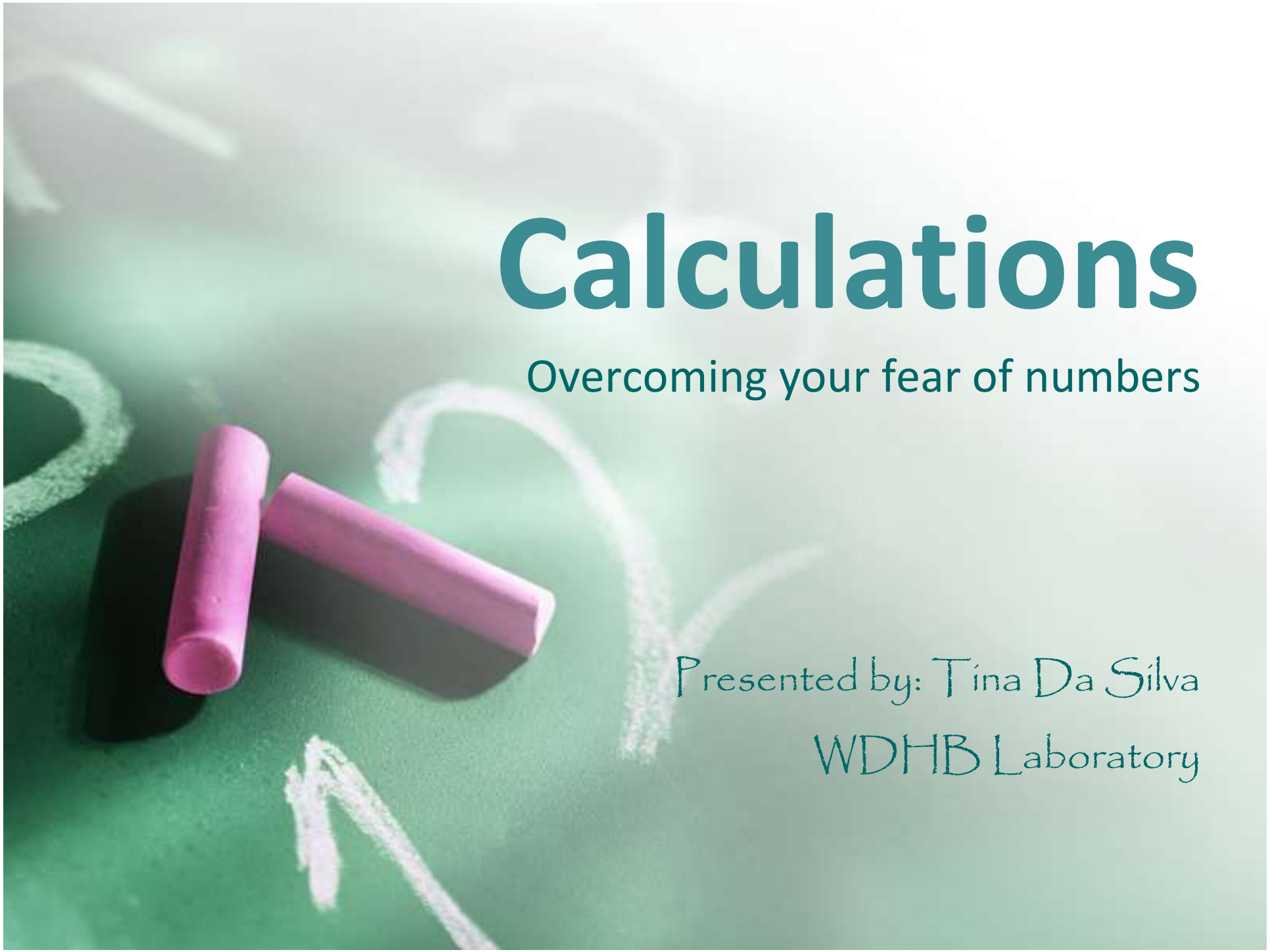


Calculations

Overcoming your fear of numbers

Presented by: Tina Da Silva

WDHB Laboratory

Calculations performed in laboratory use

- Converting metric units
- Time
- Fractions, decimals and percentages
- Converting rpm to g
- Dilutions
- Statistics

Converting Metric units

- The metric system is called a decimal based system because it is based on multiples of 10
- Any measurement given in one metric unit can be converted into another metric unit simply by moving the decimal place

Basic Units

Length	Mass	Volume	Amount of substance
metre (m)	gram (g)	litre (l)	mole (mol)

King Henry Doesn't
usually
Drink Chocolate Milkshake

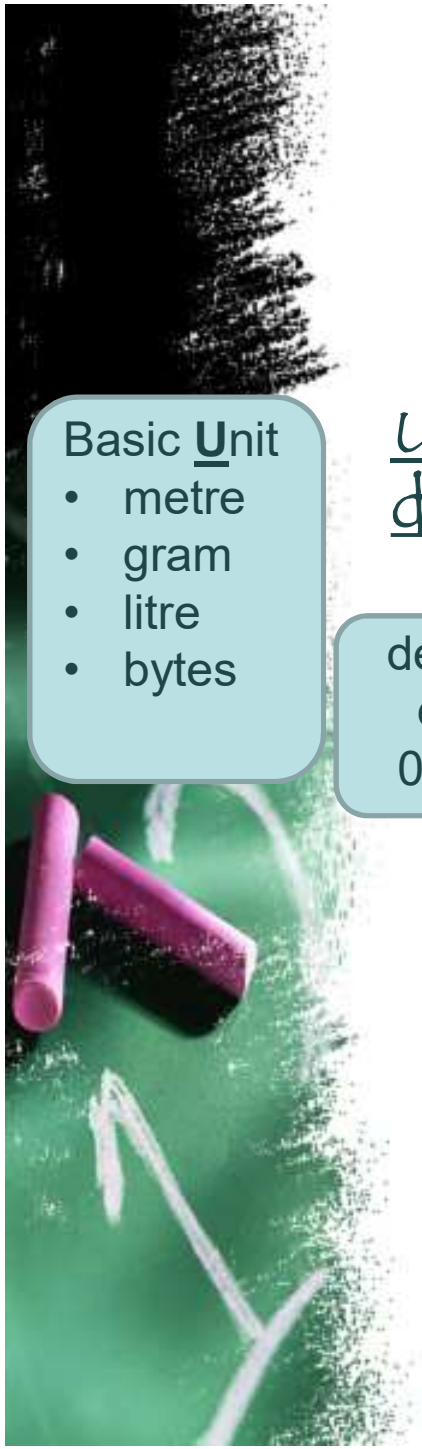
To convert metric units, multiply or divide by powers of 10

