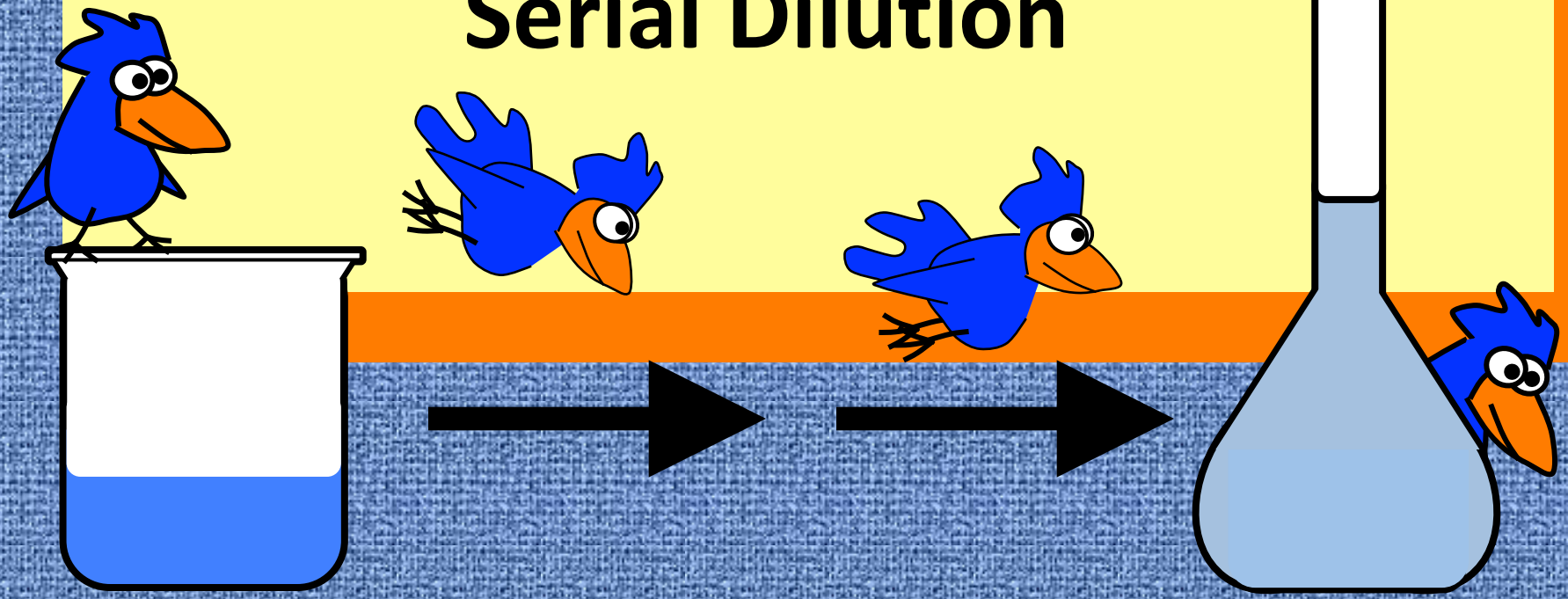
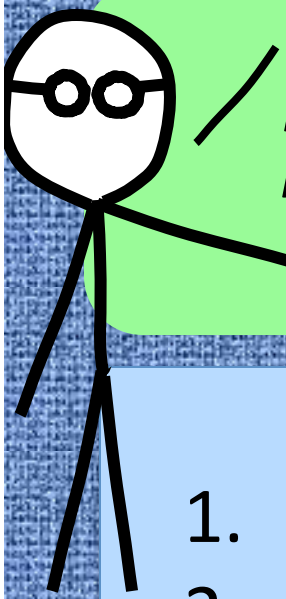
Experiment 7
8 October 2019
Serial Dilution

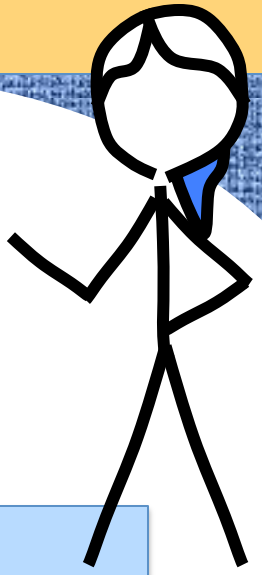


Objective: To prepare a solution of precise molarity using a Mohr pipet.



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

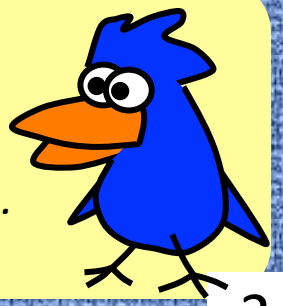
And it all comes down to properly using the Mohr pipet.



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!



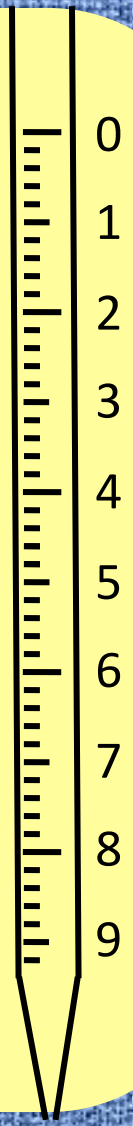
1. The Mohr pipet in review

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.

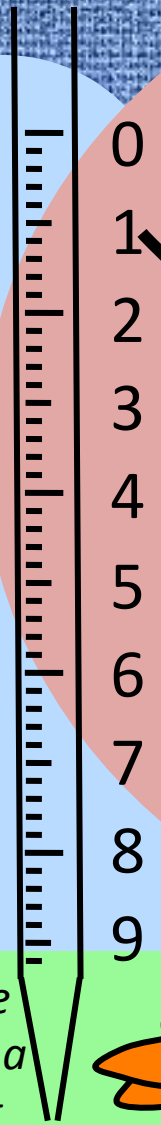
Pipet image credit: Emma Travis 2019

1. The Mohr pipet in review

Suppose we wanted 2.76 mL. Start with it filled to the 0 mark.

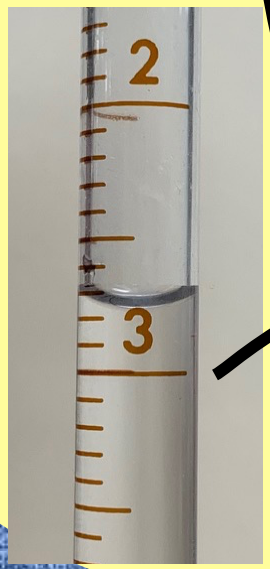
… and deliver the solution down to 2.76 mL

… and the rest goes back in the beaker.



