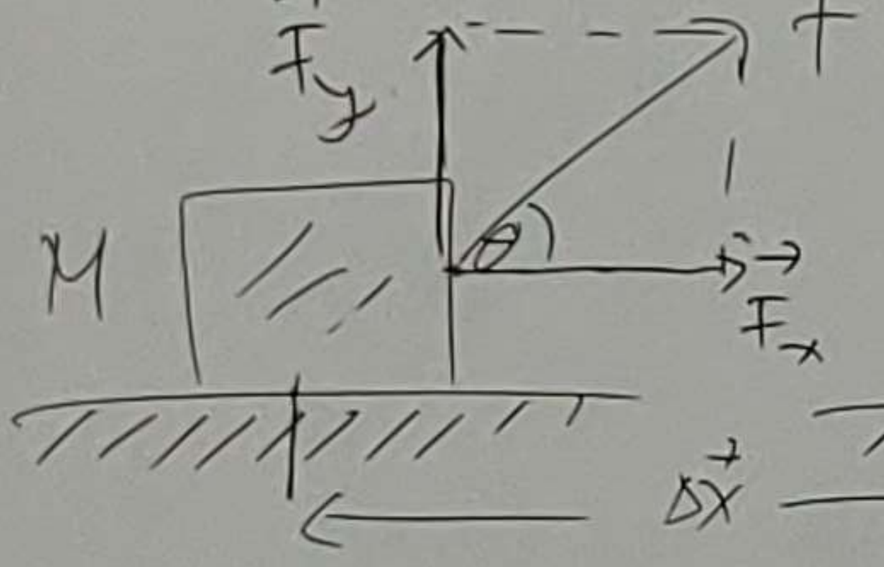
Usaha Energi

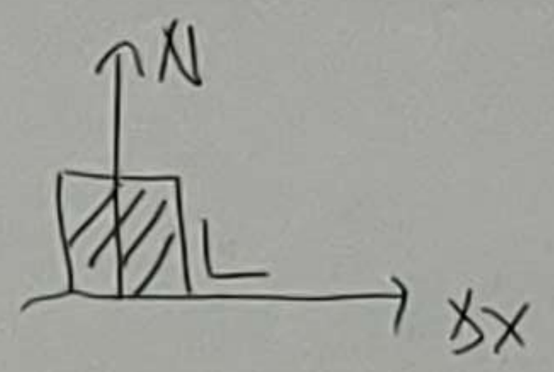
Usaha → skalar

Usaha W

↳ Definisinya :

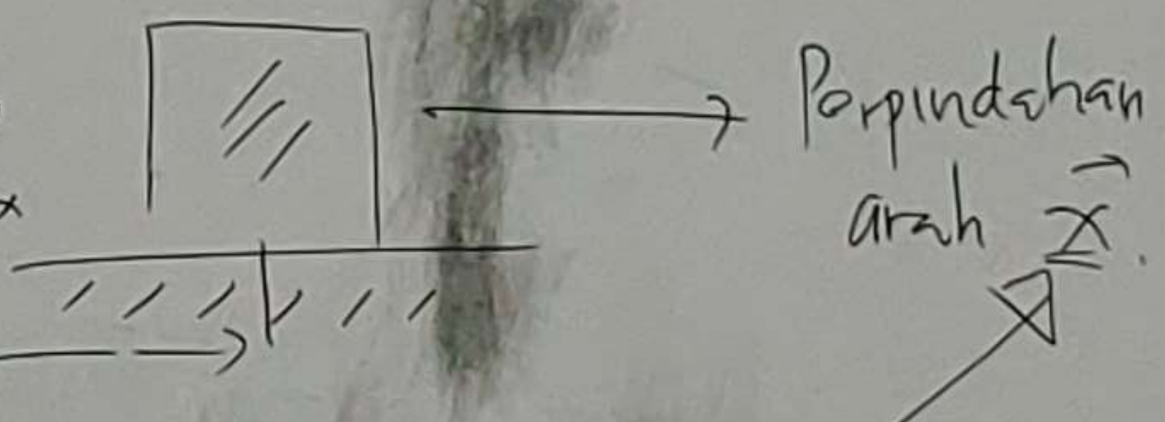
Diam





$W = N \Delta x \cos 90^\circ$

$W = 0 \, J$



→ Gaya yang segaris dengan Perpindahan

$$W = \vec{F}_x \cdot \Delta \vec{x} = \vec{F} \cdot \Delta \vec{x} \cos\theta$$

W : skalar

$\vec{F}$: vektor

$\Delta \vec{x}$: vektor

θ = sudut antara $\vec{F}$ dan $\Delta \vec{x}$

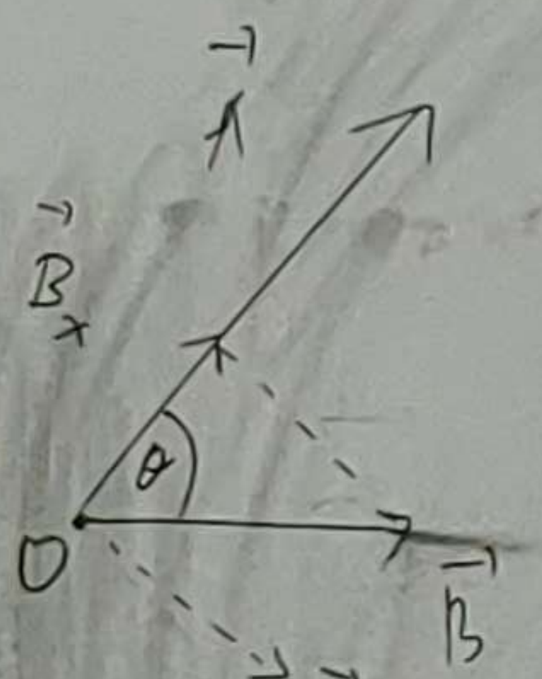
→ $\boxed{W = \vec{F} \cdot \Delta \vec{x}}$ ⟷