Move the decimal place to the right (multiply) or the left (divide)

king henry doesn't usually

- Tera T 1000 000 000 000
- Giga G 1000 000 000
- Mega M 1000 000
- Kilo k 1000
- Hekta h 100
- Deka da 10
- Basic Unit
  - metre
  - gram
  - litre
  - bytes

Move the decimal place to the right (multiply) or the left (divide)



Basic **U**nit
- metre
- gram
- litre
- bytes

usually
drink chocolate milkshake

deci
d
0.1

centi
c
0.01

milli
m
0.001

micro
μ
0.000 001

nano
n
0.000 000 0001

pico
p
0. 000 000 000 0001

Convert 2ml into µl

Basic **U**nit
- metre
- gram
- litre
- bytes

deci
d
0.1

centi
c
0.01

milli
m
0.001

micro
µ
0.000 001

Convert 2ml into µl

Basic **U**nit
- metre
- gram
- litre
- bytes

deci
d
0.1

centi
c
0.01

milli
m
0.001

micro
µ
0.000 001

Move the decimal place to the right (multiply)

2,0ml

20, 200, 2000,

2000µl

Convert 10.0mg into g

Basic **U**nit
- metre
- gram
- litre
- bytes

deci
d
0.1

centi
c
0.01

milli
m
0.001

Convert 10.0mg into g

Basic **U**nit
- metre
- gram
- litre
- bytes

deci
d
0.1

centi
c
0.01

milli
m
0.001

10,0mg

1,00 0,100 0,0100

0.01g

Move the decimal place to the left (divide)

Convert 85g into kg

Kilo
k
1000

Hekta
h
100

Deka
da
10

Basic **U**nit
- metre
- gram
- litre
- bytes

Convert 85g into kg

85,0g

8,50

0,850

0,085

0,085kg

Kilo
k
1000

Hekta
h
100

Deka
da
10

Basic **U**nit
- metre
- gram
- litre
- bytes

Move the decimal place to the left (divide)


Time

12 hour clock vs 24 hour clock

There are 2 main ways to show the time:

- 24 hr clock
- 12 hr clock or AM/PM

24 hr clock – shows how many hours and minutes since midnight

AM/PM or 12 hr clock is split into

- The hrs running from Midnight to Noon (AM)
- The other hrs running from Noon to Midnight (PM)

➢ 60 seconds in 1 minute

➢ 60 minutes in 1 hour

Convert the following:

- 11:30pm = 23:30
- 19:50 = 7:50pm
- 1:45am = 01:45
- 240sec = 4 min
- 195min = 3 hours and 15 min


Fractions,
decimals and
percentages

Fractions

$$¼ = \frac{1}{4} \quad \frac{Numerator}{Denominator}$$

Numerator = is the number of parts (top number)

Denominator = the number of parts the whole is divided into (bottom number)

Converting Fractions to Decimals

Using a calculator:

Divide the Numerator by the Denominator

- Convert $\frac{1}{4}$ $1 \div 4 = 0.25$
- Convert $\frac{1}{2}$ $1 \div 2 = 0.5$
- Convert $\frac{3}{4}$ $3 \div 4 = 0.75$

Converting Fractions to Decimals

Converting without a calculator:

Find a number that you can multiply the denominator to make it 10 or 100 or 1000, then multiply both numerator and denominator by that number.

- $\frac{3}{5} \overset{\text{x20}}{=} \frac{60}{100}$ so $60 \div 100 = 0.60$
- $\frac{3}{8} \overset{\text{x125}}{=} \frac{375}{1000}$ so $375 \div 1000 = 0.375$

exception

- $\frac{1}{3} \overset{\text{x333}}{=} \frac{333}{999}$ so $333 \div 1000 = 0.33333333$

Converting Decimals to Percentages

- Multiply the decimal by 100, then add on the % symbol

Convert 0.36	0.36 x 100 = 36%
Convert 1.65	1.65 x 100 = 165%
Convert 0.08	0.08 x 100 = 8%


Converting
rpm to g

Converting rpm and g

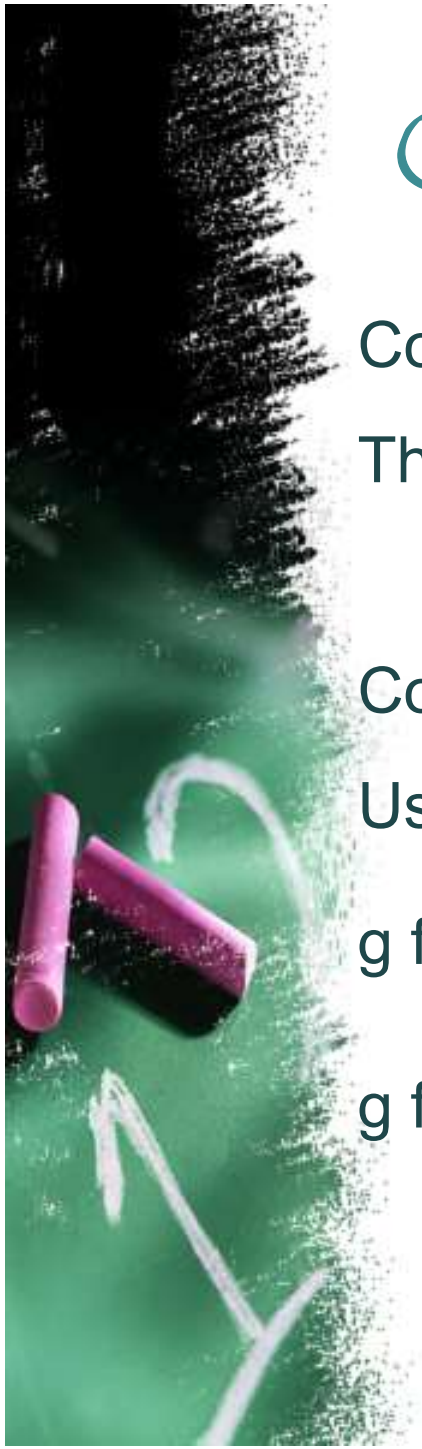
G force or RCF (Relative Centrifugal Force) is the amount of acceleration applied to a sample

This depends on

- rpm (Revolutions Per Minute)
- Radius of the rotor (r), measured in cm's

Formula to convert rpm into g:

$$\text{g force (RCF)} = 11.18 \times \left(\frac{rpm}{1000}\right)^2 \times r$$



Converting rpm and g

Convert 3000rpm to g.

