Physics Equations And Definitions

- CIRCULAR MOTION

1. Angular displacement: The angle subtended at the centre of a curved path. Measured in radians.

2. Angular velocity: The rate of change of angular displacement. Measured in radians per second (rad/s).

Circular Motion

$$\theta = \frac{s}{r}$$

$$\omega = \frac{d\theta}{dt} = rads^{-1}$$

$$\omega = \frac{\theta}{t}$$

$$\omega = \frac{s}{rt} = \frac{v}{r}$$

$$v = r\omega$$

$$a = \frac{v^2}{r} = \frac{r^2\omega^2}{r} = r\omega^2$$

$$F_c = ma = \frac{mv^2}{r} = mr\omega^2$$

$Rcos\theta = mg$, where R is the reaction force

$$Rsin\theta = \frac{mv^2}{r}$$

$$\frac{Rsin\theta}{Rcos\theta} = \frac{\frac{mv^2}{r}}{mg} \therefore tan\theta = \frac{v^2}{rg}$$

At the top of a circular loop,

$$v > \sqrt{r}g$$

For a body moving in a circle at constant speed,

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

Physics Equations And Definitions

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

$$v = r\omega \therefore \frac{r}{v} = \frac{1}{\omega}$$

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

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

Physics Equations And Definitions

- SIMPLE HARMONIC MOTION

1. Simple Harmonic Motion: The motion of a particle about a fixed point such that its acceleration is proportional to its displacement from the fixed point and the acceleration is always directed towards this fixed point of frame of reference.

2. Resonance: The maximization of the amplitude of driven oscillations, when the driver frequency is equal to the natural frequency.

3. Natural Frequency: The innate frequency due to length, structure and bonding at atomic level.

Simple Harmonic Motion

$a \propto -x \therefore a = -kx$

$a = -x\omega^2$

$x = x_0 Sin\theta$

$\omega = \frac{\theta}{t} \therefore \theta = \omega t$

$x = x_0 Sin\omega t$

$v = x_0 \omega Cos\omega t$

$v_{max} = x_0 \omega$

$a = -x_0 \omega^2 Sin\omega t$, but $x = x_0 Sin\omega t$

$\therefore a = -x\omega^2$

$Total\ energy = \frac{1}{2} m {x_0}^2 \omega^2$

$G.P.E = \frac{1}{2} m x^2 \omega^2$

$KE = \frac{1}{2} m\omega^2 ({x_0}^2 - x^2)$

Physics Equations And Definitions

- GRAVITATION

1. Gravitational field: A space or a region where a mass experiences a force of attraction.

2. Gravitational field line: Shows the path taken by a mass when placed in a gravitational field.

3. Gravitational field strength/intensity (g): The force experienced per unit mass in a gravitational field.

4. Gravitational potential at a point: The work done in moving a unit mass from infinity to a point with the gravitational field.

Gravitation

$$F = \frac{GMm}{r^2}$$

$$g = \frac{F}{m} = \frac{\frac{GMm}{r^2}}{m} \therefore g = \frac{GM}{r^2}$$

$$\Phi = \frac{-GM}{r}$$

$$KE = \frac{GMm}{2r}$$

$$Total\ energy = -\frac{1}{2}\frac{GMm}{r}$$

Kepler's Law

$$T^2 = \frac{4\pi^2 r^3}{GM}$$

Escape velocity

$$v = \frac{\sqrt{2GM}}{R}$$

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Physics Equations And Definitions

- ELECTRIC FIELDS

1. Electric field: A space or a region where a charge experiences a force.

2. Electric field line: Shows the path taken by a unit positive charge when placed in an electric field.

3. Electric field strength/intensity (E_s): The force experienced per unit charge in an electric field.

Electric Fields

$$E_s = \frac{V}{d} = \frac{F}{q}$$

$$E_s = -\frac{dV}{dr}$$

$$F = \frac{kQq}{r^2}$$

$$E_s = \frac{kQ}{r^2}$$

$$V = -\frac{kQ}{r}$$

$$k = \frac{1}{4\pi\varepsilon_0}$$

Physics Equations And Definitions

Capacitance

$C = \frac{Q}{V}$

$V = V_0 e^{-kt}, where\ k = \frac{1}{RC}$

$t_{\frac{1}{2}} = RC\ ln2$ (time taken for V to reduce to half its original value)

$E = \frac{1}{2} QV$

$E = \frac{1}{2} CV^2$

$E = \frac{1}{2} \frac{Q^2}{C}$

Capacitors in series

$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots$

Capacitors in parallel

$C_{eq} = C_1 + C_2 + C_3 + \cdots$

Physics Equations And Definitions

- MAGNETISM

1. Magnetic field: A region or a space where a moving charge experiences a force.

2. Magnetic field line: The path taken by a hypothetical north when placed in a magnetic field.

3. Magnetic flux: Total number of magnetic field lines passing through a given area.

4. Transformer: A device that converts alternating emf at one level to alternating emf at another, using electromagnetic induction

5. Eddy currents: Small circular currents that oppose the laminar flow of magnetic flux through the soft iron core (with reference to transformers).

