20.02.2024

+1 MODEL EXAM

PHYSICS ANSWER KEY

SCIENCENTRE RAYS Powered by aegon

① Work

② Instantaneous Speed

③ Poles

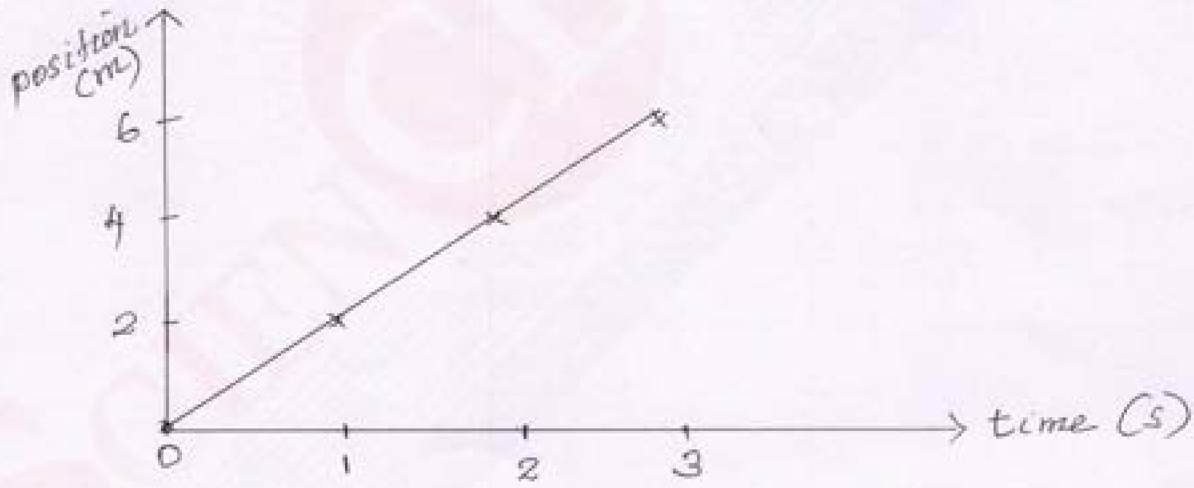
④ Young's modulus

⑤ Surface energy

⑥ Sublimation

⑦ Absolute Temperature

⑧



$$\text{velocity} = \text{slope} = \frac{y_2-y_1}{x_2-x_1} = \frac{6-2}{3-1} = \frac{4}{2} = \underline{2\,ms^{-1}}$$

⑨ $F_1 = 10N \quad F_2 = 8N \quad \theta = 60^\circ$

$$F = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

$$= \sqrt{10^2 + 8^2 + 2\times10\times8\cos 60} = \sqrt{244} = \underline{15.62\,N}$$

(10) a) Conservative force - Electrostatic force
magnetic force

Non - conservative force - frictional force
viscous force.

b) Velocity.

(11) a) M.I of a body rotating ~~body~~ about an axis is defined as the sum of product of mass of every particle present in the body and square of their respective distances from the axis of rotation.

$$I = m_1 r_1^2 + m_2 r_2^2 + \dots m_n r_n^2$$

b) Angular momentum.

(12) a) $V_e = \sqrt{\frac{2GM}{r}}$; M is the mass of the earth. r is the distance from the centre of the earth.

Escape velocity is independent of mass of the body.

b) Kepler's law

I law :- Earth and other planets revolves around the sun in an elliptical orbits with sun at one of its foci.

13) a) Isothermal Expansion – No change ($\Delta U = 0$)