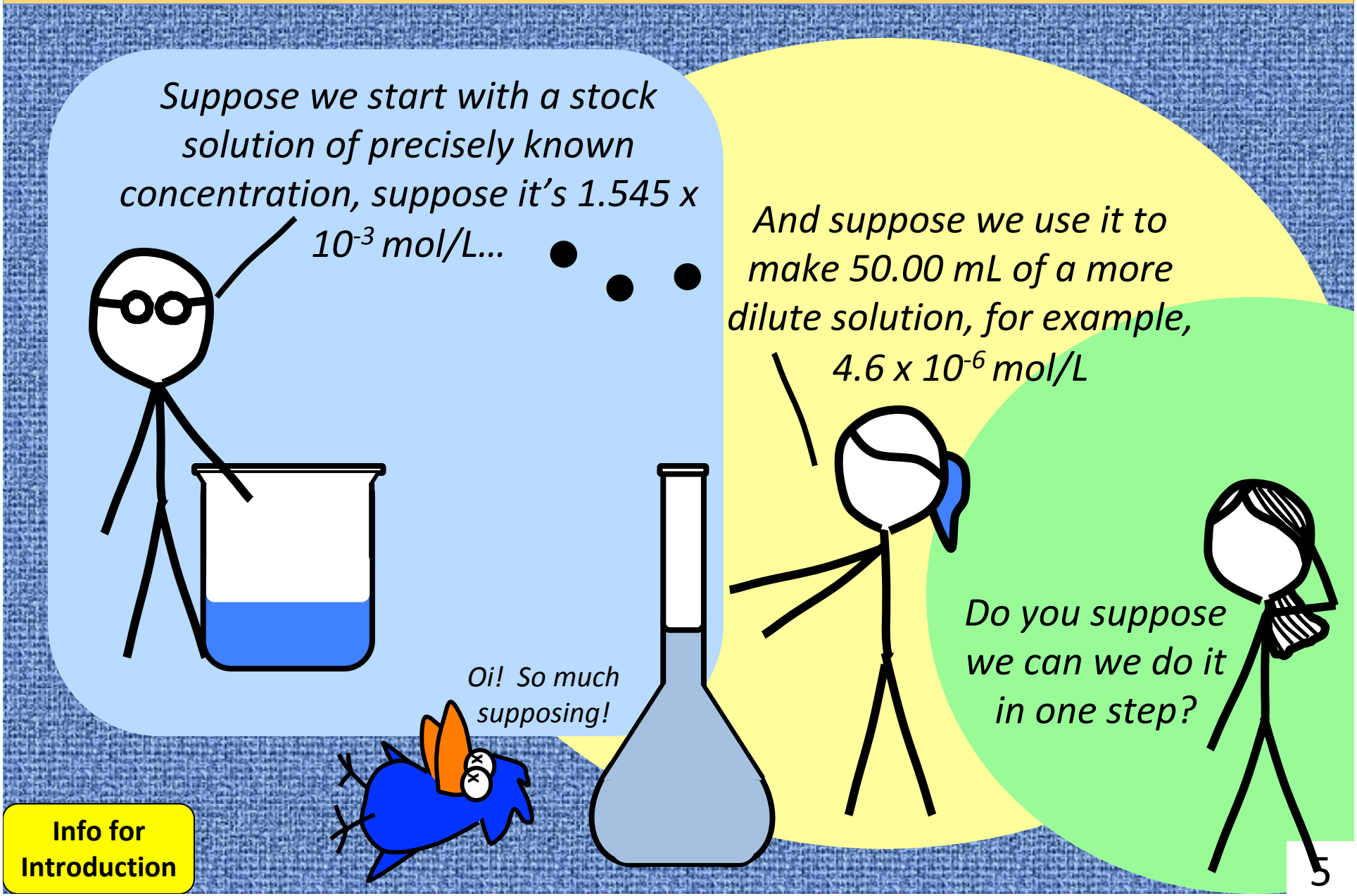
This is the part we want to use – from 0 down to 2.76 mL

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



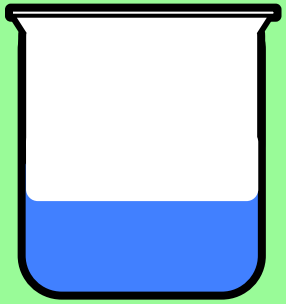
See how the Mohr pipet gets all weird before it gets to 10? Not all 10-mL Mohrs even have a 10 mL mark. Don't use this part of the pipet for anything. Nothing good happens here.

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

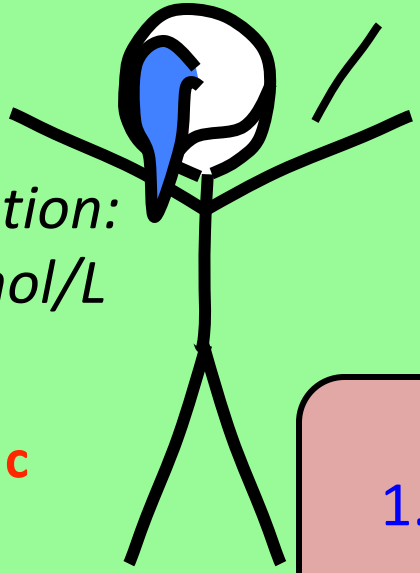


Info for Introduction

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

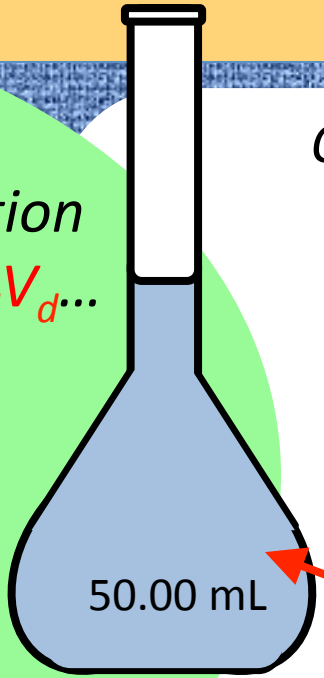


So we use the dilution formula, $M_cV_c = M_dV_d$…



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_d

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

$M_cV_c = M_dV_d$

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

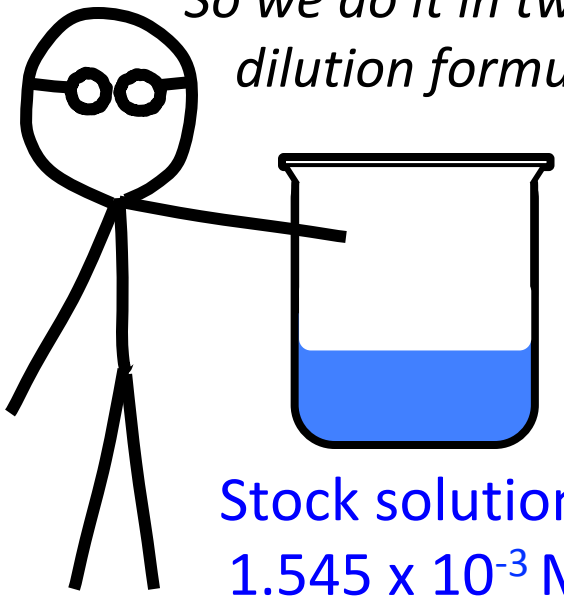
$V_c = 0.149\ mL$

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. And… if we use more than 1.00 mL, we gain a significant figure.

