Formula:

① $t = \dfrac{V_0 \sin\theta}{g} = \dfrac{V_{0y}}{g}$

Time to reach Max Height

② $T = 2t = \dfrac{2V_0 \sin\theta}{g} = \dfrac{2V_{0y}}{g}$

total time

③ $H = \dfrac{V_0^2 \sin^2\theta}{2g} = \dfrac{V_{0y}^2}{2g}$

Max Height

④ $R = \dfrac{V_0^2 \sin 2\theta}{g} = \dfrac{2V_{0x}V_{0y}}{g}$

Range

⑤ $R_{max} = \dfrac{V_0^2}{g}$ (at $\theta = 45°$)

Max Range

⑥ $R = \dfrac{R_{max}}{2}$ (at $\theta = 15°$)

④ $R = \dfrac{V_0^2 \sin 2\theta}{g}$

$= \dfrac{V_0 . V_0 (2 \sin\theta . \cos\theta)}{g}$

$$\boxed{R = \frac{2V_{0x}V_{0y}}{g}}$$

⑥ $R = \dfrac{V_0^2}{g} \sin 2\theta$

$= R_{max} \sin 2(15°)$

$= R_{max} \sin 30°$

$$\boxed{R = \frac{R_{max}}{2}}$$

PaPa Formula:

$$R \tan\theta = 4H$$

Range

(Horizontal Distance)

Height

(vertical Distance)

HIGHBROW COLLEGE

Date:

S·H·M

$F = kx$

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

$\omega = \sqrt{\frac{k}{m}}$ $\quad v = -A\omega(\sin(\omega t + \phi))$

$\omega = 2\pi f$ $\quad a = -A\omega^2(\cos(\omega t + \phi))$

$a = -\omega^2 x$

$a(t) = -(2\pi f)^2 x(t)$

Time period $T = 2\pi\sqrt{\frac{m}{k}}$

$x(t) = A\cos(2\pi f t + \phi)$

$v_{max} = \omega x_{max}$

Energy =

Total $E = \frac{1}{2}k(x^2_m)$ A^2

$K.E = \frac{1}{2}kx^2\sin^2(\omega t + \phi)$

$U = \frac{1}{2}kx^2 \cos^2(\omega t + \phi)$

Total $= \frac{1}{2}kx_m^2\cos^2(\omega t + \phi) + \frac{1}{2}kx_m^2\sin^2$

$= \frac{1}{2}x_m^2 k[\underbrace{\cos^2(\omega t + \phi) + \sin^2(\omega t + \phi)}_{1}]$

HIGHBROW COLLEGE

Date:

Damped Oscillations

$F_d = -bv$

force ↓ damping constant

$ma = -bv + (-kx)$

$ma = -bv - kx$

Total net force.

F_{net} :

$= -bv - kx = ma$

$$x(t) = x_m e^{-\frac{bt}{2m}} \cos(\omega' t + \phi)$$

ω' = damped oscillation frequency (angular)

$$\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$$

if $b < \sqrt{k/m}$ $\Rightarrow \omega' = \omega$

Damped Energy

$$E(t) = \frac{1}{2} k x_m^2 \boxed{e^{-bt/m}}$$

Oscillations

- $x(t) = x_0 \cos(\omega t + \phi)$
- $v(t) = -x_0 \omega \sin(\omega t + \phi)$
- $a(t) = -x_0^{\cancel{2}} \omega^2 \cos(\omega t + \phi)$
- $a_{max} = \pm x_0 \omega^2$
- $V_{max} = \pm x_0 \omega$
- $\omega = \sqrt{\frac{K}{m}} \Rightarrow \omega = 2\pi f$
- $T = \frac{2\pi}{\omega} \Rightarrow T = 2\pi \sqrt{\frac{m}{K}}$
- $f = \frac{1}{T} \Rightarrow f = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$
- $F = -Kx$

  $a = -\frac{Kx}{m} \Rightarrow a = -\omega^2 x$
- $V = \omega\sqrt{x_0^2 - x^2}$
- $T = 2\pi\sqrt{\frac{l}{g}}$
- $E = K.E + P.E = \frac{1}{2}Kx_0^2$
- $K.E = \frac{1}{2}mv^2 = \frac{1}{2}m x_0^2 \omega^2 \sin^2(\omega t + \phi)$
- $P.E = \frac{1}{2}Kx^2 = \frac{1}{2}K x_0^2 \cos^2(\omega t + \phi)$
- $V = \sqrt{\frac{T}{\mu}}$
- $\mu = \frac{m}{l}$

HIGHBROW COLLEGE

Date:

Waves

$c = 3 \times 10^8$, electromagnetic wave speed.

