Q1 Force of 50N acting on a body at an angle θ with horizontal. If 150 J Work is done by displacing it 3m, then θ is

(a) 60° (b) 30° (c) 0° (d) 45°

Q2 A particle is pushed by Forces $2\hat{i}+3\hat{j}-2\hat{k}$ and $5\hat{i}-\hat{j}-3\hat{k}$ simultaneously and it is displaced from point $\hat{i}+\hat{j}+\hat{k}$ to a point $2\hat{i}-\hat{j}+3\hat{k}$. The Work done is

(a) 7 Unit (b) −7 Unit (c) 10 Unit

(d) −10 Unit

Q3 The kinetic energy of a body of mass 4 kg and momentum 6 Ns will be

(a) 3.5 J (b) 5.5 J (c) 2.5 J

(d) 4.5 J

Q4 What is the relation between momentum and kinetic Energy of the particle?

(a) $KE = \frac{P^2}{2m}$ (b) $KE = \frac{P}{2m}$ (c) $KE = \frac{V^2}{2m}$

(d) $KE = \frac{V}{2m}$

Q5 When a person lifts a brick above the Surface of earth, then the potential Energy

(a) increases (b) decreases (c) remains same

(d) None of these

and momentum 6 Ns will be

(a) 3.5 J (b) 5.5 J (c) 2.5 J

(d) 4.5 J

Q4 What is the relation between momentum and kinetic Energy of the particle?

(a) $KE = \frac{P^2}{2m}$ (b) $KE = \frac{P}{2m}$ (c) $KE = \frac{V^2}{2m}$

(d) $KE = \frac{V}{2m}$

Q5 When a person lifts a brick above the surface of earth, then the potential Energy

(a) increases (b) decreases (c) remains same

(d) None of these

Q6 A spring Force Constant 800 N/m has an extention of 5 cm. The Work done in extending it from 5 cm to 15 cm is

(a) 16 J (b) 8 J (c) 32 J (d) 24 J

Q7 A man does a given amount of Work in 10 sec. Another man does the same amount of Work in 20 sec. The ratio of the output Power of 1st man to the Second man is →

(a) 1 (b) $\frac{1}{2}$ (c) $\frac{2}{1}$ (d) None of these

Q8 If the body is moving in a circle of radius r with constant speed v. It's angular velocity is

(a) $\frac{v^2}{r}$ (b) vr (c) v (d) r

Q7 A man does a given amount of Work in 10 sec. Another man does the same amount of Work in 20 sec. The ratio of the Output Power of 1st man to the Second man is →

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Q8 If the body is moving in a Circle of radius r with Constant speed v. It's angular velocity is

(a) $\frac{v^2}{r}$ (b) vr (c) $\frac{v}{r}$ (d) $\frac{r}{v}$

Q9 A body is moving in a Circular path with Constant speed. It has

(a) a Constant velocity

(b) A Constant acceleration

(c) An acceleration of Constant magnitude

(d) An acceleration which varies with time

Q10 What is the angular velocity of earth ?

(a) $\frac{2\pi}{86400}$ rad/s (b) $\frac{2\pi}{3600}$ rad/s

(c) $\frac{2\pi}{24}$ rad/s (d) $\frac{2\pi}{6400}$ rad/s

Q11 When a body moves with a Constant speed along a Circle

(a) No Work is done

(b) No acc is produced in the body

(c) No force acts on the body

(d) It's velocity remains Constant

(c) $\frac{2\pi}{24}$ rad/s (d) $\frac{2\pi}{6400}$ rad/s

Q11 When a body moves with a constant speed along a circle

(a) No work is done

(b) No acc is produced in the body

(c) No force acts on the body

(d) It's velocity remains constant

Q12 Two particles of equal masses are revolving in circular path of radii r_1 and r_2 respectively with the same speed. The ratio of their centripetal forces is

$\frac{r_1}{r_2}$ (b) $\frac{r_2}{r_1}$ (c) $\left(\frac{r_1}{r_2}\right)^2$ (d) $\left(\frac{r_2}{r_1}\right)^2$

Q13 The angular momentum L of a single particle can be represented as

(a) $r \times p$ (b) $rp\sin\theta\ \hat{n}$ (c) $rp\perp\hat{n}$

(d) both (a) and (b)

Q14 Newton's 2nd law of rotational motion of a system of particle can be represented as

(a) $\frac{dp}{dt} = \tau_{ex}$ (b) $\frac{dL}{dt} = \tau_{ex}$

(c) $\frac{dI}{dt} = \tau_{ex}$ (d) $\frac{dL}{dt} - \tau_{ex} + \tau_{in}$

Q15 If the torque of the rotational motion will be 0, then the constant quantity will be