Info for Introductio

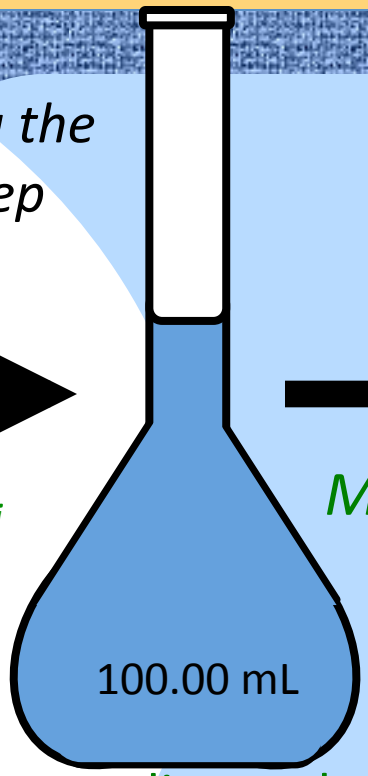
3. Planning the job

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



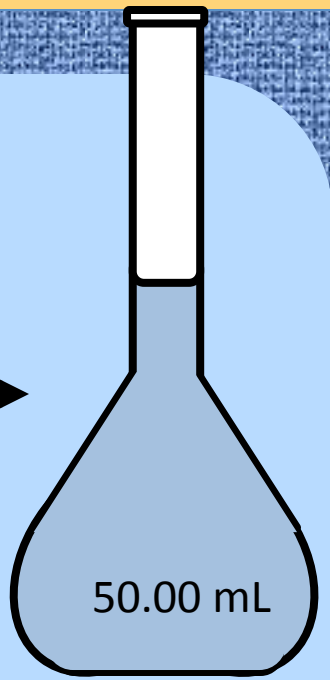
Stock solution:
1.545×10^{-3} M

$M_cV_c = M_iV_i$



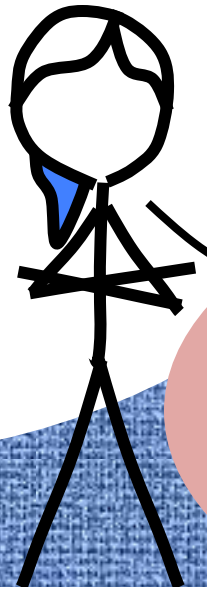
Intermediate solution

$M_iV_i = M_dV_d$



Goal solution:
4.6×10^{-6} M

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

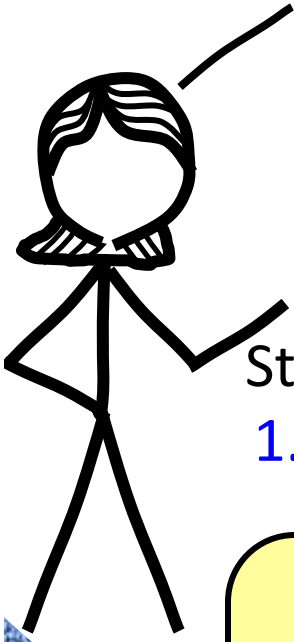


In lab we will have 5.00 and 10.00 mL volumetric pipets and 50.00 and 100.00 mL volumetric flasks available – 4 combinations.

Info for Introduction

3. Planning the job

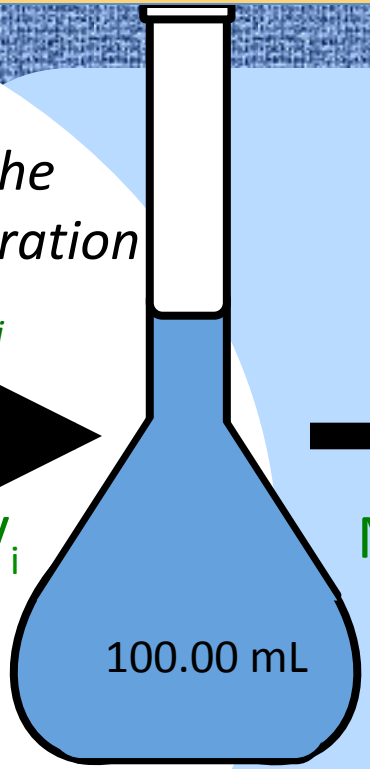
If we make 100.00 mL of the intermediate using 5.00 mL of the concentrated solution… its concentration is calculated with $M_cV_c = M_iV_i$



Stock solution:

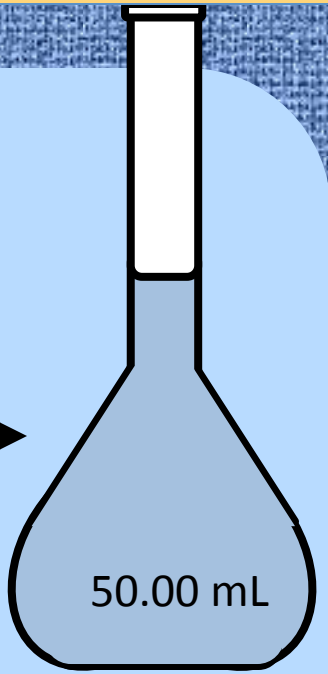
1.545×10^{-3} M

$M_cV_c = M_iV_i$



Intermediate solution

$M_iV_i = M_dV_d$



Goal solution:

4.6×10^{-6} M

Concentration of the intermediate solution:

$$M_cV_c = M_iV_i$$

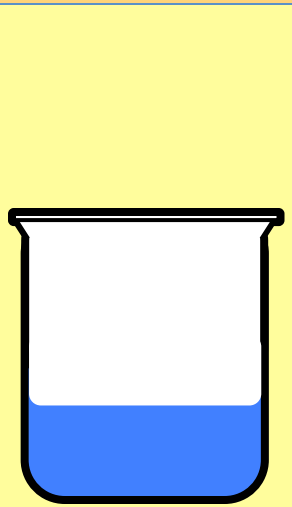
$$1.545 \times 10^{-3}\ M \times 5.00\ mL = M_i \times 100.00\ mL$$

