Physics (units & dimensions)

Newton = $KgMs^{-2}$

Power = Joules per second

Work = Joules or Newton * meter or Kgm^2s^{-2}

10^{-18} = atto	10 = deca
10^{-15} = femto	10^{18} = exa
10^{-6} = Micro	10^{12} = Tera
10^{-1} = deci	10^{9} = Giga
10^{-2} = Centi	10^{2} = hecto
10^{-12} = Pico	10^{6} = Mega
10^{-3} = milli	10^{15} = Peta
10^{-9} = nano	10^{3} = Kilo

* Astronomical distances are Measured in Light Year (LY) or parsec

$1 LY = 0.3 pc$, $1 pc = 3.0 \times 10^{16} m$

* Use of dimensions:

(i) Verification of the correctness of a physical eqn.

(ii) Derivation of unit of quantities.

(iii) Derivation of exact form of a relatn btw measured quantities.

(iv) It can be applied in Biological Science

Physics (units & dimensions)

* Speed & Velocity = ms^{-1} = LT^{-1}
* Acceleration = ms^{-2} = LT^{-2}
* Force = N = $Kgms^{-2}$ = MLT^{-2}
* Volume = m^3 = L^3
* Pressure = Pa or Nm^{-2} = $Kgm^{-1}s^{-2}$ = $ML^{-1}T^{-2}$
* Density = Kgm^{-3} = ML^{-3}
* Work & Energy = J = Kgm^2s^{-2} = ML^2T^{-2} = Nm
* Power = W = Kgm^2s^{-3} = ML^2T^{-3} = Js^{-1}
* Impulse = Ns = $Kgms^{-1}$ = MLT^{-1}
* Frequency = Hz = s^{-1} = T^{-1}
* Angle = Rad
* Coefficient of friction = F/R
* Viscosity = Force ÷ (area x vel. gradient) = $ML^{-1}T^{-1}$
* Velocity gradient = Velocity ÷ distance
* Surface tension Coefficient Y = force ÷ Length
  = MLT^{-2}/L = MT^{-2}
* Universal gravitational Constant G = $Fr^2 \div m$
  = $M^{-1}L^3T^{-2}$
* Young's Modulus, E = Stress/strain

$$E = \frac{\text{Force/Area}}{\text{extension/original len.}} = \frac{MLT^{-2}/L^2}{L/L} = ML^{-1}T^{-2}$$

Physics (units & dimensions)

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Physics

* The study of Mechanics: (1) Kinematics (2) dynamics
* Vector quantities: displ, vel.
* Scalar " : Speed, dist.
* 1 mile = 1609 metres
* 1 foot = 0.3048 metres
* 1 Metre = 39.37 inches = 3.281 feet
* 1 inch = 0.0254 Metres
* 1 inch = 2.54 cm
* To convert Kmh^{-1} to ms^{-1} use $Kmh^{-1} \times \frac{10}{36}$
* Instantaneous velocity, v at any point on a curve at time t, is the limit of the ratio $\Delta x / \Delta t$ as Δt approaches 0
* $v = dx/dt$: first derivative
* $a = d^2x/dt^2$: Second derivative
* When velocity is constant, acceleration = 0
* The root of $V = u + at$ is $a = \frac{v-u}{t}$
* $S = V_{av} t$, since we are dealing with two velocities (final & initial); $V_{av} = \frac{u+v}{2}$

$$\therefore S = \left(\frac{u+v}{2}\right) t$$

* The root of $S = ut + \frac{1}{2}at^2$ is $S = \left(\frac{u + u + at}{2}\right) t$

Physics

* Using $u = v - at$; $S = vt - \frac{1}{2}at^2$
* The root of $v^2 = u^2 + 2as$ is $\cancel{(v)^2 = (u)^2 + (at)^2}$
  $v^2 = (u + at)^2$
* Five equations of Motion:
  $v = u + at$; $v = u \pm gt$
  $S = \left(\frac{u+v}{2}\right)t$; $h = \left(\frac{u+v}{2}\right)t$
  $S = ut + \frac{1}{2}at^2$; $h = ut \pm \frac{1}{2}gt^2$
  $S = vt - \frac{1}{2}at^2$; $h = vt \pm \frac{1}{2}gt^2$
  $v^2 = u^2 + 2as$; $v^2 = u^2 \pm 2gh$