The radius of the centrifuge is 160mm.

Convert 160mm into cm = 16cm.

Using formula:

g force (RCF) = 11.18 x $(\frac{rpm}{1000})^2$ x r

g force (RCF) = 11.18 x $(\frac{3000}{1000})^2$ x 16cm = 1610g

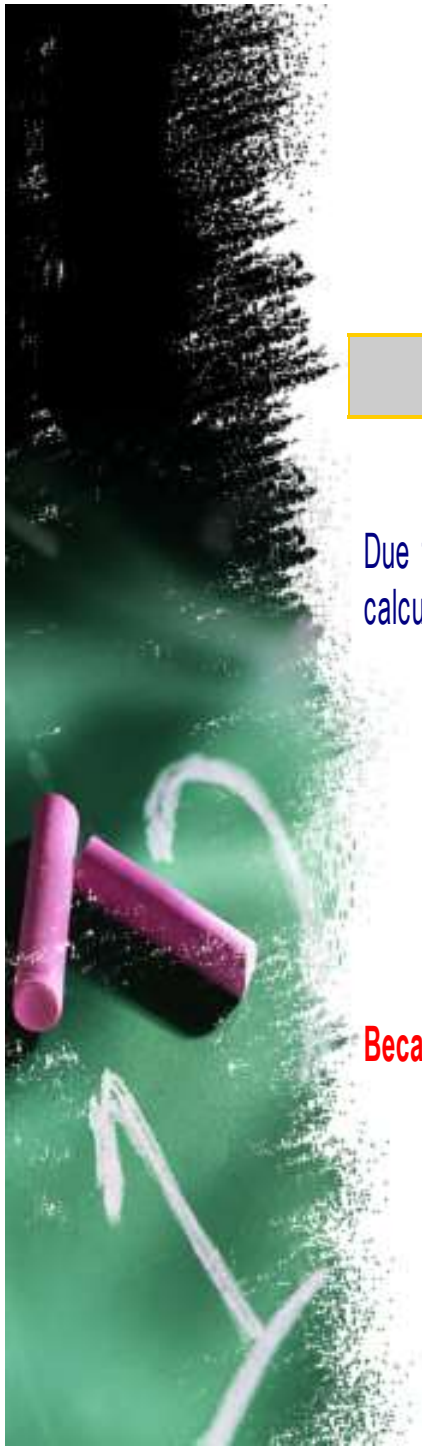

Dilutions

Simple Dilutions

- A simple dilution is one in which a ***unit volume*** of liquid material is combined with a ***solvent*** liquid to achieve a desired concentration
- The ***dilution factor*** is the total number of unit volumes in which your material will be dissolved

1:5 dilution = 1 unit volume of ***solute*** + 4 unit volume of ***solvent***

(hence 1+4 = 5)



Dilution Factor Definitions (where applicable)

Due to inconsistencies in nomenclature associated with dilution expression the following will be used for calculations in the examination:

½ and 1 in 2: implies 1 part added to 1 part making a total of 2 parts,
ie. A dilution factor of x2.

1 to 2: implies 1 part added to 2 parts making a total of 3 parts,
ie. A dilution factor of x3.

Because of the dual meaning of the expression 1:2, it will not be used in the examinations.

Simple Dilutions

Example 1

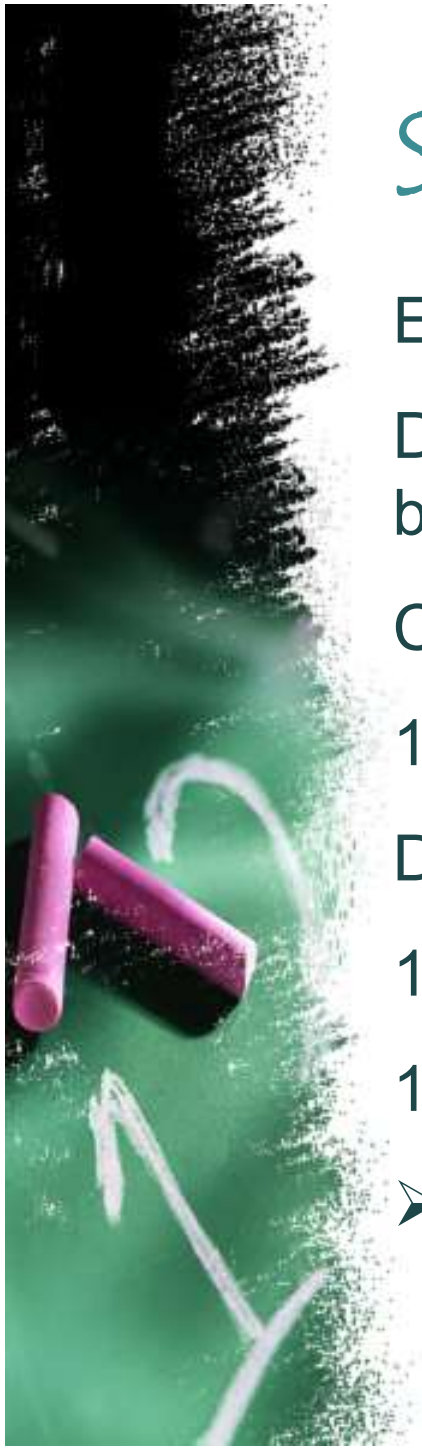
Prepare a 1:8 dilution of concentrated stock solution of Viraclean to a final volume of 400ml with Distilled water

Determine what the unit volume is :

400ml ÷ 8 = 50ml, then

400ml – 50ml = 350ml so

- *Dilute 50ml concentrated stock solution of Viraclean + 350ml Distilled water*



Simple Dilutions

Example 2

Describe the preparation of a 1:5 dilution of liquid bleach to a total volume of 1.5L

Convert 1.5L to ml

1.5L = 1500ml

Determine what the unit volume is :

1500ml ÷ 5 = 300ml, then

1500ml – 300 ml = 1200ml

- Dilute 300ml liquid bleach + 1200ml Distilled water

Making fixed volumes of specific concentrations from liquid reagents

- V = volume, C = concentration

(Stock solution) V1C1 = V2C2 (New solution)

or V1 x C1 = V2 x C2

Making fixed volumes of specific concentrations from liquid reagents

(Stock solution) V1C1 = V2C2 (Final solution)

Example 1:

You have: 3ml of 100mg/ml Ampicillin stock solution
You want: 200µl (= V2) of solution of 25mg/ml (= C2)

What is the volume of stock solution you will start with?