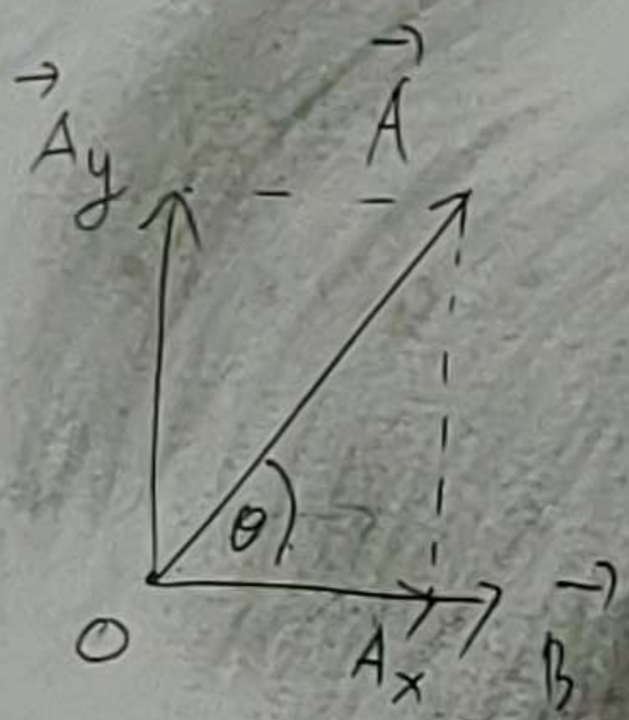
Dot product / Perkalian vektor

Perkalian Vektor

→ $\vec{A}$ • Perkalian titik

→ $\vec{B}$ ↳ Hasil: Skalar





$\vec{A} \cdot \vec{B} = \vec{A}\, B_x$

$\vec{A} \cdot \vec{B} = AB\cos\theta$

$\vec{B} \cdot \vec{A} = \vec{B} A_x$

$\vec{B} \cdot \vec{A} = BA\cos\theta$

$\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$

Vektor Satuan

↳ vektor nilai 1.

$\vec{x} \rightarrow \hat{i}$

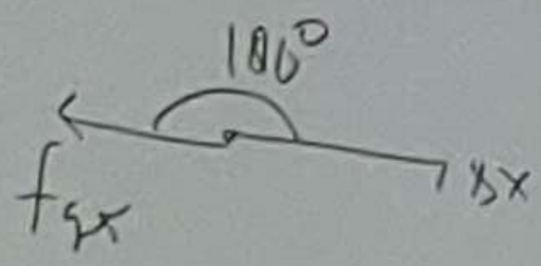
$\vec{y} \rightarrow \hat{j}$

$\vec{z} \rightarrow \hat{k}$

- $\hat{i} \cdot \hat{i} = 1 \cdot \cos 0^\circ = 1$
- $\hat{j} \cdot \hat{j} = 1 \cos 0^\circ = 1$
- $\hat{k} \cdot \hat{k} = 1$

$\therefore \hat{i} \cdot \hat{j} = 1 \cos 90^\circ = 0$

- $\hat{j} \cdot \hat{k} = 0$



© $W_{f_{ges}} = f_{ges} \Delta x \cos 180^\circ$

$= - f_{ges} \Delta x$

(a) $W_F = F \Delta x \cos\theta$.

(e) $W_T = W_N + W_w + W_{f_{ges}} + W_F$

$W_T = - f_{ges} \cdot \Delta x + F \Delta x \cos\theta$.

$W_T = (F\cos\theta - f_{ges})\ \Delta x$ J

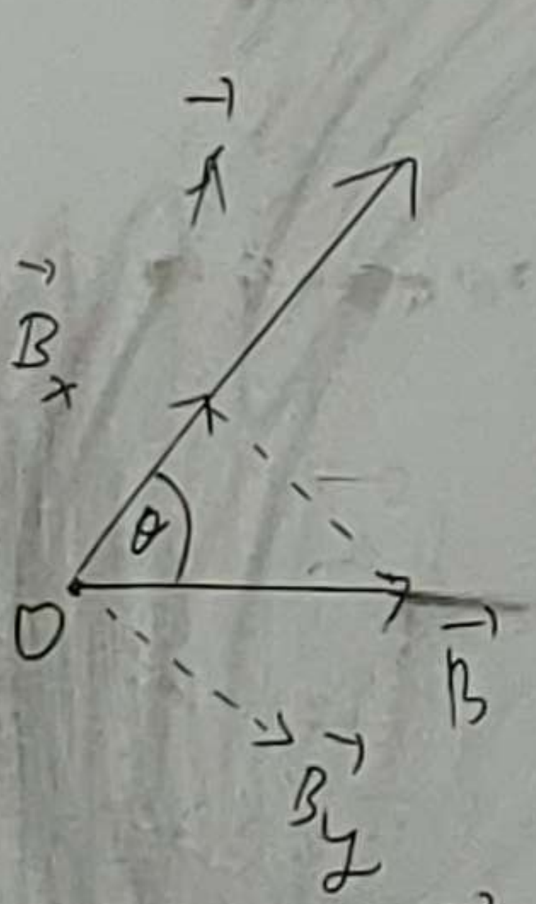
$W_T = (F_x - f_{ges})\ \Delta x$ ✓

$W_T = \sum f_x \cdot \Delta x$ ✓

Perkalian Vektor

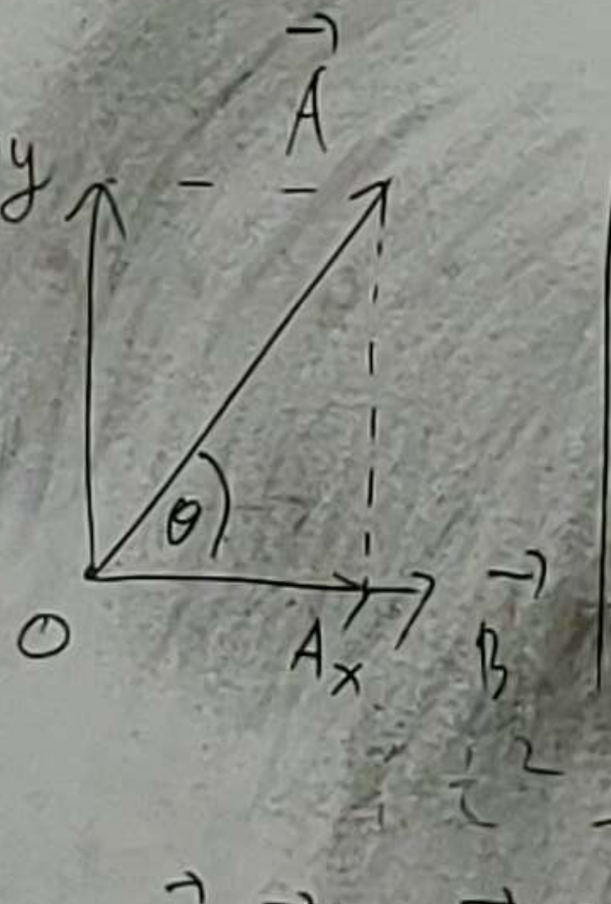
→ $\vec{A}$ · Perkalian titik

→ $\vec{B}$ ↳ Hasil: Skalar.



$$\vec{A} \cdot \vec{B} = \vec{A}\, B_x$$

$$\vec{A} \cdot \vec{B} = AB\cos\theta$$



$$\vec{B} \cdot \vec{A} = \vec{B} A_x$$

$$\vec{B} \cdot \vec{A} = BA\cos\theta$$

$$\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$$

Vektor Satuan

↳ vektor nilai 1.