(a) angular momentum

Q14 Newton's 2nd law of rotational motion of a system of particle can be represented as (a) $\frac{dp}{dt} = \tau_{ex}$ (b) $\frac{dL}{dt} = \tau_{ex}$

(c) $\frac{dL}{dt} = \tau_{in}$ (d) $\frac{dL}{dt} = \tau_{ex} + \tau_{in}$

Q15 If the torque of the rotational motion will be 0, then the constant quantity will be

(a) angular momentum
(b) linear momentum
(c) angular acceleration
(d) Centripetal acceleration

Q16 If frictional force is neglected and girl bends her hand, then

(a) I_{girl} will reduce
(b) I_{girl} will increase
(c) ω_{girl} will reduce
(d) None of the above

Q17 V_e and V_p denotes the escape velocity from the earth and another planet having twice the radius and same density as earth. then

(a) $V_e = V_p$ (b) $V_e = \frac{V_p}{2}$ (c) $V_e = 2V_p$

(d) $V_e = \frac{V_p}{4}$

(d) None of the above

Q17 V_e and V_p denotes the escape velocity from the earth and another planet having twice the radius and same density as earth. then

(a) $V_e = V_p$ (b) $V_e = \frac{V_p}{2}$ (c) $V_e = 2V_p$

(d) $V_e = \frac{V_p}{4}$

Q18 The escape velocity of a sphere of mass m from earth having mass M and radius R is given by

(a) $\sqrt{\frac{2GM}{R}}$ (b) $2\sqrt{\frac{GM}{R}}$

(c) $\sqrt{\frac{2GMm}{R}}$ (d) $\sqrt{\frac{GM}{R}}$

Q19 If V_e and V_o represent the escape velocity and orbital velocity of a satellite corresponding to circular orbit of radius R, then

(a) $V_e = V_o$ (b) $\sqrt{2}\,V_o = V_o$

(c) $V_e = \frac{V_o}{\sqrt{2}}$ (d) V_e & V_o are not related

km/s (b) 11.2 km/s (c) 41 km/s (d) 6 km/s

Q23 Orbit of a planet around a star is

(a) A circle (b) An ellipse

(c) A parabola (d) A straight line

(c) $\sqrt{\frac{2GMm}{R}}$ (d) $\sqrt{\frac{GM}{R}}$

Q19 If V_e and V_o represent the escape velocity and orbital velocity of a satellite corresponding to circular orbit of radius R, then

(a) $V_e = V_o$ (b) $\sqrt{2}\, V_o = V_e$

(c) $V_e = \frac{V_o}{\sqrt{2}}$ (d) V_e & V_o are not related

(a) 8 km/s (b) 11.2 km/s (c) 4 km/s (d) 6 km/s

Q23 Orbit of a planet around a star is

(a) A Circle (b) An ellipse

(c) A parabola (d) A straight line

Q24 Kepler's 2nd law regarding constancy of aerial velocity of a planet is a consequence of the law of conservation of

(a) Energy (b) Angular momentum

(c) Linear momentum (d) None of these

Q25 If the earth is at $\frac{1}{4}$th of it's present distance from the sun, the duration of the year will be –

(a) Half the present year

(b) $\frac{1}{8}$th " "

(c) $\frac{1}{4}$th " "

(d) $\frac{1}{6}$th " "

1

Physics

Units & Dimensions

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- Unit : Unit of measurement is a definite magnitude of a quantity, defined & adopted by convention or by law, that is used as a standard or measurement of the same kind of quantity.

Units → Fundamental, Derived

1.	Mass	metro/kg	M
2.	Length	metre	L
3.	Time	Second	T
4.	Temp.	Kelvin	K θ
5.	Amount of Substance	mole	mol
6.	~~Charge~~ Electric Current	Ampere	A
7.	Luminous Intensity	Candela, cd	cd

- System of Units

1) M.K.S – Metre, kg, s
2) C.G.S – cm, g, s
3) F.P.S – Foot, Pound (lb), s
4) SI – System of International Units. MKS is used in the.

Force in =	MKS	CGS	FPS	SI
	$kg\,m/s^2$ = N	$cm\,g/s^2$ = dyne	$foot\,pound/s^2$ = $1\,lb\,ft/s^2$ = 1 Poundal	N

→ Quantities that can be measured are known as physical quantity.

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→ Quantities which are independent of other physical quantities are known as fundamental quantities.