So, 100mg/ml (= C1)

V1 ?

200µl (= V2)

25mg/ml (= C2)

(Stock solution) V1C1 = V2C2 (New solution)

Example 1:

100mg/ml (= C1)

200µl (= V2)

25mg/ml (= C2)

What is the volume of stock solution you will start with?

convert 200µl to ml = 0.2ml, then V1C1 = V2C2

V1 x 100mg/ml = 0.2ml x 25mg/ml

So, $V1 = \frac{0.2ml \; x \; 25mg/ml}{100mg/ml} = \frac{5}{100}$ *= 0.05ml or 50µl*

Making fixed volumes of specific concentrations from liquid reagents

(Stock solution) V1C1 = V2C2 (Final solution)

Example 2:

What volume of a given 10mM stock solution is required to make 20ml of a 50μM solution?

using formula: C1V1 = C2V2

C1 = 10mM

V1 = ? Stock solution

C2 = 50μM

V2 = 20ml

(Stock solution) V1C1 = V2C2 (New solution)

Example 2:

V1 ? Stock solution

10mM (= C1)

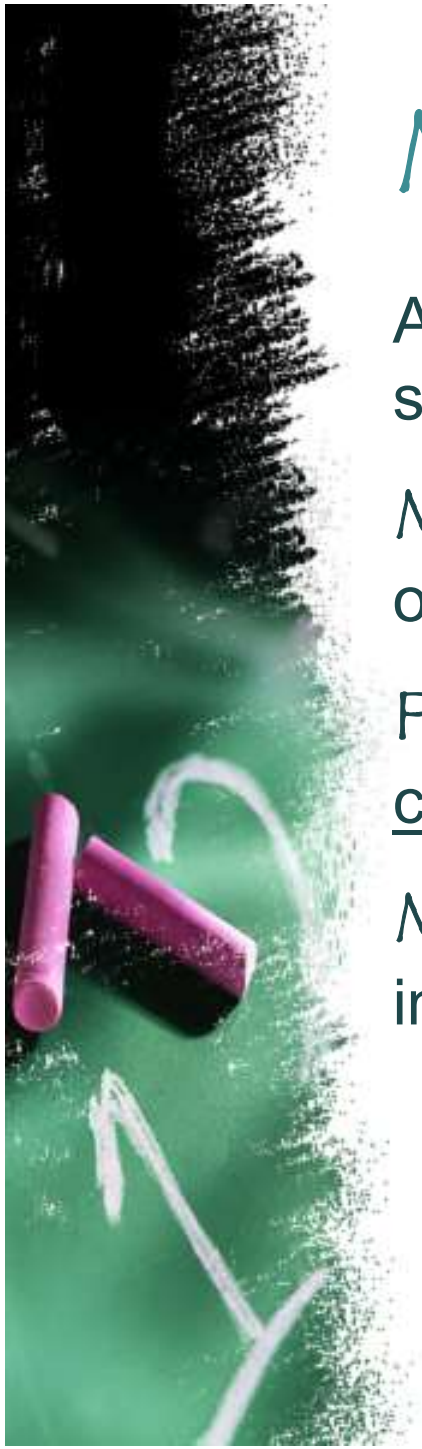
20ml (= V2)

50μM (= C2)

convert 50μM to mM = 0.05mM, then V1C1 = V2C2

V1 x 10mM = 20ml x 0.05mM

So, $V1 = \frac{20ml \; x \; 0.05mM}{10mM} = \frac{1}{10} = 0.1ml$



Mole and Molar solutions

A mole is a unit expressing the amount of a substance

Molecular weight (MW): the mass (g) of 1 mole of an element (g/mole)

Formula weight (FW): the mass of 1 mole of the compound

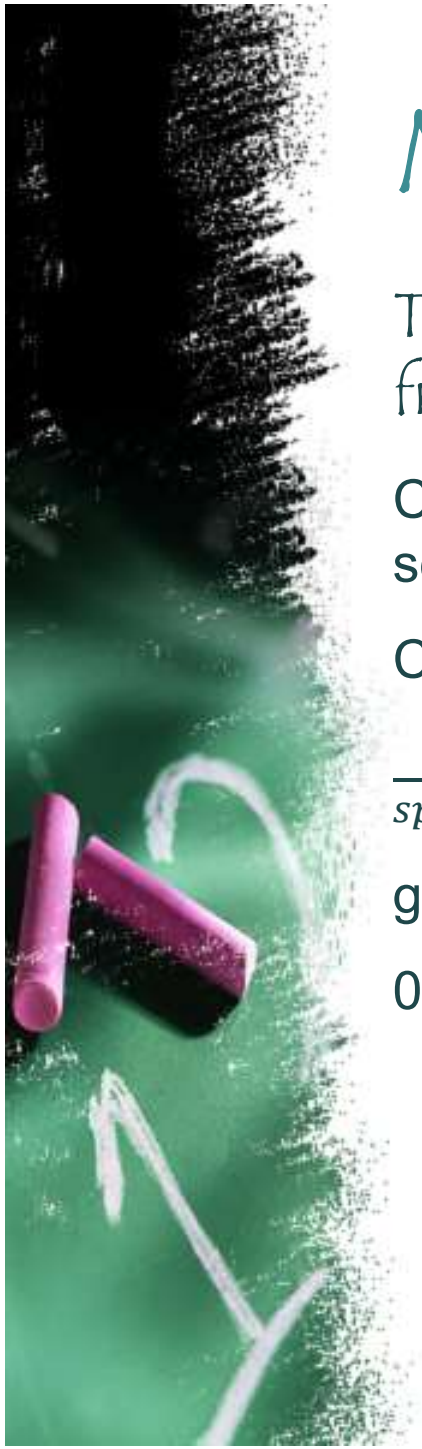
Molarity: # of moles of a chemical or compound in 1 L of solution (M = mole/L)