$\vec{x} \rightarrow \hat{i}$

$\vec{y} \rightarrow \hat{j}$

$\vec{z} \rightarrow \hat{k}$

- $\hat{i} \cdot \hat{i} = 1 \cdot \cos 0^\circ = 1$
- $\hat{j} \cdot \hat{j} = 1 \cos 0^\circ = 1$
- $\hat{k} \cdot \hat{k} = 1$

$\therefore \hat{i} \cdot \hat{j} = 1 \cos 90^\circ = 0$

- $\hat{j} \cdot \hat{k} = 0$

$\vec{F}$

$\longrightarrow \Delta x$

$\vec{N}$ gaya normal

gaya berat

gaya gesek

gaya eksternal

θ

N

Δx

W

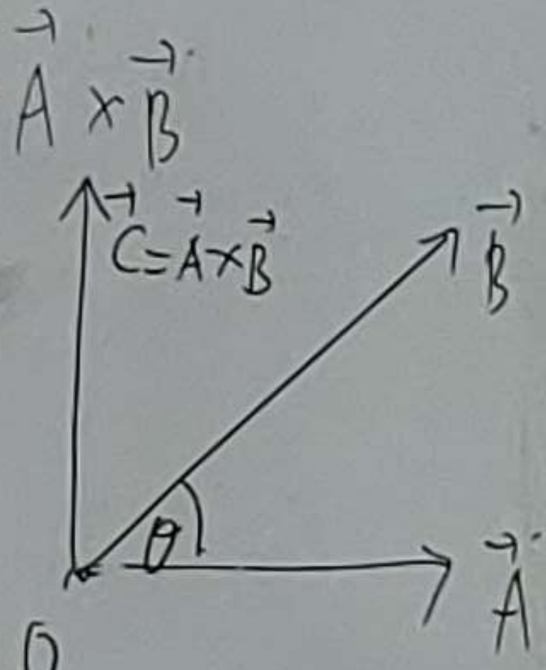
Δx

- Perkalian silang → Vektor.

$\vec{A}$
$\vec{B}$ } $\vec{A} \times \vec{B}$

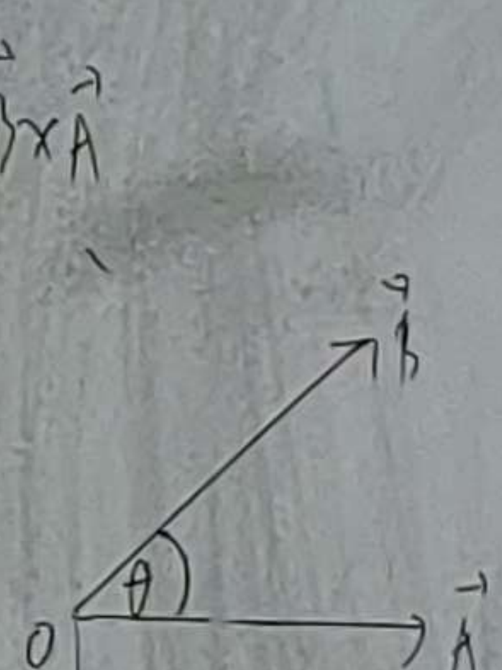
Cross

- $\vec{A} \times \vec{B}$



$\vec{A} \times \vec{B} = \vec{A}\vec{B} \sin\theta$

- $\vec{B} \times \vec{A}$



$\vec{B} \times \vec{A} = \vec{B}\vec{A} \sin\theta$

$\vec{A} \times \vec{B} = -(\vec{B} \times \vec{A})$.

ex: ① $\vec{F} = (3x - 2)$ Newton

Tent usaha F dari $x = 0$ m → $x = 2$ m !

Jb: $$W = \int_{x=0}^{x=2} F \, dx = \int_{x=0}^{x=2} (3x - 2) \, dx$$

$$W = \left(\frac{3}{2}x^2 - 2x \right) \Big|_{x=0}^{x=2}$$

$$W = \left(\frac{3}{2} \cdot 4 - 4\right) - \left(\frac{3}{2} \cdot 0 - 0\right) = 2 \text{ J}$$

② $\vec{F} = 3\hat{i} - 2\hat{j} + 4\hat{k}$

$\vec{x}_1 = \hat{i} + 2\hat{j} \longrightarrow \vec{x}_2 = 2\hat{i} - \hat{j} + 2\hat{k}$

Tent. W ?

$W = F \cdot \vec{x}$

$W = (3\hat{i} - 2\hat{j} + 4\hat{k}) \cdot (\hat{i} - 3\hat{j} + 2\hat{k})$

$W = 3 + 6 + 8 = 17 \text{ J} ///$

Persamaan $W = F \Delta x \cos\theta$

$\Downarrow$

Berlaku : $\vec{F}$ konstan.

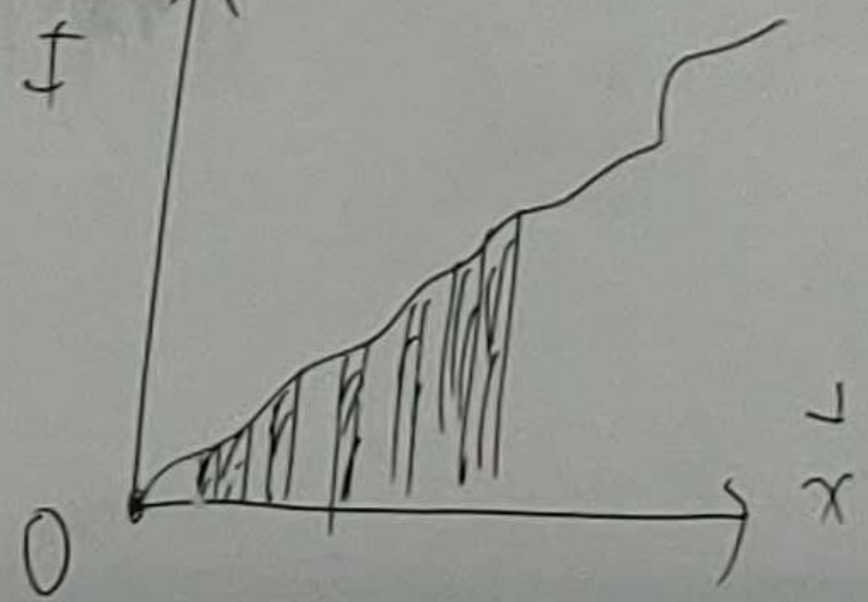
Kalau $\vec{F}$ → tidak konstan !