⇒ Dimensions : Dimensions of the quantity are the power to which fundamental quantity must be raised to represent the quantity.
eg. $1N = 1\,kg\,m/s^2 = [M^1L^1T^{-2}]$

⇒ Dimensionless quantity ⇒ $[M^0L^0T^0]$
eg. 1) Strain
2) Angle (has unit)
3) Co-efficient of friction
4) Refractive Index
5) log 5

Note: Dimensionless quantity has unit but vice-versa is not true.

= N | = dyne | = 1 lb ft/s² = 1 Poundal

2 Quantities that can be measured are known as physical quantity.

→ Quantities which are independent of other physical quantities are known as fundamental quantities.

⇒ Dimensions : Dimensions of other quantity are the power to which fundamental quantity must be raised to represent the quantity.
eg. $1N = 1 kg\,m/s^2 = [M^1L^1T^{-2}]$

⇒ Dimensionless quantity ⇒ $[M^0L^0T^0]$
eg. 1) Strain
2) Angle (has unit)
3) Co-efficient of friction
4) Refractive Index
5) log 5

Note: Dimensionless quantity has unit but vice-versa is not true.

★ Principle of Homogeneity : It states that the dimensions of each terms of a dimensional equation on both sides are the same or must be same.

$\boxed{\text{Dimension in LHS} = \text{Dimension in RHS}}$

→ Also, it states that only those physical quantities can be added or substracted which have same dimensions.

eg
$V = a + bt$
$LT^{-2} = LT^{-1} + LT^{-1}$ – it does not follow Principle of Homogeneity

eg.
$x = a + c/m$
$L = M^1L^1 + M^1L^1$ – it also does not follow the principle

○ Dimensional formulae :

1) Velocity	m/s	$[LT^{-1}]$
2) Acc^n	m/s²	$[LT^{-2}]$
3) Force	kg m/s²	$[MLT^{-2}]$
4) Work	kg m²/s²	$[ML^2T^{-2}]$
5) Energy	kg m²/s²	$[ML^2T^{-2}]$

dimensions.

eg. $V = a + bt$

$LT^{-1} = LT^{-1} + LT^{-1}$ – it does not follow Principle of Homogeneity

eg. $x = a + c/m$

$L = M^1L^1 + M^1L^1$ – it also does not follow the principle

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• Dimensional formulae :

1)	Velocity	m/s	$[LT^{-1}]$
2)	Acc^n	m/s^2	$[LT^{-2}]$
3)	Force	kg m/s^2	$[MLT^{-2}]$
4)	Work	kg m^2/s^2	$[ML^2T^{-2}]$
5)	Energy	kg m^2/s^2	$[ML^2T^{-2}]$
6)	Torque	kg m^2/s^2	$[ML^2T^{-2}]$
7)	Power	kg m^2/s^3	$[ML^2T^{-3}]$
8)	Momentum	kg m/s	$[MLT^{-1}]$
9)	Stress	kg/ms^2	$[ML^{-1}T^{-2}]$
10)	Pressure	kg/ms^2	$[ML^{-1}T^{-2}]$
11)	Frequency	1/sec	$[T^{-1}]$
12)	Angular velocity $\left(\frac{\text{Radian}}{\text{Time}}\right) / \left(\frac{\theta}{T}\right)$ (ω)	1/sec	$[T^{-1}]$
13)	M.O.I	m^4 or m^{2}kg	$[L^4]$ or $[ML^2]$
14)	Surface Tension	kg/s^2	$[MT^{-2}]$
15)	Gravitational Constant	Nm^2/kg^2 or m^3/kg s^2	$[M^{-1}L^3T^{-2}]$
16)	Angular momentum (mvr)	kg m^2/s	$[M^1L^2T^{-1}]$
17)	Co-efficient of viscosity	kg/ms	$[M^1L^{-1}T^{-1}]$
18)	Plank's Constant	Js	$[ML^2T^{-1}]$
19)	Specific heat	J/kg k	$[M^0L^2T^{-2}K^{-1}]$
20)	Thermal Conductivity	Watt/m-k	$[M^1L^1T^{-3}K^{-1}]$
21)	Gas Constant	J/mol-k	$[M^1L^2T^{-2}K^{-1}mol^{-1}]$
22)	Boltzman Constant	J/k	$[ML^2T^{-2}\theta^{-1}]$
23)	Stefan's Constant	W/m^{2}k^4	$[MT^{-3}\theta^{-4}]$
24)	Electric charge ($Q = I \times t$)	C	$[AT]$
25)	Electric intensity	N/C [N per C]	$[MLT^{-3}A^{-1}]$
26)	Electric Potential	Volt	$[ML^2T^{-3}A^{-1}]$
27)	Resistance ($R = V/I$)	Ohm	$[ML^2T^{-3}A^{-2}]$
28)	Magnetic field	Tesla or Wb/m^2 (weber)	$[MT^{-2}A^{-1}]$

