

ACDB4007 Physics all equations

1 Equations

1.1 Trigonometry

Pythagoras: width squared + height squared = diagonal squared

$$a^2 + b^2 = c^2$$

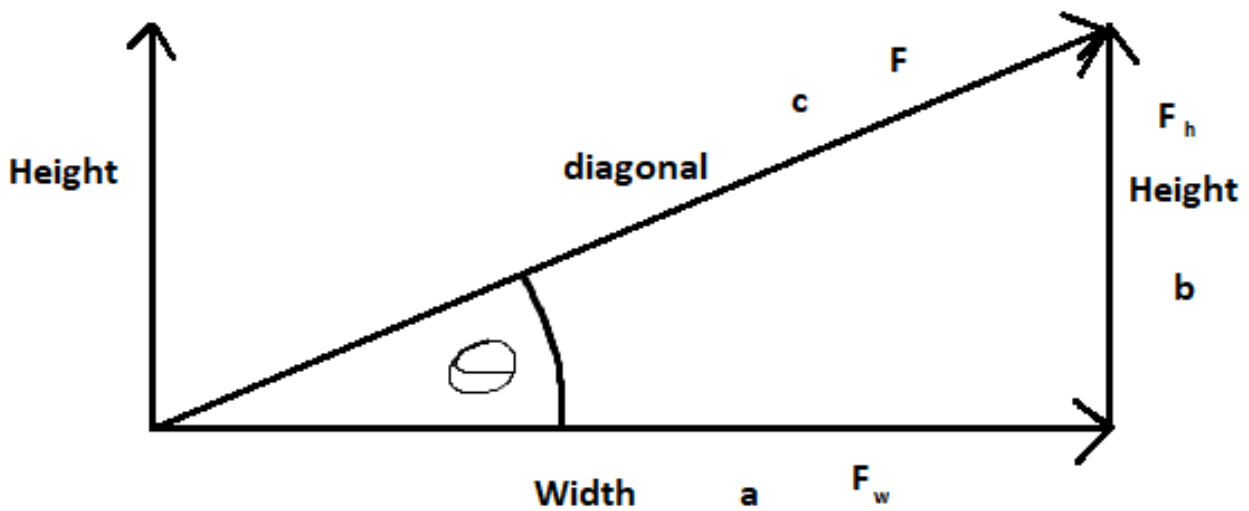


Figure 1

Components of vectors

force along width = force along diagonal x cos(angle)

$$F_w = F \cos(\theta)$$

force along height = force along diagonal x sin(angle)

$$F_h = F \sin(\theta)$$

quadratic equation gives values for x when in the form $ax^2 + bx + c = 0$.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

1.2 Force, energy and moments

Force = mass x acceleration

$$F = ma$$

Weight = mass x acceleration due to gravity

$$W = mg$$

momentum = mass x velocity

$$p = mv$$

Kinetic energy = 1/2 x mass x velocity squared

$$KE = 1/2mv^2$$

Gravitational potential energy = mass x height x acceleration due to gravity(9.81ms⁻²)

$$GPE = mhg$$

Conservation of energy

$$Total\ energy\ at\ the\ start = total\ energy\ at\ the\ end$$

Conservation of momentum

$$Total\ momentum\ at\ the\ start = total\ momentum\ at\ the\ end$$

Moment = force x perpendicular distance

$$M = F_{\perp}d$$

Friction force = coefficient of friction x normal reaction force

$$F_f = \mu R$$

definition of angular frequency angular frequency or velocity = 2 x pi x frequency of rotation

$$\omega = 2\pi f$$

frequency = 1 divided by time for one rotation

$$f = \frac{1}{T}$$

angular momentum = angular frequency x integral of r squared dm

$$L = \omega \int r^2 dm$$

Moment of inertia = angular momentum / angular frequency

$$I = L/\omega$$

Moment of inertia = integral of r squared over small mass dm up to total length L

$$I = \int^L r^2 dm$$

small mass dm = mass per unit length (M/L) x small length dr

$$dm = \frac{M}{L} dr$$

Integral of r squared dr = r cubed divided by 3 then substitute total length L

$$\int^L r^2 dr = \left[\frac{r^3}{3} \right]^L = \frac{L^3}{3}$$

1.3 SUVAT equations

final velocity = initial velocity + acceleration x time

$$v = u + at$$

displacement = initial velocity x time + 1/2 x acceleration x time squared

$$s = ut + \frac{1}{2}at^2$$

final velocity squared = initial velocity squared + 2 x acceleration x displacement

$$v^2 = u^2 + 2as$$

displacement = (final velocity + initial velocity) x time/2

$$s = (v + u)t/2$$

1.4 Simple harmonic motion

Hooke's law Force = minus spring constant x displacement

$$F = -kx$$

simple harmonic motion equation acceleration = minus constant x displacement

$$a = -kx$$

Equation above with a replaced with definition of acceleration

$$\frac{d^2x}{dt^2} = -kx$$

Solution to shm equation: displacement = amplitude x sin(angular frequency x time + phase)

$$x = A\sin(\omega t + \phi)$$

Angular frequency for a mass on a spring, angular frequency = square root of spring constant divided by mass

$$\omega = \sqrt{\frac{k}{m}}$$

1.5 Stress and strain

Stress = force divided by area

$$\sigma = F/A$$

Strain = change in length divided by original length

$$\varepsilon = \frac{\Delta L}{L}$$

Modulus of elasticity = stress divided by strain

$$E = \frac{\sigma}{\varepsilon}$$

1.6 Thermal physics

Work done = integral of Pressure x small volume dV

$$WD = \int PdV$$

Power = energy divided by time

$$P = E/t$$

Energy or internal energy = mass x specific heat capacity x change in temperature

$$U = E = mc\Delta T$$

Internal energy = heat **in** + work done **on** the system. Heat out or work done **by** the system are negative.

$$U = Q + WD$$

Pressure x volume = number of moles x molar gas constant(8.31) x temperature

$$PV = nRT$$

If temperature constant pressure x volume = constant

$$PV = constant$$

radiated power = area x emissivity x stefan constant x temperature to the power of 4.

$$P = A\varepsilon\sigma T^4$$

power per area = emissivity x stefan constant x temperature to the power of 4.

$$\dot{q} = \varepsilon\sigma T^4$$

New length = original length x (1 + thermal expansion coefficient x change in temperature)

$$L = L_0(1 + \alpha\Delta T)$$

Kelvins = degrees C + 273

$$K = C^\circ + 273$$