Physics

:physics:

UNITS & DIMENSIONS :

plane angle – ~~radian~~ = $57^\circ 17' 48''$

solid angle – steradian = —

→ Supplementary physical Quantities

Micron (μ) = (Size of bacteria) = 10^{-6} m = 10^{-4} cm

Angstrom (Å) = (Radius of ~~sun~~ atom) = 10^{-10} m = 10^{-8} cm

Fermi = (Radius of Nucleus) = 10^{-15} m = 10^{-13} cm

Astronomical Unit (A.U.) = Mean distance of the earth from the sun
$\Rightarrow 1.5 \times 10^{11}$ m = 1.5×10^{8} km

X-ray Unit (X.U.) = 10^{-13} m (wavelength of x-rays)

Light year = distance travelled by light in vaccum in 1 year = 9.5×10^{15} m
$= 9.5 \times 10^{12}$ km

• parallactic second (Parsec) = 3.26 light years
$= 3.1\times 10^{16}$ m

Vectors:

$A = a_1 i + a_2 j + a_3 k$

$B = B_1 i + B_2 j + B_3 k$

i) To be parallel : $\frac{a_1}{B_1} = \frac{a_2}{B_2} = \frac{a_3}{B_3}$

ii) To be perpendicular : $a_1B_1 + a_2B_2 + a_3B_3 = 0$.

$\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$

$\sin^2\alpha + \sin^2\beta + \sin^2\gamma = 2$

Dot product (Scalar product) :

$i.i = j.j = k.k = 1$

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

~~Scalar~~ Cross product (vector product)

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

$i.j = k$

$j.k = i$

$k.i = j$

: Kinematics :

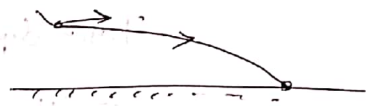
$\frac{H_{max}}{R} = \frac{\tan\theta}{4}$

$H = \frac{u^2\sin^2\theta}{2g}$

$R = \frac{u^2\sin 2\theta}{g}$

$T = \frac{2u\sin\theta}{g}$

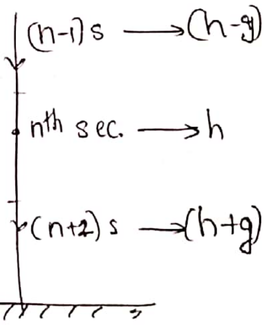
For horizontal projection ;



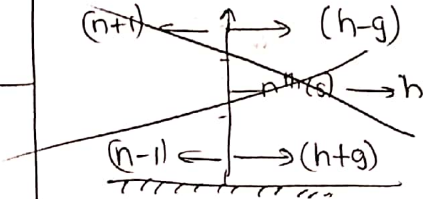
time taken by it to reach the ground
$= \sqrt{\frac{2h}{g}}$

horizontal distance travelled $= x = u \times \sqrt{\frac{2h}{g}}$

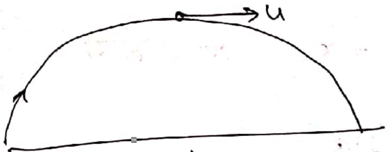
For a freely falling bodies ;



For upward body



→ A projectile is projected with a velocity at angle of 45°. The Ratio of P.E and K.E of a projectile at highest point



$PE = mgh$ | $K.E = \frac{1}{2}mv^2$

$= mg\frac{u^2\sin^2\theta}{2g}$ | $= \frac{1}{2}mu^2\cos^2\theta$

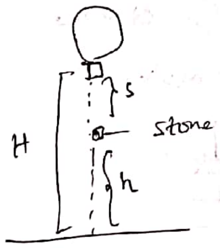
$= \frac{mu^2\sin^2\theta}{2}$ | $\frac{mu^2\cos^2\theta}{2}$

$= \sin^2\theta : \cos^2\theta$

$= \frac{1}{2} : \frac{1}{2}$

$= 1:1$

A balloon is moving upwards with a velocity of 10m/s. It releases a stone which comes down to the ground in 11s. The height of balloon from the ground at the moment of when the stone was dropped



$h = H - S$

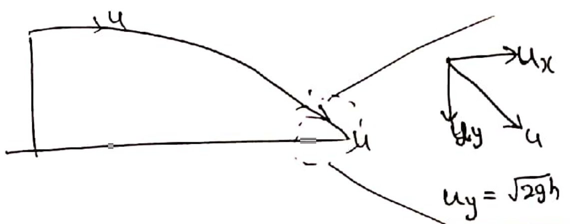
$= \frac{1}{2}gt^2 - ut$

$= \frac{1}{2}\times 10\times(11)^2 - 10\times 11$

$=$ ______

~~S~~ = ~~S~~ $\frac{1}{2}$

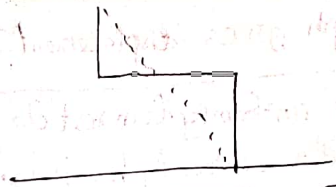
For horizontal projection:



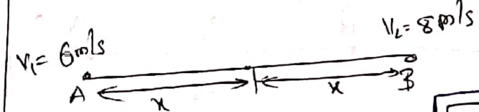
$u_y = \sqrt{2gh}$

$$\boxed{u = \sqrt{(u_x)^2 + 2gh}}$$

A particle has displacement of 4m eastward 3m northward and 12m vertically upward. The resultant displacement.



$\sqrt{3^2+4^2+12^2} = \sqrt{169} = 13m$



Velocity at mid point of AB $= \boxed{\sqrt{\frac{V_1^2+V_2^2}{2}}}$

$= \sqrt{\frac{36+64}{2}}$

$= \sqrt{\frac{100}{2}} = \sqrt{50} = 5\sqrt{2}m/s$

---

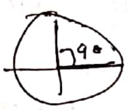
distance travelled before coming to rest

$\left[\frac{n^2}{2n-1} \times S\right] - S$

A particle move with uniform speed 'v' around a circular path of radius 'r'. As it covers $\frac{1}{4}$ of the circle, the Avg. acceleration for this motion has a magnitude of

$V_R = \sqrt{V^2+V^2+2V^2\cos 90°}$

$V_R = \sqrt{2}V$



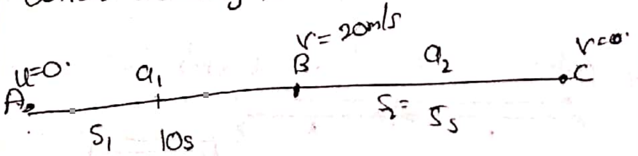
Time taken for 1 rotation $= \frac{2\pi R}{V}$

for $\frac{1}{4}$ rotation $= \frac{2\pi R}{4V} = \frac{\pi R}{2V}$

$a = \frac{v}{t} = \frac{\sqrt{2}V}{\frac{\pi R}{2V}} = \frac{2\sqrt{2}V^2}{\pi R}$

→ Area of v-t graph gives displacement

A car accelerates uniformly from rest to 20 m/s in 10s and is uniformly brought to rest in further 5s. Avg. speed for the whole Journey is



$v = \cancel{u} + a_1 t \Rightarrow 20 = a_1 \times 10 \Rightarrow a_1 = 2\,m/s^2$

$v_2 = u + a_2 t \Rightarrow 0 = 20 + a_2(5) = a_2 = -4\,m/s^2$

$v^2 - u^2 = 2a_1 s_1 \Rightarrow 20^2 = 2(2)\, s_1 \Rightarrow s_1 = \frac{400}{4} = 100m$

$v^2 - u^2 = 2a_2 s_2 \Rightarrow 0^2 - 400 = 2(-4)(s_2) \Rightarrow s_2 = \frac{-400}{-8} = 50$

Avg velocity $= \frac{100 + 50}{10 + 5} = \frac{150}{15} = 10\,m/s$

Train starting from rest, running with uniform acceleration covers the 1st 100m in 10s. Then the next 100m are covered in

$s = \cancel{ut} + \frac{1}{2}at^2$

$s = \frac{1}{2}at^2$

$100 = \frac{1}{2} \times a \times 100$

$\boxed{a = 2\,m/s^2}$

next 100m

$200 = \frac{1}{2} \times 2 \times (t)^2$

$t = \sqrt{200} = 10\sqrt{2}\,s$

time taken to cover next 100m $= 10\sqrt{2} - 10$

$= 10(1.414 - 1)$

$= 10(0.414)$

$= 4.14s$

A body starting from rest moving with uniform acceleration travels a distance x in the n^{th} second. The distance travelled in $(n-1)^{th}$ second

$S_n = (n - \frac{1}{2})a = x \Rightarrow a = \frac{x}{n - \frac{1}{2}}$

$S_{n-1} = \left((n-1) - \frac{1}{2}\right)a$

$= \frac{2n-2-1}{\cancel{2}} \times \frac{\cancel{2}x}{2n-1}$

$= \left(\frac{2n-3}{2n-1}\right)x$

A player completes a circular path of radius R in 40 seconds. His displacement at the end of 2 min, 20 sec

Time for 1 Revolution = 40s

2min.20sec = 120 + 20

$= (3 \times 40) + 20$

20s → half revolution

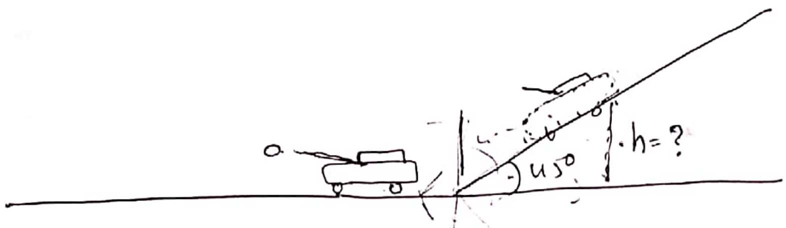
displacement = 2R

Time of ascent < time of decent

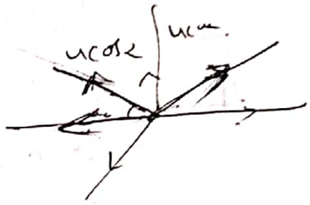
↳ ~~pure~~ For body projected vertically up

FRICTION

A cannon of mass 1000kg located at the base of an inclined plane fires a shell of mass 100 kg in a horizontal direction with a velocity 180 kmph. The angle of inclination is 45°. The coefficient of friction b/w cannon and inclined plane is 0.5. The height in meters to which the cannon ascents the inclined plane as a result of recoil. $g = 10 m/s^2$



$\mu = 0.5$



$100 \times 180 \times \frac{5}{18} \times \cos 45° = 1000 \times V_{canone} \times \cos 45°$

$\frac{10}{100 \times 180 \times \frac{5}{18}} \times \frac{1}{\sqrt{2}}$

$V_{canon} = 5/\cancel{\sqrt{2}} \approx 5 m/s$

$\frac{5000}{\sqrt{2}} =$

$u = \frac{5}{\sqrt{2}} \sim 1s$

$F = -mg(\sin\alpha + \mu_s \cos\alpha)$ (due to retardation)

$ma = -mg(\sin\alpha + \mu_s \cos\alpha)$.

$a = -g(\sin\alpha + \mu_s \cos\alpha)$.

$= -10\left(\frac{1}{\sqrt{2}} + 0.5\frac{1}{\sqrt{2}}\right)$

$\boxed{a = \frac{-10 \times 1.5}{\sqrt{2}} = \frac{-15}{\sqrt{2}}}$

$v^2 - u^2 = 2as$

$s = \frac{u^2}{2a} \Rightarrow s = \frac{(5)^2}{2\left(\frac{-15}{\sqrt{2}}\right)} = \frac{25 \times \sqrt{2}}{2 \times 15_3} = \frac{5}{\sqrt{2} \times 3}$

$h = s \sin\alpha = \frac{5}{\sqrt{2} \times 3} \cdot \sin 45° = \frac{5}{\sqrt{2} \times 3} \cdot \frac{1}{\sqrt{2}} = 5/6$ //

(Q2) A horizontal force, just at sufficient to move a body of 4kg mls lying on a rough horizontal surface is applied on it. The coefficients of static and kinetic friction between body and the surface are 0.8 and 0.6 respectively. if the force continues to act even after the block has started moving the acceleration of the block in metr/s². is.

$$F_{net} = f_{stat} - f_{kinet}$$

$$ma = \mu_s mg - \mu_k mg$$

$$\cancel{m}a = \cancel{m}g(\mu_s - \mu_k)$$

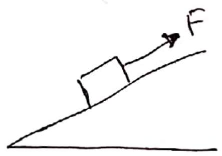
$$\boxed{a = g(\mu_s - \mu_k)}$$

$$= 10(0.2)$$

$$= 2\,m/s^2$$

(Q3) A body is moving up on inclined plane of angle with an K.E. "E". The coefficient of friction b/w plane and body is μ_s W.D. against friction before the body comes to rest.