Measurement & Errors

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• Conversion –

★ Mass

1. 1 Quintal = 100 kg
2. 1 tonne = 1000 kg
3. 1 [illegible] 1.66×10^{-27} kg

26) Electric Potential | Volt | $[ML^2T^{-3}A^{-1}]$
27) Resistance (R = V/I) | Ohm | $[ML^2T^{-3}A^{-2}]$
28) Magnetic field | Tesla or Wb/m² weber | $[MT^{-2}A^{-1}]$

Measurement & Errors

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- Conversion –

★ Mass
1. 1 Quintal = 100 kg
2. 1 tonne = 1000 kg
3. 1 Atomic mass unit = 1.66×10^{-27} kg.
4. 1 Slug = 14.59 kg
5. 1 Pound = 456 g or 0.456 kg
6. 1 Chandrasekhar limit = 2.2×10^{30} kg = 1.4 times mass of sun

★ Length
1. 1 inch = 2.54 cm
2. 1 ft = 0.30 m
3. 1 Yard = 0.91 m
4. 1 mile = 1.6 km
5. 1 Light Year = 9.46×10^{15} m
6. 1 Astronomical Unit = 1.5×10^{11} m
7. 1 Parsec = 3.26 ly = 3.08×10^{16} m
8. 1 Nautical mile = 6020 ft
9. 1 micron (μ) = 10^{-6} m
10. 1 Angstrom (Å) = 10^{-10} m

★ Time
1. 1 Solar day = 86400 sec
2. 1 Year = 365.2525 day
3. 1 Lunar month = 27.3 Solar days

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- Error : True value – Measured value
  Mean value / Ideal value

Systematic (repeat errors) | Random
→ (wear & tear, temp, humidity etc.) → Uncertain errors, fluctuation, ...

1. 1 Solar day = 86400 sec
2. 1 Year = 365.2525 day
3. 1 Lunar month = 27.3 Solar days

- Error : True value − Measured value
  Mean value / Ideal value

Systematic (repeated errors) | Random
→ (wear & tear, temp, humidity etc.) → Uncertain error, fluctuation, not the
→ Reduced by addition or Substraction → Reduced by no. of (reading) observation (mean)

Measurement

Accuracy	Same	Precision
5.1		6.01
5.2		6.015
4.9		5.0167
4.8		4.989

- Mean observation : x_1, x_2, x_3, x_4 ---
- Mean value : $\bar{x}$
- Absolute error : $\Delta x_1 = \bar{x} - x_1$, $\Delta x_2 = \bar{x} - x_2$, $\Delta x_3 = \bar{x} - x_3$
- Mean absolute error : $\overline{\Delta x}$

Representation of reading ~~of error~~ = $\boxed{\bar{x} \pm \overline{\Delta x}}$

⇒ Fractional error = $\frac{\Delta x}{x}$

⇒ % error = $\frac{\Delta x}{x} \times 100$

★ Propagation of Errors

Note! Errors are always added

1) Errors in Addition

$V_1 = 4 \pm 0.02$

$V_2 = 2 \pm 0.03$

6 ± 0.05

$\rightarrow$ Fractional Error $= \frac{\Delta x}{x}$

$\rightarrow$ % Error $= \frac{\Delta x}{x} \times 100$

★ Propagation of Error

| Note: Errors are always added |

1) Errors in Addition

$$V_1 = 4 \pm 0.02$$
$$V_2 = 2 \pm 0.03$$
$$6 \pm 0.05$$

2) Errors in Substraction

$$V_1 = 4 \pm 0.02$$
$$V_2 = -2 \pm 0.03$$
$$2 \pm 0.05$$

3) Errors in multiplication

$$\boxed{\begin{aligned} Z &= (x \cdot y) \\ \frac{\Delta Z}{Z} &= \frac{\Delta x}{x} + \frac{\Delta y}{y} \end{aligned}}$$