Projectiles

* Time of flight $= \frac{2u\sin\theta}{g}$, $t = \frac{u\sin\theta}{g}$
* $\cancel{H_{max}} = \frac{u^2\sin^2\theta}{2g}$, $H_{max} = \frac{u^2}{2g}$
* Range: $\frac{u^2\sin 2\theta}{g}$, $R_{max} = \frac{u^2}{g}$

Vectors

Cosine rule $A = \sqrt{B^2 + C^2 - 2BC\cos\theta}$
For Magnitude

Physics

Sine rule for direction; when inclined

$$\frac{\text{Sine } A}{a} = \frac{\text{Sin } B}{b}$$

* N/B: $i.i = j.j = k.k = 1$

$i.j = j.k = k.i = 0$

$i \times j = k$, $i \times i = j \times j = k \times k = 0$

$j \times k = i$

$k \times i = j$

$j \times i = -k$

$k \times j = -i$

$i \times k = -j$

* Acceleration due to gravity (g) in the moon $= 1.7 m/s^2$

* Impulse $= Ft$

Also $F = \frac{MU - Mu}{t}$

Impulse = Change in Momentum

* Inertia is the property of a body that opposes any change in its motion or change of position.

Physics

* Force parallel to plane : $F = Mg\sin\theta$
  Force perpendicular to plane : $F = Mg\cos\theta$
* Any Vector "a" Lying on x, y plane and inclined at θ with x axis can be resolved into two perpendicular Components.
  That is $a_x = |a|\cos\theta$ & $a_y = |a|\sin\theta$
  Where $\theta = \tan^{-1}\left(\frac{a_y}{a_x}\right)$
  Note: You can use this (above) or Cosine rule
* Resolving for more than two vectors
  $Sum(x) = a_x + b_x + C_x + \ldots$
  $Sum(y) = a_y + b_y + C_y + \ldots$
  $Resultant = \sqrt{Sum(x)^2 + Sum(y)^2}$
  $\theta = \tan^{-1}\dfrac{Sum(y)}{Sum(x)}$
*

S^2 sin	A^1 All
T^3 Tan	C^4 cos

* $a \cdot b = |a||b|\cos\theta$
* $a \times b = |a||b|\sin\theta$

Physics

* if $\theta = 90°$, $a \cdot b = 0$
* if $a \times b = 0$, then a is parallel to b.
* When using $(360 - \theta)$, we reverse the order of multiplication:

$$b \times a = |b||a| \sin(360 - \theta)$$

Since $a \times b = -b \times a$

The answer is always minus the result of the first formula.

NB: This is not the case for the dot product.

* Inertia is the tendency of a body to remain at rest or in uniform motion
* Newton's laws:

1st law: Inertia

2nd law: $F = \frac{\text{Change in momentum}}{\text{time}}$

NB: in a vertical motion: $Mg = R$ (normal reaction).

For three masses in a pulley system

$a = M_3 g \div (M_1 + M_2 + M_3)$

3rd law: For every action there is

Physics

an equal & opposite reaction.

* $F_g = W = mg$
* The coefficients of restitution is the ratio of the final to the initial relative velocity b/w two objects after they collide. its normally ranges from 0 to 1 where 1 would be a perfectly elastic collision.

$$\boxed{e = \sqrt{\tfrac{h'}{h}}}$$

* Weight $= mg$
* Upward acceleration; Force (N) $= m(g+a)$
* accelerating downwards; $N = m(g-a$
* $\frac{f_s}{N} = \mu_s$, $\frac{f_k}{N} = \mu_k$
* Renewable energy: Solar, wind, Hydro

Non renewable " : petroleum, coal, nuclear

1 horse power = 746 watts

* A Machine is a device by means of which an effort (E) applied at one point can be used to overcome a load (L) at some other points

Physics

* Machines

$$M.A = \frac{Load}{Effort}$$

$$V.R = \frac{S_E}{S_L}$$

$$Efficiency = \frac{Work\ outputs}{Work\ inputs} \times 100 = \frac{L \times S_L}{E \times S_E} \times 100$$

$$e = \frac{M.A}{V.R} \times 100$$

Types of Machines

(i) Lever: a rigid body resting on a pivot
 (a) First order: L–F–E
 (b) Second ": F–L–E
 (c) Third ": F–E–L