Mole and Molar solutions

To prepare a litre of a simple molar solution from a dry ingredient

Chemical MW = 194.3g/mole. Make a 0.15M (mole/L) solution

194.3g/mole x 0.15moles/L = 29.145g per 1L



Mole and Molar solutions

To prepare a specific volume of a molar solution from a dry reagent

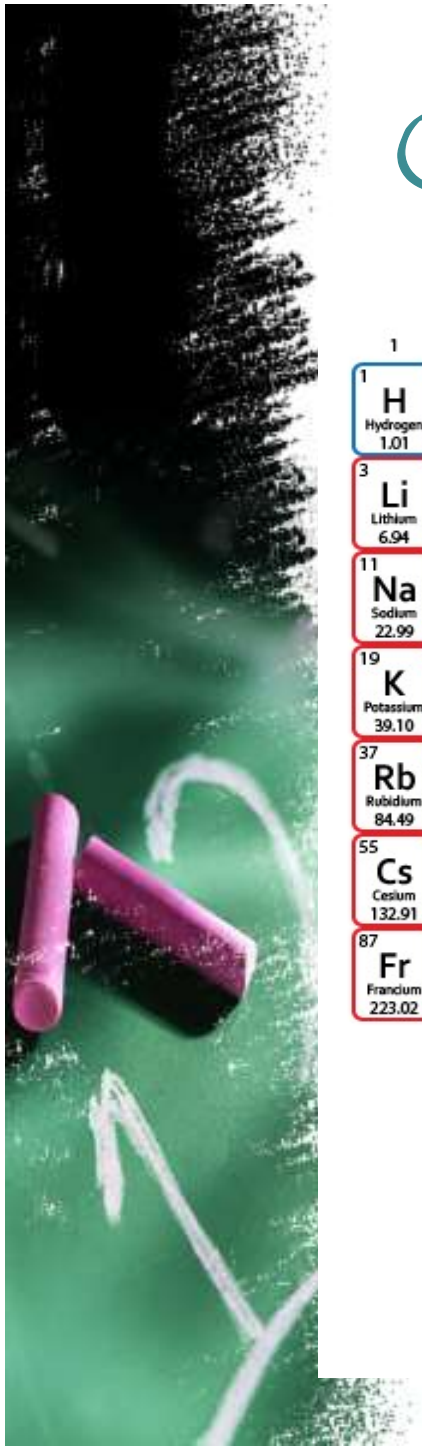
Chemical MW = 180g/mole, you need 25ml of 0.15mole/L solution

Convert 25ml to L = 0.025L

$\frac{g}{specific\ L}$ = desired molarity (mole/L) x MW (g/mole)

g = specific L x desired molarity x MW

0.025L x 0.15 x 180 = 0.675g



Calculating the MW

Periodic Table of the Elements

1																	18
1 H Hydrogen 1.01	2											13	14	15	16	17	2 He Helium 4.00
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31	3	4	5	6	7	8	9	10	11	12	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.93	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.73	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.09	35 Br Bromine 79.90	36 Kr Krypton 84.80
37 Rb Rubidium 84.49	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium 98.91	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.85	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.20	83 Bi Bismuth 208.98	84 Po Polonium [208.98]	85 At Astatine 209.98	86 Rn Radon 222.02
87 Fr Francium 223.02	88 Ra Radium 226.03	89-103 Actinides	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown

57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium 144.91	62 Sm Samarium 150.36	63 Eu Europium 151.97	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97
89 Ac Actinium 227.03	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.05	94 Pu Plutonium 244.06	95 Am Americium 243.06	96 Cm Curium 247.07	97 Bk Berkelium 247.07	98 Cf Californium 251.08	99 Es Einsteinium [254]	100 Fm Fermium 257.10	101 Md Mendelevium 258.10	102 No Nobelium 259.10	103 Lr Lawrencium [262]

Alkali Metal | Alkaline Earth | Transition Metal | Basic Metal | Semimetal | Nonmetal | Halogen | Noble Gas | Lanthanide | Actinide

Calculating the MW

MW = The sum of the atomic weight of atoms in a molecule (g/mole)

Element	Atomic weight
Ca	40
H	1
Cl	35
K	39
Na	23

- HCl = 1 + 35 = 36g/mole
- K_3Cl_2 = (39 x 3) + (35 x 2) = 117 + 70 = 187g/mole

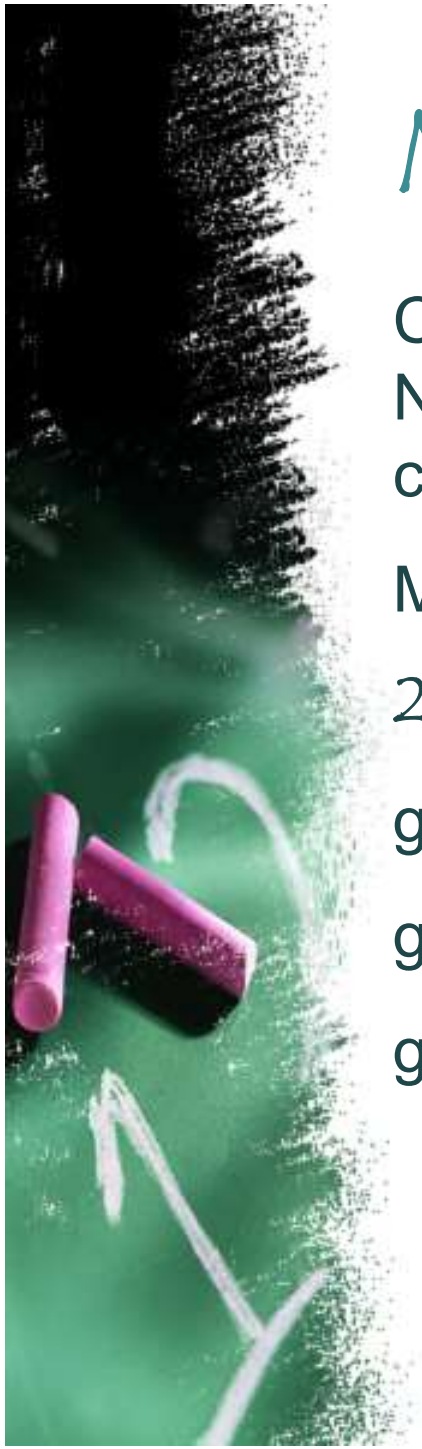
Calculating the MW

Calculate the amount of KNO_3 (Potassium Nitrate) required to prepare 500ml of 0.5mol/L concentration.

1st Calculate the MW of KNO_3

Element	Atomic weight
K	39
N	14
O	16

39 + 14 + (16 x 3) = 39 + 14 + 48 = 101g/mol



Molar solutions

Calculate the amount (g) of KNO_3 (Potassium Nitrate) required to prepare 500ml of 0.5mol/L concentration.