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

Next we calculate the second dilution

Info for Introduction

3. Planning the job



$M_c V_c = M_i V_i$

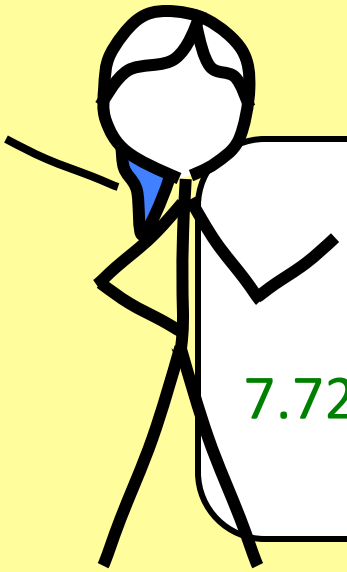
$M_i V_i = M_d V_d$

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:

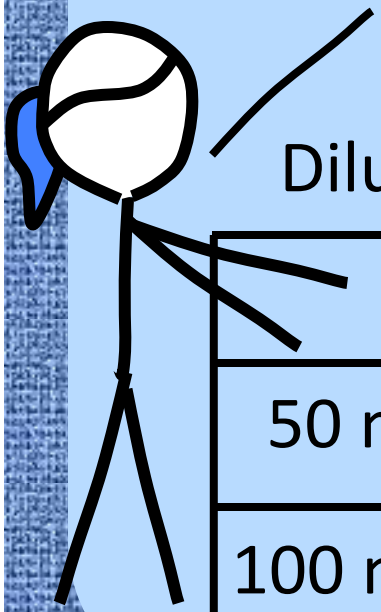
$M_i V_i = M_d V_d$

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

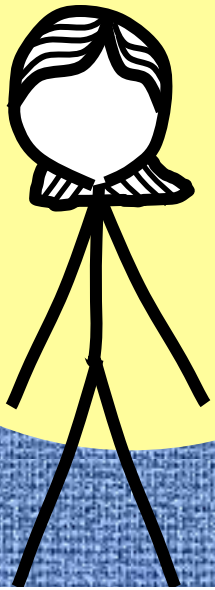
You may find this table handy for planning the intermediate solution. These are the four combinations of volumetric pipets and flasks. In the example just discussed, we diluted 5.00 mL to 100.0 mL for the intermediate – a 20-fold dilution.

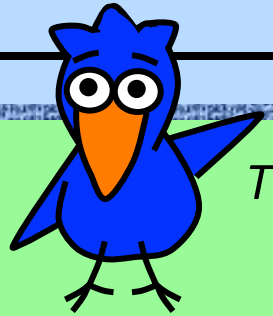


Dilution factors for Intermediate:

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

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





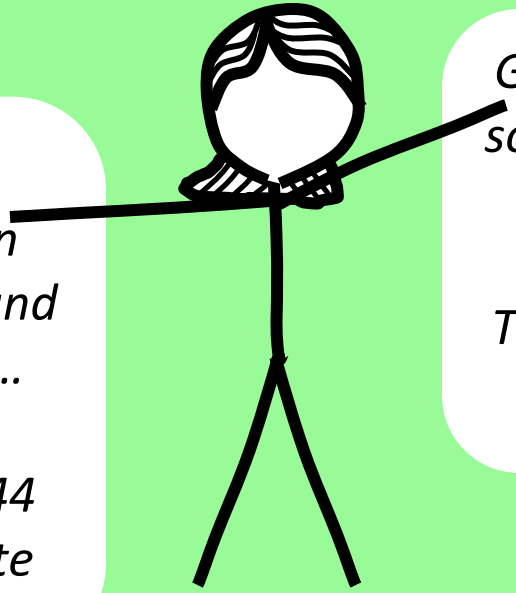
These were calculated using the dilution equation.

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…

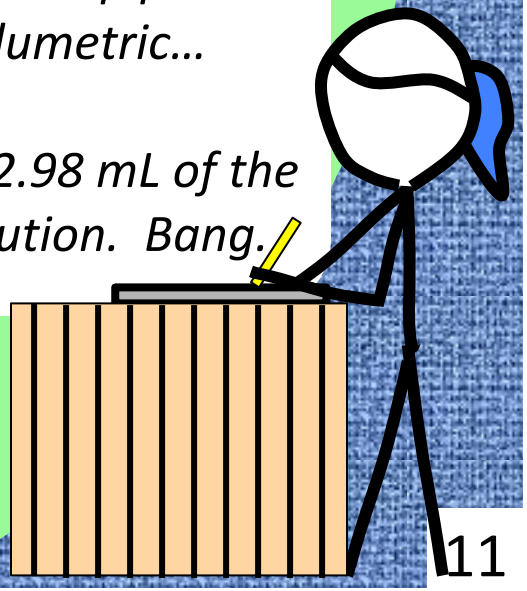
Group X made the intermediate solution using 10.00 mL pipet and 50.00 mL volumetric…

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



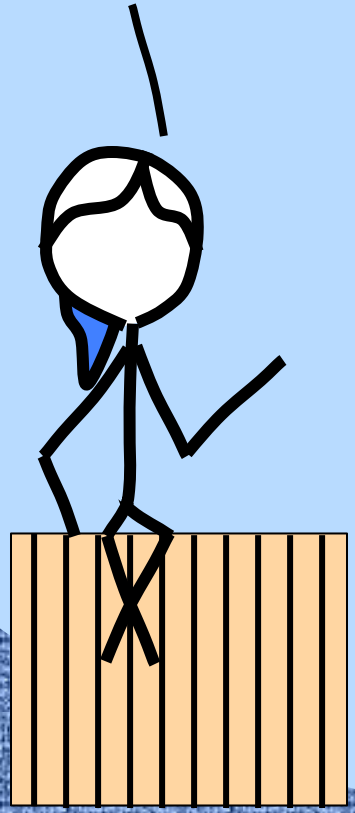
Group Y made the intermediate solution using 5.00 mL pipet and 100.00 mL volumetric…

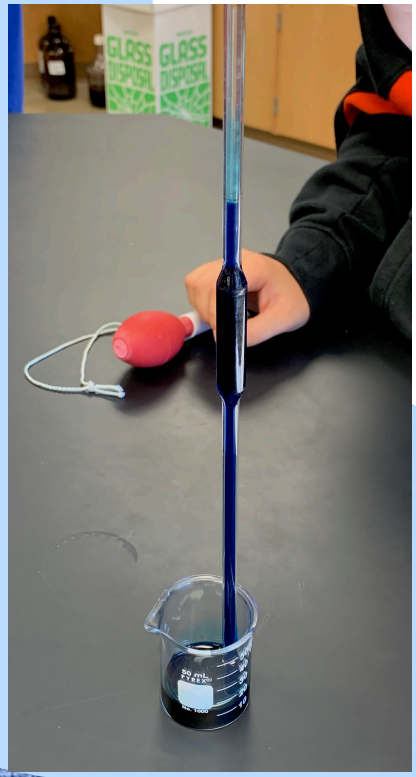
They would need 2.98 mL of the intermediate solution. Bang.