(ii) Pulley: Machine Made of Wheel & rope

(iii) Inclined plane

(iv) hydraulic press: used to generate Comp. force

(v) Screw

(vi) Wheel & axle

$$r_{cm} = \frac{M_1 r_1 + M_2 r_2 + M_3 r_3}{M_1 + M_2 + M_3}$$

Physics

If particles are spread out in two or three dimensions:

$$x_{cm} = \frac{\sum_{i=1}^{n} m_i x_i}{\sum m_i}, \quad y_{cm} = ---, \quad z_{cm} = \frac{\sum m_i z_i}{\sum m_i}$$

* Moment of Inertia (mr^2)

(i) Uniform thin rod about one end

$$I = \frac{ml^2}{3}$$

(ii) About the middle (rod): $I = \frac{ml^2}{12}$

(iii) Circular disc (about the center): $I = \frac{Mr^2}{2}$

(iv) Solid Cylinder: $I = \frac{Mr^2}{2}$

(v) Sphere Cylinder: $I = \frac{2mr^2}{5}$

* Torque: $mr^2\alpha = I\alpha = Fr$

* Coefficient of restitution (e) $= \sqrt{\frac{h'}{h}}$

Physics

* Workdone parallel to a planes
  = Force × distance along the direction
  = $F\cos\theta \times d$

Parallel $\theta = 0°$

* Formula for calculating Velocity ratio:

(a) Inclined plane, $V.R = \frac{1}{\sin\theta}$

(b) Block and tackle pulley, $V.R = \frac{S_E}{S_L}$

(c) Hydraulic press, $V.R = \frac{R^2}{r^2}$ (where R and r are the radii of the Large & small pistons)

(d) Wheel and axle, $V.R = \frac{2\pi a}{2\pi b}$ or $\frac{a}{b}$

where a = radius of wheel, b = radius of axle.

(e) Screw, $V.R = \frac{2\pi a}{P}$

* Conservation of Momentum:
  $M_1U_1 + M_2U_2 = M_1V_1 + M_2V_2$

* Conservation Kinetic energy: for collisions that are perfectly elastic

Physics

especially.

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

* State the dimension of power.

$$\text{Power} = \frac{\text{Work}}{\text{time}} = \frac{F \times s}{t}$$

$$= \frac{M \times a \times s}{t}$$

where $a = LT^{-2}$, $M = M$, $s = L$, $t = T$

$$P = \frac{M \times LT^{-2} \times L}{T}$$

$$P = M \times LT^{-2} \times L \times T^{-1}$$

$$\therefore P = ML^2T^{-3}$$

*

Kinematics	Dynamics
(i) This is the study of motion without regards to the force causing the motion	(i) This is study of motion with respect to the forces causing the motion
(ii) Equations are studied under kinematics	(ii) Newton's laws and their applications or consequences are studied

Physics

	in this branch.
(iii) Galileo Galili worked more on Kinematics.	(iii) Sir Isaac Newton worked basically on dynamics.

* Bernoulli's principles states that where the fluid velocity is high, the pressure is low and vice versa.

Mathematically: $P + \frac{1}{2}\rho v^2 + \rho g y = \text{Constant}$

where P = pressure, v = velocity, ρ = density

* Poiseulle's equations

$$Q = \frac{\pi R^4 (P_1 - P_2)}{8 \eta L}$$

where Q = quantity of fluid that flows per unit time

R = radius of pipe

L = Length of the pipe

$P_1 - P_2$ = diff. in fluid pressure at the ends of the pipe.

η = Coefficients of viscosity

Physics

* Torricelli's theorem; $U = \sqrt{2gh}$
* Kinetic Energy $= \frac{1}{2}MU^2 = \frac{1}{2}M(wr)^2$

N/B w is in rev/min or rad/s

1 rev. $= 2\pi$ rad

1 rev/min $= \frac{2\pi \text{ rad}}{60s}$

* Centre of Mass:

$$X_{cm} = \frac{M_1x_1 + M_2x_2 + \text{---} + M_nx_n}{M_1 + M_2 + \text{---} + M_n}$$

$$Y_{cm} = \frac{M_1y_1 + M_2y_2 + \text{---} + M_ny_n}{M_1 + M_2 + \text{---} + M_n}$$

* Elastic Collision	Inelastic Collision
(1) The collision of two bodies is said to be elastic if both the kinetic energy and momentum are conserved	(1) This is a type of collision where kinetic energy of the colliding bodies is not conserved but the momentum is conserved.
(2) There is no loss of energy before and after collision.	(2) There is a loss of energy through sound or heat generated during collision.

