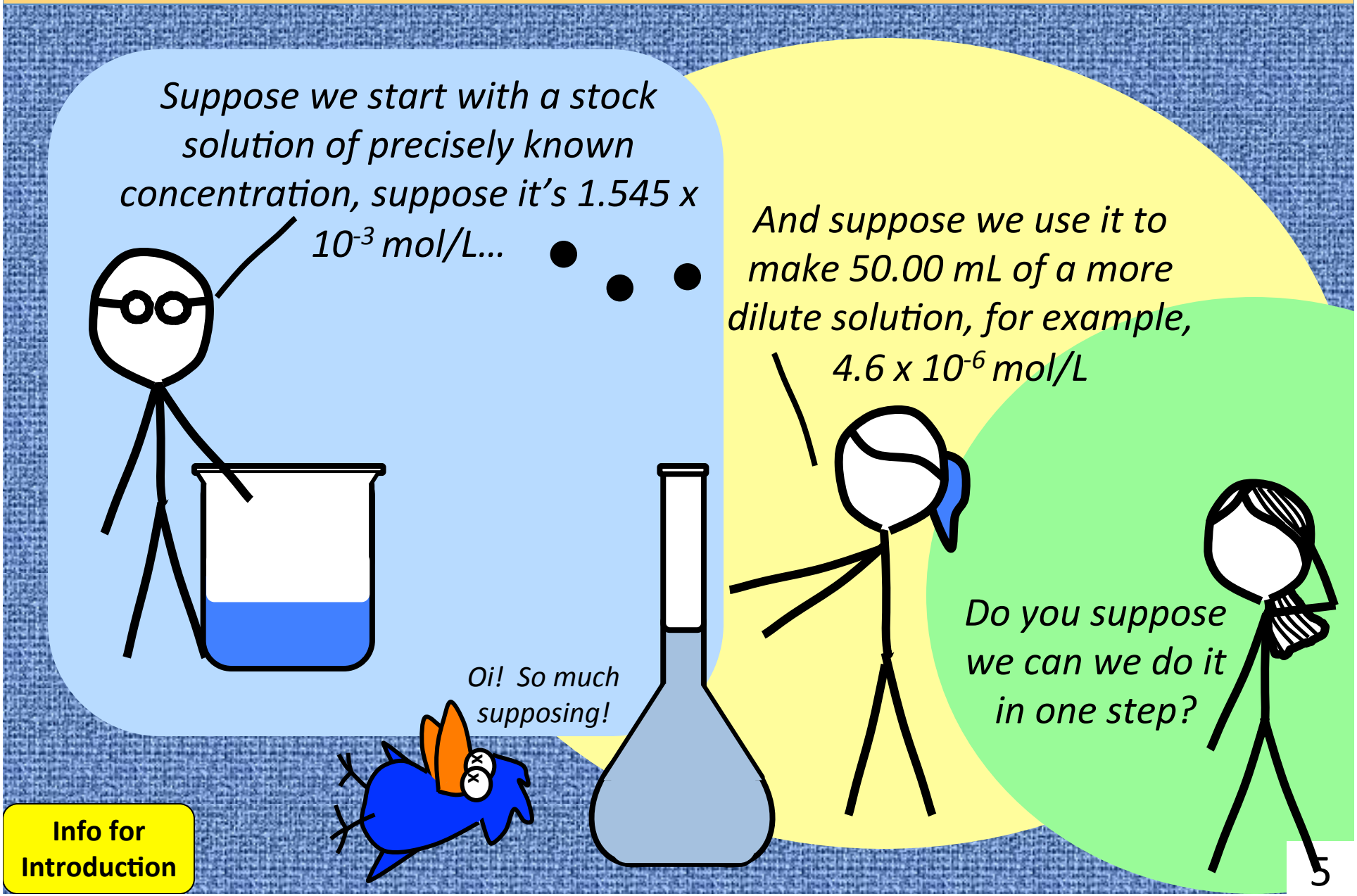
This is the part we want to use – from 0 down to 4.86 mL

You can read two places past the decimal with this Mohr pipet



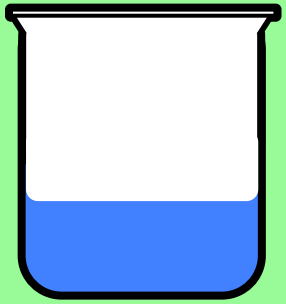
See how the Mohr pipet gets weird before it gets to 10? Not all 10-mL Mohrs even have a 10 mL mark.

