

Tutorial 1.2

Kinematics

1. The displacement, s in metres, of an object after a time, t in seconds, is given by

$$s = 90t - 4t^2$$

- a) Find by differentiation the equation for its velocity.
- b) At what time will the velocity be zero?
- c) Show that the acceleration is a constant and state its value.

2. Given that $a = \frac{dv}{dt}$, show by integration that the velocity, v , is given by $v = u + at$
State clearly the meaning of the symbol, u , in this equation.

3. Given that $v = \frac{ds}{dt}$ and $v = u + at$, show by integration that $s = ut + \frac{1}{2}at^2$
Where the symbols have their usual meaning.

4. The displacement, s , of a moving object after a time, t , is given by

$$s = 8 - 10t + t^2$$

Show that the unbalanced force acting on the object is constant.

5. The displacement, s , of an object after time, t , is given by $s = 3t^3 + 5t$

- a) Derive an expression for the acceleration of the object.
- b) Explain why this expression indicates that the acceleration is not constant.

6. A trolley is released from the top of a runway which is 6 m long.

The displacement, s in metres, of the trolley is given by the expression
 $s = 5t + t^2$, where t is in seconds.

Determine:

- a) an expression for the velocity of the trolley
- b) the acceleration of the trolley
- c) the time it takes the trolley to reach the bottom of the runway
- d) the velocity of the trolley at the bottom of the runway.

7. A box slides down a smooth slope with an acceleration of 4 m s^{-2} .

The velocity of the box at a time $t = 0$ is 3 m s^{-1} down the slope.

Using $a = \frac{dv}{dt}$ show by integration that the velocity, v , of the box is given by

$$v = 3 + 4t$$

8. The equation for the velocity, v , of a moving trolley is $v = 2 + 6t$

Using $v = \frac{ds}{dt}$ derive an expression for the displacement, s , of the trolley.

- 9 A projectile is launched from the top of a building with an initial speed of 20 m s^{-1} at an angle of 30° to the horizontal. The height of the building is 30 m.

- (a) Calculate how long it takes the projectile to reach the ground.
- (b) Calculate the velocity of the projectile on impact with the ground, (magnitude and direction).