eg. $l = 4 \pm 0.04$ $\quad b = 2 \pm 0.02$

$$A = (l \cdot b)$$

$$\frac{\Delta A}{A} = \frac{\Delta l}{l} + \frac{\Delta b}{b}$$

$$\frac{\Delta A}{A} = \frac{0.04}{4} + \frac{0.02}{2}$$

$$\frac{\Delta A}{A} = 0.01 + 0.01$$

$$\frac{\Delta A}{A} = 0.02$$

$$\Delta A = 0.02 \times 8$$

$$\Delta A = 0.16$$

$$A = 8 \pm 0.16$$

$$\frac{\Delta A}{A} = 0.02$$

$$\Delta A = 0.02 \times 8$$

$$\Delta A = 0.16$$

$$A = 8 \pm 0.16$$

4) Error in Division:

$$y = \frac{a}{b}$$

$$\frac{\Delta y}{y} = \frac{\Delta a}{a} + \frac{\Delta b}{b}$$

For above case

$\cancel{A = 2 \pm 0.16}$ $\Delta A = 2 \times 0.02 = 0.04$

$$A = 2 \pm 0.04$$

5) Error in Power / order:

$$\boxed{y = a^2 b \qquad \frac{\Delta y}{y} = 2\frac{\Delta a}{a} + \frac{\Delta b}{b}}$$

eg.

Circular Motion

- Motion: It is the change in the position of an object with respect to time.

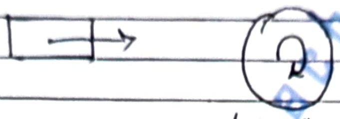
Motion

Circular Motion

Page No

- Motion : It is the change in the position of an object with respect to time.

Motion
- Linear
- Circular
- Rolling — Linear + Circular



about it's own axis

- Linear motion is a one-dimensional motion along a straight line.

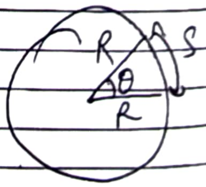
- Circular motion is the motion in a circular path.

- Rolling is the type of motion that combines rotation of object along with translation of that object.

- Angle = $\frac{\text{Arc}}{\text{Radius}}$

$\theta = \frac{S}{R}$

$\boxed{S = R\theta}$



- Angular displacement (θ) : The angle by which body is displaced.

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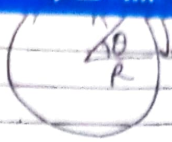
- Angular velocity (ω) = $\frac{d\theta}{dt}$

- Angular accⁿ (α) = $\frac{d\omega}{dt}$

- Tangential velocity $V = \omega r$

Radius

$\theta = \frac{S}{R}$



$\boxed{S = R\theta}$

- Angular displacement (θ): The angle by which body is displaced.

- Angular velocity (ω) = $\frac{d\theta}{dt}$

- Angular acc^n (α) = $\frac{d\omega}{dt}$

- Tangential velocity, $V = \omega r$

→ It is the velocity measured at any point tangent to a turning wheel.

Acceleration

Normal Centripetal or Centrifugal	Radial / Tangential acc^n
• $a_{normal} = \omega^2 r$	• $a_t = \alpha r$
• $a_{normal} = \frac{v^2}{r}$ $\left[\because v = \omega r\right]$	Note: For uniform motion tangential acc^n component will be zero.

Note: For linear motion, $a_{norm} = 0$ (normal component of acc^n is 0)

Resultant Acc^n: $a_R = \sqrt{(a_{nor})^2 + (a_t)^2}$

⇒ Eq^n of motion

Linear	Circular
1) $v = u + at$	1) $\omega = \omega_0 + \alpha t$
2) $s = ut + \frac{1}{2}at^2$	2) $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$
3) $v^2 - u^2 = 2as$	3) $\omega^2 - \omega_0^2 = 2\alpha\theta$

Force

Linear	Circular
1) $v = u + at$	1) $\omega = \omega_0 + \alpha t$
2) $s = ut + \frac{1}{2}at^2$	2) $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$
3) $v^2 - u^2 = 2as$	3) $\omega^2 - \omega_0^2 = 2\alpha\theta$

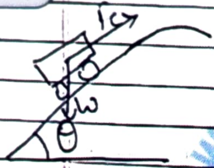
Force

- Centripetal
- Centrifugal

$$F = \frac{mv^2}{r}, \; m\omega^2 r$$

- Angular momentum $= mvr$

10 Super-elevation :



$$F_c = mv^2/r$$
$$W = mg$$

$$\tan\theta = \frac{F_c}{W} = \frac{mv^2}{rmg} = \frac{v^2}{gr}$$

$$\theta = \tan^{-1}\frac{v^2}{gr}$$

Simple Harmonic Motion

Motion

- Periodic (which repeats)
  eg. Circular
- Non-periodic
  eg. Linear motion
  Projectile motion

