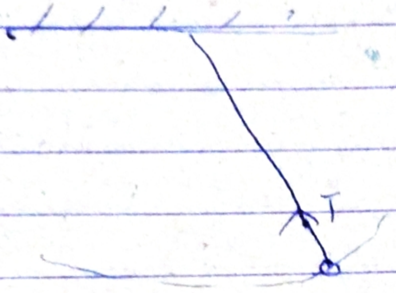
work, energy & power

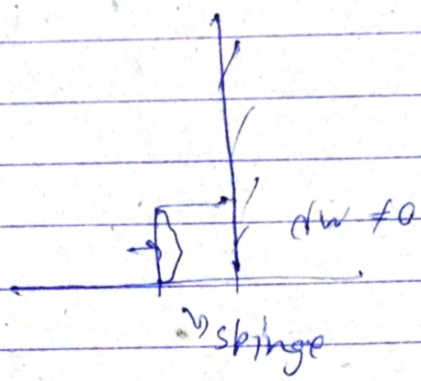
work done → scalar (+ive, -ive, 0).
Joule (SI unit)

$\boxed{dW = \vec{F} \cdot d\vec{s}}$

$d\vec{s}$ → displacement of point of application of force

$WD_T = 0 \quad \{ T \perp d\vec{s} \}$





ex $\vec{F} = 2\hat{i} + 3\hat{j} + 2\hat{k}$

m

B (3, 4, 3)

A (1, 2, 1)

$WD_F = ?$

ex $dW = \vec{F} \cdot d\vec{s}$

$\boxed{WD_F = \int \vec{F} \, (dx\hat{i} + dy\hat{j} + dz\hat{k})}$

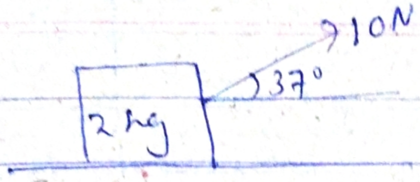
$= \int (2\hat{i} + 3\hat{j} + 2\hat{k}) \cdot (dx\hat{i} + dy\hat{j} + dz\hat{k})$

$= \int_1^3 2\,dx + \int_2^4 3\,dy + \int_1^3 2\,dz$

$= 4 + 6 + 4$

$= 14\ J$

ex.



$10\cos 37$

$2\cancel{10}\ \frac{4}{8} = 8$

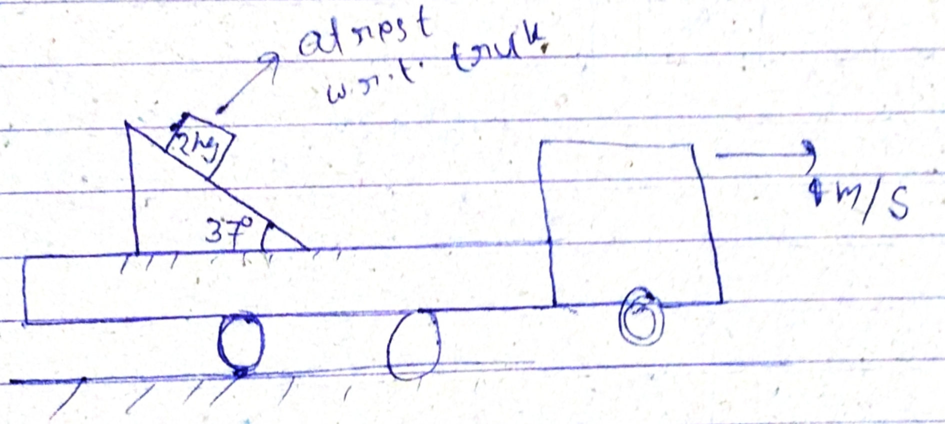
$a = 4$

$t = 0$ W.D. in 2 sec.
$u = 0$

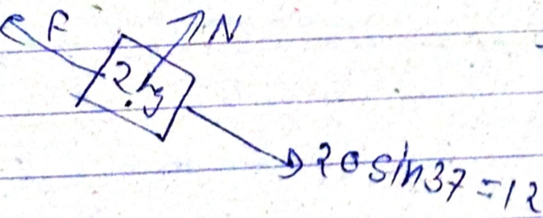
$S = \frac{1}{\cancel{2}} \times 4 \times \cancel{4}^2 = 8$