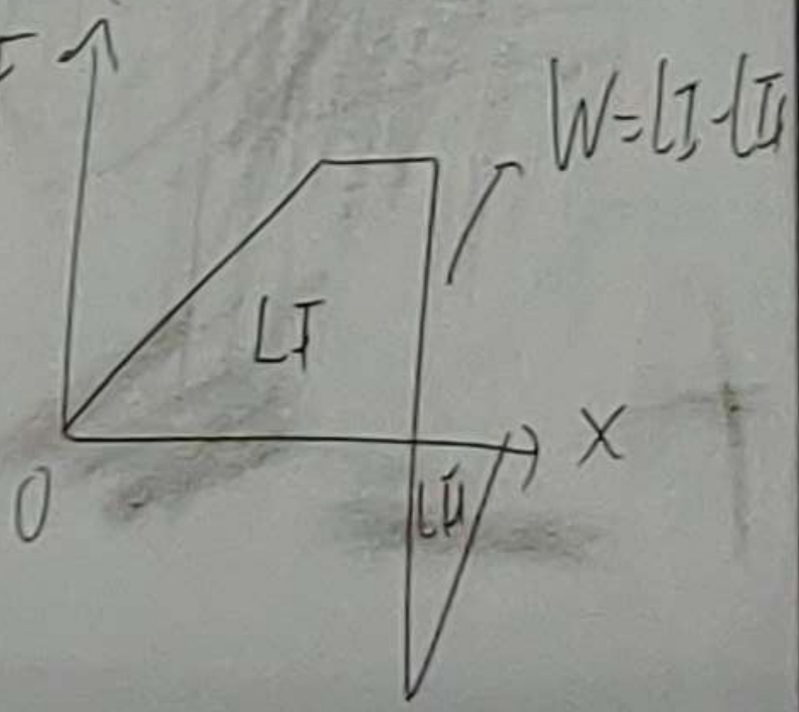
$$W = \vec{F} \cdot \Delta\vec{x}$$

$$dW = F \cdot dx$$

$$\int dW = \int F \cdot dx$$

$$W = \int F \cdot dx \rightarrow \text{luas grafik } \vec{F} \text{ thd } \vec{x}.$$





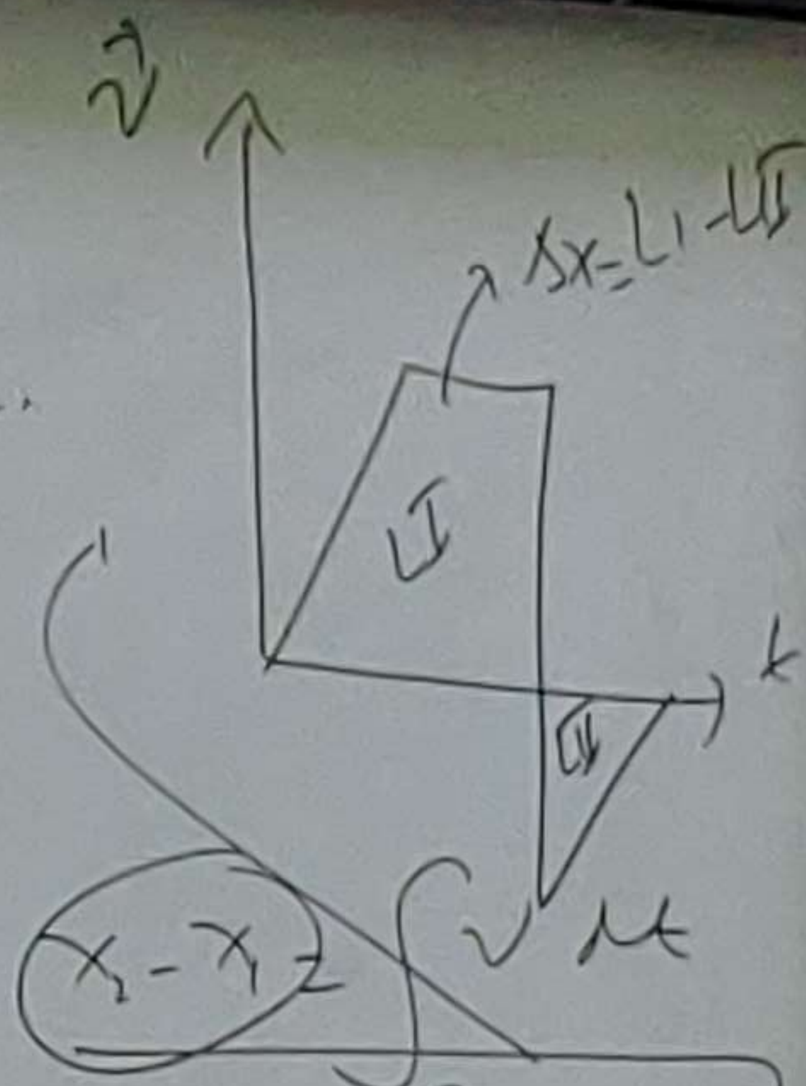
Diferensial → kalkulus.
/Turunan

→ $y = a x^n$ → n → orde
→ Variabel.
↳ koef

→ Turunan fungsi y thd x

$\frac{dy}{dx}$

$\frac{dy}{dx} = \frac{d}{dx}(ax^n) = n.a.x^{n-1}$



$\Delta x = \int v\,dt$

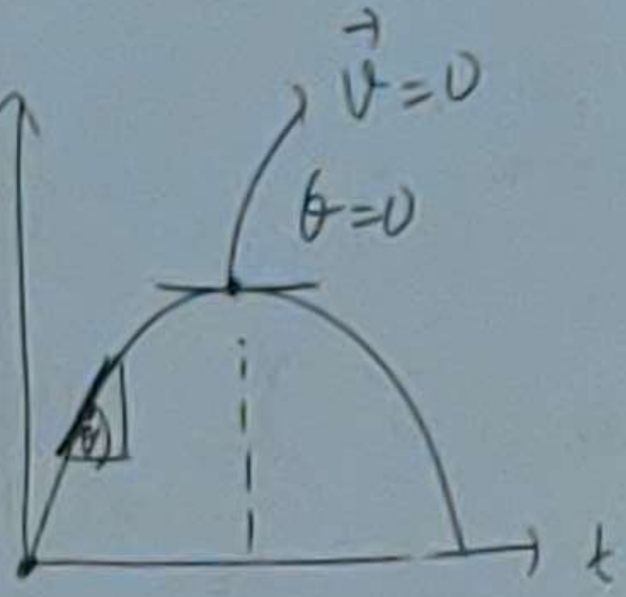
$\Delta x = v \cdot \Delta t$

- $y = 5t^2$
  $\frac{dy}{dt} = 10t$
- $y = 6$
  $\frac{dy}{dt} = 0$
- $y = 5x^2z$
  $\frac{dy}{dx} = 10xz$

→ fisika!