Simple Harmonic Motion

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Motion

- Periodic (which repeats)
  - eg. Circular
- Non-periodic
  - eg. Linear motion
  - Projectile motion

Periodic:

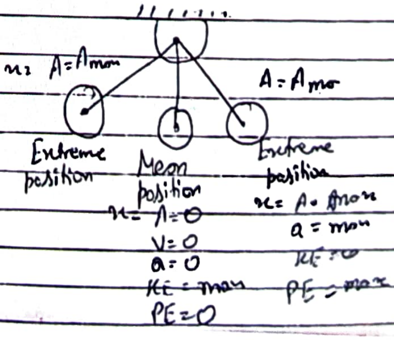
- Oscillatory (to & fro motion)
  - eg. Pendulum
  - Spring mass system
- Non-oscillatory
  - eg. Circular motion

Oscillatory:

- SHM (Simple harmonic motion) which follows some trigonometric function (Sin, Cos etc)
  - eg: Pendulum
  - Spring mass system
  - Violin string
  - Ball in concave cavity
- Non-harmonic

☆ Pendulum System

$\therefore$ $\boxed{K.E + P.E = \text{Constant}}$



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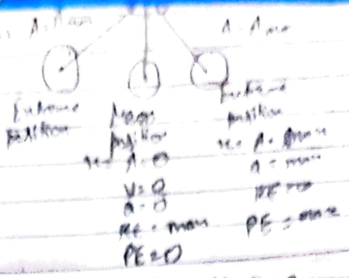
1) Amplitude (A): It is the max. displacement of the body.
2) Oscillation: It is the one complete cycle of a body.
3) Beat: $\left(\frac{\text{Oscillation}}{2}\right)$ It is the half of the oscillation / complete cycle of the body.

4) Time period (T): It is the time taken to complete one oscillation.

[KE + PE = Constant]



1) Amplitude (A): It is the max. displacement of the body.
2) Oscillation: It is the one complete cycle of a body.
3) Beat: $\left(\frac{\text{Oscillation}}{2}\right)$ It is the half of the oscillation / complete cycle of the body.

4) Time period (T): It is the time taken to comp. one oscillation.
5) Frequency (ν): $\boxed{\nu = \frac{1}{T}}$ No. of oscillations per unit time.

• Force eqn.: Restoring force

$$F = -kx^n \quad [x - \text{disp./amplitude}]$$

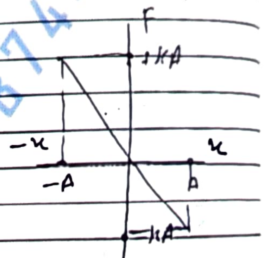
$n = 1, 3, 5, 7$

For SHM
$n = 1$

$$\boxed{F = -kx}$$

If $x = \pm A$

$$\boxed{F = \mp kA}$$



F v/s x graph

→ F & x are always opposite & F is always towards mean position.

• Acceleration

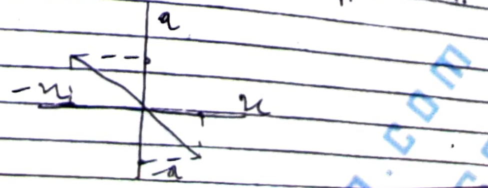
$$F = -kx = ma$$

$$a = \frac{-kx}{m} = -\left(\frac{k}{m}\right)x$$

$$\boxed{a = -\omega^2 x}$$

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

→ Direction of acceleration is always oppo. to the x.



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$F = -kx = ma$

$a = -\frac{kx}{m} = -\left(\frac{k}{m}\right)x$

$\boxed{a = -\omega^2 x}$

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

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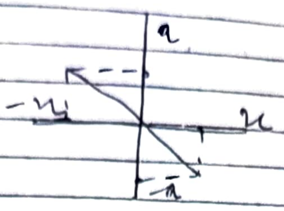
→ Direction of acceleration is always oppo. to the x.



- Time period = $\boxed{\frac{2\pi}{\omega}}$

- Linear frequency $(\nu) = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

- velocity : $\boxed{V = \omega\sqrt{A^2 - x^2}}$ — g+ b elliptical eqⁿ.

