

21 Free Cheatsheets!

Year 12
Unit 3 & 4 **MATHS METHODS**

FREE Overview_{v1.98}

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$$f(-x) = f(x)$$



Purpose of this book

Hello!

This is a brief overview of *Units 3 & 4 Mathematical Methods* to help you learn and revise more efficiently.

It was originally designed as a reference book for students who use the *online video tutorials* on **MathsMethods.com.au** but has since been used by many as their Bound Reference. Each page has a [clickable link](#) to direct you to the relevant video tutorial if you have access and there's plenty of other [free resources](#) if you don't!

Please note, like many of our resources, this overview is designed to reinforce *understanding* and may not use the exact notation you need to use when doing tests and exams.

Do well and I hope this overview makes the year a little less stressful for you :)

Kind regards

A handwritten signature in black ink, appearing to read 'Alex Bell'.

Alexander Bell | Author & Founder of **MathsMethods.com.au**

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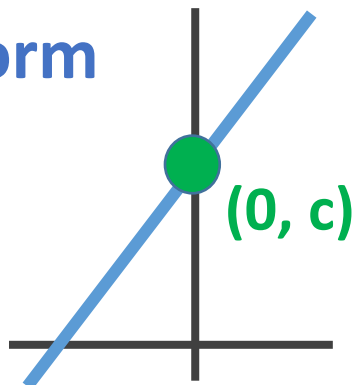
Covered in detail in video tutorials, see [LINEAR EQUATIONS](https://www.mathsmethods.com.au/linear-equations)

Gradient-Intercept Form

$$y = mx + c$$

m means gradient

c means y-intercept

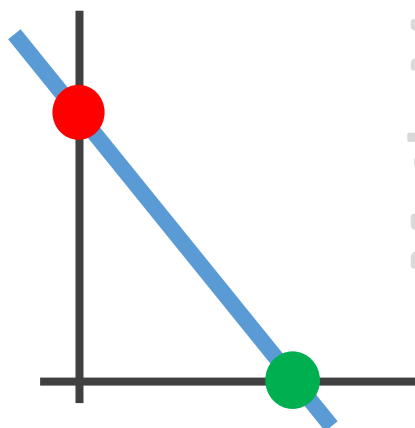


Intercept Form

$$ax + by = c$$

To find **x-intercept**, make $y = 0$

To find **y-intercept**, make $x = 0$

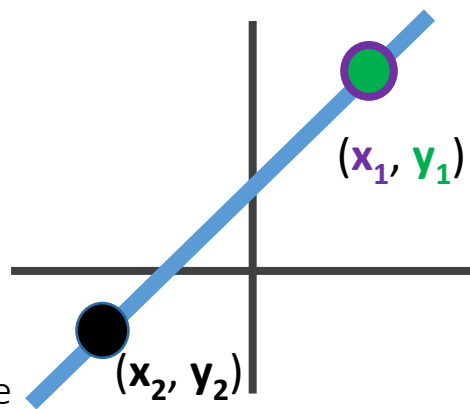


Two point Form

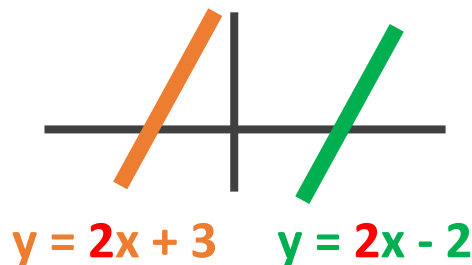
$$y - y_1 = m(x - x_1)$$

(x_1, y_1) is any point on the line

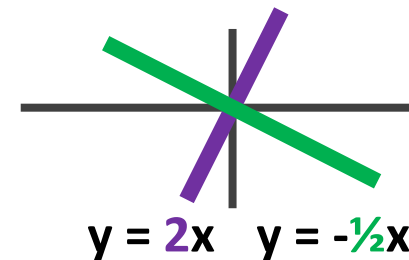
(x_2, y_2) is any *different* point on the line



Parallel means the same **gradient**



Perpendicular means $m = \frac{-1}{m}$



Simultaneous equations means solving two or more equations at the same time.

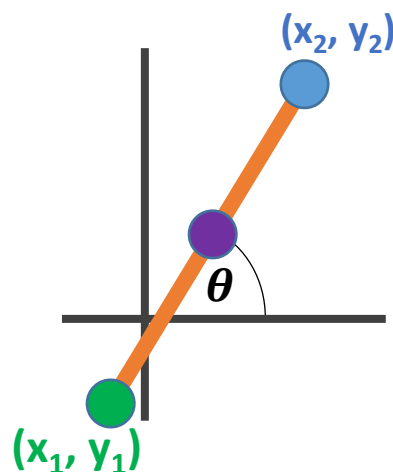
$$\begin{aligned} y &= x \\ y &= 4 - x \end{aligned}$$

Substitution

$$\begin{aligned} y &= x \\ y &= 4 - x \end{aligned}$$

Elimination

$$y + y = \cancel{x} + 4 - \cancel{x}$$



Length of line Segment = $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

Co-ordinate of Midpoint = $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$

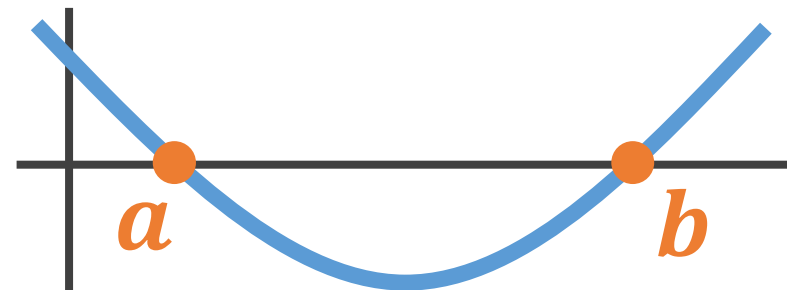
$$\theta = \tan^{-1}(\text{gradient})$$

$$\text{gradient} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\text{rise}}{\text{run}}$$

Intercept Form

$$y = d(x - a)(x - b)$$

1. See if positive or negative
2. Draw in x intercepts (which are a and b)
3. Find y intercept (make $x = 0$)

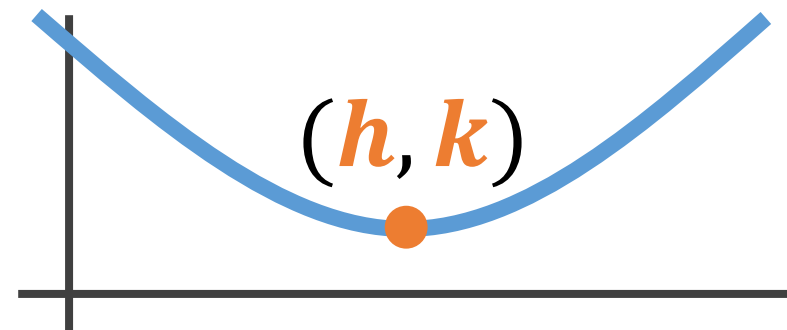


Turning Point Form

$$y = a(x - h)^2 + k$$

1. See if positive or negative
2. Draw in turning point (h, k)
3. Find intercepts (make $x = 0$ and then $y = 0$)

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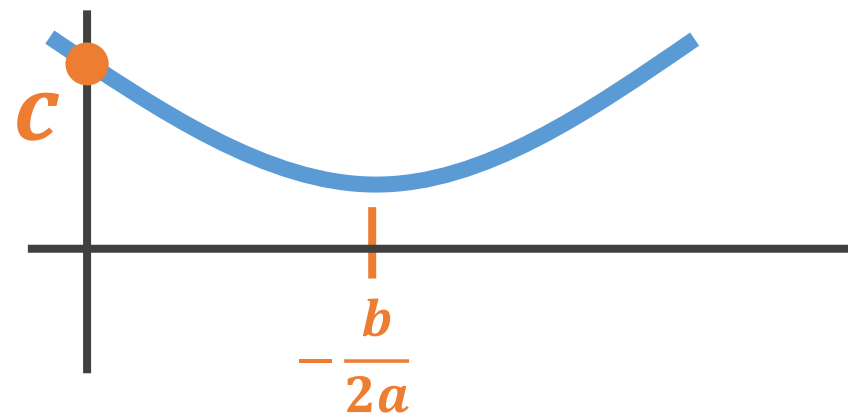