$\vec{v} = \left(\frac{\Delta \vec{x}}{\Delta t}\right)$ → kemiringan grafik

$\vec{v} = \frac{dx}{dt}$ → kemiringan grafik



$\rightarrow \vec{a} = \frac{\Delta \vec{v}}{\Delta t} \longleftrightarrow \vec{a} = \frac{d\vec{v}}{dt}$

$\rightarrow \vec{F} = \frac{\Delta \vec{p}}{\Delta t} \longleftrightarrow \vec{F} = \frac{d\vec{p}}{dt}$

- Integral $\longrightarrow \int$

$\rightarrow y = ax^n$

$\rightarrow$ Integral fungsi y thd x

$$\int y\,dx = \int ax^n\,dx$$

$$= \frac{a}{n+1}x^{n+1} + C$$

- $\int 5x\,dx = \frac{5}{2}x^2$
- $\int 2\,dx = 2x$

$$\int 2x^0\,dx = \frac{2}{1}x^{0+1}$$

- $\vec{v} = \frac{d\vec{x}}{dt}$

$dx = \vec{v}\,dt$

$$\int_{x_1}^{x_2} dx = \int_{t_1}^{t_2} v\,dt$$

$$x\Big|_{x_1}^{x_2} = \int_{t_1}^{t_2} v\,dt$$

$x_2 - x_1 = \ldots$

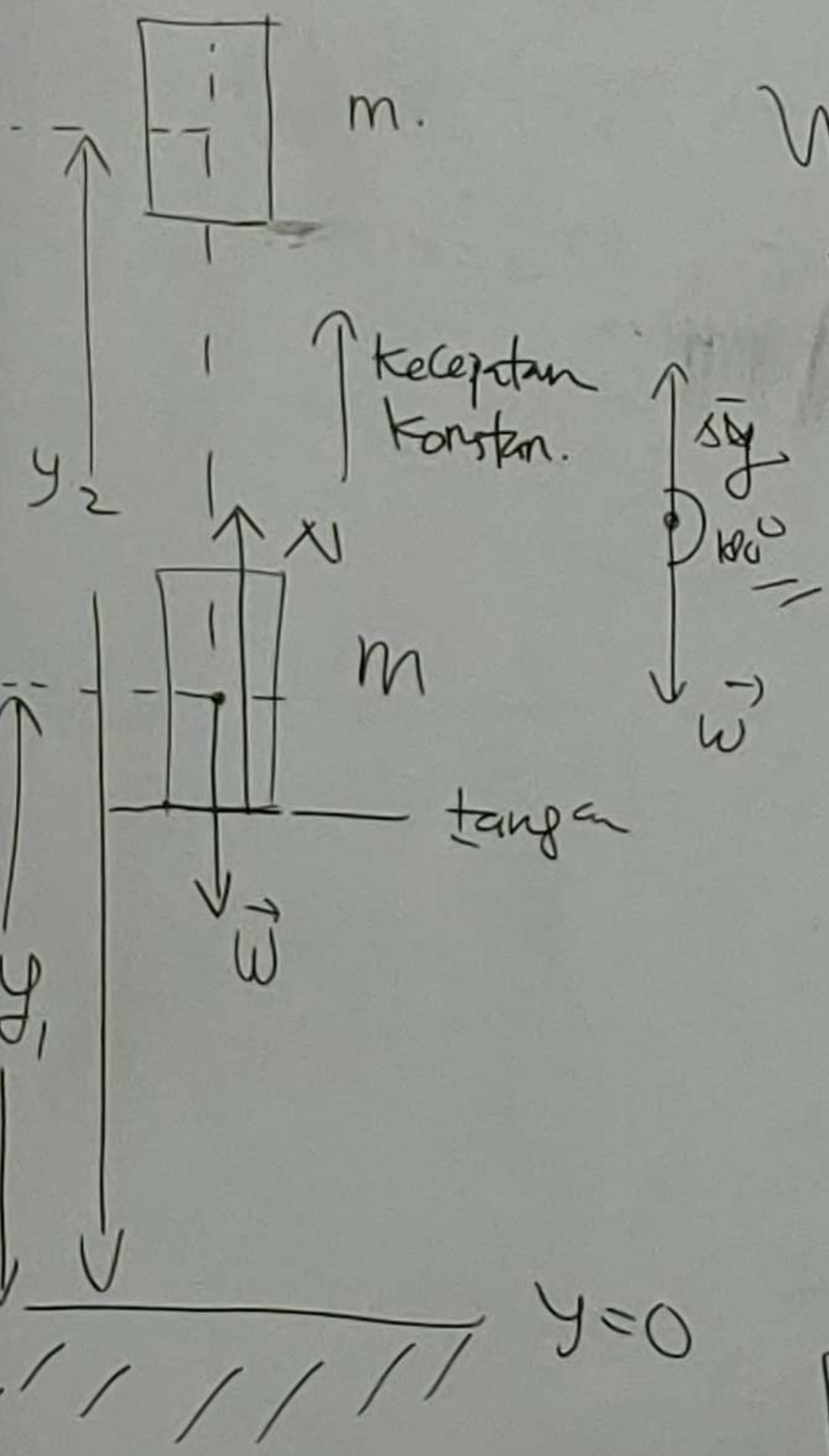
Energi (Potensial) → tersimpan

Ep. pegas.

Ep. grav

Ep. Grav.