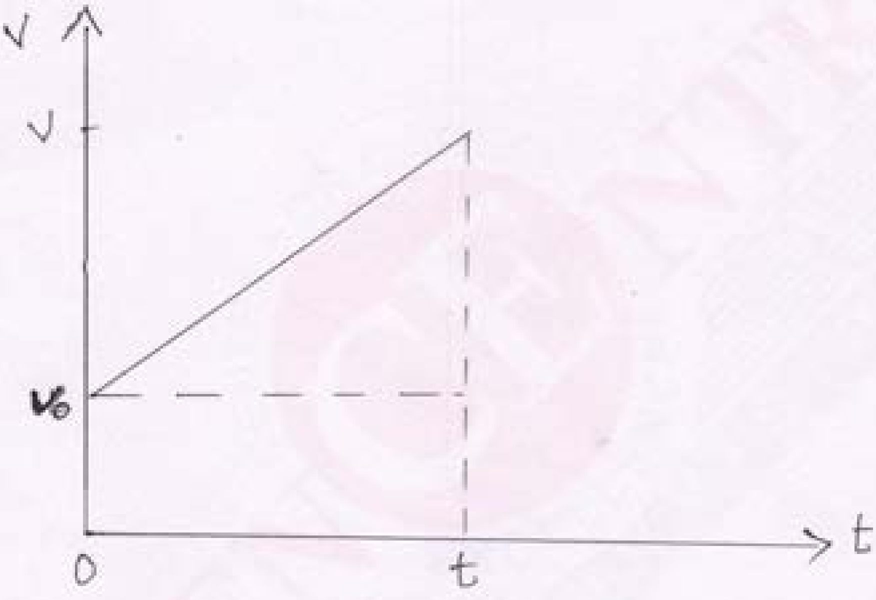
b) Adiabatic Expansion – internal Energy decreases

14) $V_{rms} = \sqrt{\frac{3RT}{M}}$ $\quad R = 8.3 \; J\,mol^{-1} K^{-1}$

$T = 300\,K$

$= \underline{483\,ms^{-1}}$ $\quad M = 0.032\,kg$

15)



a) Displacement = Area of rectangle + Area of triangle

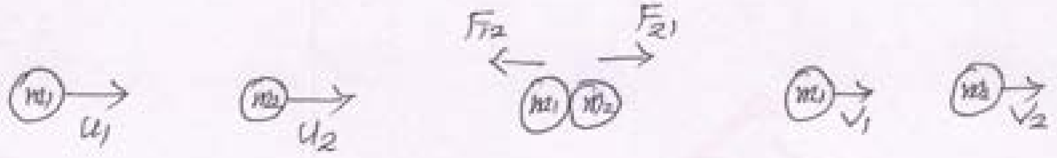
$$x = v_0 t + \frac{1}{2}at^2$$

b) Displacement = Area of the trapezium.

$$v^2 = v_0^2 + 2ax$$

(16) a) In the absence of external force the total linear momentum of a system of particles remains conserved.

b)



Force acting on m_1 due to m_2

F_{12} = Rate of change of momentum of m_1

$$F_{12} = \frac{m_1 v_1 - m_1 u_1}{\Delta t}$$

Force acting on m_2 due to m_1

F_{21} = Rate of change of momentum of m_2

$$F_{21} = \frac{m_2 v_2 - m_2 u_2}{\Delta t}$$

According to Newton's 3^{rd} law;

$$\vec{F}_{12} = -\vec{F}_{21}$$

$$\frac{m_1 v_1 - m_1 u_1}{\cancel{\Delta t}} = -\left[\frac{m_2 v_2 - m_2 u_2}{\cancel{\Delta t}}\right]$$

$$m_1 v_1 + m_2 v_2 = m_2 u_2 + m_1 u_1$$

or $m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$

ie; Total momentum is conserved.

(17) a) Moment of Inertia.

b) $\vec{L} = \vec{r} \times \vec{P}$

$$\frac{d\vec{L}}{dt} = \frac{d}{dt}(\vec{r} \times \vec{P})$$

$$= \frac{d\vec{r}}{dt} \times \vec{P} + \vec{r} \times \frac{d\vec{p}}{dt}$$

$$= \vec{v} \times m\vec{v} + \vec{r} \times \vec{F}$$

$$= m(\vec{v} \times \vec{v}) + \vec{\tau}$$

$\frac{d\vec{r}}{dt} = \vec{v}$

$\vec{P} = m\vec{v}$

$\frac{d\vec{p}}{dt} = \vec{F}$

$\vec{v} \times \vec{v} = 0$

$$\therefore \frac{d\vec{L}}{dt} = \vec{\tau}$$

(18) a) Modulus of Elasticity.

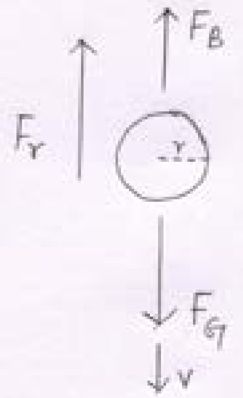
b) P - slope of stress - strain graph is greater

c) P - Young's Modulus of elasticity is greater.