General Form

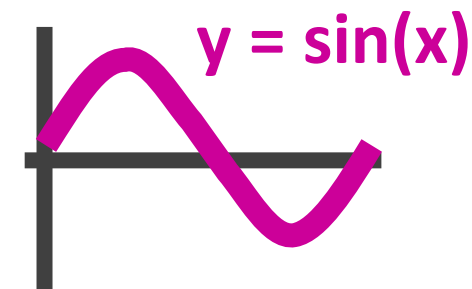
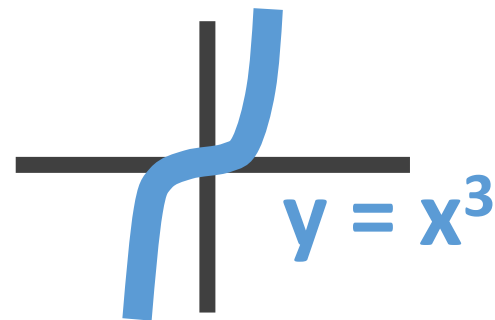
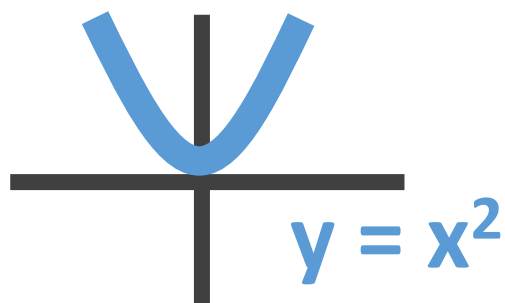
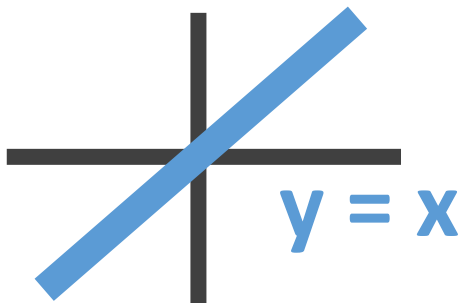
$$y = ax^2 + bx + c$$

1. See if positive or negative
2. Draw in y-intercept
3. Find x-intercepts if there are any
4. Find turning point

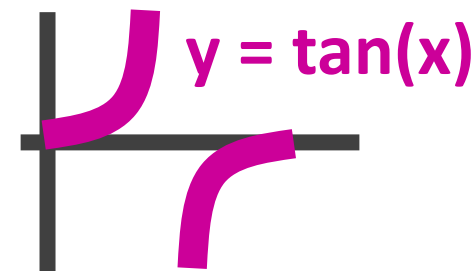
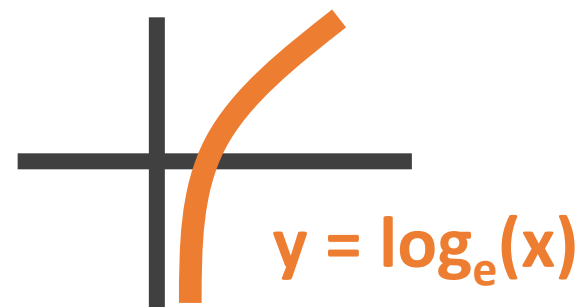
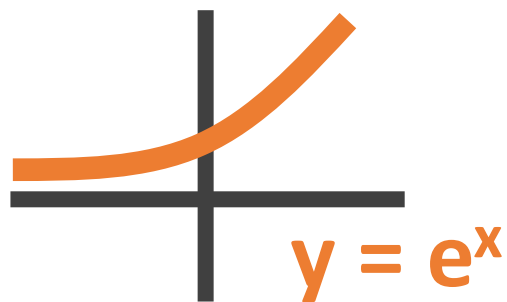
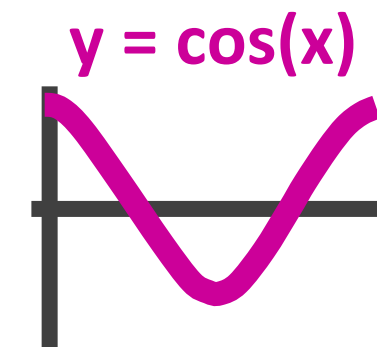
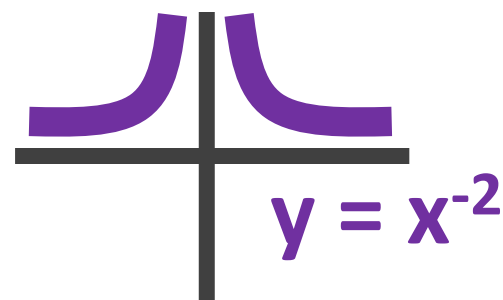
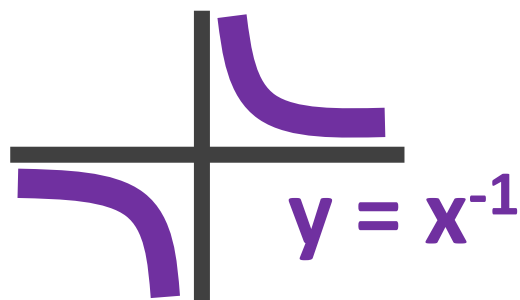
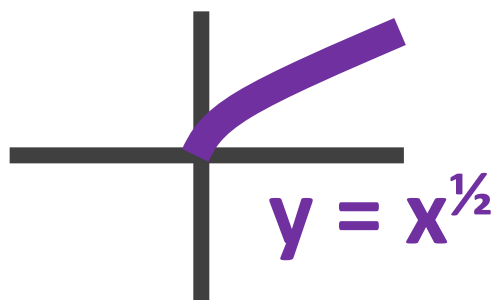
$$x \text{ intercepts} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$



Covered in detail in video tutorials, see [HOW TO SKETCH ANY FUNCTION](#)