Wave Function

$y(x,t) = f(x - vt)$

Pulse travelling to the right

$y(x,t) = f(x + vt)$

left

wave number $k = \frac{2\pi}{\lambda}$ $\lambda \rightarrow$ wave length

$K = \frac{\omega}{v}$

$\boxed{v = \frac{\omega}{k} = \lambda f}$

$\frac{\lambda}{f} = \frac{\omega}{k}$

$y = A\sin(kx - \omega t + \phi)$

SuperPosition.

$Y = y_1 + y_2$

$\alpha = kx - \omega t$

$\beta = kx - \omega t + \phi$

$Y = A[\sin(\alpha) + \sin\beta]$

$= 2A\cos\left(\frac{\phi}{2}\right)\sin(kx - \omega t + \phi)$

$A_Y = 2A\cos\left(\frac{\phi}{2}\right)$

formula

Electrostatics

- $F = \frac{kq_1q_2}{r^2}$
- $k = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9$

  $\epsilon_0 = 8.85 \times 10^{-12}$

- $E = \frac{F}{q_0}$
- $E = \frac{kq}{r^2}$
- $E = \frac{V}{d}$

Damping.

- $F_d = -bv$
- $x(t) = x_0 e^{-bt/2m} \cos(\omega' t + \phi)$
- $\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$
- $E(t) = \frac{1}{2} k x_0^2 e^{-bt/m}$
- $F = -kx - bv$

Waves

- $y(x,t) = y_m \sin(kx - \omega t)$

<u>at $t=0$:</u>

- $y(x,0) = y_m \sin kx$

- $k = \frac{2\pi}{\lambda}$ · $f = \frac{1}{T} = \frac{\omega}{2\pi}$

- $\omega = \frac{2\pi}{T}$

with phase constant:

- $y(x,t) = y_m \sin(kx - \omega t + \phi)$

- $V = \frac{\text{coefficient of } t}{\text{coefficient of } x} = \frac{\omega}{k} = \frac{\lambda}{T}$

$V = \lambda f$

Direction of wave:

$ax + bt$ / $-ax - bt$ → in $-ve$ x-direction

$ax - bt$ / $-ax + bt$ → in $+ve$ x-direction

- opp. signs → $+ve$ x
- same signs → $-ve$ x

- $\lambda = VT$

- phase difference: (same particle)

$$\Delta\phi = \frac{2\pi}{T}\Delta t \Rightarrow \omega . \Delta t$$

→ same phase conditions:

- same disp
- same velocity
- Same acc.

Interference of waves:

- superposition principle:

$$\vec{y}_{net} = \vec{y}_1 + \vec{y}_2$$

path difference:

$$\Delta r = \frac{\phi}{2\pi}\lambda$$

constructive interference.

$A_{net} \longrightarrow max$

$$\phi = 0, 2\pi, \cancel{3}4\pi, 6\pi \text{---} = 2n\pi$$

$$\Delta r = 0, \lambda, 2\lambda, 3\lambda \text{---} = n\lambda$$

Destructive Interference:

$A_{net} \rightarrow min$

$$\phi = \pi, 3\pi, 5\pi \text{---} = (2n+1)\lambda$$

$$\Delta r = \frac{\lambda}{2}, \frac{3\lambda}{2}, \frac{5\lambda}{2} \text{---} = (2n+1)\frac{\lambda}{2}$$

Interference of waves:

- $A' = 2A \cos \frac{\phi}{2}$

- longest wavelength $= \frac{n\lambda}{2}$

It can be used for multiple cases. One of them is to find the angle at which range is equal to height.

$$R\tan\theta = 4H$$

$\because R = H$

$$\tan\theta = 4$$

$$\theta = \tan^{-1}(4)$$

$$\theta = 76^\circ$$

Magnetic field,

$F_B = q|VB \sin\theta|$

+q mean F_B is upward & vice versa.

The direction of f_B is opposite to the cross / perp product.

F_B cannot change particles speed it can only change direction ∴ It is p

Motion of particle in uniform magnetic field. $|V \times B|$

$F = ma$

$qVB = \frac{mV^2}{r}$

$r = \frac{mV}{qB}$

$\omega = \frac{V}{r} = \frac{qB}{m}$

$\frac{1}{2}mV^2 = qV$

$V = \sqrt{\frac{2qV}{m}}$

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

$T = \frac{2\pi}{\omega}$ $\frac{1}{\omega} = \frac{r}{V}$

$\omega = 2\pi f$
$\omega = \frac{2\pi}{T}$
$T = 2\pi/\omega$

$J \to eV$ ÷
$eV \to J$ ×

$T = \frac{2\pi m}{qB}$

left to right (leads)
west (inside)
generators (left!

when charge particle experiences both
$F_E = F_B$
$qE = qVB$
$V = E/B$

Magnetic force on a current carrying wire.

$B = \frac{\mu_0 I_1 I_2}{2\pi r}$

$\mu_0 = 4\pi \times 10^{-7}$

~~BA~~ $F_B = i\vec{L} \times \vec{B}$

Hall Effect.