→ Usaha oleh gaya gravitasi/Berat



$$W = \vec{w} \cdot \vec{\Delta y} \cos\theta$$

$$W = \vec{w}\, \vec{\Delta y} \cos 180^\circ$$

$$W = -(mg)(\vec{y}_2 - \vec{y}_1).$$

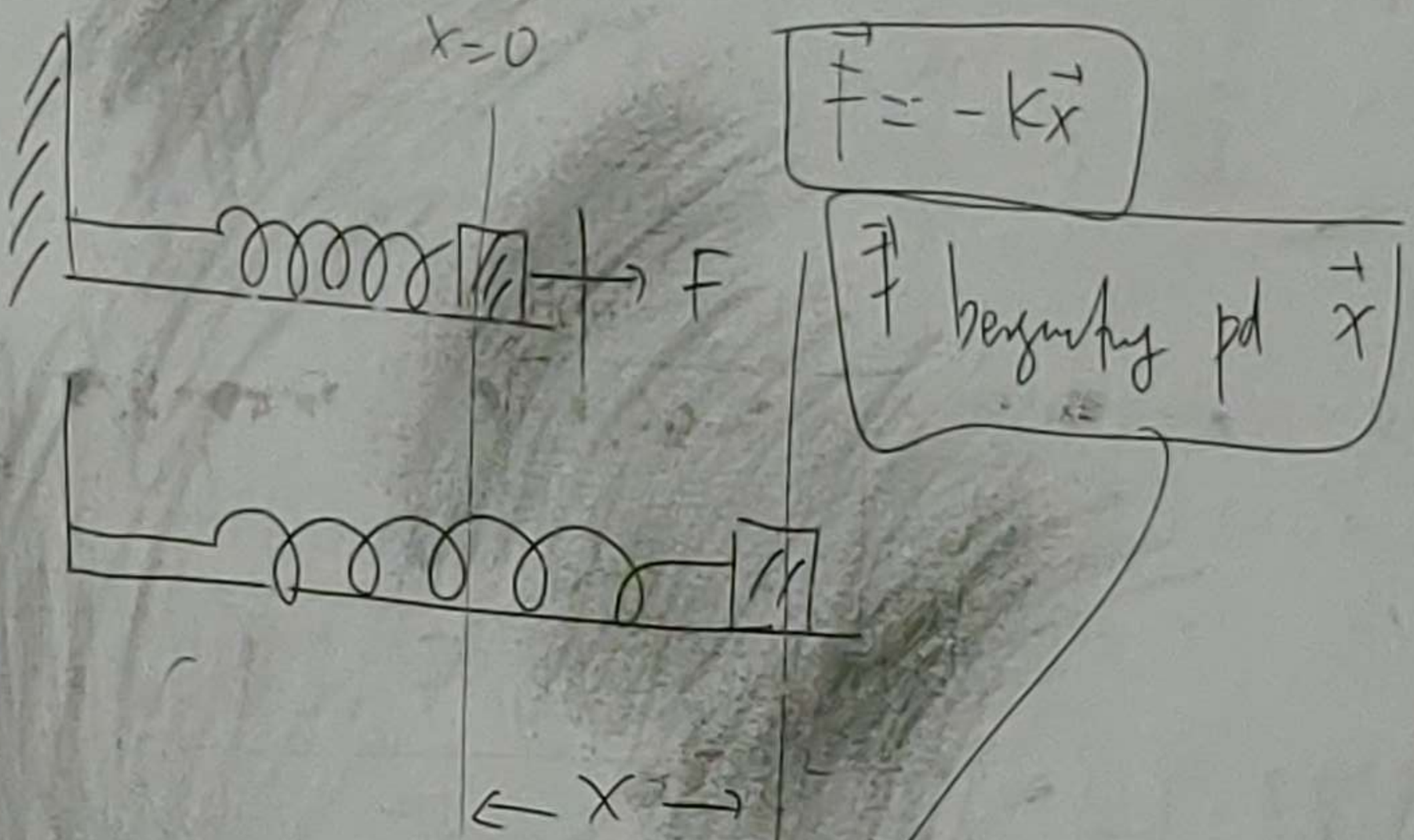
$$W = -(mgy_2 - mgy_1).$$

$$Ep_{grav} = mgy$$

$$W = -(Ep_{grav,2} - Ep_{grav,1}).$$

$$\boxed{W = -\Delta Ep}$$

Ep. Pegas



Usaha oleh gay pegas

$$W = \int_{x_1}^{x_2} F\,dx = \int_{x_1}^{x_2} -kx\,dx$$

$$W = -\frac{k}{2}x^2\Big|_{x_1}^{x_2} = -\left[\frac{1}{2}kx_2^2 - \frac{1}{2}kx_1^2\right]$$

