Kinematics Formulas – your formula sheet should contain the 8 formulas in **bold**.

We know that, Δd = displacement, v = velocity, a = acceleration and t = time.
Now add subscripts: v_1 = first velocity recorded v_2 = second velocity recorded

3 Most Basic Formulas - by definition:

$v = d_2 - d_1 / t$ ($v = \Delta d / t$) at constant velocity: **$\Delta d = vt$**

(change in displacement over time)

$a = v_2 - v_1 / t$ ($a = \Delta v / t$)

(change in velocity over time)

5 Derived Formulas

If you rearrange the acceleration formula and isolate for v_2, you get:

$v_2 = v_1 + at$

Manipulating other formulas and substituting, you also get:

$\Delta d = (v_1 + v_2/2)\ t$

$\Delta d = v_1 t + \frac{1}{2} at^2$

$\Delta d = v_2 t - \frac{1}{2} at^2$

$v_2^2 = v_1^2 + 2a\Delta d$

Why so many formulas? It depends what information you're **given** and what you're **required** to find. So the GRASS method is important! The derived formulas each contain 4 variables. If you know 3 of them, you can solve for the 4th. It's a bit like a puzzle! Look at the options you have: (x = means this variable is in the formula)

Equation (formula)	Δd	a	v_1	v_2	t
$v_2 = v_1 + at$	--	X	X	X	X
$\Delta d = (v_1 + v_2/2)\ t$	X	--	X	X	X
$\Delta d = v_1 t + \frac{1}{2} at^2$	X	X	--	X	X
$\Delta d = v_2 t - \frac{1}{2} at^2$	X	X	X	--	x
$v_2^2 = v_1^2 + 2a\Delta d$	X	X	X	X	--

Try solving these problems. For convenience (<u>this one time</u>) the formula you need is given.

Use: $v_2^2 = v_1^2 + 2a\Delta d$

<u>To solve</u>: A hybrid car with an initial velocity of 10.0 m/s [E] accelerates at 3.0 m/s^2 [E]. how long will it take the car to acquire a final velocity of 25.0 m/s [E]? **answer: 5.0 s**

Use: $\Delta d = (v_1 + v_2/2)\ t$

<u>To solve</u>: A coal train travelling west at 16.0 m/s is brought to rest in 8.0 s . Find the displacement of the coal train while it is coming to a stop. Assume uniform (ie: constant) acceleration. **Answer: 64 m [W]**

Use: $\Delta d = v_1 t + \frac{1}{2} at^2$

<u>To solve</u>: A golf ball that is initially travelling at 25 m/s hits a sand trap and slows down with an acceleration of -20 m/s^2. Find its displacement after 1.0 s. **answer: 15 m [fwd]**

Use: $\Delta d = v_2 t - \frac{1}{2} a t^2$

<u>To solve</u>: A speedboat slows down at a rate of 5.0 m/s2 and comes to a stop. If the process took 15s, find the displacement of the boat. **Answer: 5.6×10^2 m [fwd]. or 560 m [fwd].**

Use: $v_2^2 = v_1^2 + 2a\Delta d$

<u>To solve</u>: A bullet accelerates the length of the barrel of a rifle (0.750 n) with a magnitude of 5.35×10^5 m/s^2. With what speed does the bullet exit the barrel? (hint: what is v_1? It is not stated, but you should know!). answer: 896 m/s