$\therefore \boxed{\frac{V^2}{\omega^2} + \frac{x^2}{1} = A^2}$

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- Energies :

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

$= \frac{1}{2}m\left(\omega^2\left(A^2 - x^2\right)\right)$

→ $KE = \frac{1}{2}m\omega^2\left(A^2 - x^2\right)$

- $PE = \frac{1}{2}kx^2$

$PE = \frac{1}{2}kA^2 + U_0$ — initial energy

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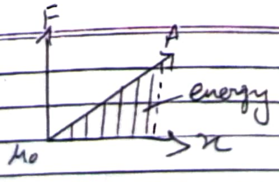
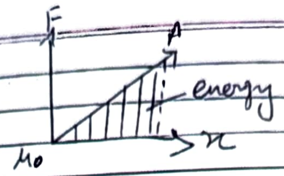


$$= \frac{1}{2} m\left(\omega^2 (A^2 - x^2)\right)$$

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

$$PE = \frac{1}{2} kx^2$$

$$PE = \frac{1}{2} kA^2 + U_0 \leftarrow \text{initial energy}$$



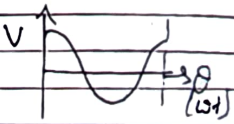
$$\boxed{\begin{aligned} P_{max} &= \omega^2 A \\ V_{max} &= \omega A \end{aligned}}$$

⇒ Differential eqn. of SHM :

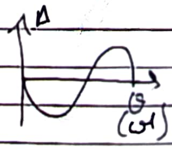
- Displacement, $x = A \sin(\omega t + \phi)$ ← Phase/Angle

~~$a = A\cos(\omega t + \phi)$~~

- $V = A\omega \cos(\omega t + \phi)$

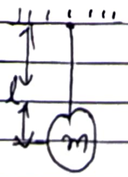


- $a = -A\omega^2 \sin(\omega t + \phi)$



★ Simple Pendulum :

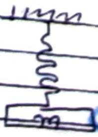
$$T = 2\pi\sqrt{\frac{l}{g}}$$



Note: Time period for simple pendulum is independent of the mass of the bob.

★ Spring mass

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



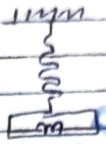
Note: Time period for th...

$T = 2\pi\sqrt{\frac{l}{g}}$

Note : Time period for simple pendulum is independent of the mass of the bob.

* Spring mass

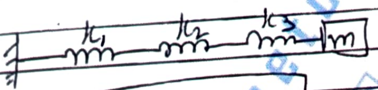
$\boxed{T = \frac{2\pi}{\omega}}$

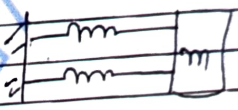


Note : Time period for spring mass system is independent of the orientation of the system.

Spring - mass

Series | Parallel





$\boxed{\frac{1}{K_{equi}} = \frac{1}{K_1} + \frac{1}{K_2}}$

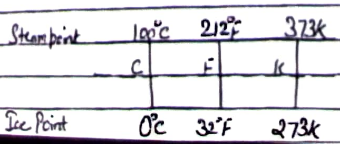
$\boxed{K_{equi} = K_1 + K_2}$

$\boxed{K_{equ} = \frac{K_1 K_2}{K_1 + K_2}}$

* $K \propto \frac{1}{\text{length of spring}}$

• HEAT

• Heat : It is a form of energy in transit.



degree of ...

• HEAT

- Heat : It is a form of energy in transit.

	C	F	K
Steam point	100°c	212°F	373K
Ice Point	0°c	32°F	273K

$$\boxed{\frac{C-0}{100-0} = \frac{F-32}{212-32} = \frac{K-273}{373-273}}$$

- Temperature : It is the measure of degree of hotness or coldness of a body.

- Heat :

$$\boxed{Q \propto m} \rightarrow \text{mass}$$

$$\boxed{Q \propto \Delta T} \rightarrow \text{Ch. K temp.}$$

$$\boxed{Q = m.\,C.\,\Delta T}$$

C → Sp. heat (Unit is kJ/kgK)

$\boxed{C}$

- Cp : Sp. heat at Constant Pressure
- Cv : Sp. heat at Constant volume

$$\therefore \boxed{C_P > C_V}$$

For air, $C_P = 1.005$ kJ/kgK
, $C_V = 0.718$ kJ/kgK

★ Zeroth Law of Thermodynamics

C_p — Sp. heat at Constant Pressure

C_v — Sp. heat at Constant volume

$$\therefore \boxed{C_p > C_v}$$

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For air, $C_p = 1.005$ kJ/kgK
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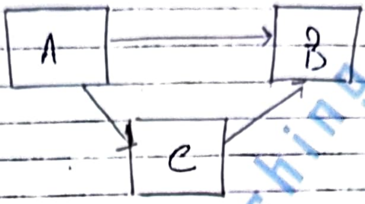
★ Zeroth Law of Thermodynamics



If, $T_A = T_C$
, $T_C = T_B$
Then, $\boxed{T_A = T_B}$

Statement: Zeroth law of thermodynamics states that if temp. of system A is equal to the temp. of system C & if temp. of system C is equal to the temp of system B then system A & B must be in thermal equilibrium.