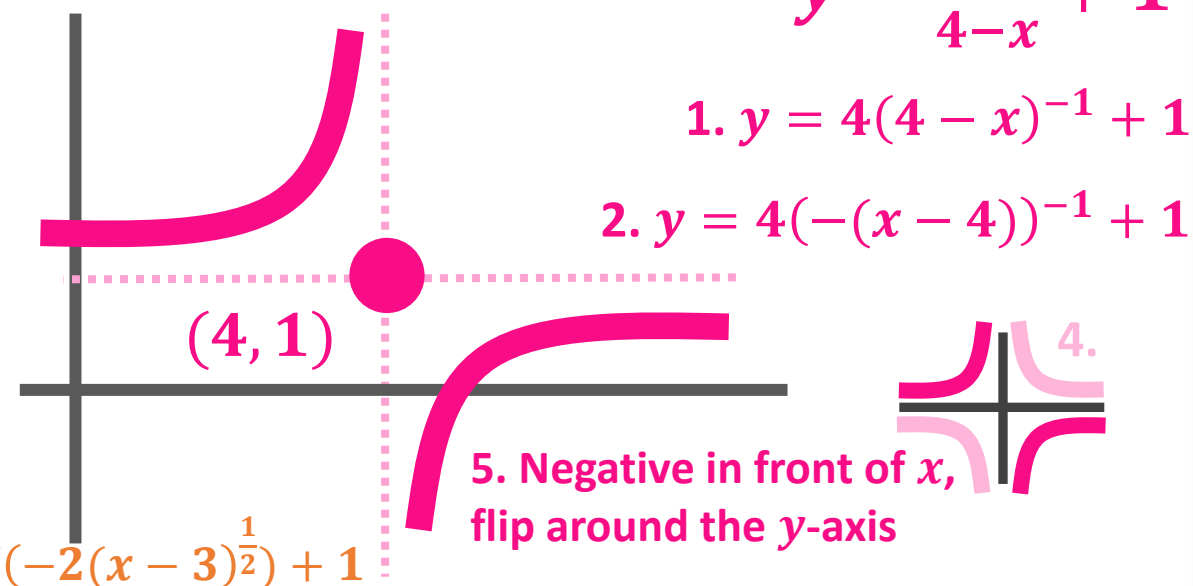
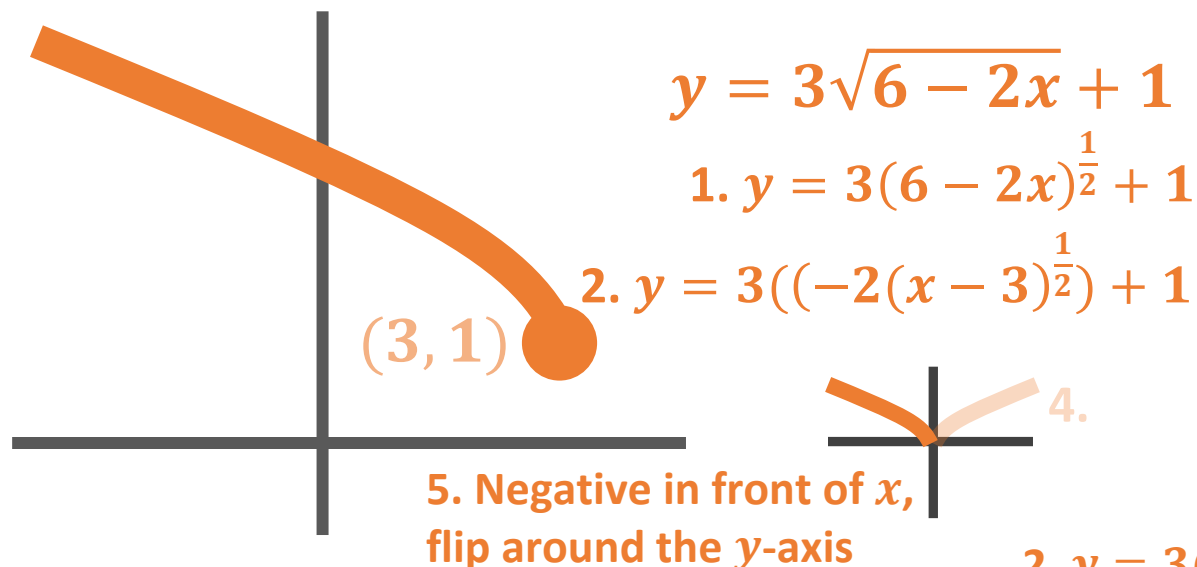
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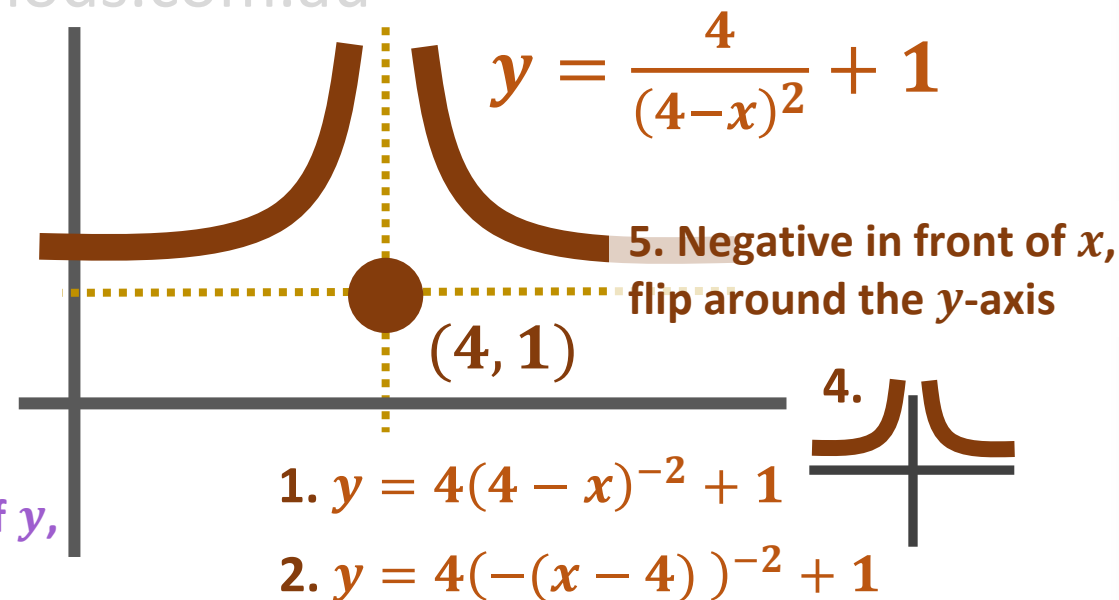
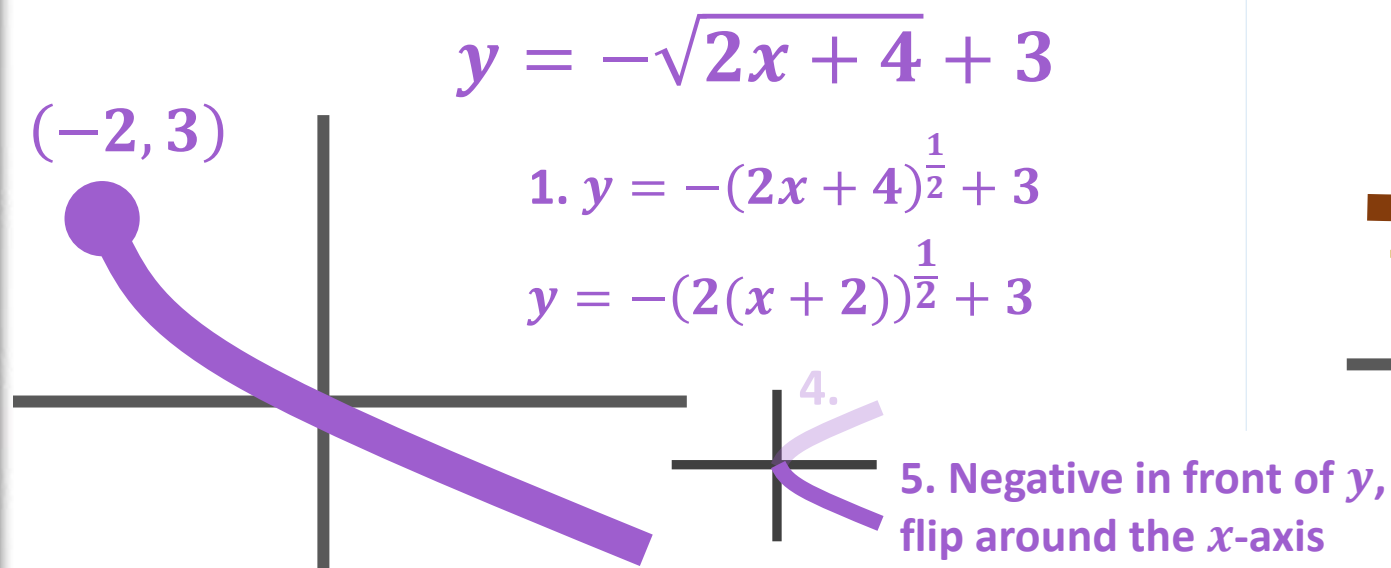
5 STEPS: 1. Change form 2. Factorise inside 3. Turning Point 4. Shape 5. Reflections

Covered in detail in video tutorials, see [TRANSLATION – MOVING FUNCTIONS](#) and [STRETCHING AND REFLECTING](#)

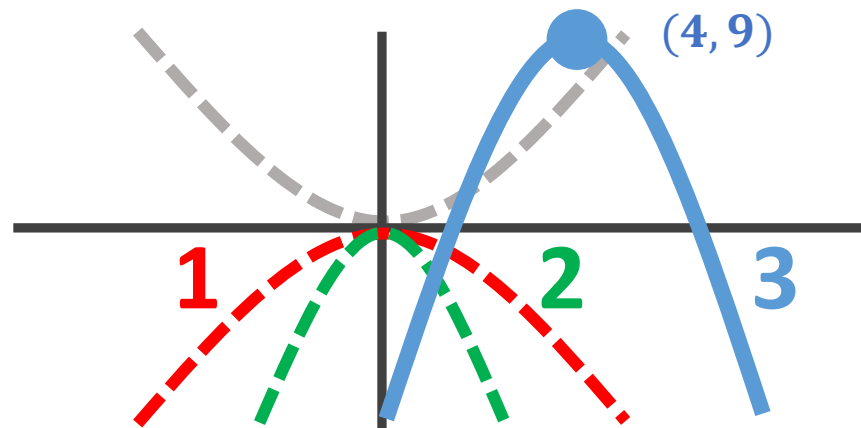
$$y = \frac{4}{4-x} + 1$$



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Covered in detail in video tutorials, see [FUNCTIONS AND POINTS](#), [USING MATRICES](#) and [SERIES OF TRANSFORMATIONS](#)



$$x^2 \rightarrow -(2(x-4))^2 + 9$$

$$-f(x) = -x^2$$

1. Reflection in the x-axis

$$f(2x) = -(2x)^2$$

2. Followed by a dilation of factor $\frac{1}{2}$ from the y-axis

$$f(x-4) + 9 = -(2(x-4))^2 + 9$$

3. Then a translation of 4 units in positive x-direction and 9 units in the positive y-direction

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$f\left(\frac{1}{a}x\right)$ is a dilation of factor **a** from the y-axis
(in the x-direction)

$f(-x)$ is a reflection in the y-axis

$-f(x)$ is a reflection in the x-axis

b $f(x)$ is a dilation of factor **b** from the x-axis
(in the y-direction)

$f(x) + k$ is a translation along the y-axis

$f(x - h)$ is a translation along the x-axis

Positive
Power

$$x^2 = 1 \times x \times x$$

$$x^1 = 1 \times x$$

$$x^0 = 1$$

Covered in detail in video tutorials, see [EXPONENTIAL LAWS \(POWER LAWS\)](#)

Negative
Power

$$\frac{x^m}{x^n} = x^{m-n}$$

$$x^{-1} = \frac{1}{x}$$

$$x^{-n} = \frac{1}{x^n}$$

Fraction
Power

$$x^{\frac{1}{2}} = \sqrt{x}$$

$$x^{\frac{1}{m}} = \sqrt[m]{x}$$

$$x^{\frac{m}{n}} = \sqrt[n]{x^m} = \left(\sqrt[n]{x}\right)^m$$

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$$x^m x^n = x^{m+n}$$

$$(x^m)^n = x^{mn}$$

$$\left(\frac{x}{y}\right)^n = \frac{x^n}{y^n}$$

Covered in detail in video tutorials, see [WHAT ARE LOGARITHMS?](#)