Physics

* Conditions necessary for a rigid body to be in static equilibrium are:
(i) The sum of clockwise moments about a fixed point is equal to the sum of anticlock wise moments about that same point.
(ii) Upward force must be equal to downward forces acting at a point.
* Important forces that can act on bodies are:
(i) Contact forces: pull, push
(ii) Field force: gravitational force, Magnetic
(iii) Spring force
(iv) Air resistance force
* Centripetal force:

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

* $Y = A\sin(wt - \phi)$
$w = 2\pi f$
* Work output = Mass x acceleration x distance
* Rise in Liquid (capillarity) = $P_1h_1 = P_2h_2$
Where P = density
h = height

Physics

* Elasticity of a spring is the tendency of a spring to return to the original position after being distorted by an external force.

$$E_p = \frac{1}{2}ke^2$$

* Coefficients of Surface tension:

$$\cancel{\gamma = \frac{K\rho g d}{4}} \quad \gamma = \frac{r\rho g h}{2}$$

Where ρ = density
d = diameter
h = height
g = acc. due to gravity

Physics

* Linear motion formulae

Displacement = Δx

Velocity = dx/dt

Acceleration = $dv/dt = d^2x/dt^2$

Rectilinear motion: $V = V_0 + at$

$S = \frac{1}{2}(V_0 + V)t$

$S = V_0t + \frac{1}{2}at^2$

$V^2 = u^2 + 2as$

Mass = M

Momentum; $P = mv$

Force = F

Kinetic energy; $K = \frac{1}{2}mv^2$

Power; $P = FV$

Newton's second law = $dP/dt = ma$

Rotational motion formulae

Angular displacement = $\Delta\theta$

Angular vel. = $d\theta/dt$

Angular acceleration; $\alpha = d\omega/dt = d^2\theta/dt^2$

Rotational motion: $\omega = \omega_0 + \alpha t$

$\theta = \frac{1}{2}(\omega_0 + \omega)t$

Physics

$$\theta = \omega_0 + \frac{1}{2}\alpha t^2$$

$$\omega^2 = \omega_0^2 + 2\alpha\theta$$

Moment of Inertia (Mass) $= I = mr^2$

Angular Momentum; $L = I\omega$

Torque (Force) $= \tau$

Kinetic energy; $K = \frac{1}{2}I\omega^2$

Power; $P = \tau\omega$

Newton's second law; $\tau_{net} = dL/dt = I\alpha$

* Elasticity is the property which enables a body deformed by applied force to return to its original size or shape when the applied forces is removed.

* Hooke's law; provided elastic limit is not exceeded the extension (e) of a wire (spring) is proportional to the applied force.

$$F = ke$$

$$\therefore E_p = \frac{1}{2}Ke^2$$

Physics

* Kepler's Laws

(i) Law of Orbits: States that each planet moves in its own elliptical orbit with the sun at one focus.

(ii) Area Law: The line joining any planet and the sun sweeps out equal areas in equal interval of time.

(iii) Period Law: States that the square of the period of revolution of any planet about the sun is proportional to the cube of the planets' mean distance from the sun.

Mathematically, $T^2 = r^3 \left(\frac{4\pi^2}{GM_s}\right)$

* Conditions necessary for a rigid body to be in static equilibrium?

(i) The sum of clockwise moments about a fixed point is equal to the sum of anticlock wise moments about that same point.

(ii) Upward force must be equal to

Physics

downward forces acting at a point

* Force is the cause of motion according to newton's first law of motion.
* For a U-shaped Manometer
  $P = \rho_1 g h_1 = \rho_2 h_2 g$
* Impulse is the product of a very large force and very short time which it acts
* Instantaneous acceleration is the limit of the ratio $\Delta v / \Delta t$ as Δt approaches zero.
* Resultant vector $= \sqrt{a^2 + b^2 - 2ab\cos}$
  Direction = $\tan\theta$ =
* S.H.M = $y = A\sin(\omega t + \theta)$
  $f = \omega / 2\pi$; $T = 2\pi / \omega$
* Drag force = $r = \dfrac{v d P}{\eta}$