$F \times S$



$$K.E = \text{Opposing forces } (F) \times S$$

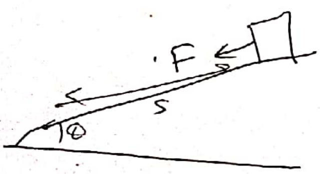
$$E = mg\sin\theta + \mu_s mg\cos\theta \times s$$

$$S = \frac{E}{mg\sin\theta + \mu_s mg\cos\theta}$$

$\Rightarrow$ W.D against frictal force $= \mu_s mg\cos\theta \times S$

$$\Rightarrow \frac{\mu_s \cancel{m}g\cos\theta \cdot E}{\cancel{m}g\sin\theta + \mu_s \cancel{m}g\cos\theta} = \frac{E\mu_s\cos\theta}{\sin\theta + \mu_s\cos\theta}$$

if P.E is considered when the bolock is moving down the plane



$$\boxed{F = mg\sin\theta + \mu_s mg\cos\theta}$$

$$\boxed{P = F \times S}$$

P = potential energy

F = downward force

S = displacements

Q) A box of mass 50kg is pulled up on an inclined plane of 12m long and 2m high by a constant force of 100N from rest. It acquires a velocity of 2m/s when it reaches the top of the plane. The ~~cos~~ W.D against friction in Joules is ($g = 10\,m/s^2$)

$$\boxed{W.D \text{ by force} + \cancel{W.D \text{ by friction}} = K.E + P.E +}\ W.D \text{ by friction}$$

conservative workdone

Non conservative workdone

$$\cancel{100\times12} + \cancel{W.D_{friction}} = \frac{1}{2}$$

$\cancel{100\times12} =$

$$W.D_{fn} = 100\times12 - \left[\frac{1}{2}\times50\times(2)\times(2) + 50\times10\times2\right]$$

$= 1200 - 1100$

$= 100\,J$

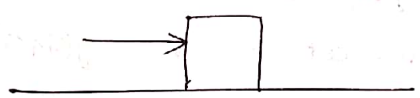
Note:

External W.D = Conser. W.D + Non Conver. W.D

A body of weight 64N is pushed with just enough force to start it moving across a horizontal and the same force continuous to act afterwards. If the coefficients of static & dynamic frictions are 0.6 and 0.4 respectively, the acceleration of the body will be (acceleration due to gravity $= g$).

$F_1 = \mu_s mg$

$F_2 = \mu_k mg$

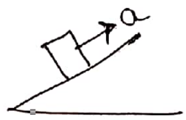


$\mu_s mg - \mu_k mg = F_{net}$

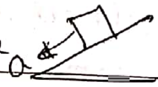
$\cancel{m}g(\mu_s - \mu_k) = \cancel{m}a$

$\boxed{a = g(\mu_s - \mu_k)}$ → rough horizontal surface

① $\boxed{a = g\cos\theta\,(\mu_s - \mu_k)}$ — inclined plane



② $a = g\cos\theta\,(\mu_k - \mu_s)$ → inclined plane



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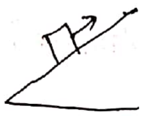
①



$F_1 = mg(\sin\theta + \mu_s\cos\theta)$

$F_2 = mg(\sin\theta + \mu_k\cos\theta)$

$\boxed{F_1 - F_2 = F_{net}}$

$\cancel{m}g\cos\theta\,(\mu_s - \mu_k) = \cancel{m}a$

$\boxed{a = g\cos\theta\,(\mu_s - \mu_k)}$

②

$F_1 = mg(\sin\theta - \mu_s\cos\theta)$

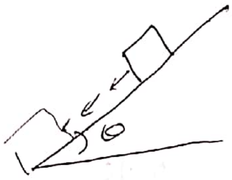
$F_2 = mg(\sin\theta - \mu_k\cos\theta)$

$\boxed{F_1 - F_2 = F_{net}}$

$\cancel{m}g\cos\theta\,(\mu_k - \mu_s) = \cancel{m}a$

$\boxed{a = g\cos\theta\,(\mu_k - \mu_s)}$

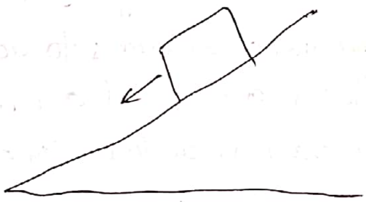
→ when angle of inclination of an inclined plane is θ, an object slides down with uniform velocity. if the same object ~~slides down with uniform velocity.~~ is pushed up with a initial velocity "u" on the same inclined plane; it goes up the plane and stops at a certain distance on the plane. Thereafter the body?



Ans: slides down the inclined plane and reaches the ground with velocity greater than 'u'.

A block of wood resting on an inclined plane of 30°, just starts moving down. if the ~~vel~~ coefficient of friction is 0.2 its velocity after 5-second is

g (10 m/s²)



$a = g(\sin\theta - \mu_k \cos\theta)$

$v = \cancel{u} + at \Rightarrow v = at \Rightarrow v = g(\sin\theta - \mu_k\cos\theta) \times 5$

$= 10\left(\frac{1}{2} - 0.2\frac{\sqrt{3}}{2}\right) \times 5$

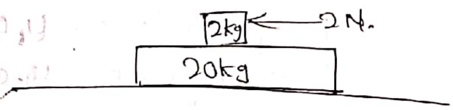
$= 5\left(1 - \frac{2}{10} \times \cancel{1.59}\,2\right) \times 5$

$= 5(1 - 0.4) \times 5$

$= 5 \times \frac{6^3}{10_2} \times 5^1$

$= 15$ //.

A block of mass 2kg is placed on the ~~surrounding~~ surface of a trolley of mass 20kg which is on a smooth surface. The coefficient of friction b/w the block and surface of the trolley 0.25. If a horizontal force of 2N acts on block the acceleration of system in $(g = 10 m/s^2)$



$f = \mu_k mg$

$= 0.25 \times 2 \times 10$

$\cancel{0.25}$

$\frac{25}{100} \times 2 \times 10$

$= 5N$

friction 5N

applied force = 2N

$\boxed{F < f}$

∴ Trolley moves due to no friction on the ground

∴ $F_{net} =$

$F = (m_1 + m_2)a$

$\frac{2}{22} = a \Rightarrow 0.09 m/s^2$

Q) Starting from rest, time taken by a body sliding down on a rough inclined plane 45° with the horizontal is twice the time taken to travel on a smooth plane of same inclination and same distance. Then coefficient of μ_k = ____________

$$S = \frac{1}{2}gt^2$$

$$\boxed{t = \sqrt{\frac{2s}{g}}}$$

$$\sqrt{\frac{2s}{g(\sin\theta - \mu_k\cos\theta)}} = 2\sqrt{\frac{2s}{g\sin\theta}}$$

$$\frac{\cancel{2s}}{g(\sin\theta - \mu_k\cos\theta)} = 4\frac{\cancel{2s}}{g\sin\theta}$$

$$g\sin\theta - g\mu_k\cos\theta = \frac{g\sin\theta}{4}$$

$$\cancel{g}\sin\theta\left(1-\frac{1}{4}\right) = \mu_k \cdot \cancel{g} \cdot \cos\theta$$

$$\frac{\sin\theta}{\cos\theta}\left[\frac{3}{4}\right] = \mu_k$$

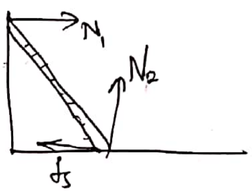
$$\tan\theta\left[\frac{3}{4}\right] = \mu_k$$

$$\frac{3}{4} = \mu_k$$

$$\boxed{0.75}$$

Note: $\mu_k = \tan\theta\left[1-\frac{1}{n^2}\right]$

Q) If ladder weighing 250N is placed against a smooth vertical wall having coefficient of friction b/w it and floor is 0.3, then what is max. force of friction available at point of contact b/w ladder and floor

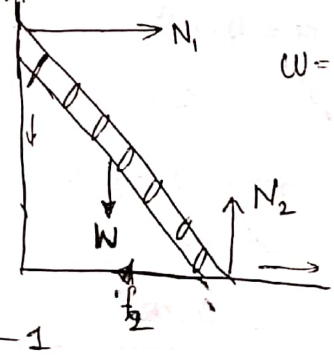


$f_s = \mu_s N_2$

$= 0.3 \times 250$

$= 75N$

Note:

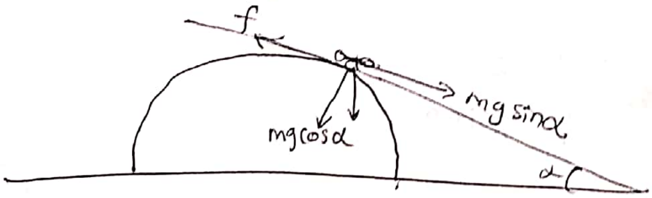


W = Weight of ladder

$\boxed{W = f_1 + N_2}$ — 1

$\boxed{N_1 = f_2}$

→ An insect crawls up a hemispherical surround surface very slow. The coefficient of friction b/w insect and the surface is 1/3. if the line joining the centre of hemispherical surface to the insect makes an angle α with vertical the max. possible value of α is given by



$f \geq mg\sin\alpha$

$\mu N \geq mg\sin\alpha$

$\mu \cdot \cancel{m}g\cos\alpha = \cancel{m}g\sin\alpha$

$\mu = \tan\alpha$

$\frac{1}{3} = \tan\alpha$

$\cot\alpha = 3$

On a rough horizontal surface, a body of mass 2kg is given a velocity of 10m/s. if the $\mu = 0.2$ and $g = 10\,m/s^2$, body will stop after covering a distance of

$f = \mu.N \Rightarrow 0.2 \times 2 \times 10$

$= 4N$

$F = f = ma$

$4 = 2 \times a$

$a = 2\,m/s^2$

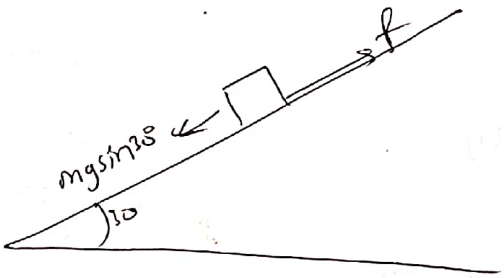
$v^2 - u^2 = 2as$

$-100 = 2(2)\,s$

$\frac{100}{4} = s$

$S = 25m$

A block of mass 10kg is placed on an Inclined plane. When the angle of inclination is 30°, the block just begins to slide down the plane. The force of static friction is



$f = mg\sin 30°$

$= 10 \times 9.8 \times \frac{1}{2}$

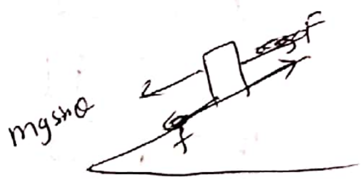
$= 5 \times 9.8$

1 kgwt = 9.8 N

$= 5$ kg.wt.

A body of 6kg rests in limiting equilibrium on an inclined plane whose slope is 30°. If the plane raised to a slope of 60°, the force in kg-wt along the plane required to support it is ($g = 10\ m/s^2$)

$\mu = \tan\theta = \tan 30 = \frac{1}{\sqrt{3}}$



$F = mg(\sin\theta - \mu\cos\theta)$

$= 6 \times 10\left(\frac{\sqrt{3}}{2} - \frac{1}{\sqrt{3}}\cdot\frac{1}{2}\right)$

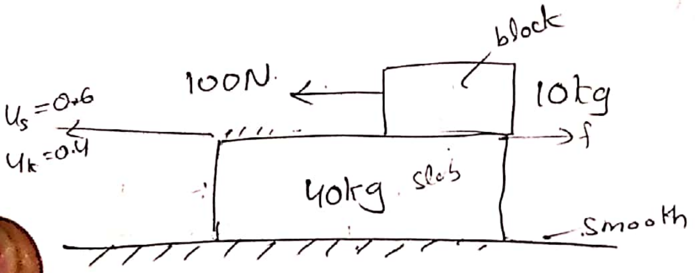
$= \frac{\cancel{6}^{3} \times 10}{\cancel{2}}\left(\sqrt{3} - \frac{1}{\sqrt{3}}\right)$

$= \cancel{30\left(\frac{2}{\sqrt{3}}\right)}\ \sqrt{3} \times 10 \left[\frac{2}{\sqrt{3}}\right.$

$= \sqrt{3} \times 2 \times 10$

$= 20\sqrt{3}$

A 40 kg slab rests on a friction less floor as shown. A 10 kg block rests on the top of the slap. The coefficient of static friction b/w block and slab is 0.6 and $\mu_k = 0.4$. If 10 kg block is acted upon by a horizontal force of 100 N, the resulting acceleration of slab will be



$f = \mu_s mg$

$= 0.6 \times 10 \times 10$

$f = 60N$

$F - f = ma$

$100 - 60^{40} = 50 \times a$

$\frac{40}{50} = a$

$0.8 m/s^2 = a$

$(\mu_k m g)$

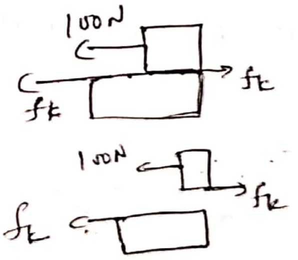
μ_k

$f_k = 0.4 \times 10 \times 10$

$= 40N$

F_{net}

$\frac{80}{50}$



$\mu_k 10 \times g = 40 \times a$

$0.4 \times 10 \times 10 = 40 a$

$\frac{40}{40} = a$

1

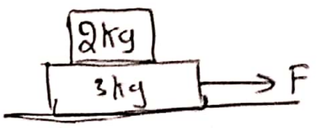
* Equation of displacement can have powers of time as $x = at^0 + bt^1 + ct^2$

→ if t^0 alone is present, it's $\boxed{\text{displacement}}$ is uniform

→ if t' alone is present (including t^0), it's $\boxed{\text{velocity}}$ is uniform

→ if t^2 alone is present (including t^0, t^1), it's acceleration is uniform.

A block of mass 2kg rests on another block of mass 3kg and the second block is on smooth table. Coefficient of friction b/w two block is 0.2. Then largest force that can be applied on lower block so that the system moves without sliding off the upper block.



for max F = mass × (max accel^n) → μg

$F = (2+3)\ 0.2 \times 9.8$

$= 5 \times \frac{2}{10} \times \frac{98}{10}$

$= 9.8N$

work and power

If momentum is increased by 100%, the % increase in K.E is

$K.E = \frac{p^2}{2m} \Rightarrow E \alpha p^2$

$\frac{E_1}{E_2} = \left(\frac{P_1}{P_2}\right)^2 = \left(\frac{100}{200}\right)^2 = \frac{1}{4} \Rightarrow \boxed{E_2 = 4E_1}$

% increase $= 4E_1 - E_1$

$= 3 \times 100$

$= \cancel{400}$ % 300%.