Log is power

$$\log_2 8 = 3$$

to get 8

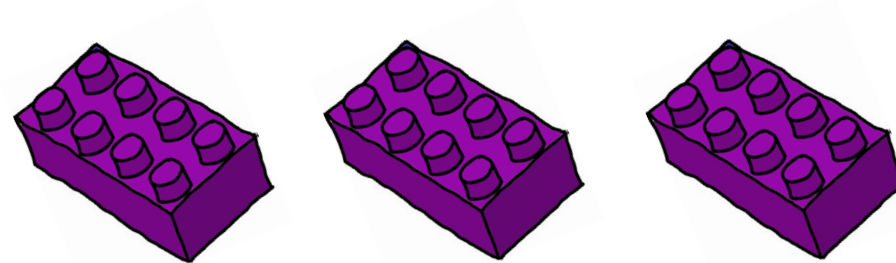
How many 2s are
multiplied together

$$2^3 = 8$$

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Logarithm is a Greek word

Logos means how many there are



Arithmos means number

2

Logarithm originally means
how many numbers

Covered in detail in video tutorials, see [SKETCHING LOGS AND EXPONENTIALS](https://www.mathsmethods.com.au/sketching-logs-and-exponentials)

$$y = -3e^{(2x+1)} - 2$$

1) Find any reflections

reflected in x-axis

2) Find asymptote

$$y = -2$$

3) Find intercepts

y-intercept, $x = 0$ no x-intercepts

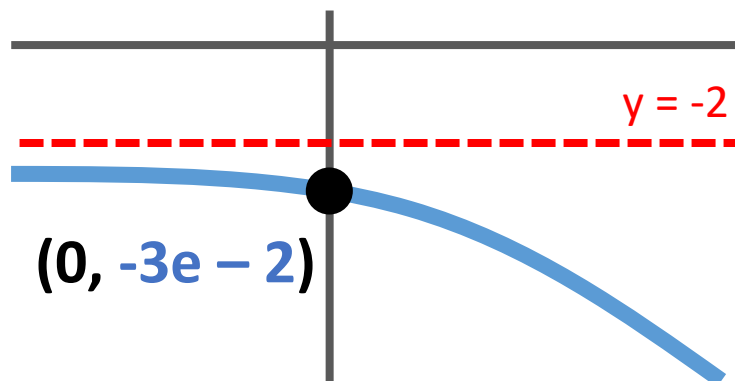
$$y = -3e^{2x+1} - 2$$

$$y = -3e^{2(0)+1} - 2$$

$$y = -3e^1 - 2$$

4) Domain **R**, Range **$(-\infty, -2)$**

Domain **R**, Range **$(-\infty, -2)$**



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$$y = \log_e(-2x + 4) - 3$$

1) Find any reflections

reflected in y-axis

2) Find asymptote

$$(-2x+4) = 0 \quad x = 2$$

3) Find intercepts

x-intercept, $y = 0$

y-intercept, $x = 0$

$$0 = \log_e(-2x + 4) - 3$$

$$y = \log_e(4) - 3$$

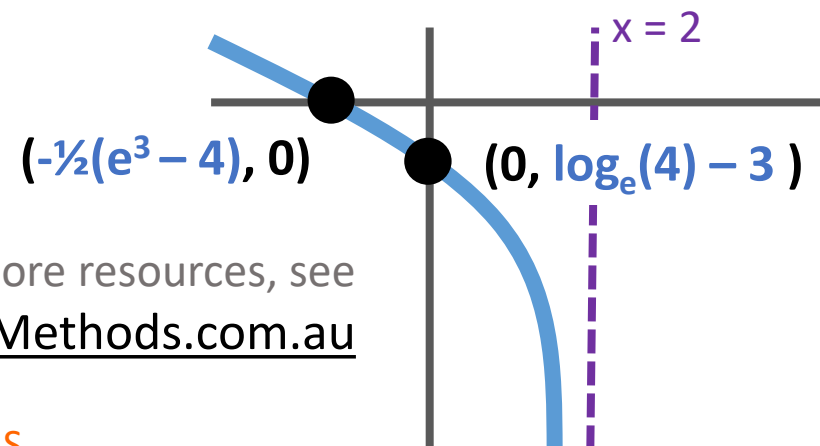
$$3 = \log_e(-2x + 4)$$

$$e^3 = -2x + 4$$

$$x = -\frac{1}{2}(e^3 - 4)$$

4) Domain **$(-\infty, 2)$** , Range **R**

Domain **$(-\infty, 2)$** , Range **R**

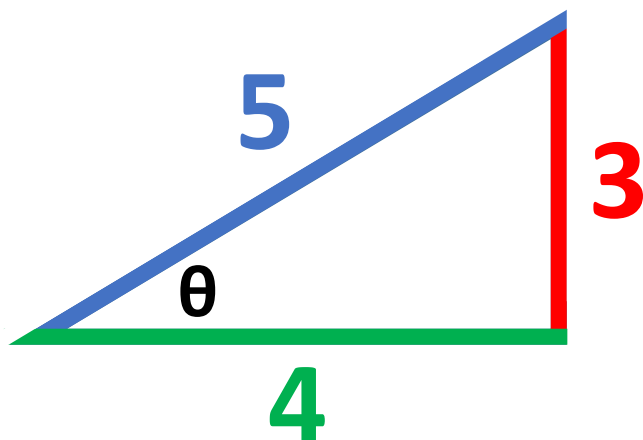


For more resources, see
[MathsMethods.com.au](https://www.mathsmethods.com.au)

Want **FREE RESOURCES** on this topic? See [SKETCHING LOGS AND EXPONENTIALS](https://www.mathsmethods.com.au/sketching-logs-and-exponentials)

Covered in detail in video tutorials, see [DEFINITIONS OF SIN AND COS](#) and [THE UNIT CIRCLE](#)

SOH CAH TOA



$$\sin(\theta) = \frac{\text{Length of Opposite}}{\text{Length of Hypotenuse}} = \frac{3}{5}$$

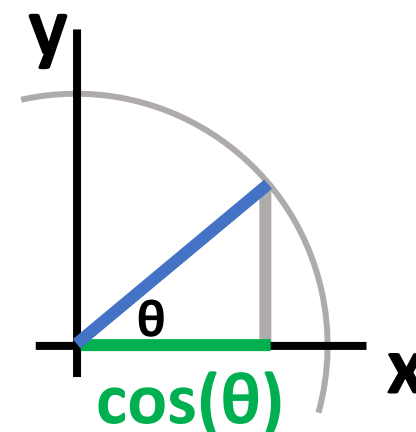
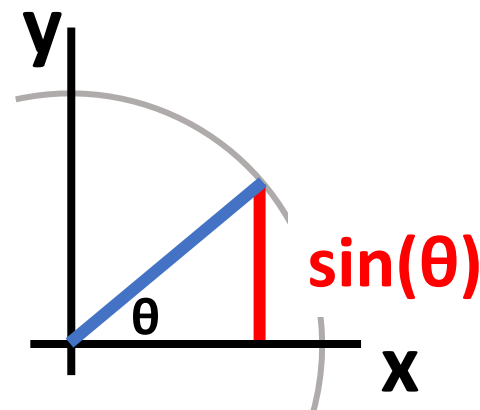
$$\cos(\theta) = \frac{\text{Length of Adjacent}}{\text{Length of Hypotenuse}} = \frac{4}{5}$$

$$\tan(\theta) = \frac{\text{Length of Opposite}}{\text{Length of Adjacent}} = \frac{3}{4}$$

In a unit circle, **hypotenuse** always = 1

$\sin(\theta)$ = Length of **Opposite**

$\cos(\theta)$ = Length of **Adjacent**

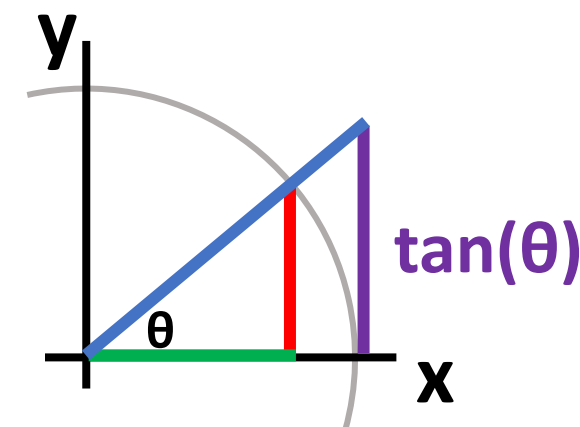


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Tangent is a line which touches a circle only at one point.