Magnetism

$I = nAve$

When the conductor is perpendicular to the magnetic field

$F = BIl$

When the conductor is at an angle to the magnetic field

$F = BIl\ sin\theta$

When the current is perpendicular to the magnetic field

$F = Bqv$

When the current is at an angle to the magnetic field

$F = Bqv\ sin\theta$

$$r = \frac{mv}{Bq}$$

$$v = \frac{E_s}{B}$$

$B = \frac{\Phi}{A}$, where Φ = magnetic flux

$\Phi = BASin\theta$, where magnetic flux is not perpendicular

$I \propto \Phi$

$Emf = -\frac{d\Phi}{dt}$

$I = I_0 Sin2\pi ft$

$I_{rms} = \frac{I_0}{\sqrt{2}}$

$V_{rms} = \frac{V_0}{\sqrt{2}}$

$P_{avg} = \frac{1}{2} I_0 V_0 = \frac{1}{2} \times peak\ power$

Transformers

$V_p I_p = V_s I_s$

$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$

Physics Equations And Definitions

- MODERN PHYSICS

1. Work function (Φ): The minimum energy required to just eject an electron from the surface of the metal.

2. Stopping voltage: The potential required in a photocell circuit to stop the fastest moving electron ejected from the cathode.

Modern Physics

$E = hf$

$KE_{max} = E_i - \Phi$

De Broglie's Wavelength

$\lambda = \frac{h}{p}$

$E_n = -\frac{13.6}{n^2}$, where 'E' is the electric potential of an electron, and 'n' is the orbital level of the electron

$I = \frac{nhc}{\lambda}$, where 'I' is intensity and 'n' is the number of photons incident per unit area per second

Photon pressure (under photon absorption)

$P = \frac{I}{c}$

Photon pressure (under photon reflection)

$P = \frac{2I}{c}$

Intensity of an x-ray

$I = I_0 e^{-\mu x}$, where 'I_0' is the initial intensity and 'μ' is the linear attenuation coefficient.

Physics Equations And Definitions

Radioactivity

$N = N_0 e^{-\lambda t}$

where N_0= initial number of undecayed radioactive nuclides
λ = decay constant
t = time
N = number of undecayed nuclides at any given time

$A = -\frac{dN}{dt}$

where A = activity

$\frac{dN}{dt} = -\lambda N$

$t_{\frac{1}{2}} = \frac{ln2}{\lambda}$

Ideal Gases

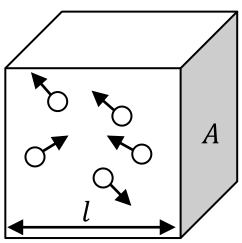
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

For $\frac{PV}{T} = k$,

$k = nR$
where n = number of moles
R = molar gas constant ($8.314\ Jmol^{-1}K^{-1}$)

$PV = nRT$
$PV = NkT$

Force on the wall with area 'A'



$$F = \frac{Mu^2}{l}$$

where M = total mass of all the molecules (mass of the gas)
u = velocity of particles

Pressure on the wall with area 'A'

$$P = \frac{Nmu^2}{Al} = \frac{Nmu^2}{l^3}$$

where N = total number of gas molecules

Physics Equations And Definitions

$$< c^2 > = \frac{{c_1}^2 + {c_2}^2 + {c_3}^2 + {c_4}^2}{N}$$

$$P = \frac{1}{3}\frac{Nm < c^2 >}{l^3}$$

$$PV = \frac{1}{3}Nm < c^2 >$$

$$P = \frac{1}{3}\rho < c^2 >$$

$$< c^2 > = \frac{3nRT}{Nm}$$

$$\frac{1}{2}m < c^2 > = \frac{3}{2}kT$$

$$U_{gas} = \frac{3}{2}NkT$$

where U = internal energy

Physics Equations And Definitions

First Law of Thermodynamics

$$\Delta U = \Delta Q + W$$

If ΔU is positive, it implies an increase (negative implies a decrease)
If ΔQ is positive, it implies heat supplied to the system (negative implies heat absorbed from the system)
If W is positive it implies work done ON the system (negative implies work done BY the system)

Telecommunications

$$number\ of\ decibels = 10\log\frac{P_{out}}{P_{in}}$$

$$signal\ to\ noise\ ratio = 10\log\frac{P_{signal}}{P_{noise}}$$

$$Refractive\ index = \frac{speed\ of\ light\ in\ vacuum}{speed\ of\ light\ in\ medium}$$

Direct Sensing

$V_{out} = A_0(V^+ - V^-)$

where A_0 is the open loop gain of the op-amp.

$\frac{V_{out}}{V_{in}} = \frac{A_0}{(1 - A_0\beta)}$

where β is the fraction of the output voltage that is fed back and added to the input voltage (feedback fraction)

Voltage gain for an inverting amplifier

$\frac{V_{out}}{V_{in}} = -\frac{R_f}{R_{in}}$

Voltage gain for a non-inverting amplifier

$\frac{V_{out}}{V_{in}} = 1 + \frac{R_f}{R_1}$

Physics Equations And Definitions