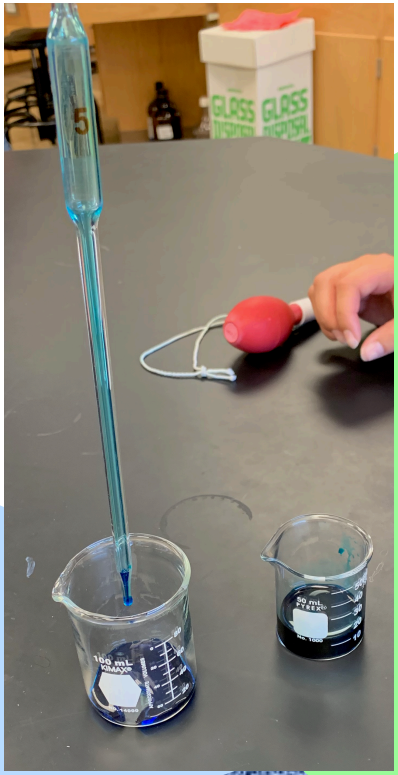
3 ½. Tricks of the trade

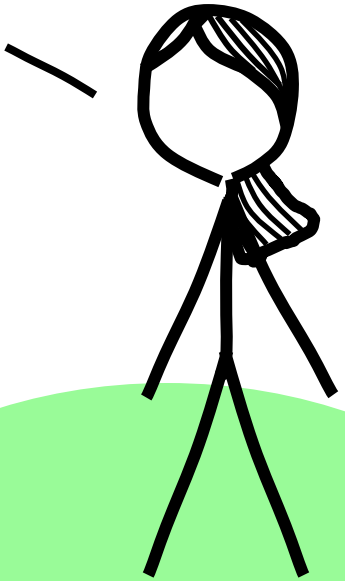
The first dilution uses the volumetric pipet – whichever one you decided to use from Slide 10 – the 5.00 or the 10.00 mL.





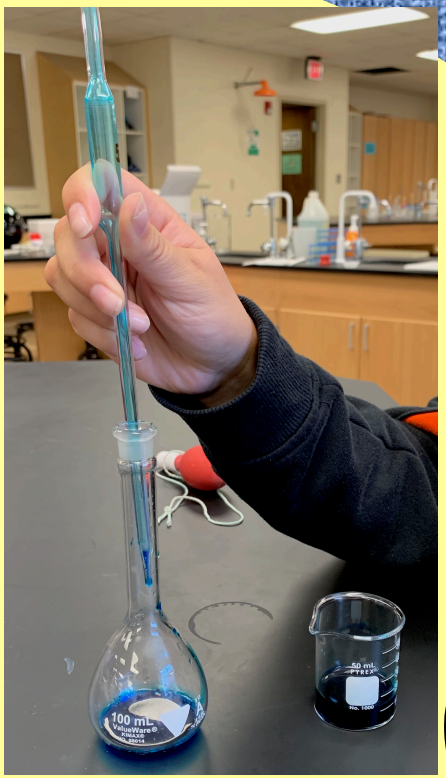
Start by rinsing the pipet with the stock solution like you see in these two pictures and discarding the rinse solution. You were given plenty.

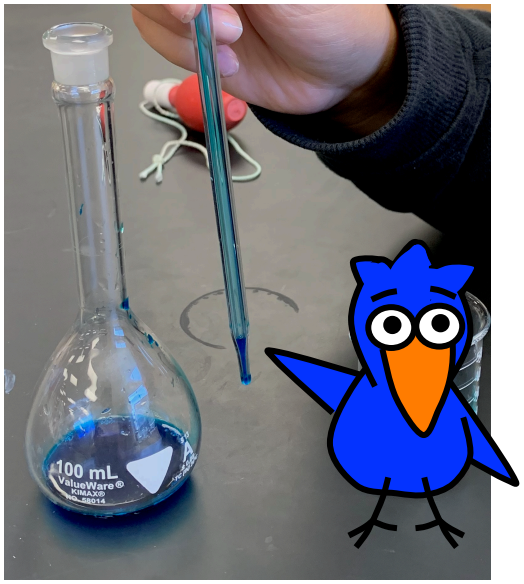




It's food coloring so you can discard it down the drain.

3 ½. Tricks of the trade

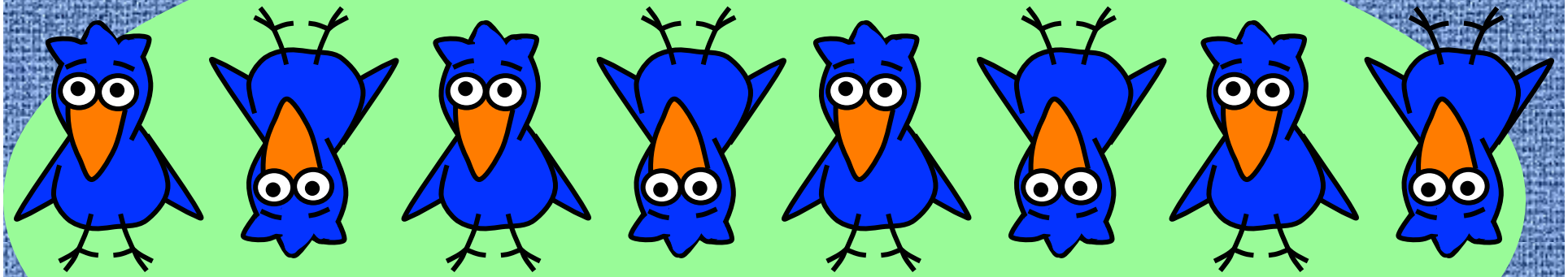




Now transfer the 5.00 mL (or 10.00 mL) to the volumetric flask you picked in Slide 10.