2. Using the dilution formula, $M_cV_c = M_dV_d$

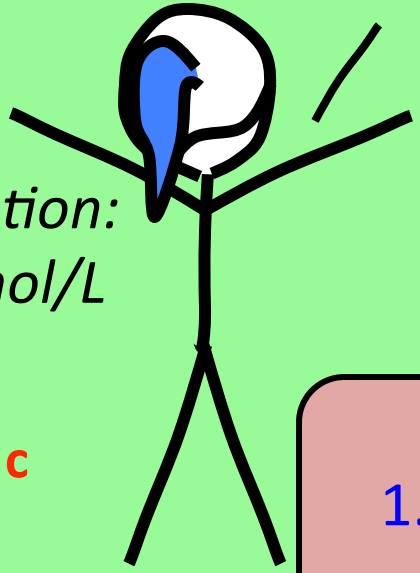


Info for Introduction

2. Using the dilution formula, $M_cV_c = M_dV_d$

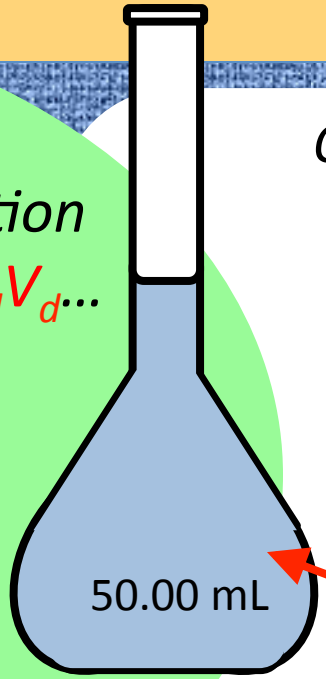


So we use the dilution formula, $M_cV_c = M_dV_d$…



Our Stock solution: 1.545×10^{-3} mol/L

M_c



Our goal solution: 50.00 mL 4.6×10^{-6} mol/L

M_d

V_c

*The little blue **c** stands for concentrated and the little **d** stands for dilute.*

$M_cV_c = M_dV_d$

$1.545 \times 10^{-3}\ M \times V_c = 4.6 \times 10^{-6}\ M \times 50.00\ mL$

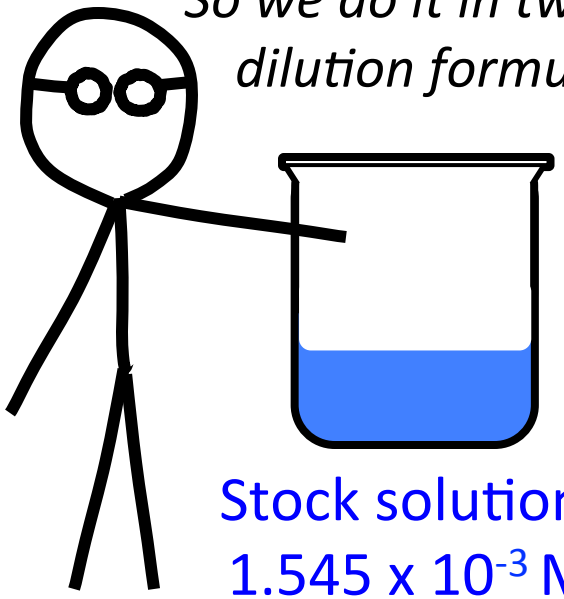
$V_c = 0.149\ mL$

So 0.149 mL is way too small of a volume to measure accurately. With our pipet, the best we can do is 0.15 mL – just to the hundredths place. If we use more than 1.00 mL, we gain a significant figure.