$W = 8 \times 8 = 64N$

ex



find W.D in 2 sec by friction in ground frame



$f = 12$

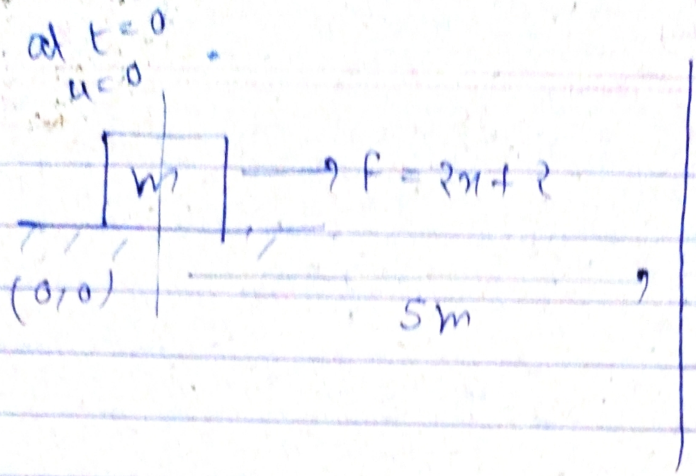
WD by fri. for chita = 0

$W.D = 12 \times 8 \times \cos(180-37)$

$= -12 \times 8 \times \frac{4}{5}$

* work done depends on frame

$dw = F\,ds$
↳ depend on frame

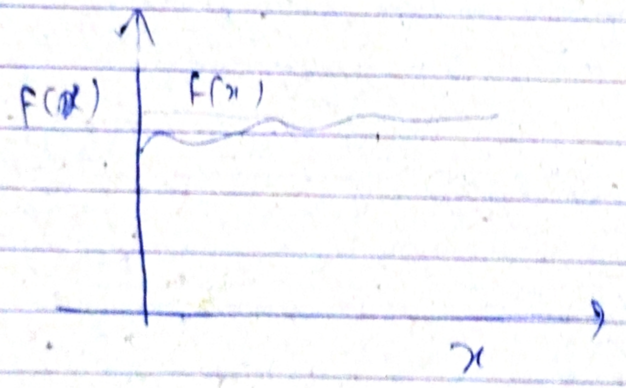


find work done by force

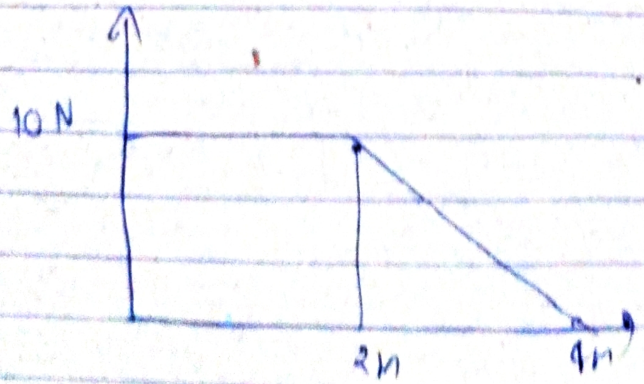
$$\int_0^W dW = \int_0^5 F\,dx$$

$$W = \left[x^2 + 2x\right]_0^5$$

$$= 25 + 10 = 35$$

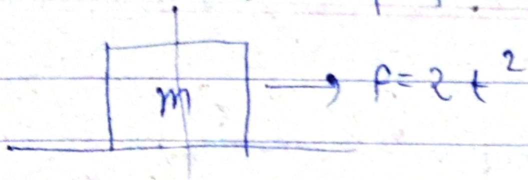


WD = Area under F(x) curve



WD = 30 J

$f = f(t)$



Find work done in to second.