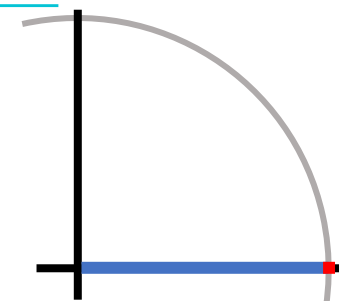


$\tan(\theta)$ is the length of the tangent, cut off by the x axis and the radius.

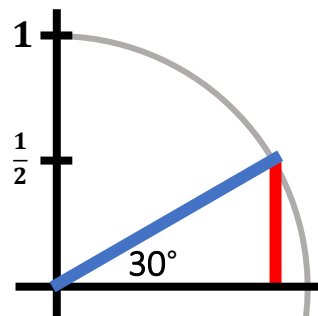


Covered in detail in video tutorials, see [PROVING EXACT VALUES](https://www.mathsmethods.com.au/proving-exact-values)

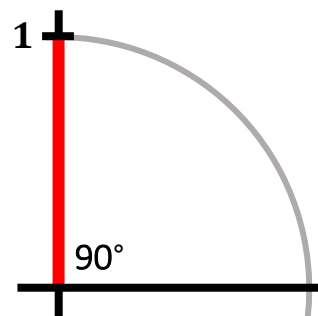
Angle	$\sin(\theta)$	$\cos(\theta)$	$\tan(\theta)$
0	0	1	0
$\frac{\pi}{6}$ 30	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$
$\frac{\pi}{4}$ 45	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{2}}{2}$	1
$\frac{\pi}{3}$ 60	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$
$\frac{\pi}{2}$ 90	1	0	undefined



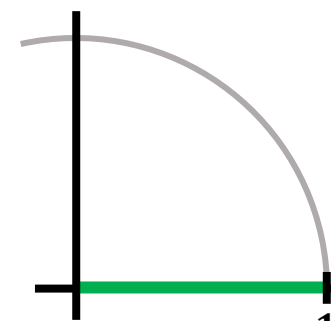
$$\sin(0) = 0$$



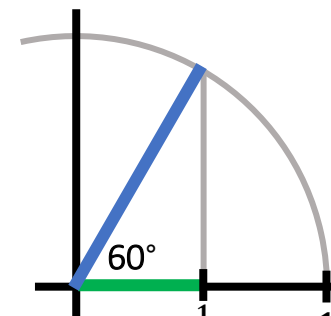
$$\sin(30) = \frac{1}{2}$$



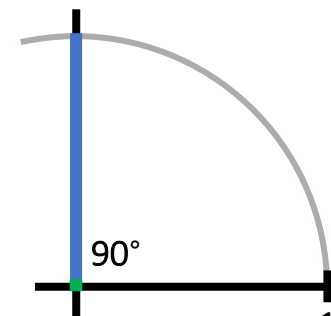
$$\sin(90) = 1$$



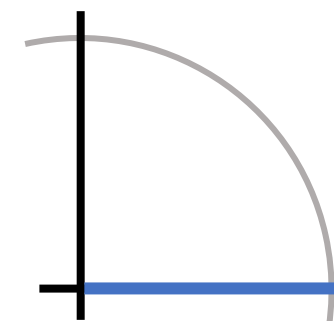
$$\cos(0) = 1$$



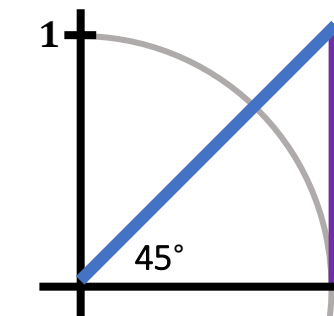
$$\cos(60) = \frac{1}{2}$$



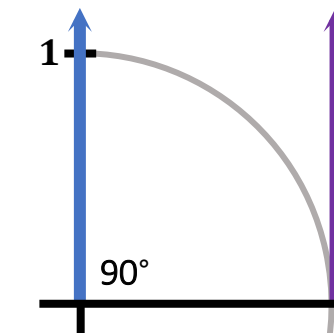
$$\cos(90) = 0$$



$$\tan(0) = 0$$



$$\tan(45) = 1$$



$$\tan(90) = \text{undefined}$$

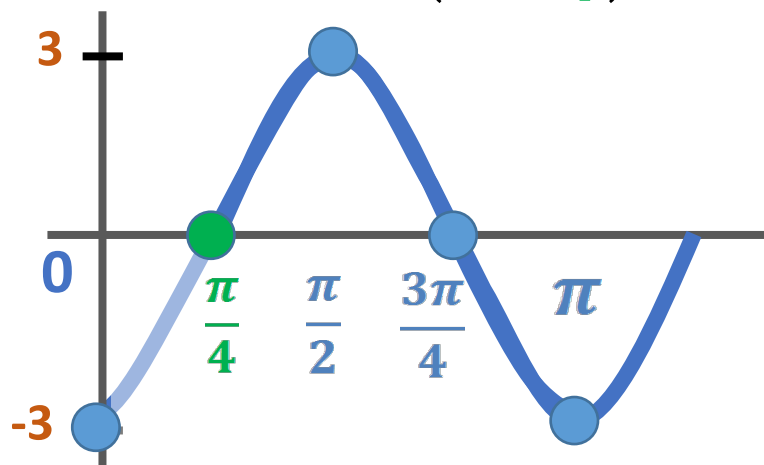
For more resources, see [MathsMethods.com.au](https://www.mathsmethods.com.au)

Graphing **SIN** or **COS** in *two* different formsCovered in detail in video tutorials, see [SKETCHING SIN, COS & TAN](#)

$$y = A \sin(k(x - b))$$

1. Draw in **starting point** and **amplitude**
2. Period = $\frac{2\pi}{k} = \pi$
3. Divide period into 4 = $\frac{\pi}{4}$
4. Add and subtract this to **starting point**

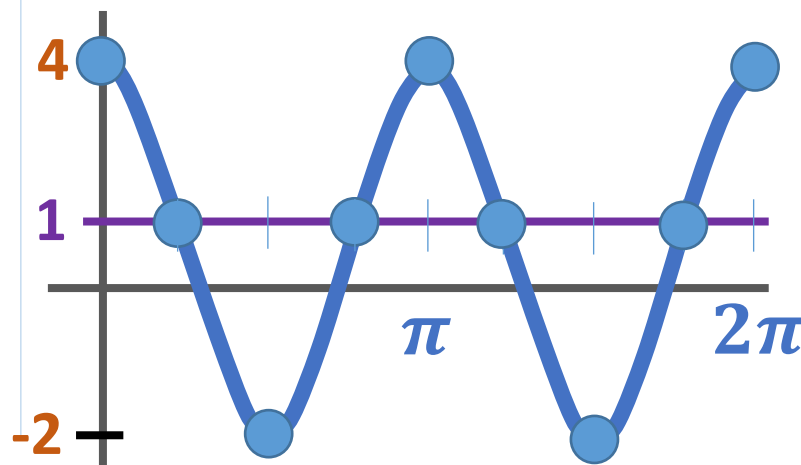
$$y = 3 \sin 2 \left(x - \frac{\pi}{4} \right)$$



$$y = A \sin(kx) + c$$

1. Draw in **vertical translation** and **A**
2. Period = $\frac{2\pi}{k} = \pi$
3. Write in period and divide it by 4
4. Find intercepts (see next page)

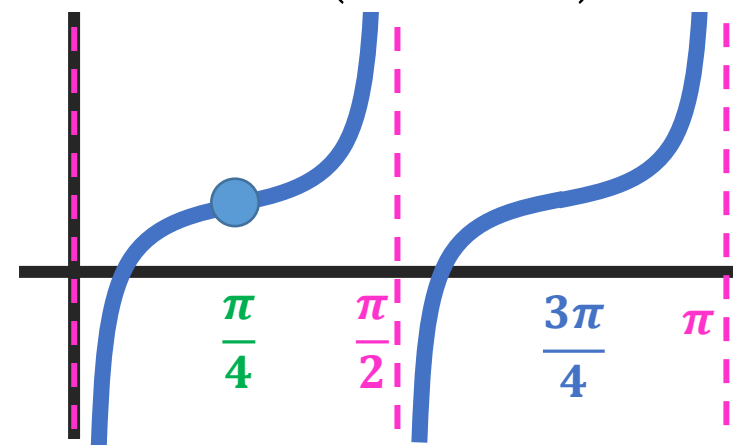
$$y = 3 \cos(2x) + 1$$

Graphing **TAN**

$$y = A \tan(k(x - b)) + c$$

1. Draw in starting point (**b**, **c**)
2. Period = $\frac{\pi}{k} = \frac{\pi}{2}$
3. Divide period into 2 = $\frac{\pi}{4}$
4. Add and subtract this to **starting point**
5. Draw in **asymptotes**

$$y = 3 \tan \left(2 \left(x - \frac{\pi}{4} \right) \right) + 1$$



Derivative of x

$$f(x) = 5x^4 \quad f'(x) = 4 \times 5x^3$$

1. Multiply the x by the power
2. Minus one from the power

$$f(x) = \text{any number} \quad f'(x) = 0$$

example

$$f(x) = 6x^5 - 3x^{\frac{2}{3}} + 2x^{-1} - 4$$

$$f'(x) = 5 \times 6x^4 - \frac{2}{3} \times 3x^{-\frac{1}{3}} + -1 \times 2x^{-2} + 0$$