A bullet fired at a target with a velocity of 100 m/s, penetrates one meter into it, If the bullet is fired with the same velocity at a similar target with a thickness 0.5m, then it emerge from it with a velocity of

$\frac{1}{2}mv^2 = f \times 1$ — ①

$\frac{1}{2} \times m \times 100 \times 100 = f$

$\boxed{f = 5000m}$

$\frac{1}{2}m[v_1^2 - v_2^2] = 5000 \times m \times \frac{5}{10}$

$\frac{v_1^2 - v_2^2}{2} = 2500$

$v_1^2 - v_2^2 = 5000$

$v_2^2 = 10000 - 5000$

$v_2 = \sqrt{5000}$

$v_2 = \sqrt{2500 \times 2}$

$v_2 = 50\sqrt{2}$ m/s

Along spring when stretched by x-cm has a potential energy "V". On increasing the stretching to 'nx', the P.E stored in the spring will be

$V = \frac{1}{2}kx_1^2 \quad | \quad V_1 = \frac{1}{2}kn^2x_1^2$

$\boxed{V_1 = n^2V}$

For the same value of K.E, the momentum shall be max for α-particle

$\therefore KE = \frac{p^2}{2m} \Rightarrow \boxed{p^2 \alpha m} \quad \boxed{p \alpha \sqrt{m}}$

α particle has max mass.

$\frac{p^2}{2m} = \frac{1}{2}mv^2$

$\frac{1}{2}m^2v^2$

A pendulum bob has a speed of 3m/s at its lowest position is 0.5m long. The speed of the bob, when the length makes an angle of 60° to vertical, will be (g = 10m/s²).

~~$\frac{1}{2}mv^2 + mgl(1-\cos\theta) = \frac{1}{2}mv^2$~~

~~$v^2 + 2gl(1-\cos\theta) = v^2$~~

~~$9 + (2 \times 10 \times \frac{5}{10}[1 - \frac{1}{2}] = v^2$~~

~~$9 + [10 \times \frac{1}{2}] = v^2$~~ $\sqrt{14}$

14

$\frac{1}{2}mv^2 + mgl(1-\cos\theta) = \frac{1}{2}mv^2$

$v^2 + 2gl(1-\cos\theta) = 9$

$v^2 + 2 \times 10 \times \frac{5}{10}(\frac{1}{2}) = 9$

$v^2 = 9 - 5$

$v = \sqrt{4}$

$v = 2$ m/s

A bomb of mass M at rest explodes into 2 fragments of masses m_1 and m_2. The total energy released in the explosions is E. If E_1 and E_2 represent the energies carried by masses m_1 and m_2 respectively, then which of the following is correct.

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

$m_1v_1 = m_2v_2$

$= \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2\left[\frac{m_1v_1}{m_2}\right]^2$ $\quad v_2 = \frac{m_1v_1}{m}$

$= E = \frac{1}{2}m_1v_1^2 + \frac{1}{2}\frac{m_1^2v_1^2}{m_2}$

$E = \frac{1}{2}m_1v_1^2\left[1 + \frac{m_1}{m_2}\right]$

$E = \frac{1}{2}m_1v_1^2\left[\frac{m_2+m_1}{m_2}\right]$

$E = E_1\left[\frac{m_2+m_1}{m_2}\right]$

$E = E_1\left[\frac{M}{m_2}\right]$

~~$E_1 = \frac{Em_2}{M}$~~ $= \boxed{\frac{E \times m_2}{M}}$

A pump motor is used to deliver water at a certain rate from a given pipe. To obtain thrice as much water from the same pipe in the same time, power of motor has to be increased

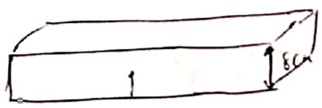
$$P = \frac{\frac{1}{2}mv^2}{t} = \frac{1}{2}3m(3v^2)$$

$$= \frac{1}{2}3m\,9v^2$$

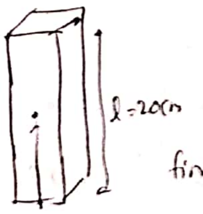
$$= \frac{1}{2}\times 27\,mv^2$$

$$= 27P$$

A 5kg brick of dimensions 20cm x 10cm x 8cm is lying on the largest base. It is now made to stand with length vertical. If $g = 10\,m/s^2$ then the amount of work done is ______



initial C.G = 4cm



final C.G = 10cm

10-4 = 6cm

$h = 0.06m$

$$5\times 10\times \frac{6}{100} = 3J$$

The displacement x of a body of mass 1kg on horizontal smooth surface as a function of time it is given by $x = t^3/3$. The W.D by external agent for the first 1 second = ——?

$$v = \frac{dx}{dt} = \frac{d}{dt}\left(\frac{t^3}{3}\right) = \frac{3t^2}{3} = t^2$$

$$KE = \frac{1}{2}mt^4 \Rightarrow \frac{t^4}{2} = \frac{1}{2} = 0.5\,J$$

Tripling the velocity of scooter multiplies the distance, required for stopping it by

$$\frac{1}{2}mv^2 = F\times S$$

$$\boxed{v^2 \propto S}$$

$$\left(\frac{V_1}{V_2}\right)^2 = \frac{S_1}{S_2} \Rightarrow \frac{V_1^2}{9V_1^2} = \frac{S_1}{S_2}$$

$$\boxed{V_2 = 3V_1} \quad \boxed{S_2 = 9S_1}$$

A 500 kg car moving with a velocity of 36 kmph on a straight road unidirectionally doubles it's velocity in one min. power delivered by engine for doubling velocity

$u_1 = 10\,m/s$

$u_2 = 20\,m/s$

$$\frac{\frac{1}{2}m(u_2^2 - u_1^2)}{60} \Rightarrow \frac{\frac{1}{2}\times 500(20^2 - 10^2)}{60}$$

$$= \frac{\cancel{500}^{250}\times \cancel{300}^{5}}{\cancel{2}\times\cancel{60}}$$

$$= 1250W$$

A 5kg stone of relative density 3 is resting at the bed of lake. it is lifted through a height of 5m in lake if $g = 10\,m/s^2$. W.D.

$$W.D = F\times S$$

relative density = $\frac{\text{weight in air}}{\text{loss of weight in water}}$

loss of weight in water = $\frac{\text{weight in air}}{R.D}$

$$= \frac{5\times 10}{3}$$

$$= \frac{50}{3}$$

weight in water = $50 - \frac{50}{3} = \frac{100}{3}$

$$W.D = \frac{100}{3}\times 5 = 500/3\ N.m$$

A machine which is 75% efficient uses $\boxed{12J}$ energy in lifting up a 1kg mass through a certain distance. The mass is then allowed to fall through that distance. velocity of the ball at the end of fall

$$\frac{\cancel{75}^{3}}{\cancel{100}_{4}}\times \cancel{12}^{3} = 9J$$

$$\frac{1}{2}mv^2 = 9J$$

$$\frac{v^2}{2} = 9J$$

$$\boxed{v = \sqrt{18}\ \text{Joules}}$$

A tennis ball dropped from a height 2m rebounds only 1.5m after hitting the ground. What fraction of its energy is lost in the impact.

$E_1 = mgh_1$ $\quad h_1 = 2m$

$E_2 = mgh_2$ $\quad h_2 = 1.5m$

$$\frac{E_1 - E_2}{E_1} = \frac{2-1.5}{2} = \frac{0.5}{2} = \frac{5}{20} = \frac{1}{4}$$

A 4kg mass is moving on a frictionless horizontal table with a velocity of 20m/s. It strikes on ideal spring and compresses it. If the spring constant of the spring is 100 N/m, compression of spring is

Sol:

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

$kx^2 = mv^2$

$x = v\sqrt{\frac{m}{k}} = 20\sqrt{\frac{4}{100}} = \cancel{20}^{2} \times \frac{2}{\cancel{10}}$

$x = 4m$

Two springs have force constants k_1 and k_2. Both are stretched till their elastic energies are equal. If the stretching forces are F_1 and F_2, then $F_1 : F_2$ = ______

$\boxed{\text{Elastic energy} = \cancel{\frac{F^2}{2m}} \; \frac{F^2}{2k}}$

$\frac{1}{2}kx^2$, $\frac{1}{2}k\frac{1}{k}$

$F^2 \propto k$

$F \propto k^{1/2}$

$\frac{F_1}{F_2} = \sqrt{\frac{k_1}{k_2}} = \sqrt{k_1} : \sqrt{k_2}$

Two bodies of masses 1kg and 4kg are moving with equal K.E. The ratio of linear moments = ____

$\boxed{\frac{m_1}{m_2} = \frac{1}{4}}$

$$\frac{\frac{1}{2}m_1v_1^2}{\frac{1}{2}m_2v_2^2} = 1 \Rightarrow \frac{m_1}{m_2} = \left(\frac{v_2}{v_1}\right)^2$$

$\frac{v_2}{v_1} = \frac{1}{2}$

$\frac{m_1v_1}{m_2v_2} = \frac{1}{4} \times 2 \neq \frac{1}{2} \Rightarrow 1:2$

A 50 g bullet moving with a speed of 10m/s strikes a stationary body of mass 950g and enters it. The percentage loss of kinetic energy

$\frac{50}{1000} \times 10 = \frac{1000}{1000} \times v$

$\frac{1}{2} = v$

$\therefore v = \frac{1}{2}$ m/s

$\frac{v_1^2 - v_2^2}{v_1^2} \times 100 \Rightarrow \frac{100 - \frac{1}{4}}{100} \times 100$

$\Rightarrow \frac{399}{4}$

4)399(99.7

$\frac{997}{10} \times 100$

$= 9970\%$

$F \propto \frac{1}{V}$ $\quad FV = C$

If a force acting on a body is inversely proportional to its velocity, then the K.E acquired by the body in time 't' is proportional to ______

$W = FS\cos\theta$

$\therefore F \propto \frac{1}{v}$

$\boxed{\cancel{F \propto} \frac{1}{V}}$

$E_k \propto \frac{S}{V}$

$E_k \propto S \times \frac{t}{S}$

$\boxed{E_k \propto t}$

W.D. by simple pendulum = $mgl(1-\cos\theta)$

W.D. for spring = $\frac{1}{2}kx^2$ or $\frac{1}{2}k(x_1^2 - x_2^2)$

$PE = \left(\frac{mgRh}{R+h}\right)$ $\quad \boxed{R <<< h}$

$= mgh$

Rest mass energy (Energy possessed by body at rest)

$\boxed{E = mc^2}$

gravity at a depth 'd' = $\left(1 - \frac{d}{R}\right)g$

gravity at height (h) = $\cancel{\frac{1+2h}{R}}$ $\left(\cancel{1+\frac{2h}{R}}\right)g$

$\left(1 - \frac{2h}{R}\right)g$

$F_G = \frac{Gm_1m_2}{r^2}$

r — centroidal distance

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Simple Harmonic Motion

S.H.M:

$\boxed{\alpha \propto \text{displacement}}$

→ without velocity, acceleration is possible

→ without acceleration, velocity is possible

S.H.M. equation:

$$\boxed{\frac{d^2y}{dt^2} + \omega^2 y = 0}$$

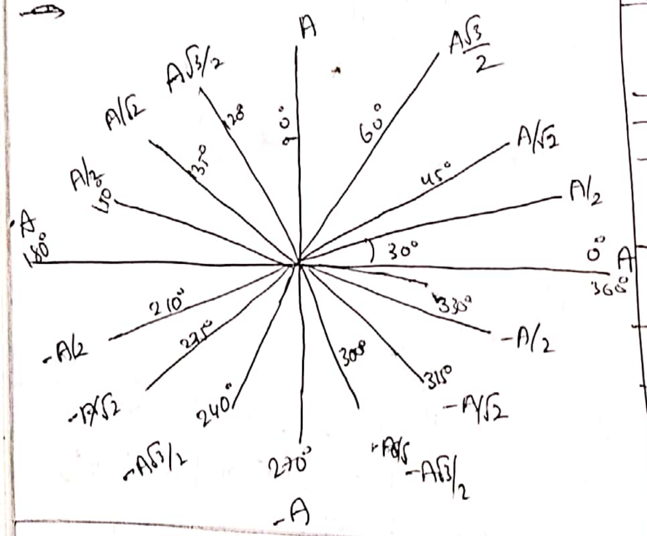
$\boxed{\text{initial phase} \Rightarrow \text{epoch } (\phi)}$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{a}{y}}} = 2\pi\sqrt{\frac{y}{a}}$ $\quad a = \omega^2 y$ $\quad \omega = \sqrt{\frac{a}{y}}$

$y = A\sin(\omega t \pm \phi)$ $x = A\cos(\omega t \pm \phi)$	$v = \omega\sqrt{A^2-y^2}$ $a = \omega^2 y$
at mean $y=0$	at extreme, $y=A$

→ A hole is drilled across the earth / inside the earth; A man is allowed to fall in that hole, the motion of man is S.H.M with Time period of 84 min

⇒



$F = ma \Rightarrow F = m\omega^2 y$

$F \propto y \quad = \boxed{\frac{F_1}{F_2} = \frac{y_1}{y_2}}$

V-y graph = ellipse

a-y graph = straight line (-ve slope)

$\tan\theta = \frac{a}{y} = \frac{\omega^2 y}{y} = \omega^2$

$\boxed{\omega = \sqrt{\tan\theta}}$

$T = \frac{2\pi}{\sqrt{\tan\theta}}$

$\boxed{K.E = \frac{1}{2}m\omega^2(A^2-y^2) \\ P.E = \frac{1}{2}m\omega^2 y^2}$ $\quad TE = PE + KE = \frac{1}{2}m\omega^2 A^2$

K.E is maximum 2 times in 1 vibration/oscillation

P.E is max 2 times in 1 vibration/oscillation

$\boxed{K = m\omega^2}$

→ when frequency of vibration is n, then n of K.E or P.E = $2n$.