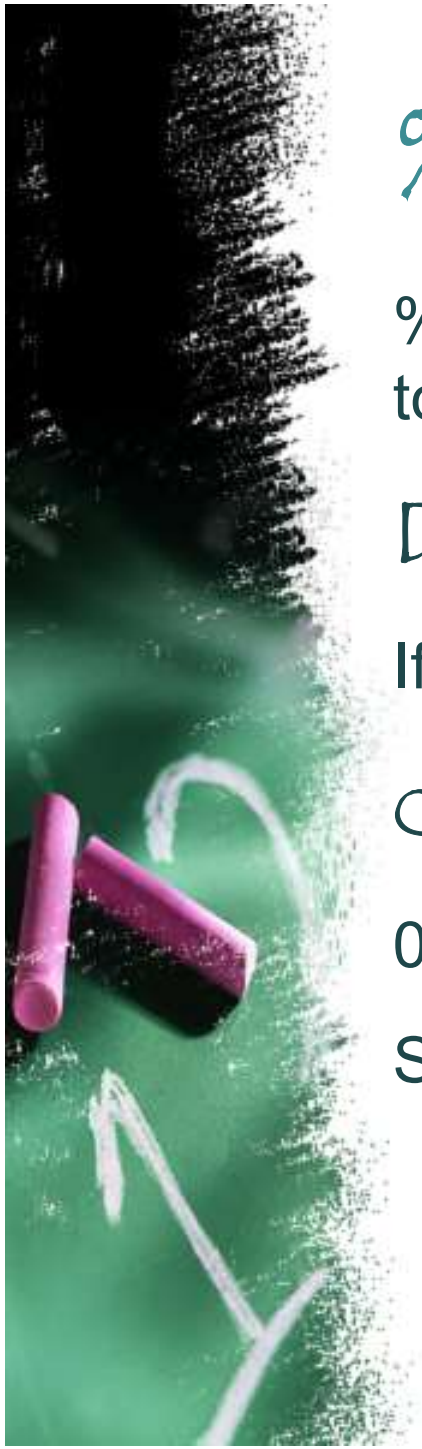
MW = 101g/mol

2nd: Convert 500ml to L = 0.5L

g = specific L x desired molarity x MW

g = 0.5L x 0.5mol/L x 101g/mol

g = 25.25g



% Solutions

% concentration x volume needed = mass of reagent to use

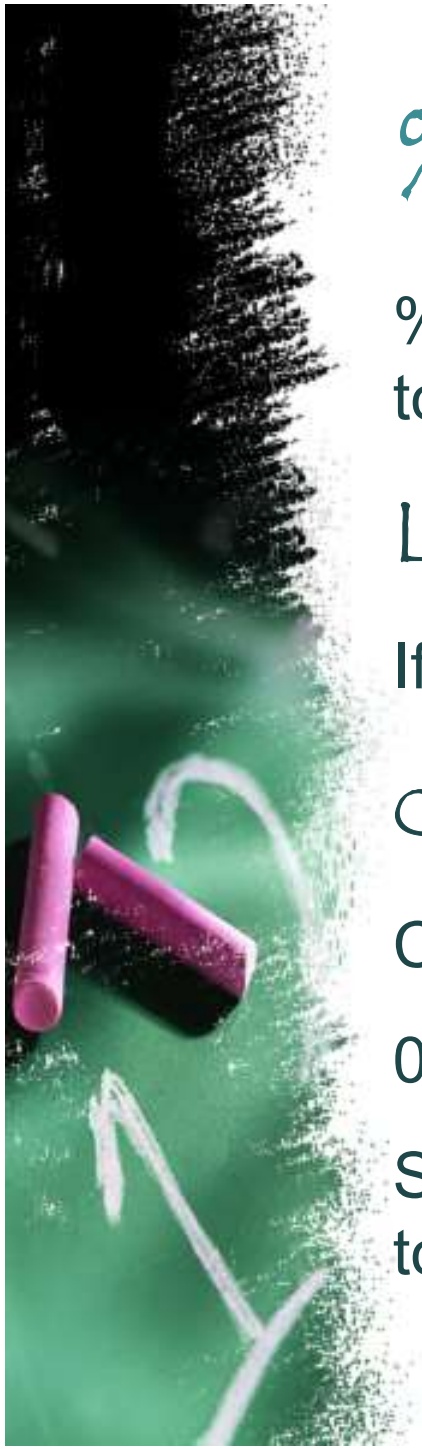
Dry reagents (g/ml)

If you want to make 200ml of 3% NaCl.

Convert 3% to a decimal = $\frac{3}{100}$ = 0.03 g/ml

0.03 x 200ml = 6 g

So, use 6 g in 200ml water



% Solutions

% concentration x volume needed = mass of reagent to use

Liquid reagents (ml/ml)

If you want to make 2L of 70% Acetone.

Convert 70% to a decimal = $\frac{70}{100}$ = 0.70 ml/ml

Convert 2L to ml = 2000ml

0.70ml/ml x 2000ml = 1400ml

So, use 1400ml Acetone with 600ml water (2000ml total volume)


Statistics:
Mean, Median, Mode,
Standard Deviation

Mean or Average

= is the sum of all elements of a set divided by the number of elements in the set

$$\text{Mean} = \frac{sum\ of\ elements\ in\ the\ set}{number\ of\ elements}$$

The table below shows the daily phlebotomy collects in ESC and Emergency Department (ED)

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
ESC	7	9	6	8	7	2	3
ED	45	50	49	46	52	47	48

Mean or Average

The table below shows the daily phlebotomy collects in ESC and Emergency Department (ED)

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
ESC	7	9	6	8	7	2	3
ED	45	50	49	46	52	47	48

Calculate the mean collects in ESC for the week.

7+9+6+8+7+2+3= 42 (sum of elements in the set)

7 (number of elements in the set)

Mean = 42 ÷ 7 = 6

Median

= is the middle value of a set.

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
ESC	7	9	6	8	7	2	3
ED	45	50	49	46	52	47	48

Calculate the median collects in ED for the week.

Reorder the data set (Odd number of data)

ED	45	46	47	48	49	50	52

Median = 48

Median

= is the middle value of a set.

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
ESC	7	9	6	8	7	2	3
ED	45	50	49	46	52	47	48

Calculate the median collects in ED from Mon to Sat

Reorder the data set (Even number of data)

ED	45	46	47	49	50	52	

Median = $\frac{47+49}{2}$ = $\frac{96}{2}$ = 96 ÷ 2 = 48

Median = 48

Mode

= is the element that occurs the most often

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
ESC	7	9	6	8	7	2	3
ED	45	50	49	46	52	47	48

What is the mode collects in ESC for the week.