(19)

a) Terminal velocity.

b)



Forces on water drop

i) $F_G = mg = V\sigma g$, downwards

ii) $F_B = m'g = V\rho g$, upwards.

iii) $F_r = 6\pi\eta r v$, upwards.

where $\sigma \Rightarrow$ density of raindrop

$\rho \Rightarrow$ density of air (atmosphere)

$\therefore$ Net force $= F_G - F_B - F_r$

when the raindrop attain constant velocity (terminal velocity),

Net force $= 0$.

$$F_G - F_B - F_r = 0$$

$$V\sigma g - V\rho g - 6\pi\eta r v = 0$$

$$6\pi\eta r v = V\sigma g - V\rho g$$

For sphere $V = \frac{4}{3}\pi r^3$

$$6\pi\eta r v = \frac{4}{3}\pi r^3 (\sigma - \rho) g$$

$$v = \frac{4}{3\times 6}\frac{r^2}{\eta}(\sigma - \rho) g$$

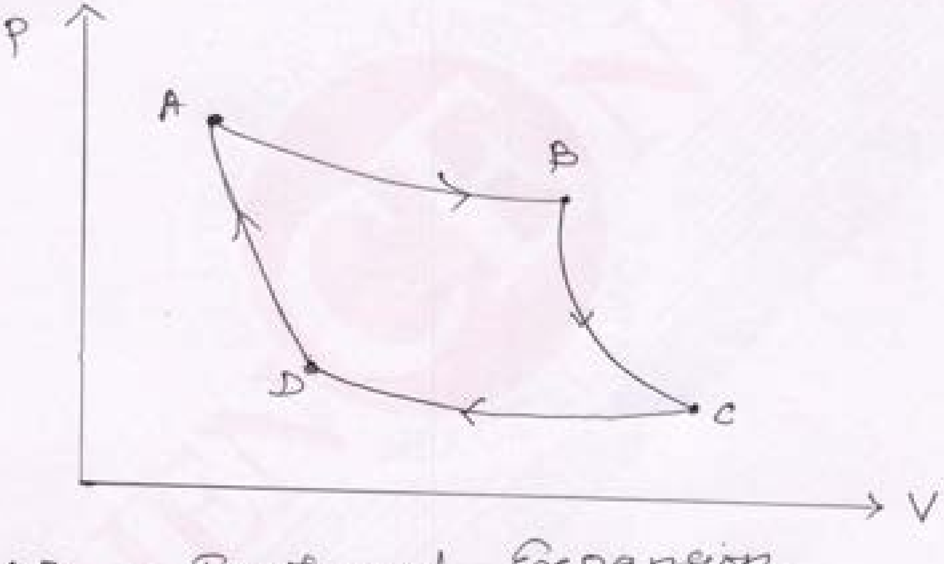
$$v_T = \frac{2}{9}\frac{r^2}{\eta}(\sigma - \rho) g$$

(20) a) The average distance travelled by the molecule between two successive collisions

b) Write any two postulates.

21 a) The amount of heat energy given to a system is used to increase the internal energy of the system and also to do external work.

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

b) 

AB – Isothermal Expansion

BC – Adiabatic Expansion

CD – ~~A~~ Isothermal Compression

DA – Adiabatic Compression

22) a) i) − 2
ii) − 2

b) $\frac{1}{2} mv^2 = mgh$

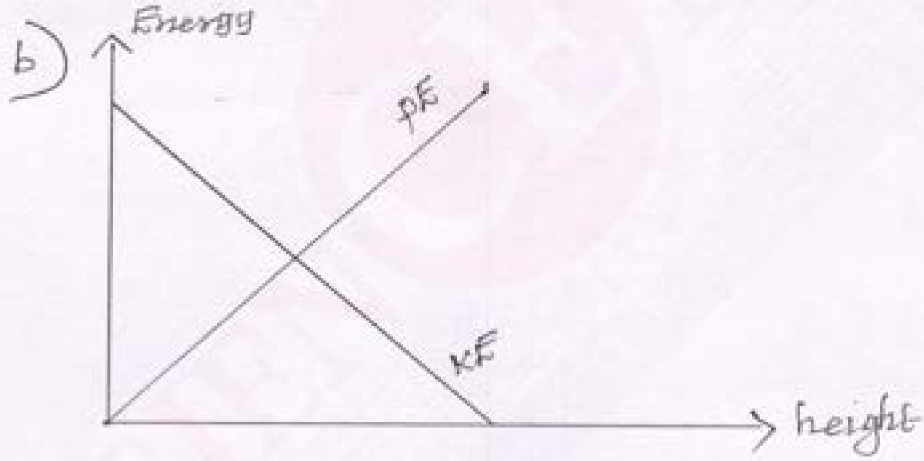
$[M][LT^{-1}]^2 = [M][LT^{-2}][L]$

$[ML^2T^{-2}] = [ML^2T^{-2}]$

The given equation is dimensionally correct.