$$= -[\,Ep\,]$$

$E_{p\,pegas} = \frac{1}{2} k x^2$

$W = -(EP_2 - EP_1) = -\Delta Ep$

Teorema Usaha - Energi →

↳ $W = -\Delta Ep$ ⟩ $EM = Ep + Ek$

$W = \Delta Ek$ ⟩

Hukum kekekalan Energi Mekanik

↳ Syarat : tidak bekerja gaya gesek

↳ $EM_{awal} = EM_{akhir}$

$\Delta Ek + \Delta Ep = 0$

$\Delta Ep + \Delta Ek =$

$\Delta Ep + \Delta Ek =$

• Integral →

→ $y = ax^n$

→ Integral fungsi

$\int y\,dx =$

$= \frac{}{n}$

* gaya gesek bekerja

↳ energi tetap berubah bentuk → panas
↳ bunyi

$$\Delta E_p + \Delta E_k = W_{fgs}$$

$$\Delta E_p + \Delta E_k = - f_{gas} \Delta x$$

$= E_p + E_k$

- Integral → $\int$

→ $y = ax^n$

→ Integral fungsi y thd x

$$\int y\,dx = \int ax^n\,dx$$

$$= \frac{a}{n+1} x^{n+1} + C$$

$v = \frac{dx}{dt}$

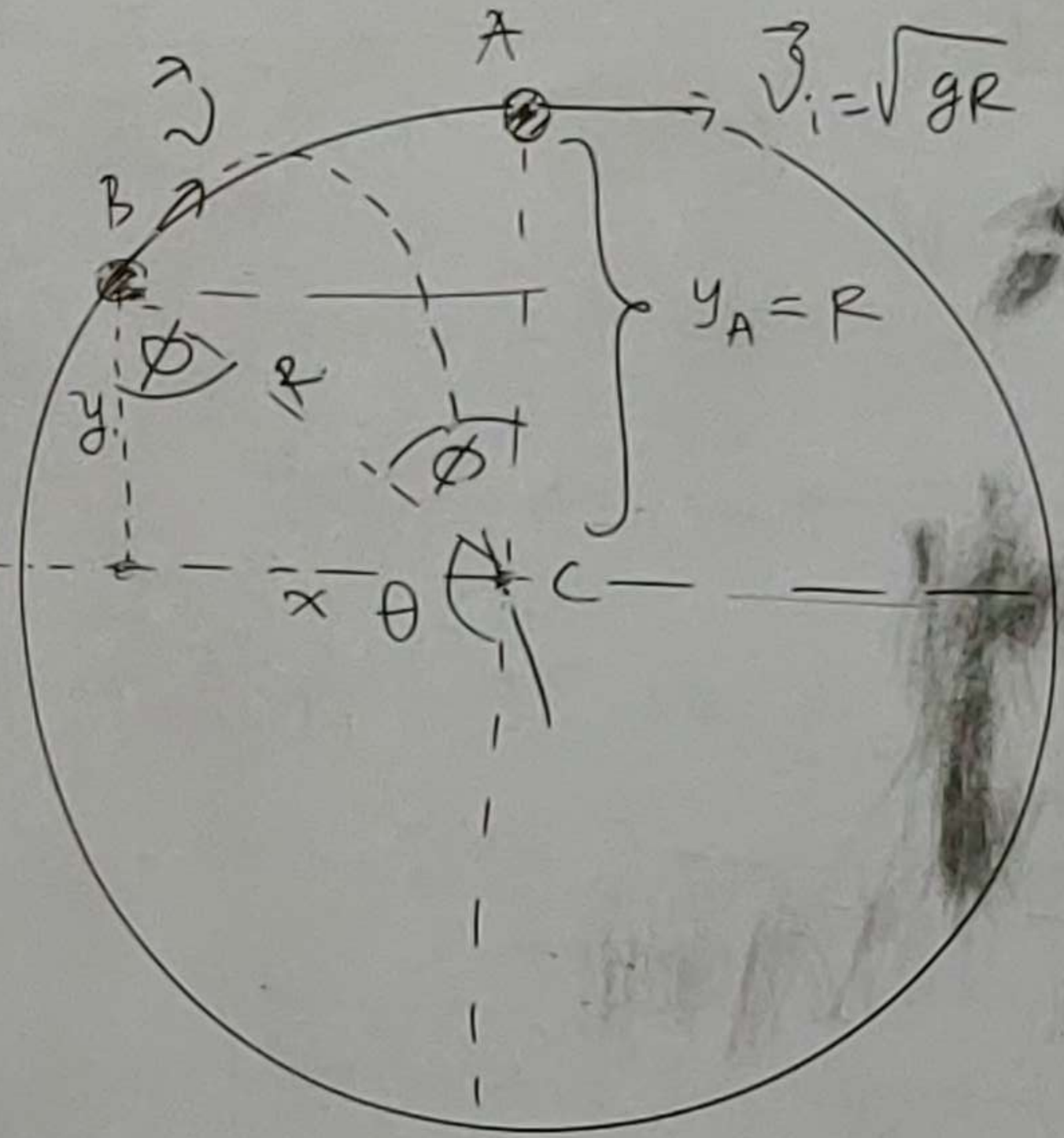
$dx = \vec{v}\,dt$

$$\int_{x_1}^{x_2} dx = \int_{t_1}^{t_2} v\,dt$$

$$x\Big|_{x_1}^{x_2} = \int_{t_1}^{t_2} v\,dt$$

$x_2 - x_1 =$ —

3)



Kordinat bola supaya melalui pusat O, $\{x, y\}$.

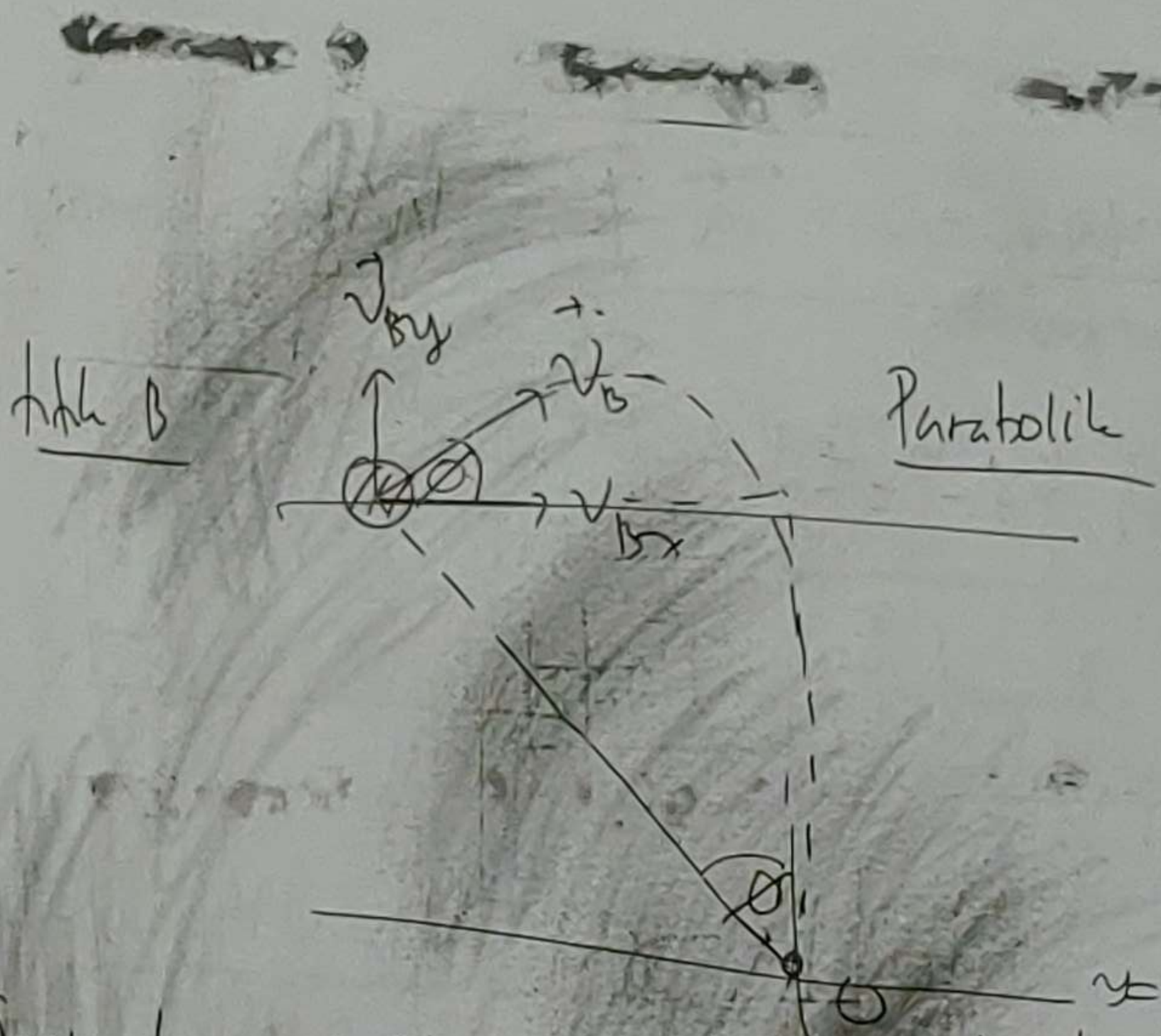
→ Ide 1 : Mencari nilai $\vec{v}_B$ → tali putus!

$$\Sigma M_A = \Sigma M_B$$

$$\Sigma P_A + \Sigma K_A = \Sigma P_B + \Sigma K_B.$$

$$mgR + \frac{1}{2}mgR = mg.R\cos\phi + \frac{1}{2}mv_B^2$$

$$\sqrt{3gR - 2gR\cos\phi} = v_B$$



Gerak sb x → GLB.

$x = v_x \cdot t$

$x = v_B \cos\theta \cdot t$

$R\sin\theta = v_B \cos\theta \cdot t$

$t = \dfrac{R\sin\theta}{v_B\cos\theta}$ --- ①

Gerak sb. y.