- Simple pendulum doesn't oscillate in space
- pendulum oscillates in vaccum continuously

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

$T \propto \frac{1}{\text{density}}$ | $d_{wood} < d_{iron}$

$T = 2\pi\sqrt{\frac{1}{g\left(\frac{1}{R}+\frac{1}{L}\right)}}$ $\quad R = 6400\,km$ (radius of earth)

→ $L = \infty$

$T = 2\pi\sqrt{R/g} = 2\pi \times \sqrt{\frac{6400\times1000}{9.8}} = 84\,min$

→ $L = R$

$T = 2\pi\sqrt{\frac{R}{2g}} = 2\pi\sqrt{\frac{6400\times1000}{2\times9.8}} = 59\,min$

→ g is more at poles

→ g is less at equator

$\boxed{g = \frac{GM}{R^2}}$ $\quad g \propto \frac{1}{R^2}$

g of moon = $\frac{1}{6}$th g of earth

escape velocity of earth = 11.2 km/s

Time period for loaded spring:

$T = 2\pi\sqrt{\frac{m}{k}}$ $\quad \boxed{F = kx} = \boxed{mgx}$

K (Force constant) $= \frac{F}{x} = \frac{mg}{x}$

$\boxed{K = m\omega^2}$ $\quad T = 2\pi\sqrt{\frac{x}{g}}$ $\quad x \to$ compression length

Springs connected in parallel $k = k_1 + k_2$ | in series $K = \frac{k_1 k_2}{k_1 + k_2}$

Force and displacement act in opposite direction.

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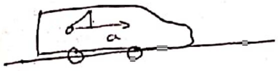
T.P of pendulum decreases when it is placed in vehicle moving with acceleration (a)



$g' = \sqrt{a^2+g^2}$

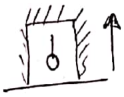
$g' \uparrow$

$\boxed{T \propto \frac{1}{\sqrt{g}}}$

→ when a pendulum is sliding down a ~~horizontal~~ smooth inclined surface

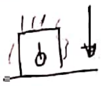
$\boxed{g' = g\cos\theta}$

$T = 2\pi\sqrt{\frac{L}{g\cos\theta}}$ $\theta\uparrow \Rightarrow \cos\theta\downarrow \rightarrow g\downarrow \rightarrow T\uparrow$



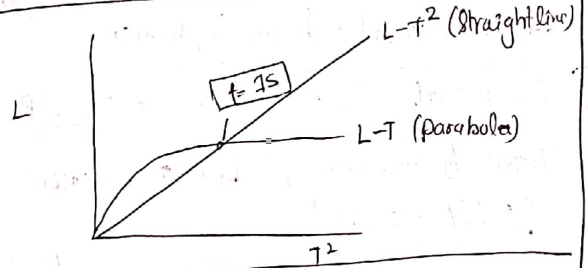
~~lift~~ pendulum in lift moving upwards with acceleration a

$g' = \boxed{g+a}$



$g' = \boxed{g-a}$

In a freely falling lift, at centre of earth and in artificial satellite $\boxed{T=\infty;\ g'=0}$



$\frac{g_1}{g_2} = \frac{n_1^2}{n_2^2}$ n_1 — oscillations at I place

n_2 = oscillations at another place

$\frac{n_1}{n_2} = \sqrt{\frac{l_2}{l_1}}$

A spring constant 'k' is cut into 'n' equal parts. If all those are connected in parallel:

The effective spring constant $= \boxed{n^2k}$

P.E. of spring $= \frac{1}{2}kx^2$

$U = \frac{1}{2}Fx$ (x is extension, F is force)

$k \propto \frac{1}{l}$ — length of spring

$k \propto \frac{1}{n}$ — no. of turns

$k \propto Y$ — Young's modulus.

The T.E. of a particle executing S.H.M is proportional to η of oscillation (frequency).

$\eta = \frac{1}{2\pi}\sqrt{\frac{g}{l}}$ $T = \frac{1}{2}m\omega^2A^2$

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

$\frac{1}{A}$ ~~A~~ $\cdot \omega$

Elastic P.E. of a spring is max. at extreme ends

Equilibrium position in S.H.M is 'Mean position'

$a : \omega$

$= c$

Acoustics:

Sound: A form of energy which causes the sensation of hearing on reaching the ear.

- → vibrating body can produce sound
- → sound waves are mechanical waves
- → sound travels in form of longitudinal waves.
- → sound can travel in any media (solid, liq, gas)
- → sound can't travel through vaccum
- → Velocity of sound > " " > " " (5000m/s) (solids) (1500m/s) (liquids) (gases 340m/s)
- → sound waves exhibit reflection, refraction, interference and diffraction
- → sound waves can't exhibit polarisation and dispersion

Sounds

- Audible / sonic (20Hz - 20000Hz)
- ultrasonics (>20,000Hz)
- Infrasonics <20Hz

- Bats, dogs, and fish can hear ultrasonic sounds
- → ultrasonic sounds have greater penetrating power. they are used in detecting mines in the seas, scanning babies in womb.

- Infrasonic waves produced during earthquakes & erruption of volcanos.
- They cause damage internal organs of human body

- Velocity of sound = 330m/s

$\boxed{V = n\lambda}$ n - frequency, λ = wavelength

When sound travels 1 media to another media, frequency and Time ~~remain~~ period remains constant

Intensity of Sound: avg. energy flowing per unit time through unit area perpendicular to the direction of propogation of wave

$$I = \frac{E}{A \times t}$$

S.I unit = watt/m2

Acoustics:

$$\boxed{I = 2\pi^2 n^2 a^2 v.d}$$

- n - frequency
- a - amplitude
- V - velocity
- d - density of media

→ Two sound waves can be heard, the ~~ga~~ if the gap b/w them is 0.1s. This is called $\boxed{\text{persistance of hearing}}$

1 - 10..
10 - 1

$\boxed{1s \Rightarrow 10 \text{ sound waves}}$

$$I \text{ (Intensity level)} = 10 \log_{10}\left(\frac{I}{I_0}\right)$$

I_0 - threshold ~~frequ~~ Intensity.
→ also knowns as relative Intensity.

Threshold of hearing / threshold of audibility / zero level of hearing: → lowest intensity of sound can be heard by human

For 1000Hz, $I_0 = 10^{-12}\, w/m^2$ = zero dB

Intensity measured by: bel and decibel

$\boxed{1 \text{ bel} = 10 \text{ dB}}$

$$L(\text{bel}) = \log_{10}\left(\frac{I}{I_0}\right) \; ; \; dB = 10\log_{10}\left(\frac{I}{I_0}\right)$$

$1dB = 1.26\, I_0$ → If intensity level changes by 1dB, then intensity of sound changes by 26%

lowest change that can be detected by human = 1dB

Threshold of pain: max. intensity of level of Intensity = 120 dB or $1\, w/m^2$

Characteristics of Sound

1) pitch:

pitch ↑, frequency ↑

pitch → sensation of hearing
frequency → measurable

pitch of buzzing bee > roaring lion

pitch of women & children > men

2) Intensity: (loudness)

Intensity ↑, loudness ↑

loudness — sensation of hearing

Intensity — measurable

Roar of lion > buzz of bee
(loudness) (loudness)

Musical scale: (diatomic scale)

- 8 frequencies covering an octave $\left(\frac{n_1}{n_2}=2\right)$.
- lowest n = 256 Hz   unison = $\left(\frac{n_1}{n_2}=1\right)$
  highest n = 512 Hz

Noise pollution ⇒ ~~>20000 Hz~~ 120 dB

Beat frequency (no: of beats per second)
$= n_1 - n_2$

- Time interval b/w 2-successive maxima / 2-successive minima $= \frac{1}{n_1-n_2}$ (Time period)
- Time interval b/w 1 max and next min $= \frac{1}{2(n_1-n_2)}$
- phenomenon of beats due to interference of sound waves

(echo) $t = \frac{d+d}{v}$; min. distance to hear an echo = 16.5 m

- min. time interval to hear an echo = 0.1s

⇒ In echo; amplitude & Intensity are different

App of echoes:

- depth of sea, height of aeroplane, be found
- stethoscope and megaphone works on this.
- SONAR uses this to detect submarine

W.C. Sabine founder of Acoustics of building.

Absorption coefficient:

= 1; for open windows and doors, they are perfect absorbers

$T = \frac{0.17V}{\Sigma as} = \frac{0.17V}{A}$ ($A = aS$)

T = 0.5 to 1s for music
= 1 to 2s for speeches

T = 0 → dead room

T = {10^6 times the threshold of audibility}

T → depends on n of sound, size of room, nature of reflecting material, area of reflecting surfaces

T → independent of shape of room, position of sound, and listener

Focussing effect due → cylindrical/spherical surfaces
↳ prevented by making parabolic surfaces

Echelon effect: [sharp sound produced in front of stairs due to successive reflections]

→ can eliminated by covering the staircases with carpets

Velocity of sound at room temperature = 340 m/s
At 0°C ⇒ 332 m/s
min. velocity ⇒ 330 m/s

1 mach = 340 m/s

Sound passes from rarer to denser → velocity decreases.

$\frac{V_1}{V_2} = \sqrt{\frac{T_1}{T_2}}$ → effect of temperature

→ No effect of pressure on velocity of sound

tuning fork is waxed → frequency ↓
tuning fork is filed → frequency ↑

walls of the halls built for musical concerts should absorb sound

fork	Beats are ↓	Beats are ↑
waxed	$n_2 - n_1$	$n_1 - n_2$
filled	$n_1 - n_2$	$n_2 - n_1$

doppler effect:

$S \xrightarrow{V_s}$ $\quad O \rightarrow V_o$

$$\boxed{n' = \left(\frac{V - V_o}{V - V_s}\right) n}$$

O – observer
S – source
n = real frequ.
n' = Apparent freq.

$S \rightarrow \leftarrow O$
$$n' = \left(\frac{V + V_o}{V - V_s}\right) n$$

$S \quad \leftarrow O$
$$n' = \left(\frac{V + V_o}{V_s}\right) n$$

$S \rightarrow \quad O \rightarrow$
$$n' = \left(\frac{V - V_o}{V - V_s}\right) n$$

$S \rightarrow \quad O$
$$n' = \left(\frac{V}{V - V_s}\right) n$$

$\leftarrow S \leftarrow O$
$$n' = \left(\frac{V + V_o}{V + V_s}\right) n$$

$S \quad O \rightarrow$
$$n' = \left(\frac{V - V_o}{V_s}\right) n$$

$\leftarrow S \quad O \rightarrow$
$$n' = \left(\frac{V - V_o}{V + V_s}\right) n$$

$\leftarrow S \quad O$
$$n' = \left(\frac{V}{V + V_s}\right)$$

$$L = 10 \log \frac{I}{I_0}$$

$$\frac{L}{10} = \log I/I_0 = e^{\frac{L}{10}} = 10^{L/10}$$

$$\boxed{I = I_0 \cdot 10^{L/10}}$$

$$L_2 - L_1 = 10 \log \frac{I_2}{I_1}$$

loudness $\propto \log I$
⇓ units = phon, sone
1 phon = 1000 Hz
= 40 dB

distance b/w antinode and node = $\lambda/4$.

Velocity of sound in solids:

$$V = \sqrt{\frac{Y}{d}} \quad Y = \text{youngs modulus}, \; d = \text{density}$$

velocity in liquids:

$$V = \sqrt{K/d} \; ; \; K = \text{bulk modulus}, \; d = \text{density}$$

velocity in gases:

$$V = \sqrt{\frac{\gamma P}{d}} \; \text{— Isothermal } \boxed{\gamma = 1}, \; \text{Adiabatic } \boxed{\gamma = \gamma}$$

effect of temperature
$\boxed{V \propto \sqrt{T}}$
V velocity
T temperature

$\boxed{\text{density} \propto \text{molecular weight}}$

Intensity of Sound depends on frequency, Amplitude

$$I = 2\pi^2 n^2 A^2 \rho . V$$

$\boxed{I \propto n^2 A^2} \rightarrow$

Sound waves of frequency 660 Hz, are reflected by a surface. The min. distance b/w the surface and the air particles have max. amplitude of vibration:

$V = n\lambda$

$$\lambda = \frac{V}{n} = \frac{330}{660} = \frac{1}{2} = 0.5m.$$

$\boxed{\text{max. Amplitude} = \lambda/4} \Rightarrow \frac{0.5}{4} = 0.125m = 12.5cm$

Amplitude & frequency of Sound are double that of another. The Intensities are in ratio –

$$\boxed{I = 2\pi^2 n^2 A^2 V d}$$

$I \propto n^2 A^2$

$$\frac{I_1}{I_2} = \frac{(n_1)^2 (A_1)^2}{(n_2)^2 (A_2)^2} = \frac{n^2 \cdot A^2}{4n^2 \cdot 4A^2} = \frac{1}{16} = 16:1$$

The Intensities at two Successive waves are Superimposed in and out of phase resp. 16:9. The amplitudes of waves:

$I \propto A^2$

$$\sqrt{\frac{I_1}{I_2}} = \frac{A_1}{A_2} = \frac{4}{3} \qquad \frac{A_{max}}{A_{min}} = \frac{4+3}{4-3} = \frac{7}{1} = 7:1$$

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Heat and temperature

Temperature: level of Internal K.E or degree of hotness or coldness

Types of thermometers:

① liquid thermometer: Ex: Mercury, Alchohal
— length is thermometric property.