Other derivatives

$$f(x) = e^x \quad f'(x) = e^x$$

$$f(x) = \ln(x) \quad f'(x) = \frac{1}{x}$$

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$$f(x) = \sin(x) \quad f'(x) = \cos(x)$$

$$f(x) = \cos(x) \quad f'(x) = -\sin(x)$$

$$f(x) = \tan(x) \quad f'(x) = (\sec(x))^2$$

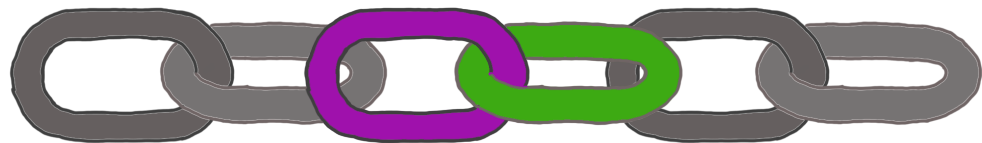
$$(\sec(x))^2 = \frac{1}{(\cos(x))^2} \quad f'(x) = y' = \frac{dy}{dx} = \frac{d}{dx}(y)$$

The Chain Rule

is used when functions are inside other functions

Covered in detail in video tutorials, see [THE CHAIN RULE](#)

$$y = f(g(x))$$



Steps of the Chain Rule

1. Determine outside function
2. Derive it but ignore inside function
3. Rewrite the inside function
4. Find derivative of inside function
5. Multiply it by derivative of the inside function

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$$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx} \quad \text{is exactly the same as}$$

$$\frac{dy}{dx} = f'(g(x)) \times g'(x)$$

Chain Rule (short version)

1. Derive outside function
2. Multiply it by derivative of the inside function

example 1

$$y = 2(x^3 - 5)^5$$

$$\begin{aligned} 1. \quad & 5 \times 2(x^3 - 5)^4 \\ 2. \quad & \frac{dy}{dx} = 5 \times 2(x^3 - 5)^4 \times 3x^2 \end{aligned}$$

example 2

$$y = \sin(3x^2 - 4)$$

$$\begin{aligned} 1. \quad & f(x) = \sin(x) \\ & f'(x) = \cos(x) \\ 2. \quad & \frac{dy}{dx} = \cos(3x^2 - 4) \times 6x \end{aligned}$$

$$f(g(x))$$

$$\frac{dy}{dx} = f'(g(x)) \times g'(x)$$

Covered in detail in video tutorials, see [THE CHAIN RULE](#)

$$f(x) = \sin(g(x)),$$

$$f'(x) = g'(x)\cos(g(x))$$

$$f(x) = \cos(g(x)),$$

$$f'(x) = -g'(x)\sin(g(x))$$

$$f(x) = \tan(g(x)),$$

$$f'(x) = g'(x)\sec^2(g(x))$$

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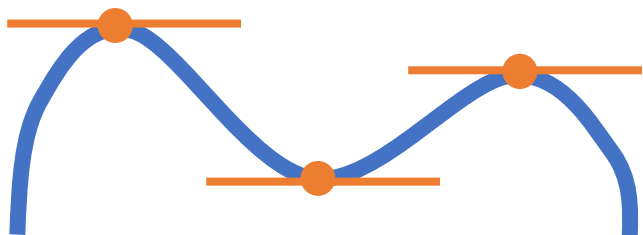
$$f(x) = e^{g(x)},$$

$$f'(x) = g'(x)e^{g(x)}$$

$$f(x) = \ln(g(x)),$$

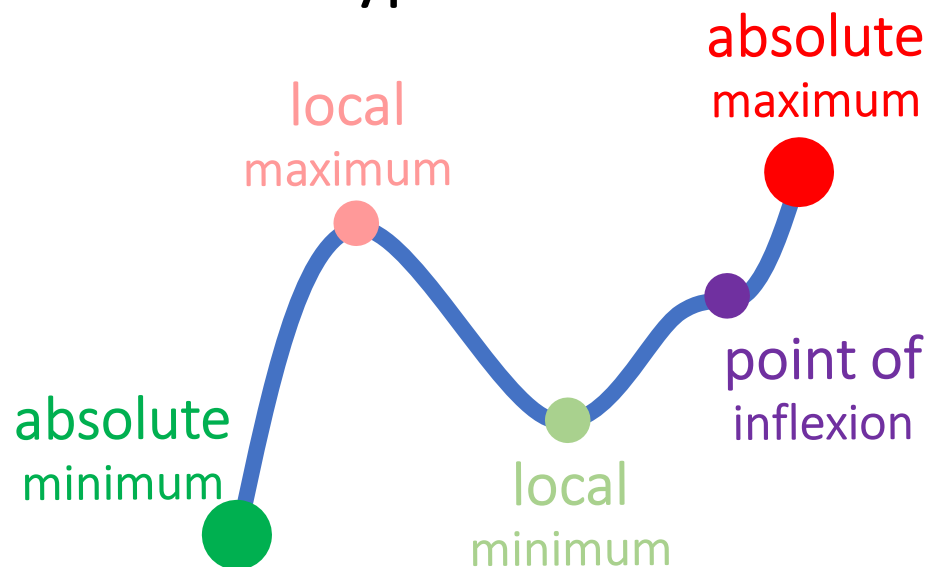
$$f'(x) = \frac{g'(x)}{g(x)}$$

Stationary point means where the gradient of the curve is zero.



$$f'(x) = 0$$

Types of S.P



How to find stationary points $f(x) = 2x^3 + 1$

1. Find $f'(x) = 0$ and solve for x

$$f'(x) = 6x^2 \quad 6x^2 = 0 \quad x = 0$$

2. Sub x value into $f(x)$

$$f(0) = 2(0)^3 + 1 = 1$$

Stationary point
at $(0, 1)$

3. To find type: Sub in two x values (before and after the S.P.)

$$f'(-1) = 6(-1)^2 = 6$$

positive

$$f'(1) = 6(1)^2 = 6$$

positive

It is a point of infection (see diagram below)



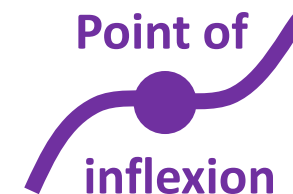
$$f'(\text{before}) = \text{positive}$$

$$f'(\text{after}) = \text{negative}$$



$$f'(\text{before}) = \text{neg}$$

$$f'(\text{after}) = \text{pos}$$



$$f'(\text{before}) = \text{pos}$$

$$f'(\text{after}) = \text{pos}$$

Brackets with any power*

$$f(x) = \int (3x + 1)^{-5} dx$$

1. Add 1 to the power

$$-5 + 1 = -4$$

2. Multiply this by number in front of the x

$$-4 \times 3 = -12$$

3. Divide by this number

$$f(x) = \frac{(3x + 1)^{-4}}{-12} + c$$

*except -1

Brackets with a -1 power

$$f(x) = \int (3x + 1)^{-1} dx$$

1. Put it inside ln
2. Divide by number in front of the x

$$f(x) = \frac{1}{3} \ln|3x + 1| + c$$

$$e^x \quad f(x) = \int e^{7x} dx$$

1. Write down e^{kx} again
2. Divide by number in front of the x

$$f(x) = \frac{1}{7} e^{7x} + c$$

Sine and Cosine

$$f(x) = \int \cos(5x + 2) dx$$

1. Rewrite with sin
2. Divide by number in front of the x

$$f(x) = \frac{1}{5} \sin(5x + 2) + c$$

$$f(x) = \int \sin(3x + 2) dx$$

1. Rewrite with negative cos
2. Divide by number in front of the x

$$f(x) = -\frac{1}{3} \cos(3x + 2) + c$$

$$f(x) = \ln(3x^2 + 1)$$

Find $f'(x)$ and therefore find $\int \frac{x}{3x^2+1} + e^{5x} dx$

1. Differentiate function

$$\frac{d}{dx} \ln(3x^2 + 1) = \frac{6x}{3x^2 + 1}$$

2. Make it look like inside the integral

$$\frac{d}{dx} \ln(3x^2 + 1) = \frac{6x}{3x^2 + 1}$$

$$\frac{1}{6} \times \frac{d}{dx} \ln(3x^2 + 1) = \frac{x}{3x^2 + 1}$$

$$e^{5x} + \frac{1}{6} \times \frac{d}{dx} \ln(3x^2 + 1) = \frac{x}{3x^2 + 1} + e^{5x}$$

