## The Kinematic Equations

IB PHYSICS | MOTION

## Motion Variables

| Displacement | Initial Velocity | Final Velocity | Acceleration | Time |
| :--- | :--- | :--- | :--- | :--- |
|  |  |  |  |  |

Whenever we are describing the motion of an accelerating object, there are five variables that we need to take into account

Note: The variables used in IB Physics vary slightly from other nomenclature standards

## Calculating Acceleration

$$
\text { acceleration }=\frac{\text { final velocity }- \text { initial velocity }}{\text { change in time }}
$$

$n$
0
䇾
n
$=$
$\stackrel{n}{5}$

## Think about this unit...



## Try This | 1

What is the acceleration of a car that accelerates from $15 \mathrm{~m} \mathrm{~s}^{-1}$ to $35 \mathrm{~m} \mathrm{~s}^{-1}$ in 10 seconds?

| $u$ |  |
| :--- | :--- |
| $v$ |  |
| $a$ |  |
| $t$ |  |

$$
a=\frac{v-u}{t}
$$

## Try This | 2

Find the average acceleration of a northbound train that slows down from $12 \mathrm{~m} \mathrm{~s}^{-1}$ to a complete stop in 8 sec *Tip: You can get a negative value!

| $u$ |  |
| :--- | :--- |
| $v$ |  |
| $a$ |  |
| $t$ |  |

$$
a=\frac{v-u}{t}
$$

## Solve for v

$$
a=\frac{v-u}{t}
$$

## Physics Data Booklet

$$
\begin{aligned}
& \text { Sub-topic } 2.1-\text { Motion } \\
& \begin{array}{l}
v=u+a t \\
s=u t+\frac{1}{2} a t^{2} \\
v^{2}=u^{2}+2 a s \\
s=\frac{(v+u) t}{2}
\end{array}
\end{aligned}
$$

## How far have I gone?



## Use the graphs to tell you MORE!



## How far have I gone?



## Physics Data Booklet

$$
\begin{aligned}
& \text { Sub-topic } 2.1-\text { Motion } \\
& \begin{array}{l}
v=u+a t \\
s=u t+\frac{1}{2} a t^{2} \\
v^{2}=u^{2}+2 a s \\
s=\frac{(v+u) t}{2}
\end{array}
\end{aligned}
$$

## What if I don't know v?

$$
s=\frac{(v+u) t}{2}
$$

## $v=u+a t$

## Physics Data Booklet

$$
\begin{aligned}
& \text { Sub-topic } 2.1-\text { Motion } \\
& \begin{array}{l}
v=u+a t \\
s=u t+\frac{1}{2} a t^{2} \\
v^{2}=u^{2}+2 a s \\
s=\frac{(v+u) t}{2}
\end{array}
\end{aligned}
$$

## One more equation

$$
v^{2}=u^{2}+2 a s
$$

## Equations

|  | $m$ | $m s^{-1}$ | $m s^{-1}$ | $m s^{-2}$ | $s$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $v=u+a t$ |  | $u$ | $v$ | $a$ | $t$ |
| $s=u t+\frac{1}{2} a t^{2}$ | $s$ | $u$ |  | $a$ | $t$ |
| $v^{2}=u^{2}+2 a s$ | $s$ | $u$ | $v$ | $a$ |  |
| $s=\frac{(v+u) t}{2}$ | $s$ | $u$ | $v$ |  | $t$ |

## Try This | 3

You speed up with a uniform acceleration from $0 \mathrm{~m} / \mathrm{s}$ to $30 \mathrm{~m} / \mathrm{s}$ in 5 seconds. How far have you gone?

| $s$ |  |
| :--- | :--- |
| $u$ |  |
| $v$ |  |
| $a$ |  |
| $t$ |  |

## Try This | 4

If a plane on a runway is accelerating at $4.8 \mathrm{~m} \mathrm{~s}^{-2}$ for 15 seconds before taking off, how long should the runway be?

| $S$ |  |
| :--- | :--- |
| $u$ |  |
| $v$ |  |
| $a$ |  |
| $t$ |  |

## Try This | 5

A driver slams on the brakes and skids for 3 seconds before coming to a stop. You go and measure that the skid marks show a deceleration over 9 m . What was the initial speed of the car?

| $S$ |  |
| :--- | :--- |
| $u$ |  |
| $v$ |  |
| $a$ |  |
| $t$ |  |

## Lesson Takeaways

$\square$ I can identify the 5 primary variables of motion
$\square$ I can identify the proper kinematic equation to use for a problem that is presented
$\square$ I can rearrange to solve for the unknown variable
$\square$ I can calculate for an unknown