Info for Introductio

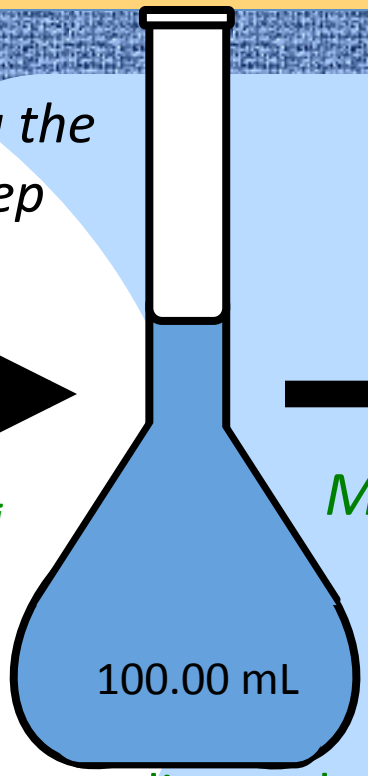
3. Planning the job

So we do it in two steps, using the dilution formula for each step



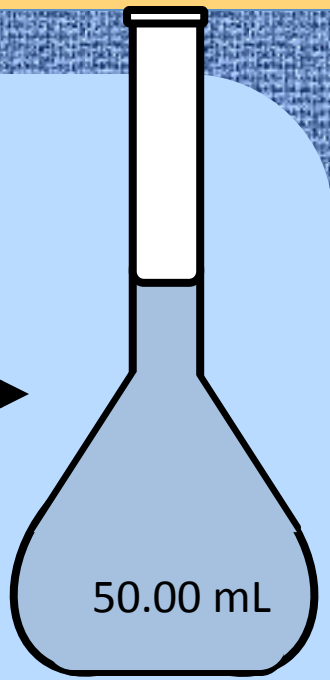
Stock solution:
1.545×10^{-3} M

$M_c V_c = M_i V_i$



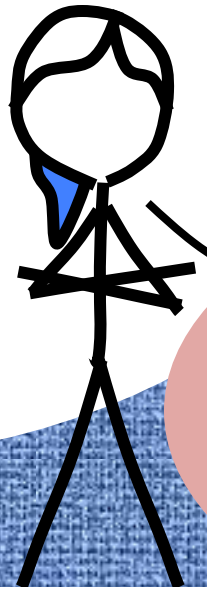
Intermediate solution

$M_i V_i = M_d V_d$



Goal solution:
4.6×10^{-6} M

*And the little green **i** stands for intermediate.*

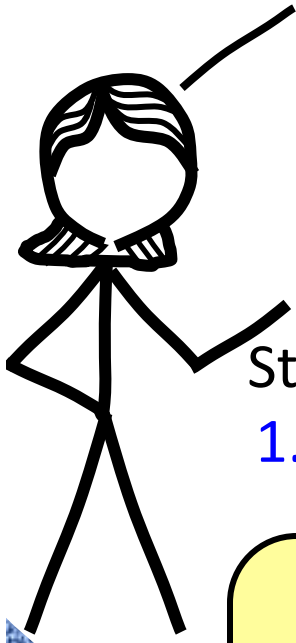


In lab we will have 5.00 and 10.00 mL volumetric pipets and 50.00 and 100.00 mL volumetric flasks available – 4 combinations.

Info for Introduction

3. Planning the job

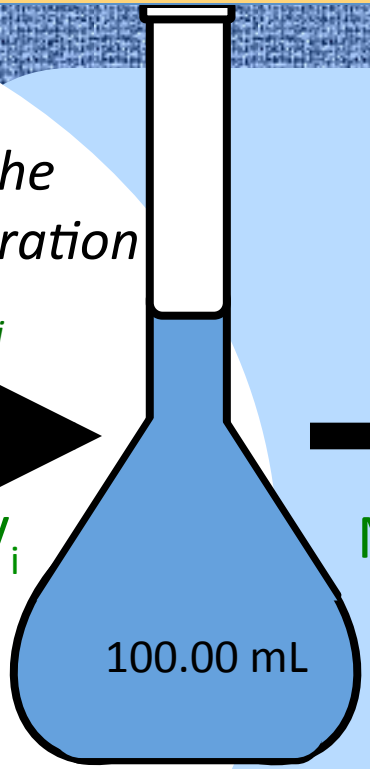
If we make 100.00 mL of the intermediate using 5.00 mL of the concentrated solution… its concentration is calculated with $M_cV_c = M_iV_i$



Stock solution:

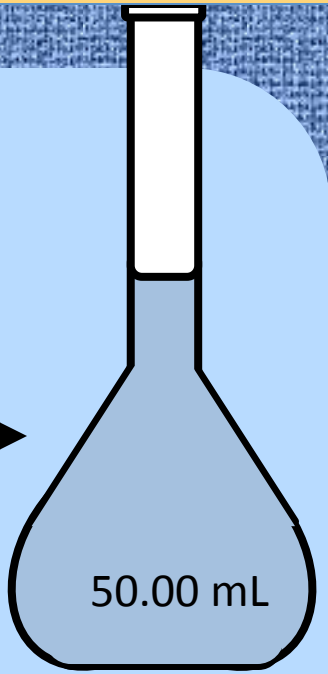
1.545×10^{-3} M

$M_cV_c = M_iV_i$



Intermediate solution

$M_iV_i = M_dV_d$



Goal solution:

4.6×10^{-6} M

Concentration of the intermediate solution:

$M_cV_c = M_iV_i$

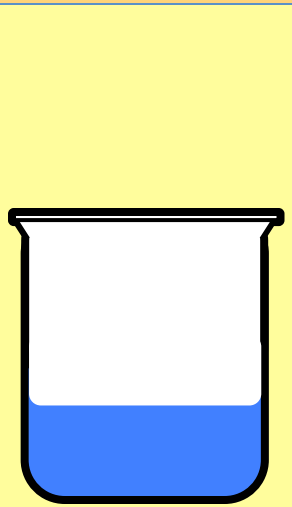
1.545×10^{-3} M x 5.00 mL = M_i x 100.00 mL

$M_i = 7.725 \times 10^{-5}$ M

Next we calculate the second dilution

Info for Introduction

3. Planning the job



$M_cV_c = M_iV_i$

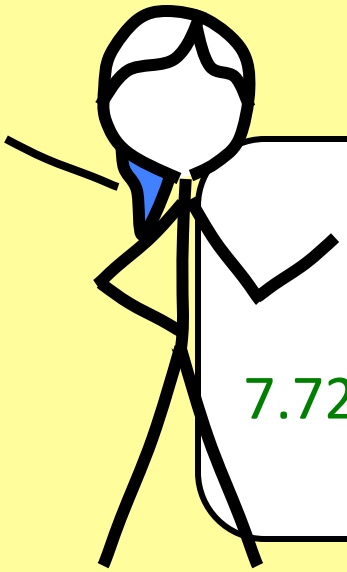
$M_iV_i = M_dV_d$

Stock solution:
1.545×10^{-3} M

Intermediate:
7.725×10^{-5} M

Goal solution:
4.6×10^{-6} M

We need 2.98 mL of the intermediate solution. This is good because it is between 1 and 9ish – within the Mohr's capabilities.



The dilute solution:

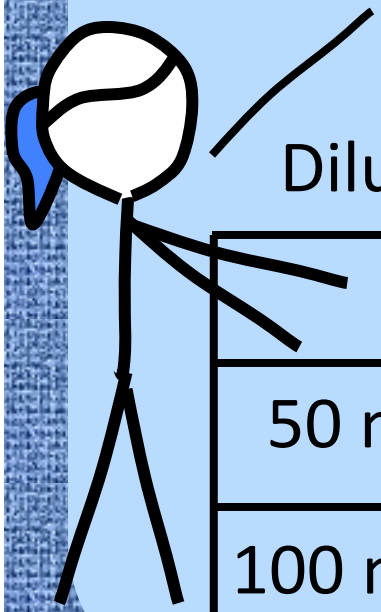
$M_iV_i = M_dV_d$

7.725×10^{-5} M x $V_i = 4.6 \times 10^{-6}$ M x 50.00 mL

$V_i = 2.98$ mL

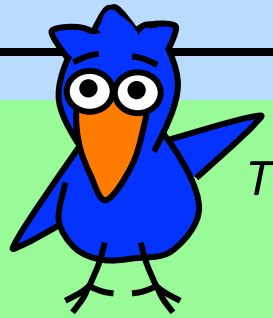
3. Planning the job

You may find this table handy for planning the intermediate solution. These are the four combinations of volumetric pipets and flasks. In the example just discussed, we diluted 5.00 mL to 100.0 mL for the intermediate – a 20-fold dilution.



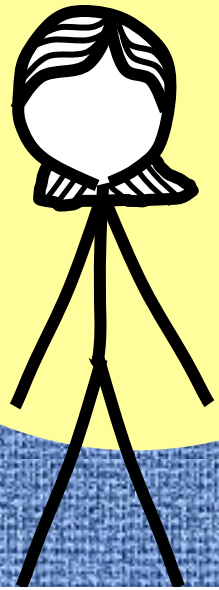
Dilution factors for Intermediate:

	5 mL pipet	10 mL pipet
50 mL Flask	10 x	5 x
100 mL Flask	20 x	10 x



These were calculated using the dilution equation.