② constant volume gas thermometer:
→ $\boxed{\text{pressure}}$ is thermometric property

③ Resistance thermometer: [−200°c to 1200°c]
→ Resistance is thermometric property

$$R_t = R_0[1+\alpha\Delta t]$$

④ Thermo electric thermometer
→ emf is thermometric property
— works on seaback effect
— Rapid change in temperatures are measured.

⑤ Magnetic thermometer:
— Intensity of magnetisation is thermometric property.
— used for very low temperatures.

High temperatures can be measured by pyrometer, Bolometer, thermopile, thermo electric thermometer, radiation thermometer

$$\frac{C}{100} = \frac{F-32}{212-32} = \frac{K-273}{373-273} = \frac{Ra-492}{672-492} = \frac{R}{80}$$

$1°R > 1°C > 1°F$

$$\boxed{\Delta C = \Delta K = \frac{5}{9}(F_2-F_1)}$$

$C° = F° \Rightarrow -40$
$C° = K° \rightarrow 0$
$F° = K \xrightarrow{at} 574.25$
$F° = R \Rightarrow at\ 25.6.$

$$\boxed{°C = \frac{5}{9}(F°-32)}$$

Heat and temperature.

expansion of gases:

Volume expansion: $P=C$ — ~~Regnaults apparatus~~
pressure expan.: $V=C$ — ~~Jolly's bulb app.~~

(Regnaults Apparatus)
Volume coefficient $\alpha = \dfrac{V_1-V_2}{V_2t_1 - V_1t_2}$
$\boxed{P=C}$

(Jolly's Bulb Apparatus)
pressure coefficient $\beta = \dfrac{P_1-P_2}{P_2t_1-P_1t_2}$
$\boxed{V=C}$

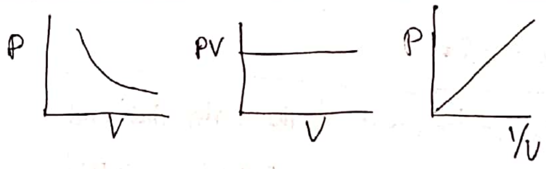
$$C_V = \frac{R}{\gamma-1}\ ;\ C_P = \frac{\gamma R}{\gamma-1}$$

$$\left(\frac{V_1}{V_2}\right)^{1} = \left(\frac{P_2}{P_1}\right)^{\frac{1}{\gamma}} = \left(\frac{t_2}{t_1}\right)^{\frac{1}{\gamma-1}}$$

Thermal capacity (C) $= m \times S$ — Specific heat
$= \rho V \times S.$

Thermal capacity/volume $= \rho S.$

$$\boxed{\frac{C_1/V}{C_2/V} = \frac{\rho_1 S_1}{\rho_2 S_2}}$$



$\boxed{PV = \mu n R_u T}$ $\boxed{P=V=R_u=T=C}$

$$n = \frac{m}{M} \Rightarrow \frac{m_1}{M_1} = \frac{m_2}{M_2}$$

expansion in solids:

$$L_f = L_0[1+\alpha(\Delta T)]$$
$$V_f = V_0[1+\gamma\Delta T]$$
$$A_f = A_0[1+\beta(\Delta T)]$$

graph b/w temp°c & pressure of perfect gas:
→ A straight line with a +ve intercept on pressure axis intercepting temperature axis at −273°C

	Transl.	Rotal.	Total	C_p	C_v	γ
mono atomic	3	0	3	$5R/2$	$3R/2$	1.66
diatomic	3	2	5	$7R/2$	$5R/2$	1.4
Poly atomic	3	3	6	4R	3R	1.3.

Internal energy (U) $= \frac{nRT}{2}$

n = deg. of freedom

$C_p = R\left[\frac{n}{2}+1\right]$

$C_v = \frac{nR}{2}$

Two thermometers x and y have fundamental intervals of 80° and 120°. When immerse in ice, they show the reading of 20° and 30°. If y measures the temperature of body as 120°, then reading on x = ____

$$\boxed{\frac{{}^\circ - L.F.P}{U.F.P - L.F.P} = \frac{{}^\circ C - L.F.P}{\text{Fundamental Interval}}}$$

$$\frac{x - 20^\circ}{80} = \frac{120^\circ - 30^\circ}{120}$$

$x = 80°c$

At what temperature, the Fahrenheit and Celsius scale will give numerically equal (but opposite in sign) values.

$$\frac{C}{100} = \frac{F-32}{180}$$

$$\frac{C}{5} = \frac{F-32}{9}$$

$$\frac{-x}{5} = \frac{x-32}{9}$$

$-9x = 5x - 160$ $\quad F = +x^\circ \quad C = -x^\circ$

$160 = 14x$

$x = \frac{160}{14} = \boxed{11.43^\circ F \text{ and } -11.43^\circ C}$

Constant volume gas thermometer :

$$t = \frac{P_t - P_0}{P_{100} - P_0} \times 100 \quad (\text{in } ^\circ C)$$

P_t = pressure at $t^\circ c$

P_0 = pressure at $0^\circ c$

P_{100} = pressure at $100^\circ c$

Eg: A constant vol. gas thermometer shows pressure readings 50cm and 90cm of Hg at 0°c and 100°c. when the pressure reading is 60cm the temperature is ____

$P_0 = 50$

$P_t = 60cm$

$P_{100} = 90cm$

$$t = \frac{(60-50)}{(100-50)} \times 100 \rightarrow \frac{10}{50} \times 100 = 25^\circ c$$

platinum resistance thermometer :

$$t = \frac{R_t - R_0}{R_{100} - R_0} \times 100 \quad (\text{in } ^\circ c)$$

R_t = Resistance at $t^\circ c$

R_0 = Resistance at $0^\circ c$

R_{100} = Resistance at $100^\circ c$

Eg: when a platinum resistance thermometer is put in contact with ice, steam and a liquid, the resistances are 2.56, 3.56, 5.06, temperature of liquid. =.

$R_0 = 2.56$ (ice = 0°c)

$R_t = 5.06$ (liquid temperature)

$R_{100} = 3.56$ (steam)

$$t = \frac{5.06 - 2.56}{3.56 - 2.56} \times 100$$

$= 250°c$

→ The temperature of a body on kelvin scale is found to be "x" K. when it is measured by a Fahrenheit thermometer it is found to be x°F

$f° = k° = x = 574.26°$

→ A thermometer has wrong calibration. it reads the melting point of ice as $-10°c$ it reads 60°c instead of 50°c. The temperature of Boiling water on this scale?

$L.F.P = -10°c$ (L.F.P) | 6F

$T_f = 60°c$

$$\frac{60°-(-10°)}{U.F.P-(-10°c)} = \frac{50°c}{100}$$

$$\frac{70}{U.F.P+10} = \frac{1}{2}$$

$140 = U.F.P + 10$

$\boxed{U.F.P = 130°C}$

At what temperature, kelvin and Reamer scale agree?

$k = r = x$

$$\frac{K-273}{100} = \frac{R°}{80}$$

$$\frac{x-273}{\cancel{100}_5} = \frac{x}{\cancel{80}_4}$$

∴ $\boxed{\text{They never agree}}$

$4x - 1092 = 5x$

$\boxed{-1092 = x}$

$\boxed{x = -1092}$

In the case of diatomic gas, the Ratio of energy used for expansion and heat supplied at $\boxed{P=C}$ is

energy used for expansion $= \boxed{Pdv = RdT}$

energy supplied at $\boxed{P=C}$ $= C_p dT = \frac{7R}{2} dt$

$\frac{7R}{2}$

$$\Rightarrow \frac{RdT}{\frac{7R}{2}dT} = \frac{2}{7} = \boxed{2:7}$$

If the reading of reamer scale is numerically less than that of celsius scale by 3, then reading on celsius scale is ______

$\boxed{R° = C-3}$

$$\frac{R}{80} = \frac{C}{100}$$

$$\frac{C-3}{\cancel{80}_4} = \frac{C}{\cancel{100}_5}$$

$5C - 15 = 4C$

$\boxed{C = 15°c}$

The steam point and ice point of mercury thermometer are wrongly marked as 92°c and 2°c. what temperature read by this thermometer would be correct.

$$\frac{x-2}{9\cancel{0}} = \frac{x}{10\cancel{0}}$$

$10x - 20 = 9x$

$x = 20°C$

out 4 given temperatures 40°R, 49°c, 113°F and 320k.

⇒ 49°c

⇒ $320 - 273 = 47°C$

$$40°R = \frac{40}{\cancel{80}_4} = \frac{C}{\cancel{100}_5} \Rightarrow 4C = 200 = 50°C$$

$$113°F = \frac{113-32}{\cancel{180}_9} = \frac{C}{\cancel{100}_5} = \frac{81 \times 5 = 9C}{C = \frac{81 \times 5}{9}}$$

45°

45°c 50°c 47° 49°

50 49° 47 45°

40°R 49°c 320K

A mono atomic ideal gas expands at $\boxed{P=C}$ with heat Q supplied. The fraction of Q which goes as work done by gas ⇒ W/Q

$$\frac{W}{Q} = \frac{Pdv}{nC_p dT} = \frac{RdT}{\frac{5R}{2}dT} = \frac{2}{5} = 2:5$$

The upper fixed point and L.F.P are wrongly marked as 96°c and −2°c respectively. The reading of this thermometer is (correct thermometer reads 50°c).

$$\boxed{\frac{x+2}{98} = \frac{50}{100}}$$

$$\frac{x+2}{98} = \frac{1}{2}$$

$$2x+4 = 98$$

$$2x = 94$$

$$\boxed{x = 47°c}$$

On a hypothetical scale X, the ice point is 40° and steam point is 120°. For another scale Y ice point and steam point are −30c and 130° respectively. If X reads 50°, then 'Y' would read

X   Y

$$\frac{50-40}{120-40} = \frac{\cancel{y}+30}{130+30}$$

$$\frac{10}{80} = \frac{x+30}{160}$$

$$\frac{1}{\cancel{8}} = \frac{x+30}{\cancel{160}_{20}}$$

$$20 = x+30$$

$$\boxed{\cancel{x} = -10°c}$$

A Fahrenheit reads 113°F while a faulty celcius thermometer reads 44°c. The correction required to be applied to the °c thermometer

$$\frac{113-32}{\cancel{180}_9} = \frac{c}{\cancel{100}_5} =$$

$$\frac{81}{9} = \frac{c}{5}$$

$\boxed{C = 45°}$ → correct scale

$\boxed{C = 44°}$ → given scale

Correction $45-44 = 1°c$

Expansion of gases

$$\frac{P_1}{V_1}$$

$$\frac{P_1}{P_2} = \frac{r_2^3}{r_1^3}$$

$$\frac{\cancel{8}\cancel{r_1^3}}{\cancel{r_1^3}}$$

$$\begin{array}{r} 2\,3 \\ 10.34 \\ \times 8. \\ \hline 82.72 \end{array}$$

82

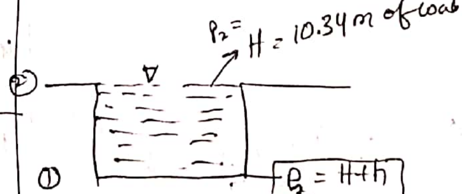
A balloon of 100 litres rises to a height where the pressure is half that on the ground. Assuming temperature is constant the volume is

$$\boxed{P_1V_1 = P_2V_2}$$

$$V_2 = \frac{P_1 V_1}{P_2} = \frac{P \times 100}{P/2} = 2 \times 100$$

∴ Volume $(V_2) = 200\,l$

An air Bubble rises from bottom to the Top of a water tank. If the radii of bubble increases to 2times by reaching the top, depth of water in Tank.



$P_1 = H+h$ | $P_2 = H$

$V_1 = \frac{4}{3}\pi r_1^3$ | $V_2 = \frac{4}{3}\pi n^3 r_1^3$

As $\boxed{\text{Temp} = C}$

$$P_1V_1 = P_2V_2$$

$$(H+h)\left(\cancel{\frac{4}{3}\pi r_1^3}\right) = H\,\cancel{\frac{4}{3}\pi}\, n^3 \cancel{r_1^3}$$

$$H+h = Hn^3$$

$$\boxed{h = H(n^3-1)}$$

$$h = 10.34(8-1)$$

$$= 10.34 \times 7$$

$$= 72.38\,m$$

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A mercury baromometer reads 70 cm pressure, A water barometer reads water pressure at. ____

$\boxed{S_1 h_1 = S_2 h_2}$

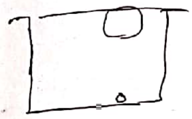
(1) $h_1 = \frac{13.6 \times 70}{100}$

$= 13.6 \times 0.7$
$= 9.52m$

If an air bubble rises from the bottom to surface of a late at constant temperature, its volume :

$\boxed{\text{pressure is function of depth}}$

$\boxed{P = \rho g h}$



depth decreases ↓ pressure ↓
$\boxed{\text{Volume Increase}}$

A vessel of volume 30 litres contains a gas of density 1.3 g/litre. The pressure decreases by 0.78 atm. under constant Temp. Find mass of gas escaped.