Mode = 7

Standard Deviation (σ)

= is a measure of the dispersion or variation of a set of data values from its mean

Standard Deviation (σ) = $\sqrt{Variance}$

Calculating the Variance

To calculate the variance:

1. Work out the mean
2. For each number set, subtract the mean and then square the result
3. Then work out the mean or average of the squared differences

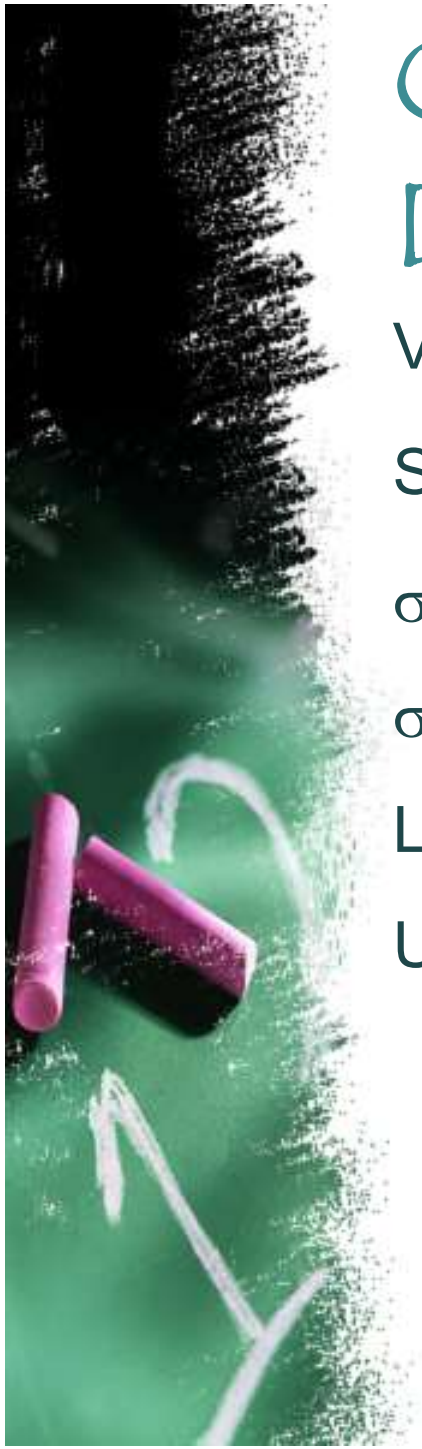
Calculating the Variance

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
ESC	7	9	6	8	7	2	3

1. 7+9+6+8+7+2+3= 42 (sum of elements in the set)
   7 (number of elements in the set)
   Mean = 42 ÷ 7 = 6

2. 7-6=1, 9-6=3, 6-6=0, 8-6=2, 7-6=1, 2-6=-4, 3-6=-3
   1^2, 3^2, 0^2, 2^2, 1^2, 4^2, 3^2
   1, 9, 0, 4, 1, 16, 9

3. 1+9+0+4+1+16+9 = 40
   40 ÷ 7 = 5.714



Calculating the Standard Deviation (σ)

