Equations of Motion, Force, Work, Energy et al

Equations Motion

For constant acceleration we define

$a = (v - u) / t$

and we rearrange to get 1) $v = u + a t$

(no ***s*** term)

From the concept that distance is average speed x time we get 2) $s = \frac{1}{2}(u + v)t$

(no ***a*** term)

Putting the value of ***v*** from 1) into 2) we get

3) $s = u t + \frac{1}{2} a t^2$

(no ***v*** term)

Putting the value of ***u*** from 1) into 2) we get

4) $s = v t - \frac{1}{2} a t^2$

(no ***u*** term)

Finally putting ***t*** from 1) into 2) we get

5) $v^2 = u^2 + 2 a s$

(no ***t*** term)

Thus we work with five equations, each equation inter-relating 4 terms from "***s u v a t***" and leaving out the 5th. It is recommended the student carries out each of these substitutions to gain familiarity.

nb Differentiating 1) gives the definition of acceleration.

Differentiating 3) gives 1).

Force, Work, Energy, Momentum Impulse

force = mass × acceleration

F = m a

work = force × distance

W = F s

Energy is the potential to do work so has the same units

power = rate of doing work

P = F s/t

momentum = mass × velocity

p = m v

impulse = force × time (duration)

I = $F \times \Delta t$

hence impulse = change in momentum

I = mv – mu

the units are thus either kg-m/s or N-s

In collisions, momentum after = momentum before so

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

Moments

If force $[{}^{a}{}_{b}]$ acts on position vector (x_1,y_1) the moment about (0,0) taking anticlockwise as positive is $^{-}(y_1 a) + (x_1 b)$

The moment about (x_2,y_2) is

$$^{-}\{(y_1 - y_2)\, a\} + \{(x_1 - x_2)\, b\}$$

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