$\boxed{PV = MRT}$

$\boxed{P \propto M}$

$\frac{P_1}{m_1} = \frac{P_2}{m_2} \Rightarrow$

$P_1 = 1\,atm$
$P_2 = 0.78\,atm \times 1\,atm$

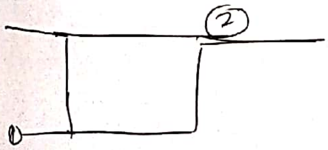
$m_1 = 30 \times 1.3$
$= 39\,gm$

$\frac{1}{39} = \frac{0.78}{m_2}$

$m_2 = 0.78 \times 39$
$= 30.42g$

mass of gas escaped $= m_2 - m_1$
$= 39 - 30.42$

A bubble rises from the bottom of lake 90m deep on reaching the surface, it volume become



$P_1 = 10.34 + 90$
$V_1 = V$
$V_2 = ?$
$P_2 = 10.34$

$P_1 V_1 = P_2 V_2$

$V_2 = \frac{P_1 V_1}{P_2} = \frac{100.34 \times V}{10.34} = 9.8\,V \approx 10V$

Two gases A and B having pressure 'P' volume (V) & temperature (T) are mixed. If the mixture has volume and temperature as 'V' and 'T', Then final pressure is ____

$\boxed{\frac{P_1 V_1}{T_1} + \frac{P_2 V_2}{T_2} = \frac{P_3 V_3}{T_3}}$

total moles,

$\frac{PV}{T} + \frac{PV}{T} = \frac{P_3 V}{T}$ $\quad \boxed{n_3 = n_1 + n_2}$

$\frac{2P\cancel{V}}{\cancel{T}} = \frac{P_3 \cancel{V}}{\cancel{T}}$
$P_3 = 2P$

A vessel contains a gas under a pressure 6 atm, when 3/8 of the content of vessel have been released without change in Temperature, what is new pressure.

$P_1 = 6\,atm$ $\quad P_2 = ?$
$m_1 = m$ $\quad m_2 = m - \frac{3}{8}m = \frac{5}{8}m$

$\frac{P_1}{m_1} = \frac{P_2}{m_2} \Rightarrow \frac{6}{\cancel{m}} = \frac{P_2}{5/8\cancel{m}}$

$\Rightarrow \frac{6 \times 5}{8} = 30/8 = 15/4\,atm$

A flask breaks when pressure inside 1.5 atm the temperature to which it can heated, without breaking it. If the initial pressure is atmospheric at 0°C

$P_1 = 1\,atm$ $\quad P_2 = 1.5$
$t_1 = 0°C = 273k.$ $\quad t_2 = ?$

$\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow \frac{1}{273} = \frac{1.5}{t_2} = 273 \times \frac{15}{10}$

$= 409.5k.$
~~$= 273 - 409.5k =$~~
$= 136.5°c$

Q. ~~A closed vessel~~ To double the volume of given mass of a ideal gas at 27°c keeping P=C, one must raise temp. in ____ °C to

$V_1 = V$ $\quad V_2 = 2V$
$T_1 = 300k$ $\quad T_2$ -

$\frac{300}{\cancel{V}} = \frac{T_2}{2\cancel{V}} = 600k.$ $\quad \frac{600}{-273} = 327°c$

The pressure of a gas in a closed vessel is increased by 0.4%. If temperature of gas is increased by 1°C, initial temp. of gas:

$$\frac{P_2-P_1}{P_1} \times 100 = 0.4$$

$$\frac{P_2-P_1}{P_1} = \frac{4}{1000}$$

$$\frac{T_2-T_1}{T_1} = \frac{4}{\cancel{1000}}$$

$$\frac{1}{T_1} = \frac{1}{250} \qquad \boxed{T_1 = -23°C}$$

$$\boxed{T_1 = 250K}$$

The Ratio of weights of air filling your room in winter (7°C) and in Summer (47°C). If the pressure is same

$$\boxed{PV = mRT} \qquad \boxed{m \propto \frac{1}{T}}$$

$$\frac{m_1}{m_2} = \frac{T_2}{T_1} = \frac{320}{280} = \frac{8}{7} = 8:7$$

A balloon of volume 5m³, pressure at 1atm. and temperature 27°C goes to a height where pressure is 0.5 atm. and temp. is −3°C. Volume of balloon?

K 270

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

$$V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{1 \times 5 \times 27\cancel{0}}{\frac{1}{2} \times 30\cancel{0}}$$

$$= \frac{2 \times \cancel{5} \times 27\,9}{\cancel{30}\ 10_2} = 9m^3$$

An ideal gas is found to obey the additional law $\boxed{VP^2 = C}$. The gas initially at a temperature T and volume V, when it expands to volume 2V, it's temp becomes ___

$$\boxed{VP^2 = C} \qquad \frac{PV}{T} = C$$

$$\boxed{P = \frac{CT}{V}}$$

$$V \frac{C^2T^2}{V^2} = C$$

$$\frac{CT^2}{V} = 1$$

$$\boxed{\frac{T^2}{V} = C}$$

$$\left(\frac{T_1}{T_2}\right)^2 = \frac{V_1}{V_2} = \frac{V}{2V}$$

$$\frac{T_1}{T_2} = \sqrt{\frac{1}{2}}$$

$$\frac{T_1}{T_2} = \frac{1}{\sqrt{2}}$$

$$\boxed{T_2 = \sqrt{2}\,T_1}$$

: Modern physics :

- photo electric effect discovered by Hertz
- current due to photoelectrons — photoelectric current
- independent of η of light and ~~intensity~~ energy of light.
- photo electric current doesn't follow ohm's law
- based on law of conservation of energy

1 nanometer = 10 A°

$$W_{in\,eV} = \frac{12400}{\lambda \text{ in } A^\circ}$$

$$\boxed{\frac{h \times c}{\lambda}}$$

$$K.E = h\nu - W$$

$$\boxed{E = h\nu} \quad \boxed{C = \nu\lambda}$$

energy of photon

$$\boxed{\frac{1}{2}mv^2 = E - h\nu_0}$$

$$\mu = \frac{1}{\sin C}$$

$$\boxed{h = r\sqrt{\mu_1^2 - 1}}$$

$$\boxed{\mu = \frac{\sin i}{\sin r}}$$

launching angle :

$$\angle L = \boxed{\sin^{-1}\sqrt{\mu_1^2 - \mu_2^2}}$$

$$\boxed{\mu \propto \frac{1}{\lambda}}$$

$$\boxed{\mu \propto \frac{1}{v}} \text{ — velocity of light}$$

$$\boxed{v \propto \lambda} \text{ — wavelength of light}$$

$$\mu = \frac{\text{real depth}}{\text{apparent depth}}$$

Wavelengths of given light waves in air & H_2O medium is 6000 and 4000 respectively. The angle of total internal reflection.

$$\mu = \frac{1}{\sin C} = \frac{\lambda_{medium}}{\lambda_{air}} = \frac{4000}{6000} = \frac{2}{3}$$

$$\sin C = \frac{3}{2} \Rightarrow C = \sin^{-1}(3/2).$$

If wavelength of electron and a photon is same, then they will have same

$$\boxed{\lambda = \frac{h}{p} \text{ or } p = \frac{h}{\lambda}}$$

$$\boxed{\lambda = c} \Rightarrow \boxed{p = h}$$

---

* Important points *

$\mu_1 \rightarrow$ refractive index of medium-1

$\mu_2 \rightarrow$ refractive index of medium-2

then C (critical angle) $\Rightarrow \sin C = \frac{\mu_2}{\mu_1}$

$$C = \sin^{-1}\left[\frac{\mu_2}{\mu_1}\right]$$

---

stopping pottential (V_0) = max. K.E.

$$\therefore V_0 = K_E = h\nu - W_0$$

$$\boxed{V_0 = K_E = h\nu - h\nu_0}$$

$$\boxed{V_0 = \frac{1}{2}mv^2 = h\nu - h\nu_0}$$ (v = velocity of emitted electron)

---

* $\boxed{1A^\circ = 10^{-10}m}$ *

---

* h (planks constant) = 6.63×10^{-34} J *

$\Rightarrow \frac{hc}{\lambda} \rightarrow$ units $\Rightarrow$ Joules.

$\Rightarrow \frac{hc}{\lambda \times 1.6 \times 10^{-19}} \rightarrow$ units = volts

pottential (V) = $\frac{W \rightarrow \text{work}}{q \rightarrow \text{charge}}$ } J/coloumb.

Magnetism &

magnetic pole strength (m) = current (I) × magn length.

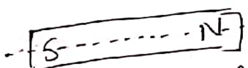
length of magnet

$\boxed{\text{magnetic length} = 2l}$

magnetic length $\leq$ Geometric length / length of magnet

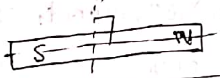
magnetic length $= \frac{5}{6}$ G.L / L. of magnet

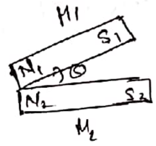
$\boxed{M = m \times 2l}$



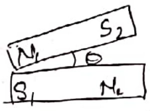
Axial / magnetic line / polar axis

equitorial line

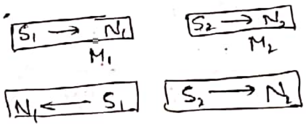




$\Rightarrow M' = \sqrt{M_1^2 + M_2^2 + 2M_1M_2\cos\theta}$



$\Rightarrow M' = \sqrt{M_1^2 + M_2^2 - 2M_1M_2\cos\theta}$

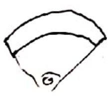


$\Rightarrow M_1 + M_2$

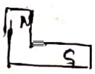
$\Rightarrow M_1 - M_2$

$\sqrt{M_1^2 + M_2^2}$

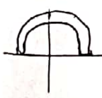
$\Rightarrow \boxed{M' = 0}$



$M' = \frac{2M\sin\theta/2}{\theta}$ θ — rad.



$M' = M/\sqrt{2}$



$M' = \frac{2M}{\pi}$

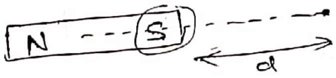
$M' = \frac{2\sqrt{2}M}{\pi}$

$F \propto \frac{m_1 m_2}{d^2} \Rightarrow F = \frac{\mu}{4\pi}\frac{m_1 m_2}{d^2}$

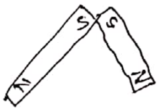
[illegible]

Magnetic flux density (B) $= \frac{\phi}{A}$.

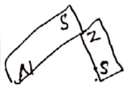
$\boxed{1\ \text{Tesla} = 10^4\ \text{gauss}}$



$B = \frac{\mu_0}{4\pi} \cdot \frac{m}{d^2}$

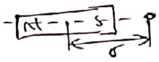


$B' = \left[\frac{\mu_0}{4\pi}\frac{m}{d^2}\right]\sqrt{3}$

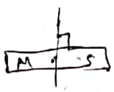


$B' = \left[\frac{\mu_0}{4\pi} \cdot \frac{m}{d^2}\right]$

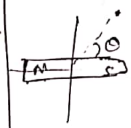
$B' = \frac{\mu_0}{\pi} \cdot \frac{m}{r^2}$



$B = \frac{\mu_0}{4\pi} \cdot \frac{2M}{r^3}$ $\boxed{B_A = 2B_E}$



$B = \frac{\mu_0}{4\pi} \cdot \frac{M}{r^3}$



$B = \frac{\mu_0}{4\pi} \cdot \frac{M}{r^3}\left(\sqrt{1+\cos^2\theta}\right)$.

M of solenoid $= \boxed{I \times n \times (\pi a^2) \times 2l}$

cu   no. of turn   area

$\vec{T} = MB\sin\theta$

T of magnetic needle $= 2\pi\sqrt{\frac{I}{MB}}$

M.M.F = $I \times n$.

Magnetic field Intensity (H) $= \frac{M.M.F.}{l} = \frac{I.n}{l}$

$\boxed{B = \mu_0 \cdot \mu_r \cdot H}$

Reluctance (S) $= \frac{MMF}{\phi}$

permeance $= \frac{1}{S}$

Reluctivity $= \frac{1}{\mu}$

Magnets

- Natural (earth, loadstone, Magnetite (Fe_3O_4))
- Artificial
  - permanent magnets (Nickel, cobalt, steel) $\boxed{Al, Ni, Co}$
  - electromagnets

Magnetic pole strength (m): $\boxed{I \times 2l}$

S.I. = Ampere-meter

m.k.s = weber. $\boxed{\text{Scalar}}$

$\boxed{D.M.F = M^0L^1T^0A^1}$

Factors affecting:
- independent of shape of magnet
- depends on nature of material
- depends on A.C.S

$\boxed{\text{area of cross section} \propto m}$

Magnetic moment (M): $m \times 2l$

S.I = $A\text{-}m^2 = \frac{N\text{-}m}{Tesla} = \frac{Joule}{Tesla} = \frac{N\text{-}m^3}{Tesla}$

D.M.F: $M^0L^2T^0A^1$ $\boxed{\text{Vector}}$

M of n^{th} part (M') $= \frac{M}{n}$ (Magnet divided into n parts)

$= \frac{M}{xy}$

x — horizontal cut/graph

y — vertical part

$F \propto \frac{m_1m_2}{d^2} \Rightarrow F = \frac{\mu}{4\pi}\frac{m_1m_2}{d^2}$

μ = permeability (depends on medium)

$\boxed{\text{ability of material which allow magnetic lines}}$

N/A^2

$\boxed{MLT^{-2}A^{-2}}$ | depends on type of material

Magnetic flux (ϕ)

unit = weber (SI) ~~Vect~~

= Maxwells (C.G.S) $\boxed{\text{Scalar}}$

$\boxed{1\text{ weber} = 10^8\text{ maxwells}}$

$ML^2T^{-2}A^{-1}$

Magnetic flux density / Magnetic flux field Intensity / induction

$\boxed{\text{Vector quantity}}$

$B = \frac{\phi}{A}$ = weber/m² = Tesla (S.I)

maxwell/cm² = gauss

$\boxed{1\text{ Tesla} = 10^4\text{ gauss}}$

$\boxed{N/A\text{-}m}$

(B) $M^1L^0T^{-2}A^{-1}$

$\vec{T}$ (Couple) = $MB\sin\theta$

MMF = NI

= ampere-turn

M.M.F/unit length $= \frac{N.I}{2l}$

Magnetic field intensity (H) $= \frac{N.I}{2l}$

= Ampere turn/meter

= N/weber

= oersted (C.G.S)