$$a = \frac{2t^2}{m}$$

$$s = \frac{1}{2}\frac{2t^2}{m}t^2$$

$$= \frac{t^4}{m}$$

$$W = \int_0^{t_0} \frac{t^4}{m}\,dt$$

$$= \frac{t^5}{5m} = \frac{t_0^5}{5m}$$

$$dW = f\,dx$$

$$= 2t^2 \cdot \frac{dx}{dt} \cdot dt$$

$$= 2t^2\, v \cdot dt$$

$$= 2t^2\, \frac{2t^3}{3m}\, dt$$

$$\int_0^W dW = \int_0^{t_0} \frac{2t^2\, 2t^3}{3m}\,dt$$

Conservative forces are the forces whose work done is path independent

ex Gravitational force, electrostatic force, spring force etc.

Type of conservative force.

① $f = 2\hat{i} + 3\hat{j}$ (constant force)

$\cdot(2, 4)$

$(0,0)$

$$W.D = \int (2\hat{i} + 3\hat{j})(dx\hat{i} + dy\hat{j})$$

$$= \int_0^2 2dx + \int_0^4 3dy$$

$$= 4 + 12 = 16\,J$$

form (2)

(2) $f = x^2\hat{i} + y^2\hat{j}$ $\qquad f = f(x)\hat{i} + f(y)\hat{j} + f(z)\hat{k}$

$$dw = \int_0^2 x^2\,dx + \int_0^4 y\,dy$$

$$= \left(\frac{x^3}{3}\right)_0^2 + \left(\frac{y^2}{2}\right)_0^4$$

$$= \frac{8}{3} + 8 = \frac{32}{3}$$

form 3
(perfect defferential form)

$x^2y\hat{i} + x^2y\hat{j}$

यह जानने का तरीका।

(3) $f = 2xy\hat{i} + x^2\hat{j}$

$$dw = \int_0^2 2xy\,dx + \int_0^4 x^2\,dy$$

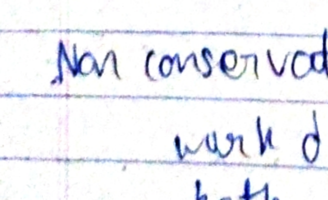
$$= \int 2xy\,dx + x^2\,dy$$

$$\int d(x^2 \cdot y)$$

$$= x^2y = 4 \times 4 = 16$$

(4) $f = 2y\hat{i}$ $\qquad$ non-conservative force

$$dw = \int 2y\,dx$$



$\downarrow$
not possible, possible only when path is known

$w_1 \neq w_2$

Non conservative: in these type of force work done by force is dependent on path.