Your final Mohr pipet value has to be between 1 and 9 mL – you may need to change your first dilution.

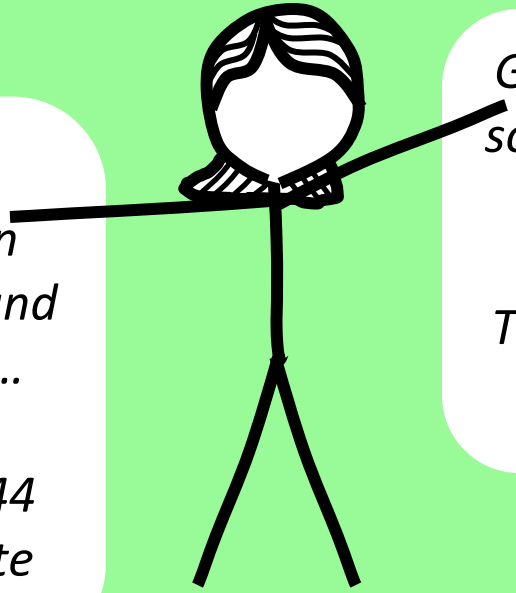


3. Planning the job

Do all of your calculations before you start making the intermediate solution – so you don't make the wrong intermediate solution and have to do it over. Suppose two groups were both making 50.00 mL of 4.6 x 10^{-6} M solution from the same 1.545 x 10^{-3} M stock solution. Suppose they made their intermediate solution as follows…

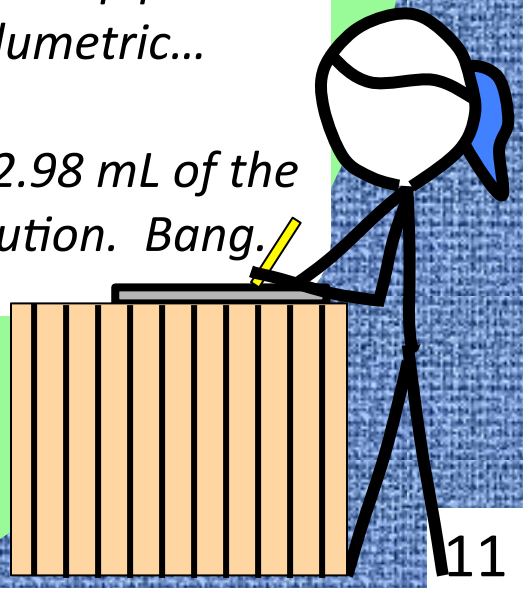
Group X made the intermediate solution using 10.00 mL pipet and 50.00 mL volumetric…

They would need 0.744 mL of the intermediate solution. Oooops.

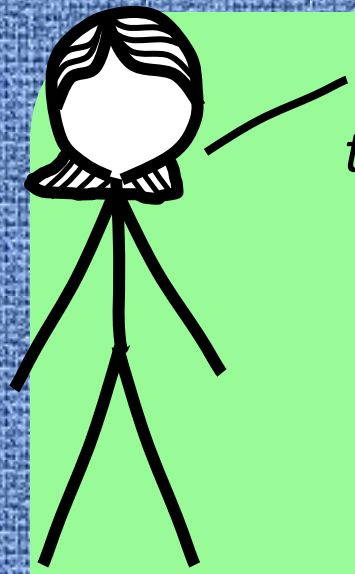


Group Y made the intermediate solution using 5.00 mL pipet and 100.00 mL volumetric…

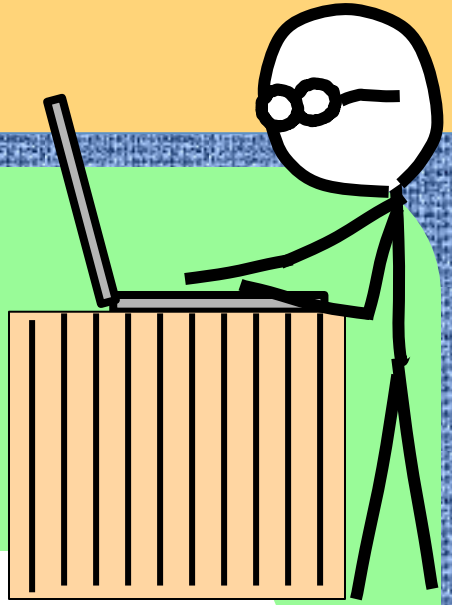
They would need 2.98 mL of the intermediate solution. Bang.