Variance = 5.714

Standard Deviation (σ) = $\sqrt{Variance}$

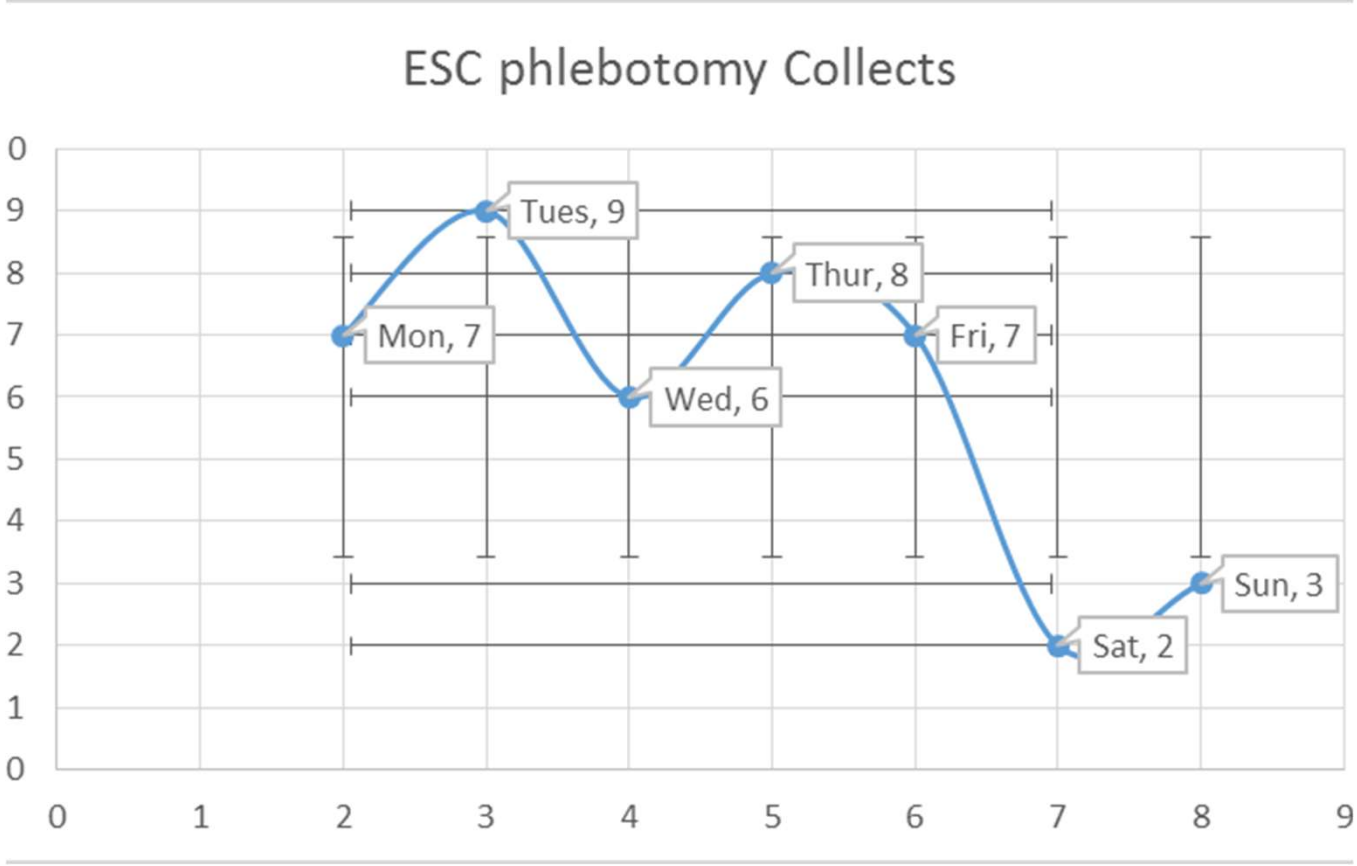
σ = $\sqrt{5.714}$

σ = 2.39

Lower SD = 6 – 2.39 = 3.61

Upper SD = 6 + 2.39 = 8.39

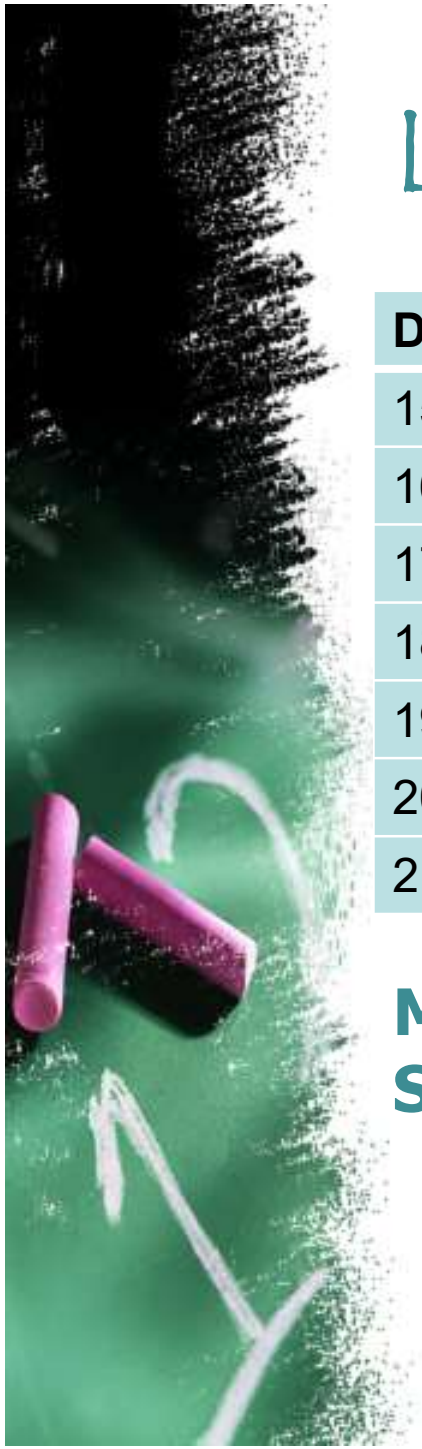
Plot on a Levy Jennings graph



σ = 2.39

Lower 1 SD = 6 – 2.39 = 3.61

Upper 1 SD = 6 + 2.39 = 8.39

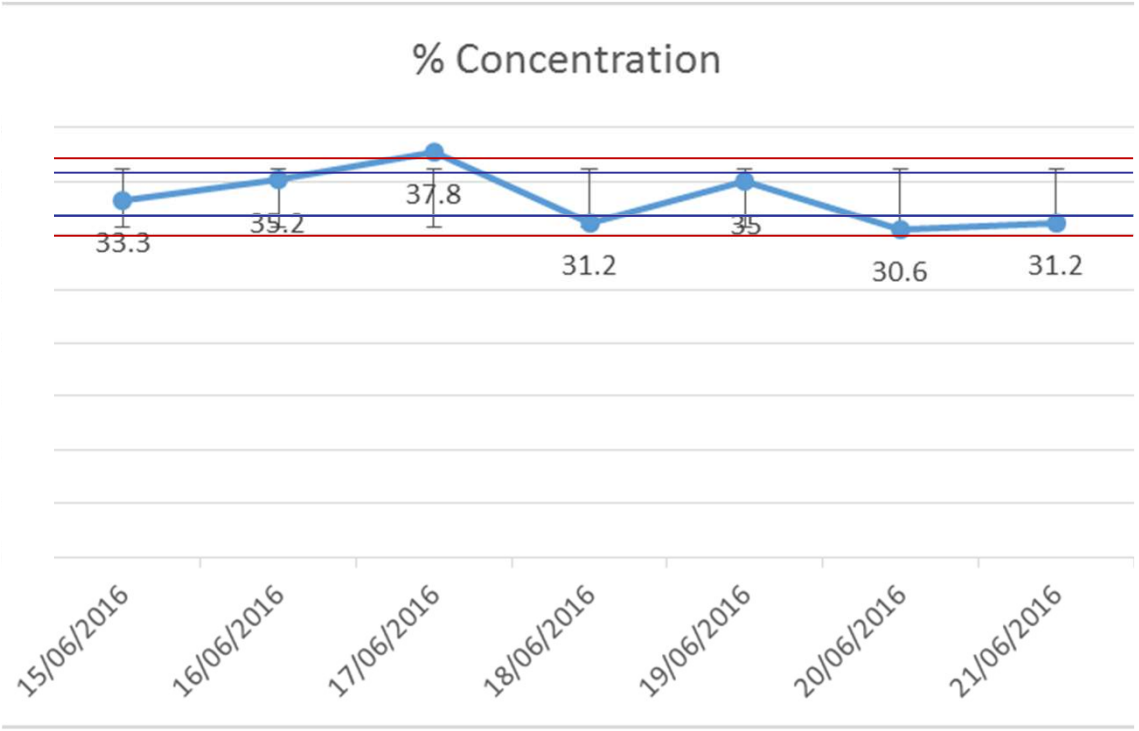


Levy Jennings Graph

Date	% Concentration
15/06/16	33.3
16/06/16	35.2
17/06/16	37.8
18/06/16	31.2
19/06/16	35
20/06/16	30.6
21/06/16	31.2

Mean = 34
SD = 1.2

Levy Jennings Graph



σ = 1.2 Mean = 34		
1SD	34 - 1.2 = 32.8	34 + 1.2 = 35.2
2SD	32.8 – 1.2 = 31.6	35.2 + 1.2 = 36.4
3SD	31.6 – 1.2 = 30.4	36.4 + 1.2 = 37.6


π
KEEP
CALM
AND
CALCULATE
ON

References

- Abacus.bates.edu > biology > Resources
- Mathsisfun.com
- Chemistry.about.com
- Math-aids.com

Thank You