3. Antidiff it!

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$$\int e^{5x} + \frac{1}{6} \times \frac{d}{dx} \ln(3x^2 + 1) dx = \int \frac{x}{3x^2 + 1} + e^{5x} dx$$

$$\frac{1}{5} e^{5x} + \frac{1}{6} \ln(3x^2 + 1) + c = \int \frac{x}{3x^2 + 1} + e^{5x} dx$$

$$\int \frac{x}{3x^2 + 1} + e^{5x} dx = \frac{1}{5} e^{5x} + \frac{1}{6} \ln(3x^2 + 1) + c$$

Kinematics is the subject about how objects move

x = displacement

$\frac{dx}{dt}$ = velocity

$\frac{dv}{dt}$ = acceleration

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Differentiate →

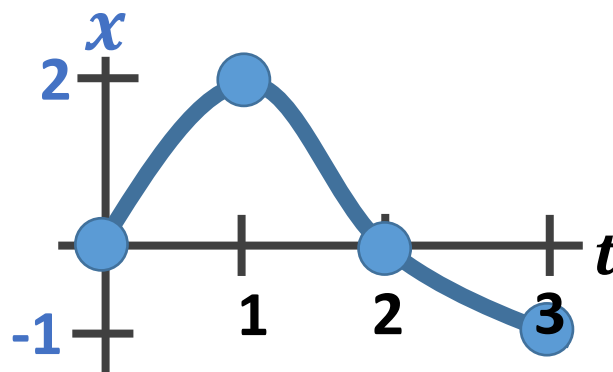
x $\frac{dx}{dt}$ $\frac{dv}{dt}$

← Antidifferentiate

Distance means how far something has moved

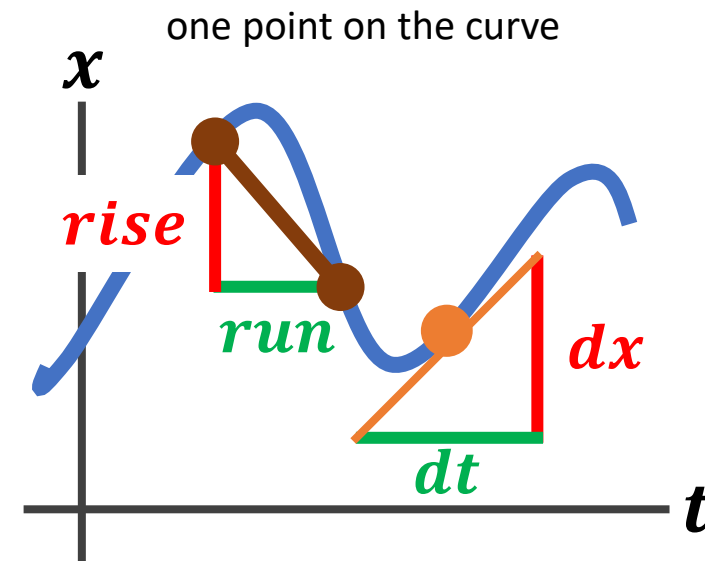


Displacement means how far away something is



time	0	1	2	3
Distance	0	2	4	5
Displacement	0	2	0	-1

Instantaneous means gradient



Average means $\frac{\text{rise}}{\text{run}}$

two points on the curve

instantaneous velocity = $\frac{dx}{dt}$

average velocity = $\frac{\text{rise}}{\text{run}}$

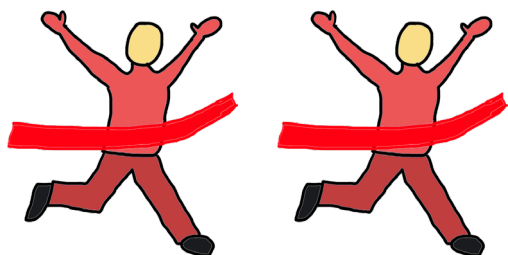
Covered in detail in video tutorials, see [RANDOM VARIABLES](#) and [DISCRETE RANDOM VARIABLES](#)

Discrete Random Variable is a letter that represents an outcome in terms of **countable** numbers

Usually use capital letter **X**

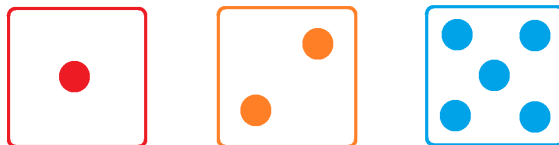
Races won (out of 3)

$\Pr(X = 2)$



Sum of a die when rolling 3 times

$\Pr(X = 8)$



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A few rules

If you add all the $\Pr(X)$, it will = 1

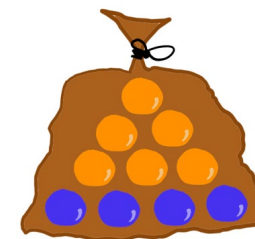
$\Pr(X = x)$ is **always positive** and **never larger than 1**

To find $\Pr(a \leq X \leq b)$, just add up all $\Pr(X)$ from a to b

Want **FREE RESOURCES** on this topic? See [DISCRETE RANDOM VARIABLES](#)

Example: 10 balls in a bag: 4 blue and 6 orange

If picking 3 balls at a time (with replacement), what is probability of only getting one blue ball?

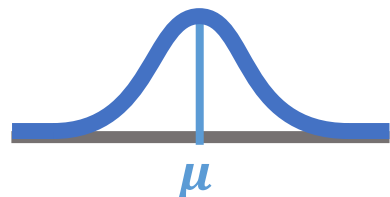


Outcome	X	$\Pr(X)$
BBB	3	$0.4 \times 0.4 \times 0.4 = 0.064$
BBO	2	$0.4 \times 0.4 \times 0.6 = 0.096$
BOB	2	$0.4 \times 0.6 \times 0.4 = 0.096$
OBB	2	$0.6 \times 0.4 \times 0.4 = 0.096$
OOB	1	$0.6 \times 0.6 \times 0.4 = 0.144$
OBO	1	$0.6 \times 0.4 \times 0.6 = 0.144$
BOO	1	$0.4 \times 0.6 \times 0.6 = 0.144$
OOO	0	$0.6 \times 0.6 \times 0.6 = 0.216$

$$\Pr(X = 1) = 0.144 + 0.144 + 0.144 = 0.432$$

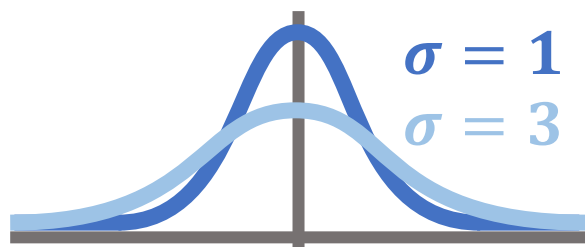
For more resources, see [MathsMethods.com.au](#)

Normal Distribution is a probability density function that looks like this:

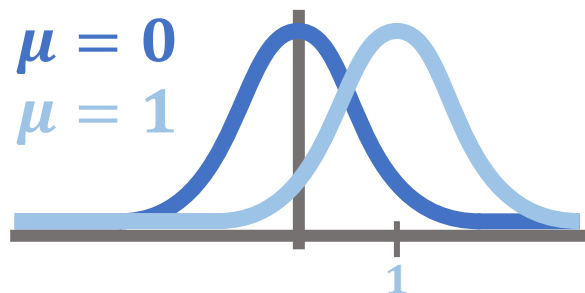


In a normal distribution
mean = mode = median

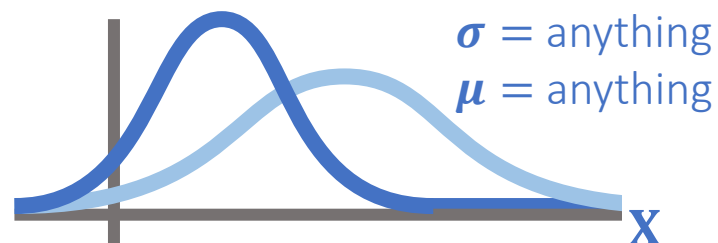
Standard deviation is how stretched the distribution is