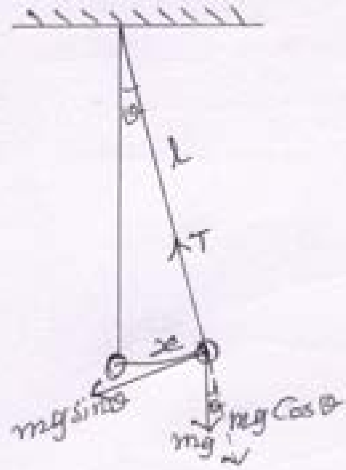
23) a) i) positive work
(ii) Negative work

b)



24) a) Motion of a body about a fixed point in such a way that its acceleration is directly proportional to its displacement and are in opposite directions.

b)



$F = -mg\sin\theta$

$ma = -mg\sin\theta$

$a = -g\sin\theta$ | $\sin\theta = \frac{x}{l}$

$a = -g\left(\frac{x}{l}\right)$

$= -\left(\frac{g}{l}\right)x$

$a \propto -x$

Since acceleration $\propto$ − (Displacement)
∴ the oscillation of a pendulum is SHM.

c) potential energy is maximum at Extreme position and Kinetic Energy is maximum at mean position.

25) a) $y = 0.005 \sin(80x - 3t)$

$K\cancel{x} = 80\cancel{x}$

$\frac{2\pi}{\lambda} = 80$

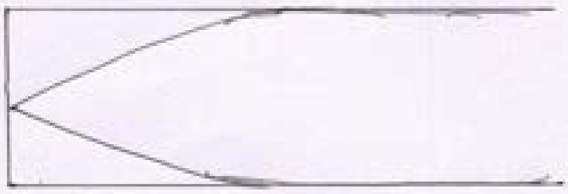
$\lambda = \frac{2\pi}{80} = \frac{\pi}{40}\,m = 0.0785\,m$

$\omega = 3$

$\frac{2\pi}{T} = 3$

$T = \frac{2\pi}{3} = 2.09\,s$

b) Fundamental Mode of vibration



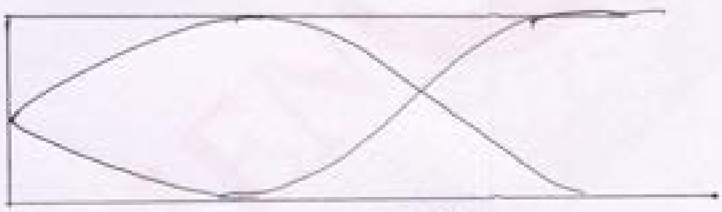
$L = \frac{\lambda_1}{4}$

$\therefore \lambda_1 = 4L$

frequency $\nu_1 = \frac{V}{\lambda_1} = \frac{V}{4L}$

It is called fundamental frequency or 1^{st} harmonic.

1st overtone



$L = \frac{3\lambda_3}{4}$

$\therefore \lambda_3 = \frac{4L}{3}$

frequency $\nu_3 = \frac{V}{\lambda_3} = \frac{3V}{4L}$ ie; $\nu_3 = 3\nu_1$

This frequency is called 3^{rd} harmonic or 1^{st} overtone.

Ratio of frequency $= 1:3$

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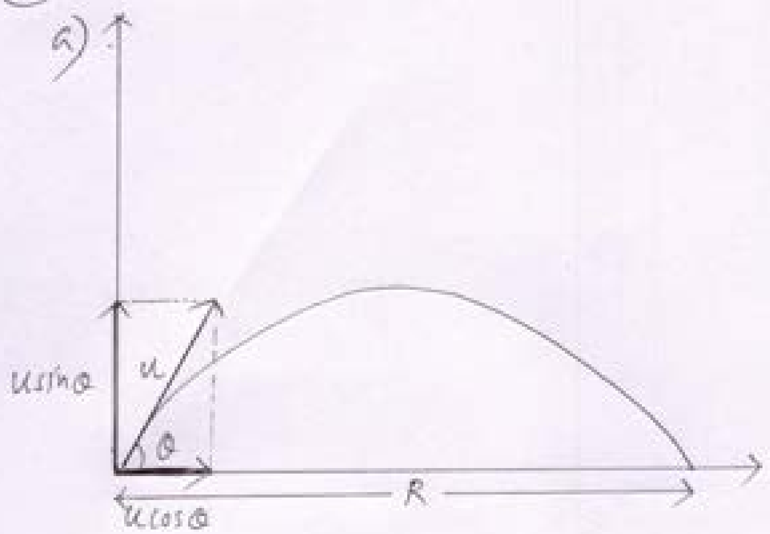
a)