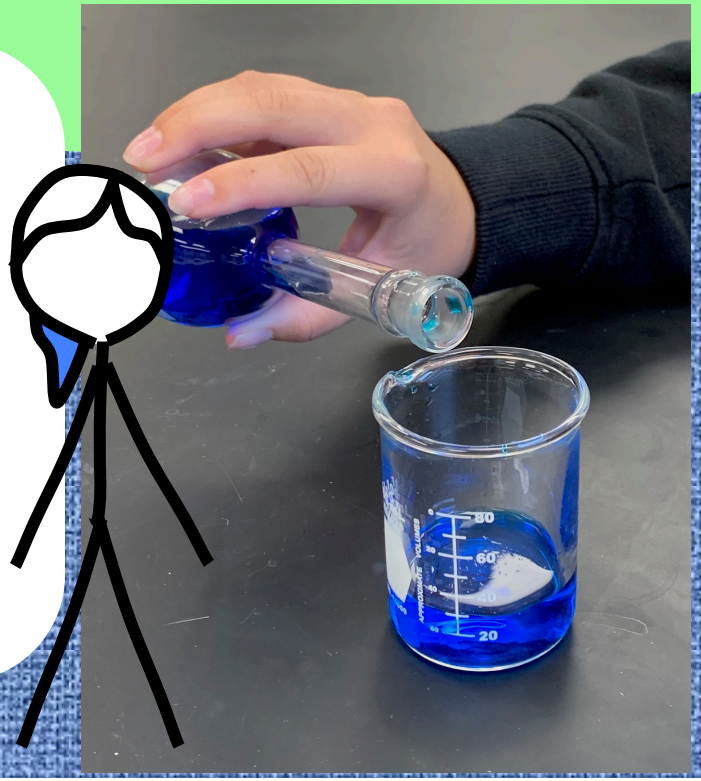
The little drop at the end that seems stuck is supposed to stay in the pipet. The people at the volumetric pipet factory designed it around water's high surface tension.

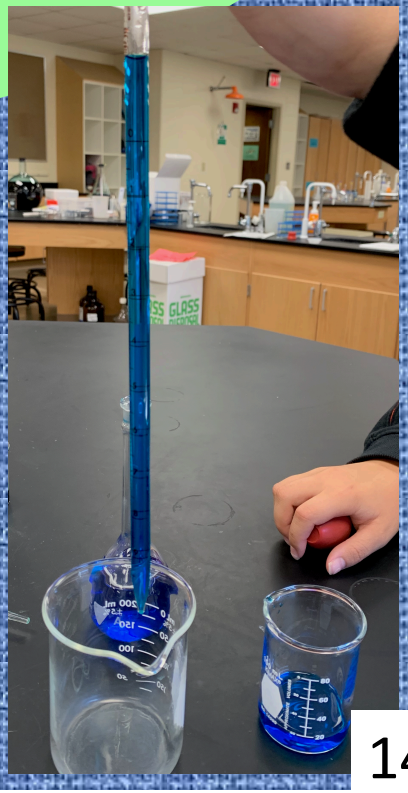
3 ½. Tricks of the trade



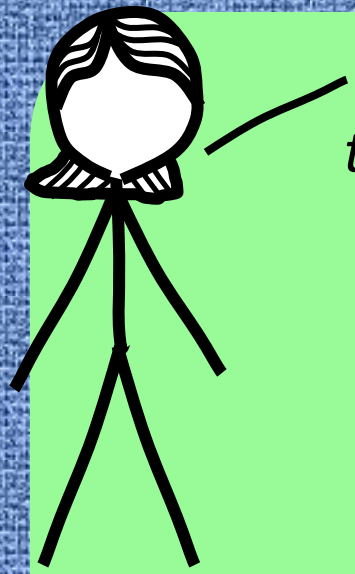
Mix Mix Mix Mix Mix Mix Mix Mix Mix Mix Mix Mix Mix Mix
your intermediate solution by turning it end for end 10 or 12 times.

So you made either 50.00 or 100.00 mL of this intermediate solution and you will need to use less than 10 mL of it. We have plenty extra to rinse the Mohr pipet with some of the intermediate solution… like you see happening here.

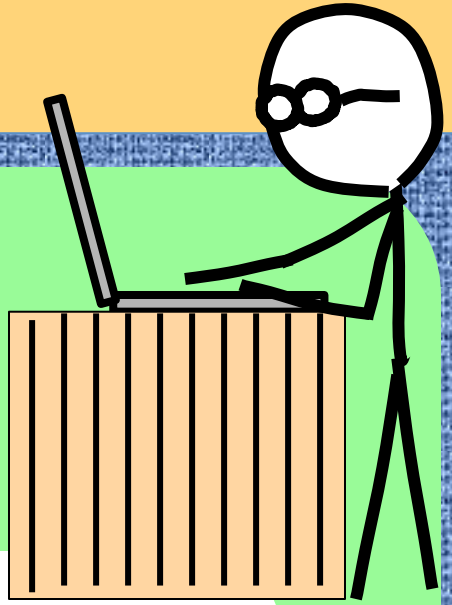




4. Procedure

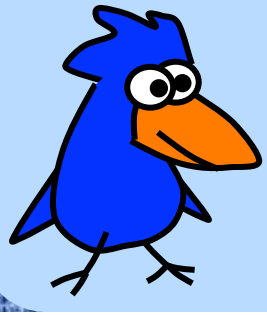


You will be turning in results on-line today. Many of the numbers are very small, such as 4.12 x 10^{-6} M.



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

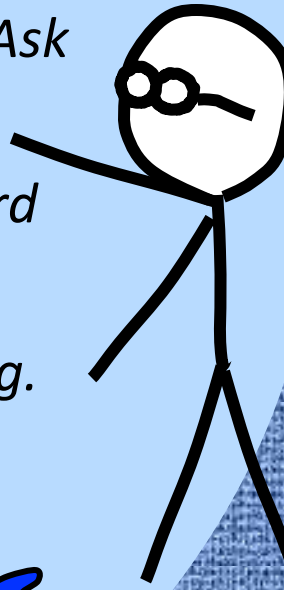
I. *Wearing your safety glasses is always prudent, but today we will not be enforcing it. No special attire needed – we are working with blue food coloring!*

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.*

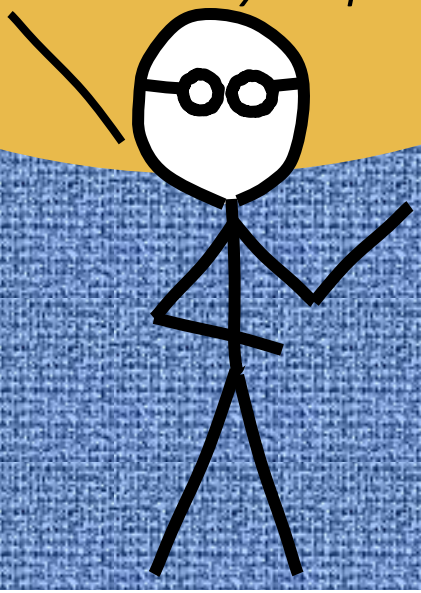
V. *The cover sheet summarizes everything that you need to include with your report.*

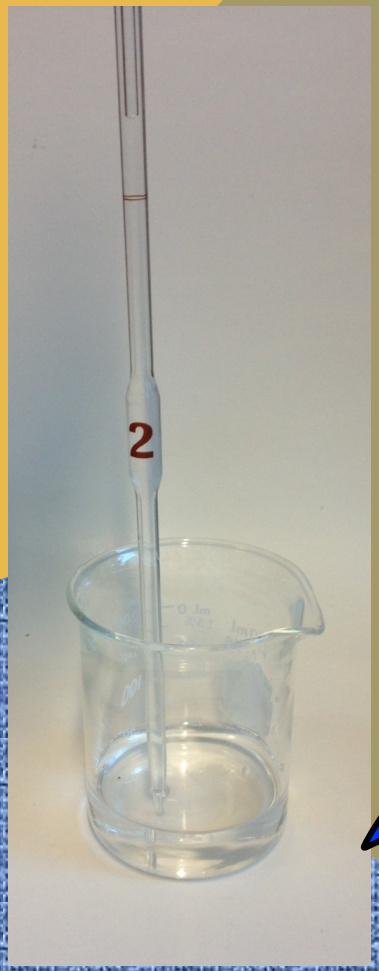


You're gonna love the next slide!