Note: It is the basis for temp. measurement.

★ First law of Thermodynamics
→ It is based upon the law of conservation of energy.

$$\boxed{\begin{aligned} &\text{Heat} = \text{Work} + \text{Energy}(\uparrow) \\ &Q = W + \Delta E \end{aligned}}$$

Note: This law defines the property called internal energy.
$\Delta E / \Delta U$ – Change in internal energy

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★ Second Law of Thermodynamics

① Kelvin-Plank Statement : It is impossible to construct a heat engine whose sole purpose is to convert heat from higher degree temp. source into work, there must be some

Heat = Work + Energy (?)

Q = W + ΔE

Note: This law defines the property called internal Energy.
ΔE / ΔU - change in internal energy.

★ Second Law of Thermodynamics

① Kelvin-Planck Statement : It is impossible to construct a heat engine whose sole purpose is to convert heat from higher degree temp. source into work, there must be some heat rejection takes place.

② Clausius Statement : It is impossible to construct a refrigerator which transfer heat from lower temp. reservoir to higher temp. source without any work input.

Note: 2nd law of thermodynamics defines the property called Entropy.

⇒ Modes of Heat Transfer

① Conduction : It occurs b/w solids.

Rate of heat transfer, $\dot{Q} \propto A$

, $\dot{Q} \propto \frac{1}{t}$ — thickness

, $\dot{Q} \propto \Delta T$

$$\boxed{\dot{Q} = \frac{-kA\Delta T}{t}}$$

Fourier's law of heat Conduction

'k' → Thermal Conductivity of Material.

$k \rightarrow \frac{Watt \times m}{m^2 \times K}$

→ W/mK.

Also, $\dot{Q} = -kA\,dT$

, $Q \propto \Delta T$

$$\boxed{Q = -KA\frac{\Delta T}{t}}$$

Fourier's law of heat Conduction.

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'k' → Thermal Conductivity of Material.

$k \rightarrow \frac{Watt \times m}{m^2 \times K}$

$\rightarrow W/mK$.

Also, $$\boxed{Q = -KA\frac{dT}{dx}}$$

for small change in temp.
& small change in thickness.

(2) Convection: It occurs b/w fluids as well as some solids.

$Q \propto A$

$Q \propto \Delta T$

$$\boxed{Q = h.A.\Delta T}$$

→ Thermal Co-efficient of heat transfer.

$h \rightarrow W/m^2K$.

(3) Radiation: It passes through vaccuum also.

$Q \propto A$

$Q \propto T^4$

$$\boxed{Q = \sigma A(T_1^4 - T_2^4)}$$

Stefan's Boltzman Constant.

$\sigma = 5.67 \times 10^{-8}\ W/m^2K^4$.

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Total Heat, $Q = Q_A + Q_T + Q_R$

absorbed Transmitted Reflected

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→ Thermal Co-efficient of heat transfer.

$\rightarrow$ W/mt·k

(3) Radiation: It passes through vacuum also.

$Q \propto A$

$Q \propto T^4$

$$\boxed{Q = \sigma A (T_1^4 - T_2^4)}$$

σ → Stefan's Boltzmann Constant.

$\sigma = 5.67 \times 10^{-8}$ W/mt·k^4.

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⇒ Total Heat,

$$Q = \underset{\text{absorbed}}{Q_A} + \underset{\text{Transmitted}}{Q_T} + \underset{\text{Reflected}}{Q_R}$$

Divided by Q on both sides

$$1 = \underset{\substack{\text{Absorptivity} \\ (\alpha)}}{\frac{Q_A}{Q}} + \underset{\substack{\text{Transmissibility} \\ (\tau)}}{\frac{Q_T}{Q}} + \underset{\substack{\text{Reflectivity} \\ (\rho)}}{\frac{Q_R}{Q}}$$

$$\therefore \boxed{\alpha + \tau + \rho = 1}$$

→ For black body, $\boxed{\alpha = 1}$

→ For white body, $\boxed{\rho = 1}$

→ For transparent body, $\boxed{\tau = 1}$

→ For opaque body, $\boxed{\tau = 0}$ & $\boxed{\alpha + \rho = 1}$