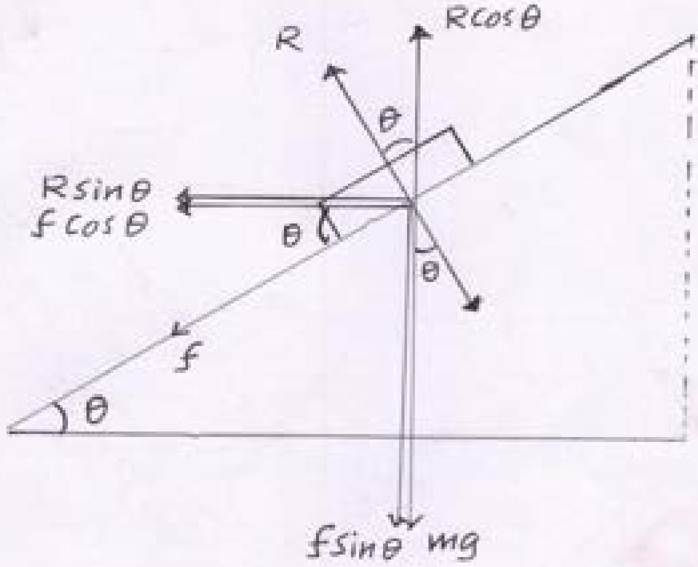
When the projectile reaches same horizontal level,
vertical displacement, $y = 0$.

I)
$$S = ut + \frac{1}{2}at^2$$
$$y = u_y t + \frac{1}{2} a_y t^2$$
$$0 = u\sin\theta \cdot T - \frac{1}{2} g T^2$$
$$\frac{1}{2} g T^2 = u\sin\theta \cdot T$$
$$T = \frac{2u\sin\theta}{g}$$

II) Horizontal range
$$x = u_x t + \frac{1}{2} a_x t^2$$
$$x = R, \; a_x = 0, \; t = T = \frac{2u\sin\theta}{g}$$
$$R = u\cos\theta \cdot \frac{2u\sin\theta}{g}$$
$$R = u^2 \frac{2\cos\theta \cdot \sin\theta}{g}$$
$$R = \frac{u^2 \sin 2\theta}{g}$$

b) given
$$H = \frac{1}{4} R$$
$$\frac{u^2 \sin^2\theta}{2g} = \frac{1}{4} \frac{u^2 \sin 2\theta}{g}$$
$$\sin\theta \cdot \sin\theta = \frac{2\sin\theta \cdot \cos\theta}{4}$$
$$\frac{\sin\theta}{\cos\theta} = 1$$
$$\tan\theta = 1$$
$$\therefore \theta = 45^\circ$$

Q.27 (a)



(b) From fig:

$$\frac{mv^2}{r} = R\sin\theta + f\cos\theta$$

$$\frac{mv^2}{r} = R(\sin\theta + \mu\cos\theta) \rightarrow ① \quad \because f = \mu R$$

$$\Rightarrow \quad R\cos\theta = mg + f\sin\theta$$

$$mg = R\cos\theta - f\sin\theta$$

$$\text{ie} \quad mg = R[\cos\theta - \mu\sin\theta] \rightarrow ②$$

$$\frac{①}{②} \Rightarrow \quad v = \sqrt{rg\left[\frac{\tan\theta + \mu}{1 - \mu\tan\theta}\right]}$$

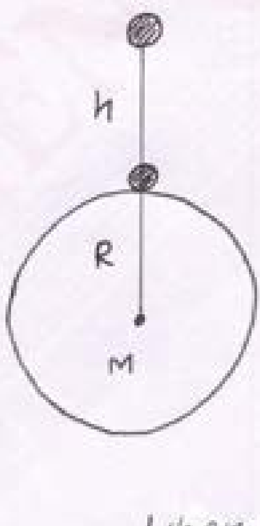
Q.28 (a) Every body in the universe attract each other. this force of attraction is directly propotional to the product of their masses and inversely propotional to the square of the distance between them.

ie $F = \frac{G m_1 m_2}{r^2}$

(b) $g = \frac{GM}{R^2}$

Acceleration due to gravity only depends upon mass of the body and radius of earth. It does not depends on mass of the body.