$\boxed{1\text{ AT/m} = 10^{-3} \times 4\pi\text{ oersted}}$

$\boxed{B = \mu_0\mu_r H}$

Reluctance: $\frac{MMF}{\phi}$ = $\frac{\text{Ampere-turn}}{\text{weber}}$

$S = \frac{NI}{\phi} = \frac{NI}{AB} = \frac{N.I}{A\mu H} = \frac{N.I}{A.\mu.\frac{NI}{l}} = \frac{l}{A\mu}$

$\boxed{M^{-1}L^{-2}T^2A^2}$

Permeance: $\frac{1}{S} = \frac{\phi}{NI} = \frac{A\mu}{l}$

$\boxed{\text{weber/Ampere-turn}}$

~~$M^{-1}L^{-2}T^2$~~ $\boxed{M^1L^2T^{-2}A^{-2}}$

Reluctivity: $\frac{1}{\mu}$ = meter/Henry

$\mu = MLT^{-2}A^{-2}$

$\frac{1}{\mu}$ $M^{-1}L^{-1}T^2A^2$

Intensity of Magnetisation (I_0)

$I = \frac{M}{V} = \frac{m \times 2l}{V} = \frac{Am^2}{m^3} = A/m$

$M^0L^{-1}T^0A^1$

Susceptibility (χ) (chi)

$= \frac{I_0}{H}$

$\boxed{\text{No unit}}$

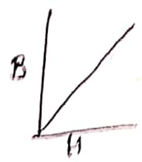
1)

For Ideal Magnets : $\boxed{B = \mu_0 H}$

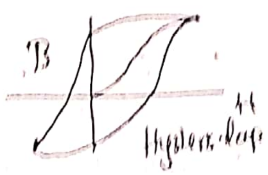
For practical Magnets : $B = \mu_0 [H + I_0]$

$$\boxed{\begin{array}{l} \mu_r = [1 + \chi] \\ \hline \mu = \mu_0 [1 + \chi] \end{array}}$$

For ideal magnets !



For practical magnetic materials



$\boxed{\text{Magnetic Materials}}$

Dia — para — ferro

Diamagnetic materials :

→ freely repelled by magnet

→ No permanent magnetic Moment (M)

→ $\mu_r << 1$ (very less)

→ $(\chi) << 0$ (less and -ve)

→ weakly magnetised in the direction opposite to magnetic field.

Eg : Antimony, Bismuth, Copper, Ag, Au, Hg, Quartz, Alcohol (C_2H_5OH), water, H_2, air, Argon, Chromium

---

Para Magnetic materials :

→ weak attraction

→ have less permanent magnetic moment

→ $\mu_r > 1$ (high)

→ χ → less & +ve

→ weakly magnetised in direction of magnetic field

Eg : Al, Cr, Alkali and Alkali earth metals, Platinum, O_2, glass

$\boxed{\text{Atoms must have resultant dipole moment}}$

→ can be magnetised only very slightly

Ferromagnetic materials :

→ strong attraction force

→ more permanent magnetic moment

→ $\mu_r >> 1$ (+ve)

→ $\chi >> 1$ (+ve

→ strongly magnetised in direction of magnetic field

→ Eg: Iron, cobalt, Nickel, Gadolonium dysprosium, steel

A magnetic substance can be magnetised to a maximum limit called Magnetic saturation

---

Brass → Non-magnetic Substance

Force of attraction / repulsion b/w two magnetic poles does not depends on length of magnet

---

Time period of freely suspended magnet doesn't depend on length of suspension

---

permeance ≈ conductance

Higher retentivity of magnetism → Alnico

low retentiveness materials used → electro magnets

---

* potential (V) = $\dfrac{W(\text{work})}{q\ (\text{charge})}$ = J/Columb.

Sound:

Two bodies frequencies η_1 and η_2 and $\eta_1 > \eta_2$ are sounded together the frequency of amplitude of beats = $\frac{\eta_1 - \eta_2}{2}$

Doppler effect is used in RADAR & SONAR

RADAR: Radio Detection & Ranging used to detect space crafts, air crafts, guided missiles etc.

SONAR: Sound Navigation And Ranging. used to detect objects under water

---

Change in pitch of fire engine due to doppler effect.

An observer sits at a distance 1.5 times that of this friend sits from the same source. The ratio of the intensities of waves recieved by the observer and his friend.

$\boxed{I \propto \frac{1}{d^2}}$ $\boxed{\begin{array}{l} d = \text{distance} \\ I = \text{Intensity} \end{array}}$

$\frac{I_1}{I_2} = \frac{d_2^2}{d_1^2} = \frac{d^2}{(1.5d)^2}$

$= \frac{1}{2.25} \Rightarrow \frac{100}{225} = \frac{4}{9} = \boxed{4:9}$

Pitch of musical note depends upon η of sound

If the temperature of tuning forks is increased, its frequency = ______

temp ↑, length of prongs ↑, Amplitude ↑

η ↓

A room has total absorption A_1, when a material of absorption A_2, is brought into it, the reverberation time becomes 75% of initial value, then $\frac{A_1}{A_2}$

$T = \frac{0.17V}{\Sigma As} \Rightarrow T \propto \frac{1}{\Sigma as \text{ (Total Absorp)}}$

$T_1 = T$

$T_2 = \frac{75}{100}T = \frac{3}{4}T \Rightarrow \frac{T_1}{T_2} = \frac{A_2}{A_1} \Rightarrow 4/3$

$A_1/A_2 = 3/4$

Sound

A room of dimension $l \times b \times h$ has reverberation time 't' s. Another room $2l \times 2b \times 2h$ with same average coefficient will have, the Reverberation time.

$T = \frac{0.17V}{\Sigma as}$

$\boxed{T \propto V}$ $\frac{T_1}{T_2} = \frac{V_1}{V_2}$ | $V_1 = V = l b h$, $V_2 = 8lbh$

$\frac{T_1}{T_2} = \frac{lbh}{8lbh}$ $T_2 = 8T_1 = 8t$

The Intensity of sound produced by A is 1000 times greater than B, then the diff in the Intensity level

$L_2 - L_1 = 10 \log \frac{I_2}{I_1}$

$= 10 \log \frac{1000 \cancel{I_1}}{\cancel{I_1}}$

$= 10 \log 10^3$

$= 30(1)$

$\boxed{\therefore \Delta L = 30\,dB}$

properties of matter:

Bulk modulu of water is $2\times10^9\ N/m^2$. The ~~ch~~ ΔP required to increase the density of water by 0.1% is

$\uparrow$ density = $\frac{mass}{volume\downarrow}$

To increase density by 0.1%, volume be decreased by 0.1%

$$k = \frac{\Delta P}{\frac{\Delta V}{V}}$$

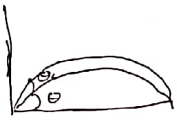
$$\Delta P = k\times\frac{\Delta V}{V} = \left(\frac{0.1}{100}\right)\times 2\times10^9$$

$$\boxed{\Rightarrow 2\times10^6\ N/m^2}$$

practice set questions & previous year concepts

A projectile can have the same range R for two angles of projection. if t_1 and t_2 be the times of flight in 2-cases, then the product of two times of flights.

$$\boxed{\begin{aligned} t_1 &= \frac{2u\sin\theta}{g} \\ t_2 &= \frac{2u\sin(90-\theta)}{g}\end{aligned}}$$



$$t_1t_2 = \frac{2u\sin\theta}{g}\cdot\frac{2u\cos\theta}{g} = \frac{2u^2\sin2\theta}{g.g}$$

$$t_1t_2 = \frac{2R}{g} \Rightarrow \boxed{t_1\cdot t_2 \propto R}$$

Ten litre of water per second is lifted from a well through 10m and delivered with a velocity of 10m/s, $g=10m/s^2$ then power of motor

$$\boxed{P = \frac{W.D}{t} = \frac{mgh+\frac{1}{2}mv^2}{1}}$$

$$= m\left(gh+\frac{v^2}{2}\right)$$

$$= 10\left(10\times10 + \frac{100}{2}\right)$$

$$= 10(150)$$

$$= 1500W = 1.5\,kW$$

A man slides down on a telegraphic pole with an acceleration equal to $\frac{1}{4}$ of g. friction b/w man and mole: is equal to

$$\boxed{F = m(g-a)}$$

$$= m\left(g-\frac{g}{4}\right)$$

$$= mg\,3/4$$

$$= \frac{3W}{4}$$

A pendulum bob has a speed of 3m/s at its lowest position. The pendulum is 0.5m length. The speed of bob, when the length makes an angle of 60° to vertical, will be ($g=10m/s^2$)

$$\boxed{\frac{1}{2}mv^2 = \frac{1}{2}mv_1^2 + mgl(1-\cos\theta)}$$

$$\frac{v^2}{\cancel{2}} = \frac{v_1^2+2gl(1-\cos\theta)}{\cancel{2}}$$

$$\cancel{9 = 2v_1^2 + 4gl(1-\cos\theta)}$$

$$\cancel{9 = 2v_1^2 + 4\times10\times\frac{1}{2}\left(1-\frac{1}{2}\right)}$$

$$\cancel{9 = 2v_1^2 + 20\times\frac{1}{2}}$$

$$9 = v_1^2 + 2\times10\times\frac{1}{2}\left(\frac{1}{2}\right)$$

$$4 = v_1^2$$

$$\boxed{V = 2m/s}$$

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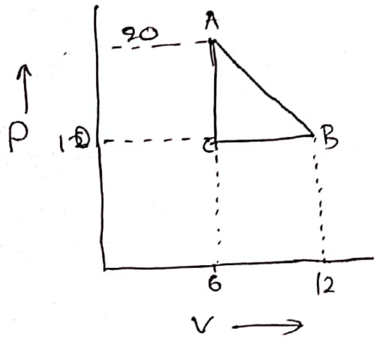
The P-V graph for a thermodynamically system is shown in Fig. 17. The work done by the system in process



W.D = Area of trapezium ABDGC

$\Downarrow \boxed{\frac{1}{2}(a+b)\times h}$

$= \frac{1}{2}(10+20)\times 6$

$= \frac{1}{2}\times 30\times 6$

$= 90J$

For a gas, $\gamma = 1.286$. what is the no: of degrees of freedom of molecules of this gas

$\boxed{1+\frac{2}{n}=\gamma}$ $n \rightarrow$ degree of freedom

$1+\frac{2}{n} = 1.286$

$\frac{2}{n} = 0.286$

$n = \frac{2}{0.286} \approx 7$

The resistances in left and right gaps of metre bridge are 4 and 6 Ω. The balance point is obtained at.

Balance point of metre bridge $= \boxed{\frac{R_{left}}{R_{right}} = \frac{l}{100-l}}$

$\Rightarrow \frac{4}{6} = \frac{l}{100-l}$

$\frac{2}{3} = \frac{l}{100-l}$

$200-2l = 3l$

$200 = 5l$

$\boxed{l = 40cm}$

$1N = 10^5$ dynes

$1J = 10^7$ ergs

$1A° = 10^{-10}m$ $\boxed{1m^3 = 1000l}$

$1nm = 10^{-9}m.$

$1\mu = 10^{-6}m. = 1000nm.$

The mass and diameter of a planet are twice those of earth. The period of oscillation of pendulum on this planet will be ____ (if it is seconds pendulum on earth)

$\boxed{g = \frac{GM}{r^2}}$

$g' = \frac{G(2M)}{(2R)^2} = \frac{\cancel{2}MG}{\cancel{4}_2 R^2} = \frac{1}{2}\frac{GM}{r^2}.$

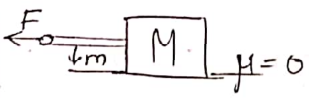
$\boxed{g' = \frac{g}{2}}$

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

$\cancel{2 = 2\pi\sqrt{\frac{2l}{g}}}$ $T' = 2\pi\sqrt{2}\sqrt{\frac{l}{g}}$

$\cancel{\frac{2}{\sqrt{2}} = 2\pi\sqrt{\frac{l}{g}}}$ $T' = \sqrt{2}T$

$\sqrt{2} =$ $\boxed{T' = \sqrt{2}\,2\,s}$



∴ Force acting on block (M) =

Net acceleration:

$F = (m+M)a$

$\boxed{\frac{F}{(m+M)} = a}$

Force acting on 'M' block $= \boxed{\frac{F}{(m+M)}\times M}$

Force acting on 'm' rope $= \boxed{\frac{F\times m}{(m+M)}}$

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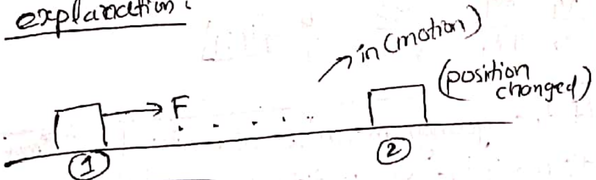
WORK POWER, ENERGY

Concept

when force acts on a body, it's K.E ↑

explanation:



$\boxed{K.E \uparrow}$

Thermodynamics:

* Two thermally insulated vessels of V_1 and V_2 are joined with a valve and filled with air at Temperature T_1 and T_2 at presure P_1 and P_2 respectively. If the valves joining the two vessels are opened, the temperature inside vessels at equilibrium is

$$\frac{P_1V_1}{T_1} + \frac{P_2V_2}{T_2} = \left(\frac{P_1V_1 + P_2V_2}{T}\right)_{\text{mixture}}$$

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

$$\boxed{T = \frac{(P_1V_1 + P_2V_2)T_1T_2}{P_1V_1T_2 + P_2V_2T_1}}$$

Specific heat dring isothermal → ∞

Specific heat during Adiabatic → 0

The rate of radiation of a black body at 0°c is E J/s. The rate of radiation of this body at 273°C will be

$$\boxed{\frac{E_2}{E_1} = \left(\frac{T_2}{T_1}\right)^4} = \left(\frac{273+273}{273}\right)^4$$

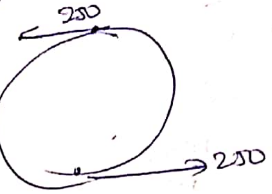
$$\frac{E_2}{E_1} = 2^4$$

$$\boxed{E_2 = 16\,E_1}$$

~~PTO~~

MOCK TEST

An Aeroplane is moving on a circular path with a speed 250 km/hr. what is the change in velocity in half revolution —



$= 250 - (-250)$

$= 250 + 250$

$= \boxed{500 \text{ km/hr}}$

Range of projectile is R, when the angle of projection is 30°, Then the value of the other angle projection for same projectile Range.