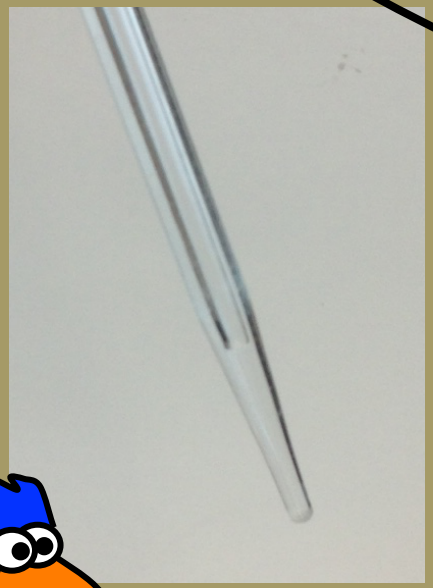
4. Procedure and Tricks of the Trade

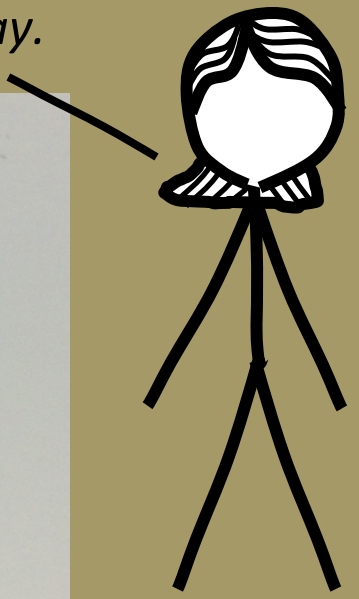
One easy way to start exactly at the mark is to draw the solution up past the mark, hold your finger firmly on the top and hold the tip of the pipet on the bottom of the beaker. Roll your finger slightly off the pipet and solution will slowly drop.

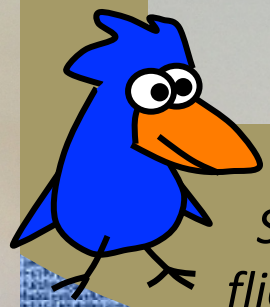




The last drop in a volumetric pipet is supposed to stay in the pipet. It's been calibrated to work that way.

