Common Physics Equations

Motion

$$v_{ave} = \frac{\Delta x}{t}$$

$$v_{ave} = \frac{(v_i + v_f)}{2}$$

$$a = \frac{\Delta v}{t} = \frac{(v_f - v_i)}{t}$$

$$v_f = v_i + at$$

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$\Delta x = v_i t + 1/2\, at^2$$

$$x = \left(\frac{v_i + v_f}{2}\right)t$$

Variables: (mks unit)

v_{ave} : average velocity (m/s)

Δx or x : change in position or displacement (m)

Δt or t : change in time or time (s)

Δv : change in velocity (m/s)

v_i : initial velocity (m/s)

v_f : final velocity (m/s)

a : acceleration (m/s^2)

(note: on many different equation sheets x is substituted by d for displacement)

Projectile Motion

X axis projectile equation	Y axis projectile equations
$x = v_x t$ **Note: the Y axis equations are the same as the accelerated motion equations above but specialized for something in freefall along the Y axis**	$\Delta y = v_{iy} t + 1/2\, gt^2$ $v_{fy} = v_{iy} + gt$ $v_{fy}^2 = v_{iy}^2 + 2g\Delta y$ $g = 9.8\, m/s^2$ **Only if $v_{iy} = 0$** $\Delta y = v_{iy} t + 1/2\, gt^2$ **Becomes** $t = \sqrt{\left(\frac{2\Delta y}{g}\right)}$

Variables (mks unit)

Δy or y : change in position or displacement (m) in the y axis

Δv : change in velocity (m/s)

V_{iy} : initial Y axis velocity (m/s)

V_{fy} : final Y axis velocity (m/s)

g : acceleration due to gravity (m/s^2)

Force and Friction

$$\sum F = F_{net} = ma$$

$$m_1 a_1 = m_2 a_2$$

$$F_W = mg$$

$$F_f = \mu F_N$$

$$F_s = -kx$$

Variables (mks unit)

$\sum F$ or F_{net} : vector sum of forces (N)

m : mass (kg)

a : acceleration (m/s^2)

F_W : weight (N)

F_f : Force of friction (N)

μ : coefficient of friction (no unit)

F_s : Spring Force (N)

k : spring constant (N/m or kg/s^2)

x: displacement of stretched spring

Gravitation and Circular Motion

$$F_c = ma_c$$

$$F_c = \frac{mv^2}{r}$$

$$a_c = \frac{v^2}{r}$$

$$v = \frac{2\pi r}{T}$$

$$F_g = \frac{Gm_1 m_2}{d^2}$$

$$G = 6.67x10^{-11} \frac{Nm^2}{kg^2}$$

$$\mathrm{T} = F_{\perp} d$$

$$F_1 d_1 = F_2 d_2$$

Variables (mks unit)

F_c : centripetal force (N)

a_c : centripetal acceleration (m/s^2)

v : velocity (m/s)

r : radius

π : pie (3.14 rounded)

F_g : Force of Gravity (N)

G : universal gravitation constant

m_1 : mass one

m_2 : mass two

d : distance between objects (m)

Τ : Torque (Nm)

$F_{\perp}$: Perpendicular Force (N)

F_1 and F_2 represent two different forces created by object 1 or 2

d_1 and d_2 represent two different distances that object one or two are from the fulcrum or rotational point

Energy and Momentum

$PE = mgh$

$KE = \frac{1}{2} mv^2$

$P = mv$

$Impulse = F\Delta t$

$F\Delta t = \Delta(mv)$

Elastic Collisions

$m_1v_{1i} + m_2v_{2i} = m_1v_{1f}+m_2v_{2f}$

Inelastic Collisions

$m_1v_1 + m_2v_{2i} = (m_1 + m_2)v_f$

Variables (mks unit)

PE : potential energy (J)

m : mass (kg)

g : acceleration due to gravity (m/s^2)

h : height (m)

KE : kinetic energy (J)

v : velocity (m/s)

p : momentum (kg·m/s)

J: Impulse (Ns)

m_1 : first objects mass (kg)

v_{1i} : first objects initial velocity (m/s)

m_2 : second mass (kg)

v_{2i} : second objects initial velocity (m/s)

v_{1f} : first objects final velocity (m/s)

v_{2f} : second object final velocity (m/s)

v_f : combined final velocity (m/s)

Work and Power

$W = F_{//} d$

$$P = \frac{W}{t}$$

$$P = \frac{F_{//} d}{t}$$

$W = \Delta KE$

Variables (mks unit)

W : work (J)

P : power (W)

$F_{//}$: Force parallel to the motion (N)

Electricity

$$F_{el} = \frac{kq_1q_2}{d^2}$$

$$k = 9.0x10^9 \frac{Nm^2}{C^2}$$

$$I = \frac{q}{t}$$

$$E = \frac{F}{q}$$

$$E = \frac{V}{d}$$

$$V = \frac{W}{q}$$

V = IR

P = IV

$P = I_2R$

$$P = \frac{V^2}{R}$$

$$P = \frac{Energy}{t}$$

q_e : charge of electron = -1.6×10^{-19} C

Variables (mks unit)

F_{el} : electrical force (N)

k : coulomb constant

q : charge (C)

q_1 or q_2 : multiple objects with charge (C)

d : distance between (m)

I : current (A)

T: time (s)

E : electrical field (N/C)

V : potential difference or voltage (V)

W : work (J)

P : power (W)

R : resistance (Ω or Ohms)

Series Circuit

$$V_{emf} = v_1 + v_2 + v_3 + \cdots$$

$$I_T = I_1 = I_2 = I_3 = \cdots$$

$$R_T = R_1 + R_2 + R_3 + \cdots$$

Parallel Circuit

$$V_{emf} = v_1 = v_2 = v_3 = \cdots$$

$$I_T + I_1 + I_2 + I_3 + \cdots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$$

At Device (more in last section)

$$V = IR$$

$$P = IV$$

Variables and Subscripts

Subscripts

(1,2,3, …): first, second, third resistor or device, and so forth…

T or emf: equivalent or total calculated at the battery or power source

V : voltage (m/s)

I : Current (A)

R : resistance (Ω or Ohms)

Sound and Waves

$$v = f\lambda$$

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

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

v_{sound}= 331m/s + 0.6$T_{(°C)}$

Variables (mks unit)

v : velocity (m/s)

f : frequency (Hz)

λ : wavelength (m)

T : period (s)

V_{sound} : velocity of sound

Optics

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

$$M = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$$

$n_i \sin\Theta_i = n_r \sin\Theta_r$

$$Sin\Theta_c = \frac{n_r}{n_i}$$

$$n = \frac{c}{v_{material}}$$

$c = 3x10^8$ m/s

Variables (mks unit)

f : focal length

d_i : distance to image

d_i : distance to object

M : magnification

h_i : height of image

h_o : height of object

n : index of refraction

n_i : index of refraction incident side

n_r : index of refraction refracted side

Θ_i : angle of incidence

Θ_r : angle of refraction

Θ_c : critical angle

$v_{material}$: velocity of light in a material (m/s)

c : speed of light or any electromagnetic wave in a vacuum ($3x10^8$ m/s)

Trig Reminders

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

$$sin\Theta = \frac{opp}{hyp} \qquad cos\Theta = \frac{adj}{hyp} \qquad tan\Theta = \frac{opp}{adj}$$