$\Rightarrow \boxed{90 - \theta}$

$90 - 30$

$= 60°$

Gases are best lubricants

Time taken by a body to slide down a smooth inclined plane can be doubled by.

$s = ut + \frac{1}{2}at^2$

$t = \sqrt{\frac{2s}{a}}$

$\boxed{s \propto t^2}$

$\frac{t_1^2}{t_2^2} = \frac{s_1}{s_2} \Rightarrow \frac{1}{4} = \frac{s_1}{s_2}$

$\boxed{s_2 = 4s_1} \Rightarrow \boxed{l_2 = 4l_1}$

S.I unit of heat = Joule

A mass attached to a spring oscillates with a period of 2s. If the mass is increased by 2kg, the period increases by 1s. The initial mass of spring.

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

$$2 = 2\pi\sqrt{\frac{m}{k}} \quad \text{—(1)}$$

$$3 = 2\pi\sqrt{\frac{m+2}{k}} \quad \text{—(2)}$$

$$(1) \div (2) \Rightarrow \frac{9}{4} = \frac{m+2}{m}$$

$$\frac{9}{4} = 1 + \frac{2}{m}$$

$$9/4 - 1 = \frac{2}{m}$$

$$\frac{5}{4} = \frac{2}{m}$$

$$\frac{4\times 2}{5} = \frac{8}{5} = 1.6\,kg$$

What is the minimum Time taken by a particle in S.H.M of Time period 'T' from point of max displacement to that at which the displacement is half of Amplitude.

$$\text{displacement} = a\cos\omega t$$

$$\frac{a}{2} = a\cos\omega t$$

$$\frac{1}{2} = \cos\omega t$$

$$\omega t = 60^\circ$$

$$\omega t = \pi/3$$

$$t = \frac{\pi/3}{\omega}$$

$$t = \pi/3 \times \frac{T}{2\pi}$$

$$\boxed{t = T/6\ s}$$

At stopping pottential;

$$\boxed{K.E = P.E}$$

Velocity of sound is measured in H_2 and O_2 gases at given temperatures. The Ratio of 2 velocities.

$$V \propto \frac{1}{\sqrt{M}} \rightarrow \text{Molecular weight}$$

$$\frac{V_1}{V_2} = \sqrt{\frac{M_2}{M_1}} = \sqrt{\frac{32}{2}} = \frac{4}{1} = \boxed{4:1}$$

If the youngs modulus of material is 3 times it's modulus of Rigidity, then its volume elasticity (Bulk modulus / dilatation constant) = ______

$$\frac{9}{E} = \frac{3}{G} + \frac{1}{K} \quad \left\{ E = \frac{9KG}{3K+G} \right\}$$

$$\frac{\cancel{9}^{3}}{\cancel{3}G} = \frac{3}{G} + \frac{1}{K}$$

$$\cancel{\frac{3}{G}} - \cancel{\frac{3}{G}} = 1/K$$

$$0 = \frac{1}{K}$$

$$\boxed{K = \frac{1}{0} = \infty} \quad \boxed{K = \text{Infinity}}$$

If the W.D in stretching a wire by 1mm is 2J, the work necessary for stretching another wire of same material but with double radius of cross section and half the length by 1 mm. is ______

$$\cancel{\tfrac{1}{2}W \times \delta l} \quad \boxed{W.D = \frac{1}{2} \times F \times \delta l}$$

$$\delta l = \frac{Pl}{AE} = \frac{Fl}{\cancel{AY}} = \frac{F\times l}{\pi r^2 Y}$$

$$\boxed{F = \frac{\pi r^2 Y \cdot \delta l}{l}}$$

$$W.D = \frac{1}{2} \times \frac{\pi r^2 Y}{l} \times \delta l^2$$

$$\boxed{W.D \propto r^2/l}$$

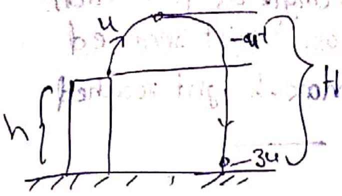
$$\frac{W_1}{W_2} = \left(\frac{r_1}{r_2}\right)^2 \times \frac{l_2}{l_1}$$

$$= \frac{\cancel{r_1^2}}{4\cancel{r_1^2}} \times \frac{\cancel{l}/2}{\cancel{l}}$$

$$\frac{W_1}{W_2} = \frac{1}{4} \times \frac{1}{2} = \frac{1}{8}$$

$$W_2 = 8W_1 \Rightarrow \boxed{8\times 2 = 16J}$$

A stone thrown vertically up with initial velocity 'u' from top of tower, reaches ground with 3u velocity, Then the height of tower



$h = H - ut$

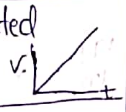
$\boxed{h = \frac{1}{2}gt^2 - ut}$ or $\boxed{\frac{v^2-u^2}{2g} = h}$

$$\frac{9u^2-u^2}{2g} = h$$

$$\frac{8u^2}{2g} = h$$

$$\boxed{\frac{4u^2}{g} = h}$$

Velocity-time graph for vertical projected upward body $\longrightarrow$ $\boxed{\text{straight line}}$



$R\tan\theta = 4H$ {Hint R tan = chor Hei 4}

The horizontal and vertical displacement x and y of a projectile at a given time 't'. are given by $x = 6t$ and $y = 8t - 5t^2$ meters. The range of projectile.

$x = 6t$

$\boxed{t = \frac{x}{6}}$ → put in $(8t - 5t^2 = y)$

$$\therefore y = 8\times\frac{x}{6} - 5\frac{x^2}{36}$$

$$y = \frac{4x}{3} - \frac{5x^2}{36}$$

$\boxed{\text{For range } y=0}$

$$0 = x\left[\frac{4}{3} - \frac{5x}{36}\right]$$

$$0 = \frac{4}{3} - \frac{5x}{36}$$

$$0 = 144 - 15x$$

$$15x = 144$$

$$x = \frac{144}{15}$$

$$\boxed{x = 9.6\,m}$$

15) 144 (9.6
135
90
90
0

For maximum height ⇒ $\boxed{x=0}$

$y = 8t - 5t^2$

$\boxed{\frac{y+5t^2}{8} = t}$ → put in $x = 6t$

$$\therefore x = 6\left[\frac{y+5t^2}{8}\right]$$

$$0 = 6\left[\frac{y+5t^2}{8}\right]$$

$$0 = \cancel{y+5t^2}$$

Two wires of same material and length but diameters in the ratio 1:2 are stretched by the same force, The P.E. per unit volume for two wires when stretched will be in the ratio of ______

Sol:

Energy density $= \frac{1}{2} \times \text{stress} \times \text{strain}$

(P.E. per unit volume) $= \frac{1}{2} \times \text{stress} \times \frac{\text{Stress}}{E}$

$$= \frac{(\text{Stress})^2}{2E}$$

$$= \frac{F^2/A^2}{2E}$$

$\boxed{\text{Energy density}} = \frac{F^2}{(A)^2\, 2E}$ A - Area, F - Force

$$\therefore E_d \propto \frac{1}{[(D)^2]^2} \propto \frac{1}{D^4}$$

$$\frac{E_1}{E_2} = \left(\frac{D_2}{D_1}\right)^4 = \left(\frac{2}{1}\right)^4 = 16$$

$$\frac{E_1}{E_2} = \frac{16}{1} = \boxed{16:1}$$

Two wires of the same material and length are stretched by same force. Their masses are 3:2. Their elongations are in ratio of ______

$\delta l = \frac{Fl}{AE}$

$\boxed{\delta l \propto \frac{1}{A}}$ —①

~~A = P.V = P.a.l~~

A density = $\frac{\text{mass}}{\text{Vol}}$

mass = density × Vol.

mass = $\rho \times A \times l$

$m \propto A$

$\therefore \boxed{\delta l \propto \frac{1}{m}}$

$\frac{\delta l_1}{\delta l_2} = \frac{m_2}{m_1} = \frac{2}{3} = \boxed{2:3}$

The Ratio of Intensities of sounds A and B is 100 : 1. Then Intensity level of A is greater than ______ of B.

$\boxed{L = \log_{10}(100)}$ $\boxed{\frac{L_A}{L_B} = \log_{10}\left(\frac{I_A}{I_B}\right)}$

$L = \log_{10} 10^2$

$L = 2\log_{10} 10$

$\boxed{\frac{L_A}{L_B} = \frac{2}{1}}$ $\boxed{L_A = 2L_B}$

A wire of Resistance 'R' is stretched so that its length increases by 10%. The resistance of wire increases by ______

$R = \frac{Sl}{a}$

$\boxed{l_1 a_1 = l_2 a_2}$

$a_2 = \frac{l_1}{l_2}(a_1)$

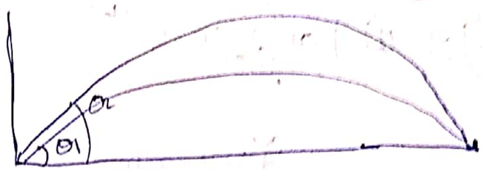
$\boxed{a_2 = \frac{100}{110}(a_1)}$

$R_2 = \frac{S l_2}{a_2}$

$R_2 = \frac{S\left(\frac{110}{100}\right)l_1}{\left(\frac{100}{110}a_1\right)} \Rightarrow S \times \frac{l_1}{100} \times l_1 \times \frac{110}{100} a_1$

$\Rightarrow S \times \frac{121}{100} \Rightarrow 21\%$

Two stones are projected with same speed but making different angles with same speed, but making different angles with horizontal. The angle of projection of one is $\pi/3$ and max. height reached by it is 102 m. Then max. height reached by other in meters is ______



$H_{max} = \frac{u^2 \sin^2\theta}{2g}$

$\boxed{h \propto \sin^2\theta}$

$\frac{h_1}{h_2} = \frac{\sin^2\theta_1}{\sin^2\theta_2} \Rightarrow \frac{\sin^2 60^\circ}{\sin^2(90-60)} = \frac{3/4}{1/4}$

$\frac{h_1}{h_2} = \frac{3}{4} \times \frac{4}{1} = 3.$

$h_2 = h_1/3 \Rightarrow \frac{102}{3} = \boxed{34m}$

K.E. of a photoelectron is E and its wavelength of incident light $\lambda/2$. if energy becomes double when wavelength is reduced to $\lambda/3$, then work function of metal is ______

$E = \frac{2hc}{\lambda} - W.F$ — ①

$2E = \frac{3hc}{\lambda} - W.F$

$\frac{4hc}{\lambda} - 2W.F = \frac{3hc}{\lambda} - W.F$

$\frac{4hc}{\lambda} - \frac{3hc}{\lambda} = -W.F + 2W.F$

$\boxed{\frac{hc}{\lambda} = W.F}$

A person of carrying a whistle emitting continuously a note of 272 Hz is running towards a reflecting surface with a speed of 18 km/hr. The speed of sound in air is 345 m/s. The no. of beats heard by him.

Case i)

S → O

$n' = \frac{V}{V-V_s}$ —(1) $\quad \frac{5}{18} \times 1$

case ii)

← S O.

$\frac{V}{V+V_s}$ —(2)

$n' = \frac{V+V_s}{V-V_s} \times n = \frac{350}{340} \times 272 = 280.$

no. of beats $= n_1 - n_2$
$= 280 - 272$
$= 8$

A man sets his watch by a whistle that is 2 km away, how much will his watch be in error? Given speed of sound = 330 m/s

$330 = \frac{2000}{t}$

$t = \frac{200\cancel{0}}{33\cancel{0}}$

$33)\,200\,(6.06$
198
200
198
20

$\therefore$ $\boxed{t = 6 \text{ seconds slow}}$

A stone is dropped from the Top of a tall tower. The ratio of K.E of stone at the end of three seconds ~~and~~ to the increase in the K.E of stone during the next three seconds.

$K.E = \frac{1}{2} mv^2 \quad (v = gt)$

$\boxed{K.E = \frac{1}{2} m g^2 t^2}$

$\frac{K.E_1}{K.E_2} = \frac{\frac{1}{2} m g^2 t^2}{\frac{1}{2} m g^2 (t_2^2 - t_1^2)} = \frac{t^2}{t_2^2 - t_1^2}$

$= \frac{3^2}{6^2 - 3^2} = \frac{9}{36-9} = \frac{9}{27} = \frac{1}{3}$

$\Rightarrow \boxed{1:3}$

The thermal resistance of two blocks connected in series will be, if their separate thermal resistances are 2 and 3.

$\Rightarrow 3+2=5$

Notes on Friction:

$\boxed{\text{Limiting}_f > \text{Static}_f > \text{Kinetic}_f > \text{Rolling}_f}$

→ friction $\propto \frac{1}{\text{motion}}$

→