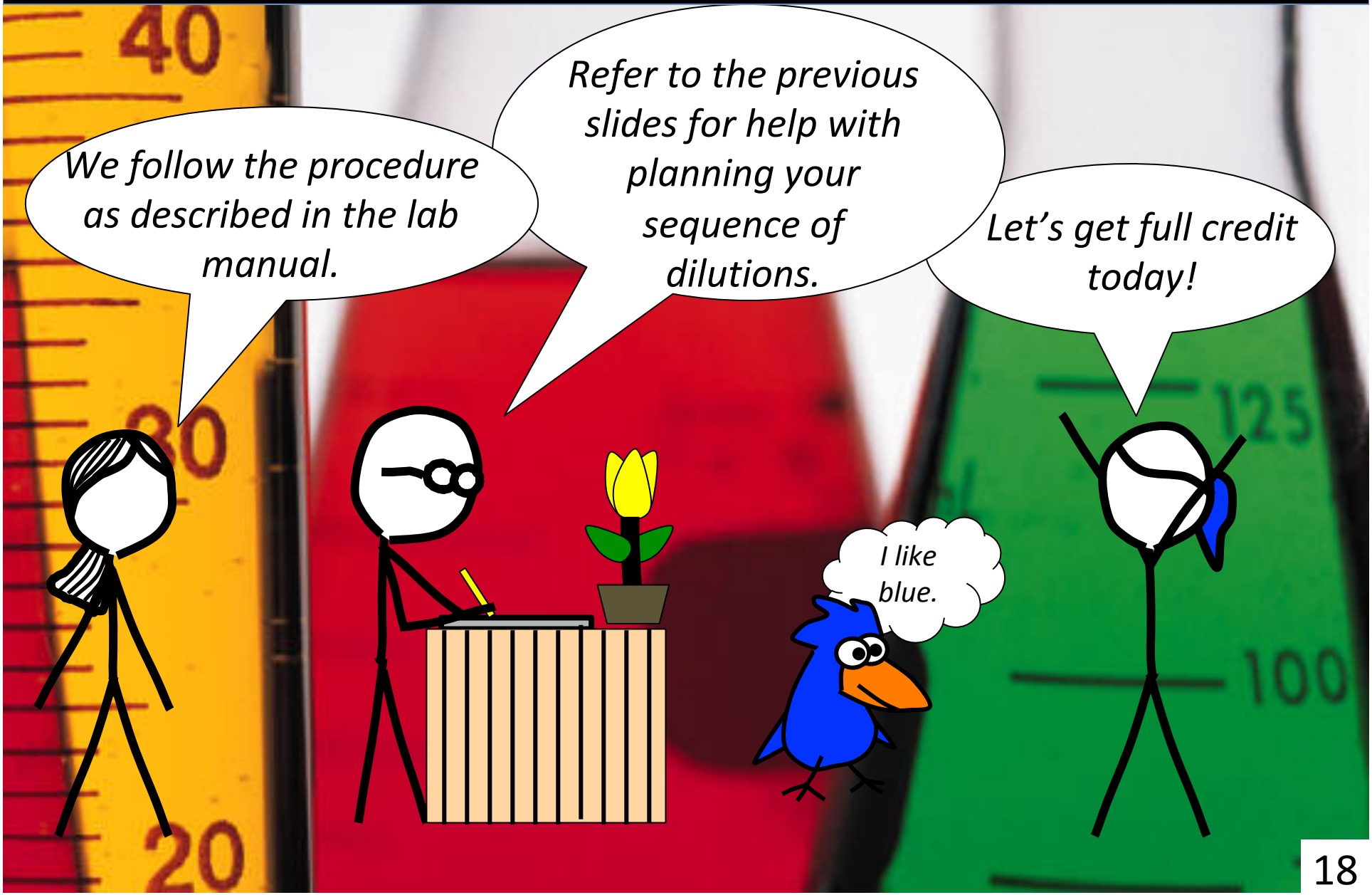




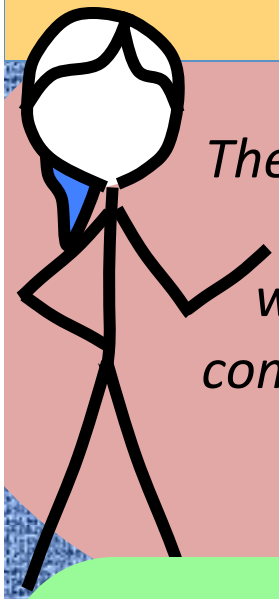


So don't shake, flick or blow it out

5. Procedure.

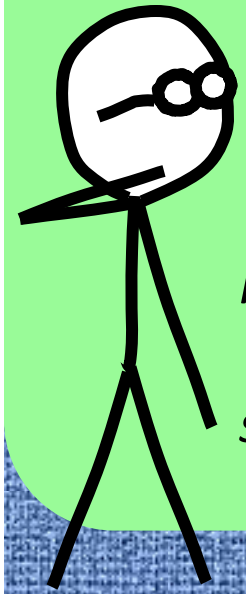

We follow the procedure as described in the lab manual.
Refer to the previous slides for help with planning your sequence of dilutions.
Let's get full credit today!
I like blue.

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.

Pssst. Yeah, you. Want some bonus points? See the next slide.

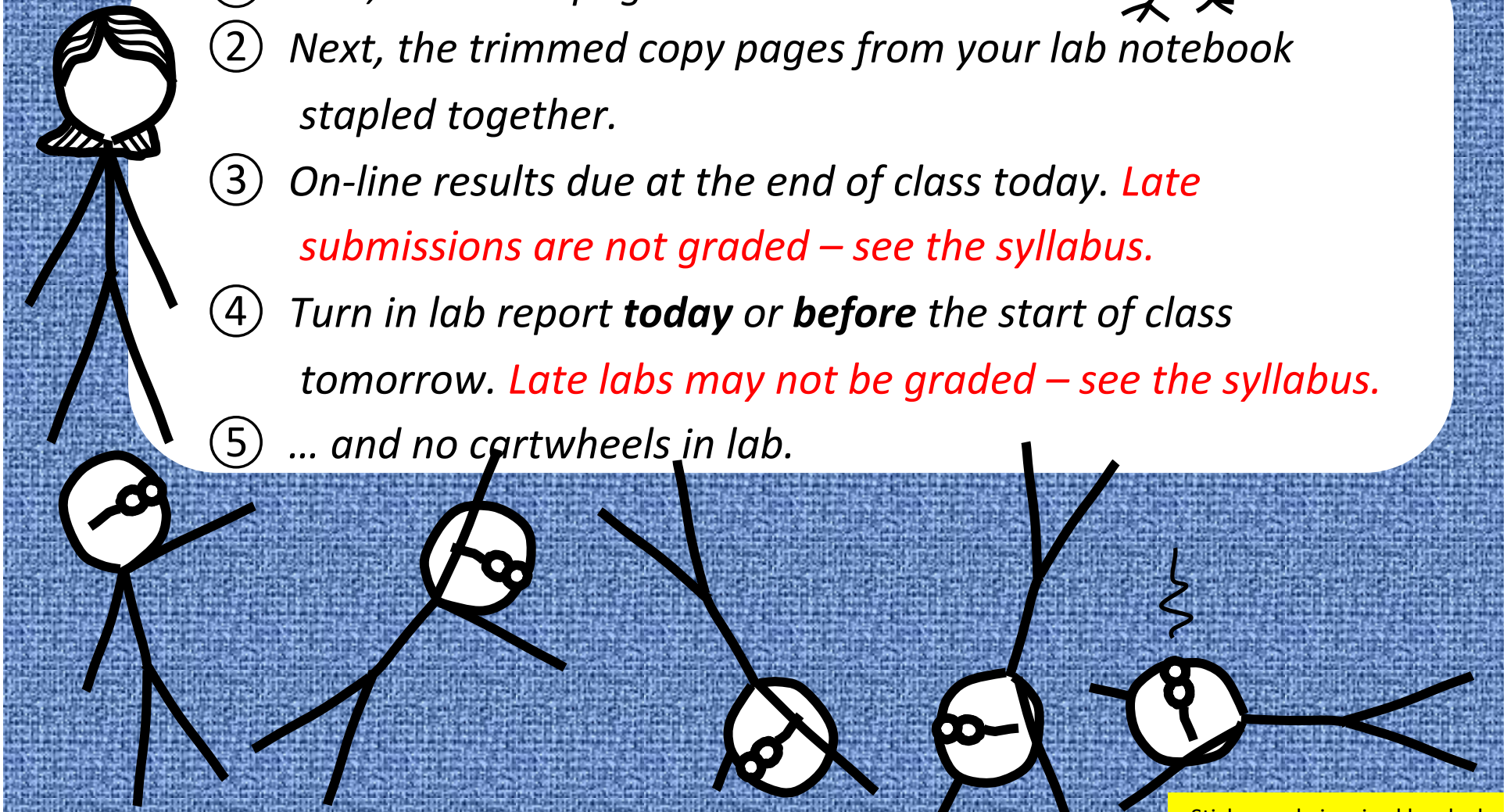
① *First, the cover page with TA initials.*

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)

Bonus! (Optional)

Make a YouTube video on the proper use of the Mohr pipet. You must finish your experiment first and complete the filming during lab. Editing can be done overnight but the video is due by the start of class tomorrow. TAs will pick the 1st, 2nd and 3rd place winners. First place is 5 bonus points, 2nd place is 4 bonus points. All others that meet the criteria listed below will get three bonus points.

① *Video must show skilled filling past the 0.00 mark from a beaker of food colored water and the proper slow release of water down to the 0.00 mark. The movie must show a close-up of the water's meniscus at the 0.00 mark. Mohr pipet must be completely vertical.*

② *Deliver exactly 3.70 mL into a volumetric flask. Show a close up of the water's meniscus at the 3.70 mL mark.*

③ *Return the rest of the water to the beaker.*

④ *Dialog must be technically accurate (proper names for things, etc.)*

⑤ *Video has to be uploaded to YouTube and must be under 2 minutes long.*

⑥ *Video must not be offensive in any way and must reflect Creighton's values.*

⑦ *Everybody must be wearing eye protection.*

⑧ *Upload video and send Dr Mattson the url address.*