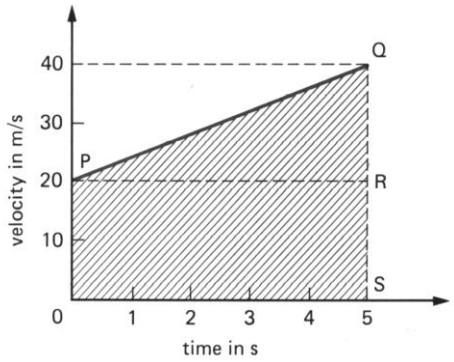
THE EQUATIONS OF MOTION…….. *Mr Smith's derivation*



The slope of the above graph tells us the acceleration of an object. Let **u** = velocity at P, and **v** = velocity at Q. Since slope = **a**,

$$\boldsymbol{a} = \frac{\boldsymbol{v}-\boldsymbol{u}}{t} \quad or \quad \boldsymbol{v} = \boldsymbol{u} + \boldsymbol{a}t \quad \textbf{(EQN 1)}$$

The area under the graph is the area of the rectangle OPRS (which has height u and length t), plus the area of triangle PQR on top of it. This area is the object's displacement, **s**:

$$\boldsymbol{s} = \boldsymbol{u}t + \frac{1}{2}(\boldsymbol{v}-\boldsymbol{u})t$$

substituting $\boldsymbol{at}$ for $\boldsymbol{(v - u)}$ from (EQN 1) gives:

$$\boldsymbol{s} = \boldsymbol{u}t + \tfrac{1}{2}\boldsymbol{a}t^2 \quad \textbf{(EQN 2)}$$

Now since the object's average velocity can be calculated from its displacement and time, we can also calculate the object's displacement from its average velocity:

$$\boldsymbol{v}_{ave} = \frac{\Delta \boldsymbol{s}}{\Delta t} = \frac{\boldsymbol{v}+\boldsymbol{u}}{2} \quad \text{or} \quad \boldsymbol{s} = \frac{(\boldsymbol{v}+\boldsymbol{u})t}{2} \quad \textbf{(EQN 3)}$$

Finally, equations 1 and 3 can be combined. Rearrange equation 1: $t = \frac{\boldsymbol{v}-\boldsymbol{u}}{\boldsymbol{a}}$

Substitute this expression for t into equation 3 and rearrange:

$\boldsymbol{s} = \frac{(\boldsymbol{v}+\boldsymbol{u})}{2}\frac{(\boldsymbol{v}-\boldsymbol{u})}{\boldsymbol{a}}$ giving $2\boldsymbol{a}\boldsymbol{s} = (\boldsymbol{v}+\boldsymbol{u})(\boldsymbol{v}-\boldsymbol{u})$ or $\boldsymbol{v}^2 = \boldsymbol{u}^2 + 2\boldsymbol{a}\boldsymbol{s}$ **(EQN 4)**

Now refer to the equations of motion as given to you in your IB data booklet. Same?

SOLVING EQUATIONS OF MOTION PROBLEMS:

1. Write a *suvat* table, and fill it in.
2. Identify the equation(s) you can use based on what you know.
3. Solve it! (and check your answers if you have time).