4. Procedure

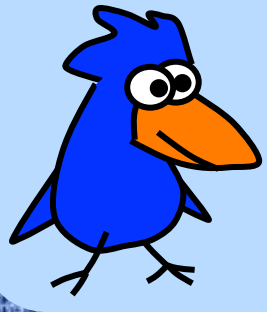


You will be turning in results on-line today. Many of the numbers are very small, such as 4.12 x 10^{-6} M.



There is only one correct way to enter this sort of data so Excel can recognize it. Use this E format and NO spaces at all:

4.12E-6



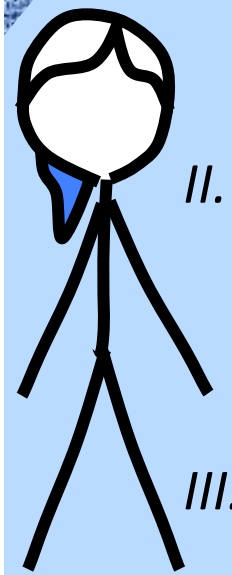
Picky Picky
4.12 x 10-6 doesn't work.
4.12 E-6 doesn't work.
4.12 x 10^-6 doesn't work.
Incorrect entries result in point loss.

There are no spaces except to add units.

4.12E-6 mL

is ok

4. Procedure



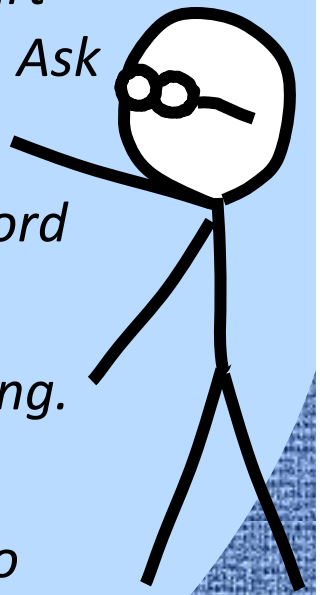
I. *Wearing your safety glasses is always prudent, but today we will not be enforcing it. No special attire needed – we are working with blue food coloring!*

II. *Make sure you are reading the Mohr pipet correctly and to the appropriate number of significant figures. Don't start the experiment until you are good with the Mohr pipet. Ask for help.*

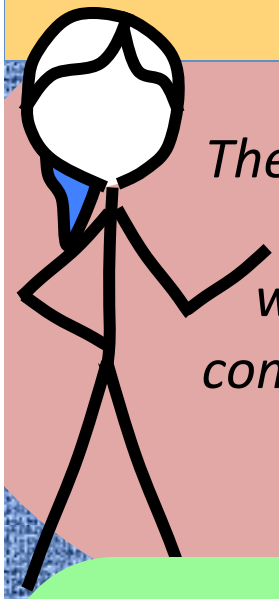
III. *Follow the procedure as written in the lab manual. Record observations in your lab notebook.*

IV. *You will turn in a sample of your solution today for testing. You are being graded for accuracy – worth 9 points.*

V. *The cover sheet summarizes everything that you need to include with your report.*

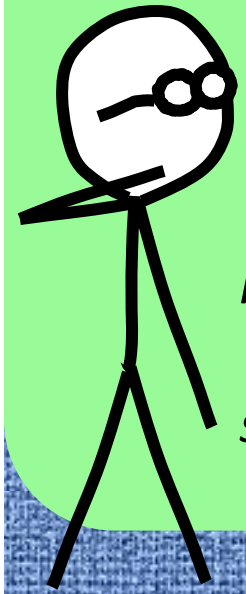


5. Your lab report – Sources of Error.



There is always a lot of pondering and wondering when it comes to writing about sources of error.

Be specific. Saying human error is vague. Saying an instrument wasn't working properly needs to be substantiated. Transferring the solution… Mixing the solution... Was the sample cuvette clean? Stuff like that is more realistic.



As we do the experiment, think about the places where errors could happen. Errors with the Mohr pipet should come to mind. Using it correctly, reading it correctly. Even if we did everything correctly, it is still a potential source of error.

This week we are figuring out percent error. Even if our results were good, we still need to think about what could have gone wrong.