ex Frictional force

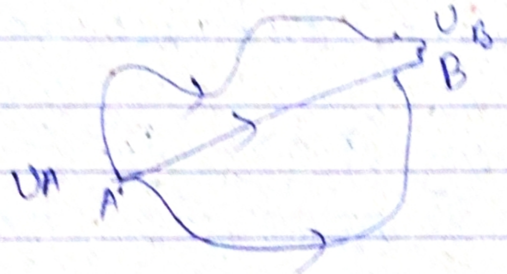
Potensial energey

$$\int_{U_i}^{U_f} dU = -\int dW_c$$

$$\cancel{U_f - U_i} = U_f - U_i = -W.D._c$$

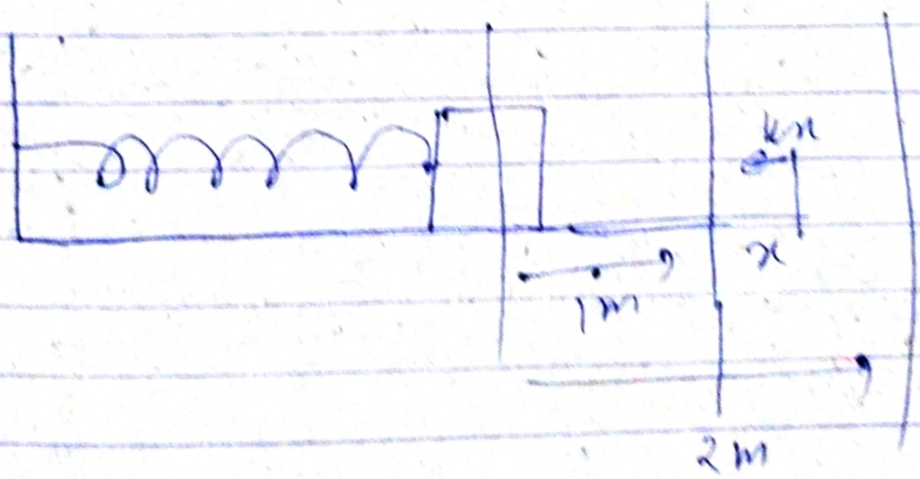
$$\Delta U = -W.D._c$$

$$\boxed{U_i - U_f = WD_c}$$



$$U_B - U_A = -WD_c$$

Potensial energey का concept केवल conservative force के लिए meaghneful है।



$$WD_c = -\int kx\,dx$$

$$= -k\left[\frac{x^2}{2}\right]_1^2$$

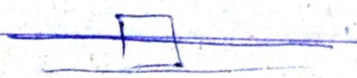
$$= -k\left(\frac{3}{2}\right)$$

Potensial energey of spring $= \frac{1}{2}kx^2$

$$\frac{1}{2}k(4-1) = \frac{3}{2}k$$

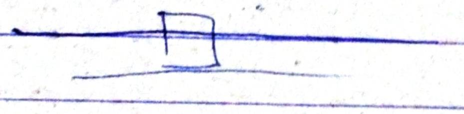
Potensial energy पढ़ेगा मुझे integration से बचायेगा
और सवाल को short करेगा।

it may be +ve, -ve or zero
unit → joule
it is only defined for conservative forces. It is because W.D. by conservative force is path independent
P.E ~~defend~~ at a point depends on refrence
but P.E difference does not defend on reference point.
असलियत में हमें समय से पता चलेगा कि P.E का use
~~हमें integration से बचायेगा और साथ ही साथ सवालों को आसान करता है।~~

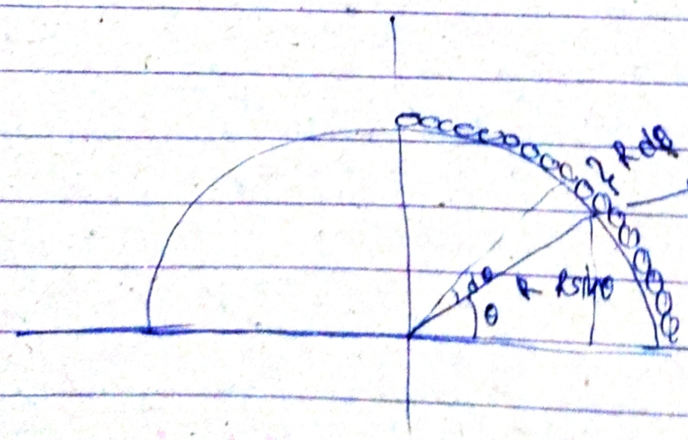


mgh

when g is assumed constant



0



$dM = \frac{M}{\pi R} 2 R\, d\theta = \frac{2M}{\pi} d\theta$

$l = \frac{\pi R}{2}$

R.L = 0

$dPE = dmgh$

$= \int_0^{\pi/2} g \frac{2M}{\pi} R \sin\theta \, d\theta = \frac{2MgR}{\pi} \left[-\cos\theta\right]_0^{\pi/2}$