(c)



$$g = \frac{GM}{R^2}$$

$$g_h = \frac{GM}{(R+h)^2}$$

$$\frac{g_h}{g} = \frac{R^2}{(R+h)^2}$$

$$\frac{g_h}{g} = \left[1 + \frac{h}{R}\right]^{-2}$$

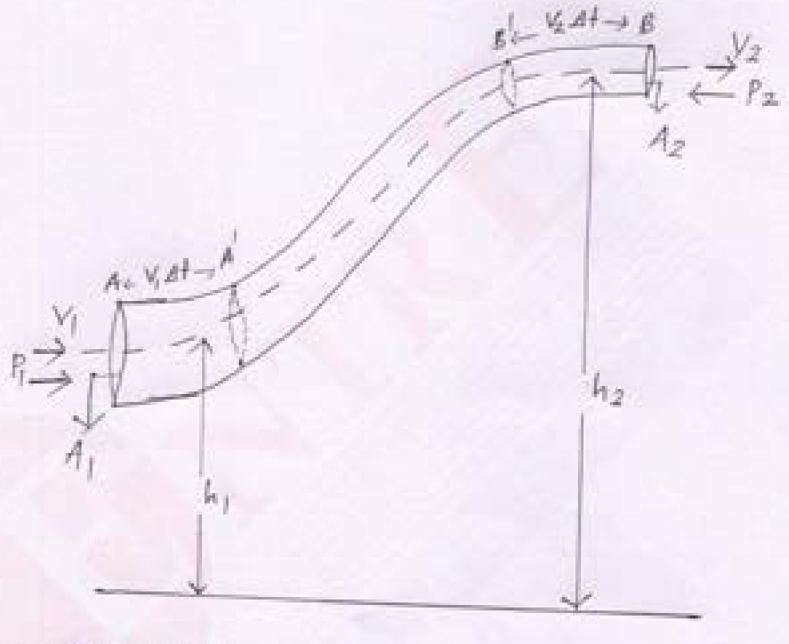
When, $h \ll R$, $g_h = g\left(1 - \frac{2h}{R}\right)$

(29)

a) In a streamline flow, the total Energy of small amount of ideal fluid remains constant.

$P.E + KE + PE =$ a constant.

Proof:-



Workdone on fluid, $W_1 = P_1 A_1 v_1 \Delta t$

workdone by fluid, $W_2 = -P_2 A_2 v_2 \Delta t$

Network, $W = W_1 + W_2$

$$W = P_1 A_1 v_1 \Delta t - P_2 A_2 v_2 \Delta t$$

By Equation of continuity,

$$A_1 v_1 \Delta t = A_2 v_2 \Delta t = V, \text{Volume}$$

$$\therefore W = P_1 V - P_2 V \quad — (1)$$

By work-Energy theorem,

$$\text{Workdone} = \Delta KE + \Delta PE \quad — (2)$$

$P = F/A$

$F = PA$

$V = \dfrac{\Delta x}{\Delta t}$

$\Delta x = V\Delta t$

Now,

$$\Delta KE = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$$
$$\Delta PE = mgh_2 - mgh_1 \quad (3)$$

From (1) and (3), (2) become,

$$P_1V - P_2V = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 + mgh_2 - mgh_1$$

Rarrange,

$$P_1V + \frac{1}{2}mv_1^2 + mgh_1 = P_2V + \frac{1}{2}mv_2^2 + mgh_2$$

In general,

$$PV + \frac{1}{2}mv^2 + mgh = \text{a constant} \quad (4)$$

$$\frac{(4)}{V} \Rightarrow \quad P + \frac{1}{2}\rho v^2 + \rho gh = \text{a constant}$$

(b) For a steady flow,

shearing stress $\propto$ strain rate

$$\frac{F}{A} \propto \frac{\theta}{\Delta t}$$

shearing stress $= \eta \cdot$ strain rate

$$\therefore \eta = \frac{\text{shearing stress}}{\text{strain rate}}$$

It is the ratio of shearing stress to strain rate.

or

Co-efficient of viscosity can be defined as viscous force existing between two layers of unit area of cross-section having unit velocity gradient between them.