5. Your lab report.

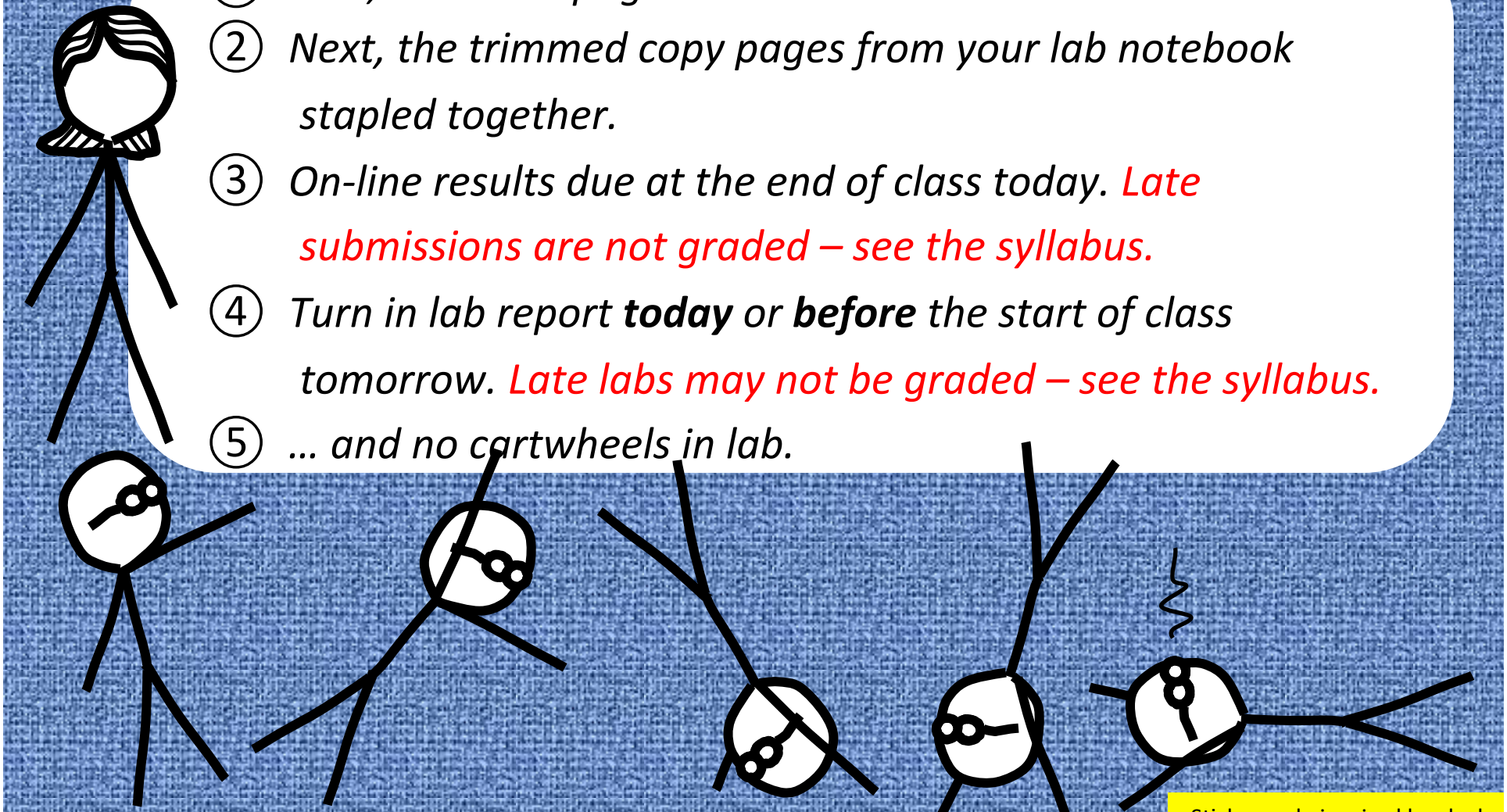
① *First, the cover page with TA initials.*

② *Next, the trimmed copy pages from your lab notebook stapled together.*

③ *On-line results due at the end of class today. Late submissions are not graded – see the syllabus.*

④ *Turn in lab report **today** or **before** the start of class tomorrow. Late labs may not be graded – see the syllabus.*

⑤ *… and no cartwheels in lab.*



Chem Lab with the Stick People and Bird *was created and produced by Dr. Bruce Mattson, Creighton Chemistry. Enjoy it and share it if you wish.*

Stick people inspired by xkcd cartoons by Randall Munroe (www.xkcd.com)