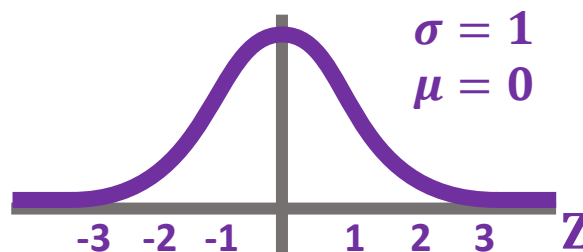
Mean is how far over it has been moved



Normal Distribution



Standard Normal Distribution



$$z = \frac{x - \mu}{\sigma}$$

z = how many standard deviations

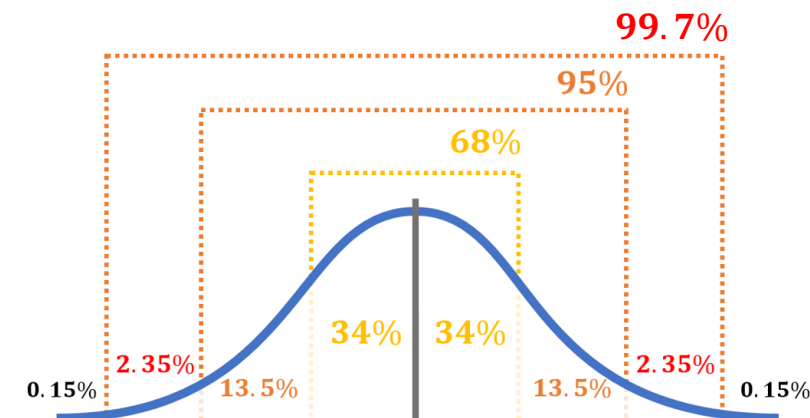
x = value on x-axis

μ = value of the mean

σ = value of one standard deviation

Using Standard Normal

- 1) Put in **mean** in **X** row
- 2) Add and subtract **standard deviation**



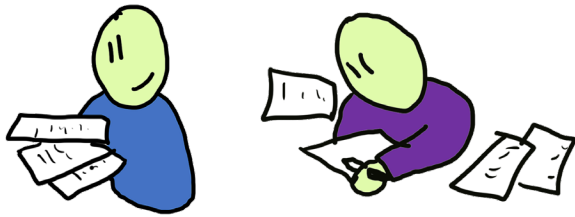
%	0.15	2.5	16	50	84	97.5	99.85
Z	-3	-2	-1	0	1	2	3
X							

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Use this template for any normal distribution, just add the values in **X** row. Then just read off the graph!

Covered in detail in video tutorials, see [WHAT ARE STATISTICS?](#)

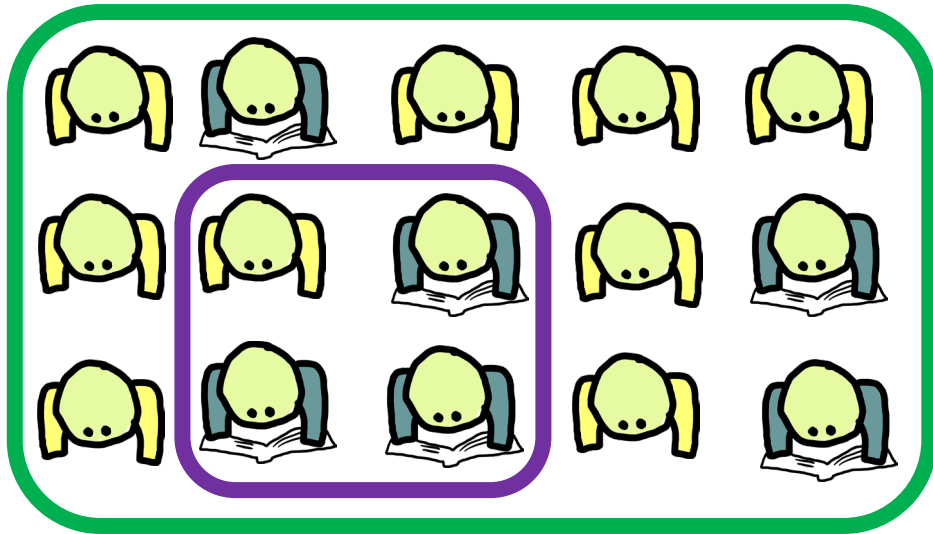
Statistics is the subject of **collecting**, **summarizing** and **showing information** in a way that can be **analyzed** to learn more about the group.



Like Soft Drink	600
Don't like it	400

60% of people like Soft Drink!

Population basically means an entire group that has something in common



Sample means a small part of the population

Want **FREE RESOURCES** on this topic? See [STATISTICS \(FREE VIDEO\)](#)

Population proportion means how many have a certain attribute compared to the entire population

$$p = \frac{\text{How many with attribute}}{\text{Total population}}$$

Sample proportion means how many have a certain attribute compared to the entire sample

$$\hat{p} = \frac{\text{How many with attribute}}{\text{Total number in sample}} = \frac{1}{4}$$

Example. A bag has 6 orange balls and 4 blue ones. Find the probability there is one blue ball in a sample of 4.

- Find probability of one combination

$$\Pr(\text{B000}) = \frac{4}{10} \times \frac{6}{9} \times \frac{5}{8} \times \frac{4}{7} = \frac{2}{21}$$

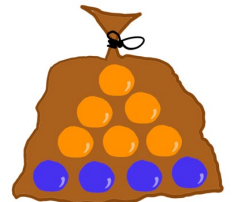
- Find amount of combinations

B000 0B00 00B0 000B

OR $\binom{4}{1} = 4$

- Multiply Probability by combinations

$$\Pr(\hat{p} = \frac{1}{4}) = \frac{2}{21} \times 4 = \frac{8}{21}$$



For more resources, see [MathsMethods.com.au](#)

Final thoughts & extra resources!

Hope you have enjoyed this material! If you have any comments or feedback, please feel free to contact me at alex@mathsmethods.com.au. Good luck!

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Kind regards



Alex Bell | Founder of **MathsMethods.com.au**

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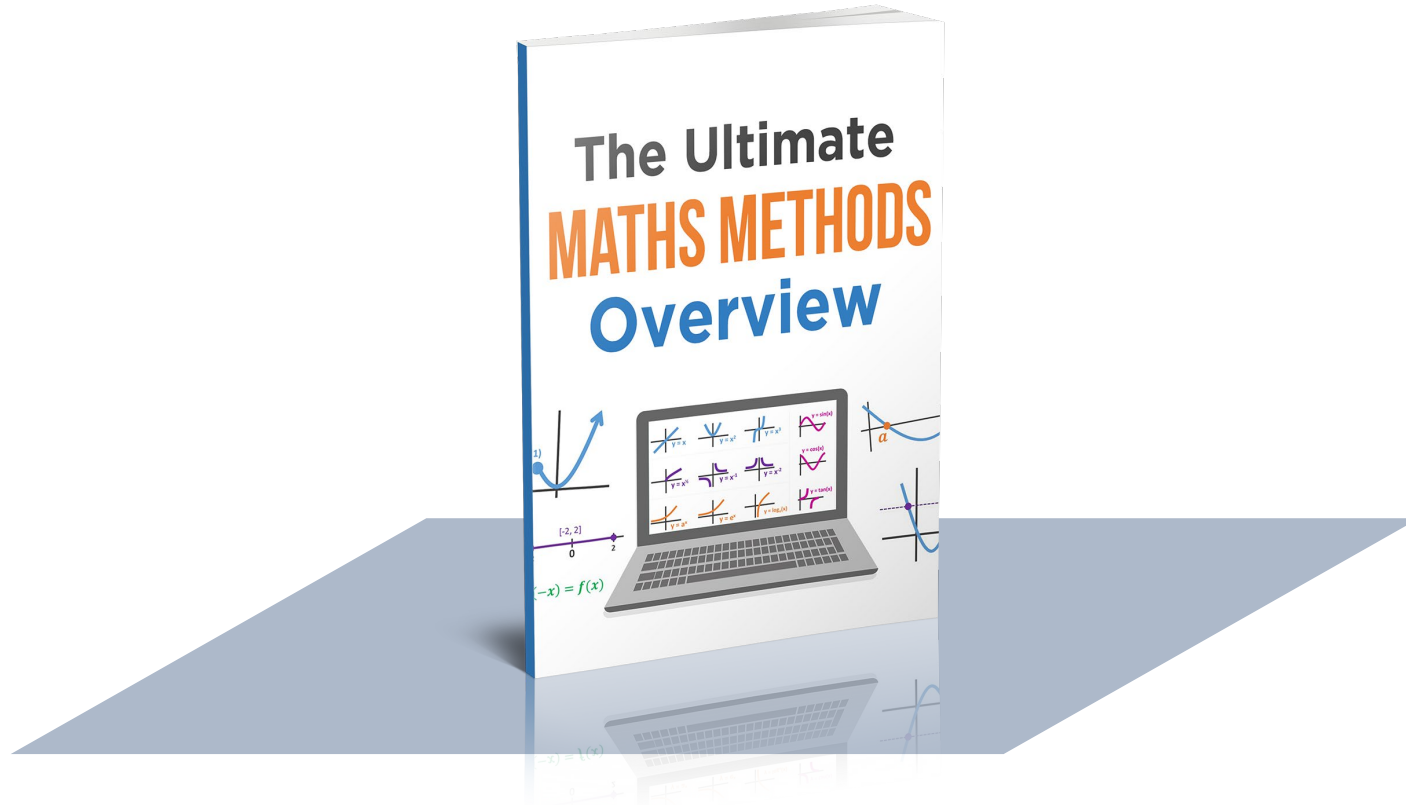
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