$y = v_{0y} \cdot t - \frac{1}{2}gt^2$

$y_2 - y_1 = v_{0y} t - \frac{1}{2}gt^2$

$0 - R\cos\theta = v_B \cdot \sin\theta \cdot t - \frac{1}{2}gt^2$

$-R\cos\theta = v_B \sin\theta t - \frac{1}{2}gt^2$ ②

II

$-\phi$

$\cos^2\phi$

$) \cos^2\phi$

$\times \cos\phi$

$) \cos^2\phi$

$\cos\phi$

$) \cos^2\phi$

$\phi) \cos\phi$

$R \cos\phi) \cos\phi$

$- 4gR\cos^2\phi$ ✓

$$gR\sin^2\varphi + 4gR\cos^2\varphi - 6gR\cos\varphi = 0$$

$$\boxed{\sin^2\varphi = 1 - \cos^2\varphi.}$$

$$gR(1 - \cos^2\varphi) + 4gR\cos^2\varphi - 6gR\cos\varphi = 0$$

$$gR - gR\cos^2\varphi + 4gR\cos^2\varphi - 6gR\cos\varphi = 0$$

$$3gR\cos^2\varphi - 6gR\cos\varphi + gR = 0$$

$$3\cos^2\varphi - 6\cos\varphi + 1 = 0$$

$a = 3$

$b = -6$ $c = 1$

$$\cos\varphi_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{6 \pm \sqrt{36 - 4(3)(1)}}{2(3)}$$

$$\cos\varphi_{1,2} = \frac{6 \pm \sqrt{24}}{6}$$

$$\cos\varphi_1 = \frac{6 + \sqrt{24}}{6} \; ; \; \cos\varphi_2 = \frac{6 - \sqrt{24}}{6}$$

↓ TM

$$\boxed{\cos\varphi_2 = 0{,}18}$$

arc. cos

$\varphi_2 = \cos^{-1}(0{,}18)$

$\varphi_2 = 79{,}63$

$\theta = 180 - 79{,}63$

$\phi = 100{,}37^0$

Pers 2

$$-R\cos\phi = v_B \sin\phi \cdot \frac{R\sin\phi}{v_B\cos\phi} - \frac{1}{2} g \frac{R^2\sin^2\phi}{v_B^2\cos^2\phi}$$

$$-R\cos\phi = \frac{R\sin^2\phi}{\cos\phi} - \frac{gR^2\sin^2\phi}{2\,(3gR - 2gR\cos\phi)\cos^2\phi}$$

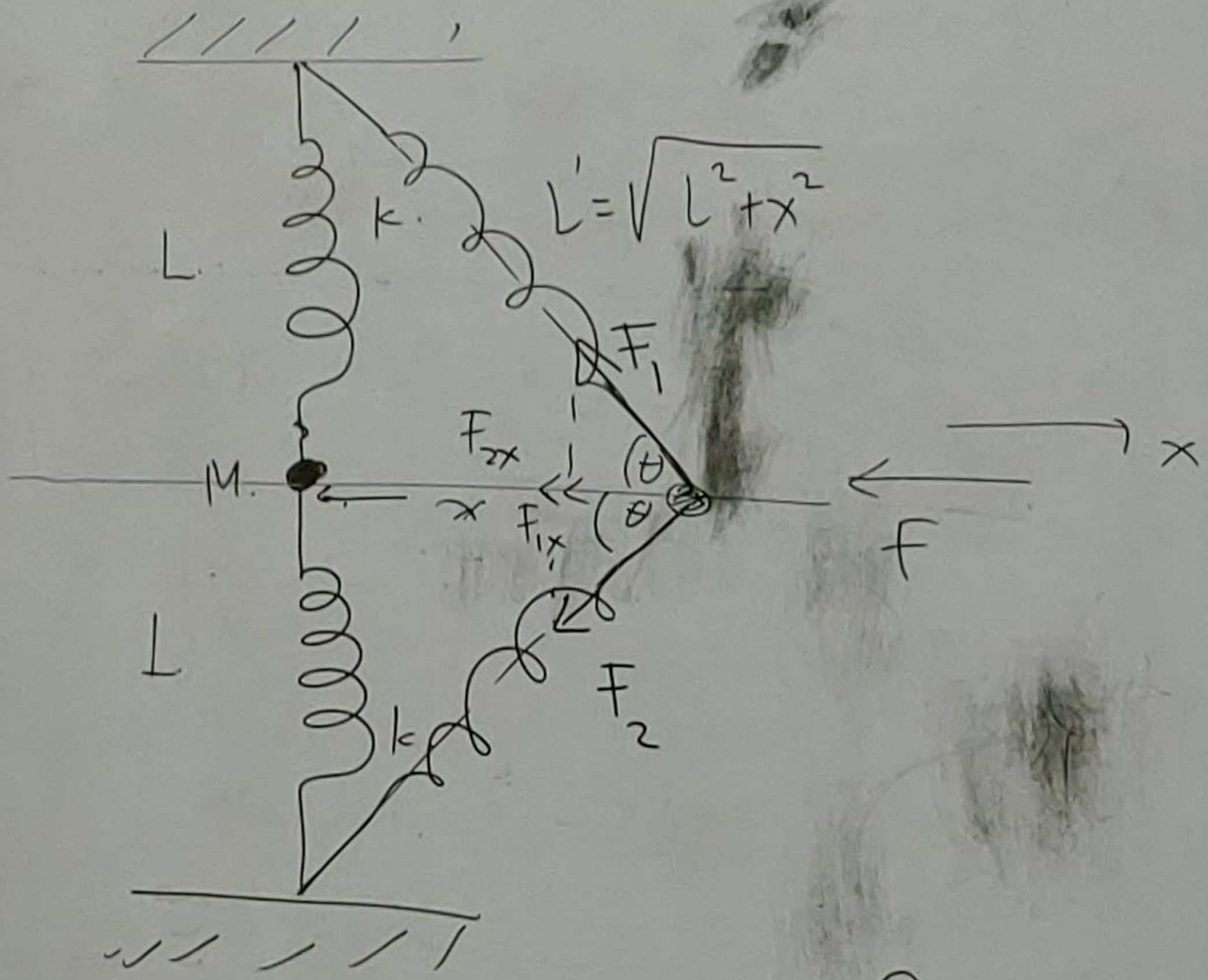
$$-\cos\phi - \frac{\sin^2\phi}{\cos\phi} = \frac{-Rg\sin^2\phi}{(6gR - 4gR\cos\phi)\cos^2\phi} \quad \Big| \times \cos\phi$$

$$-\cos^2\phi - \sin^2\phi = \frac{-Rg\sin^2\phi \cdot \cancel{\cos\phi}}{(6gR - 4gR\cos\phi)\cos^2\phi}$$

$$-(\sin^2\phi + \cos^2\phi) = \frac{-gR\sin^2\phi}{(6gR - 4gR\cos\phi)\cos\phi}$$

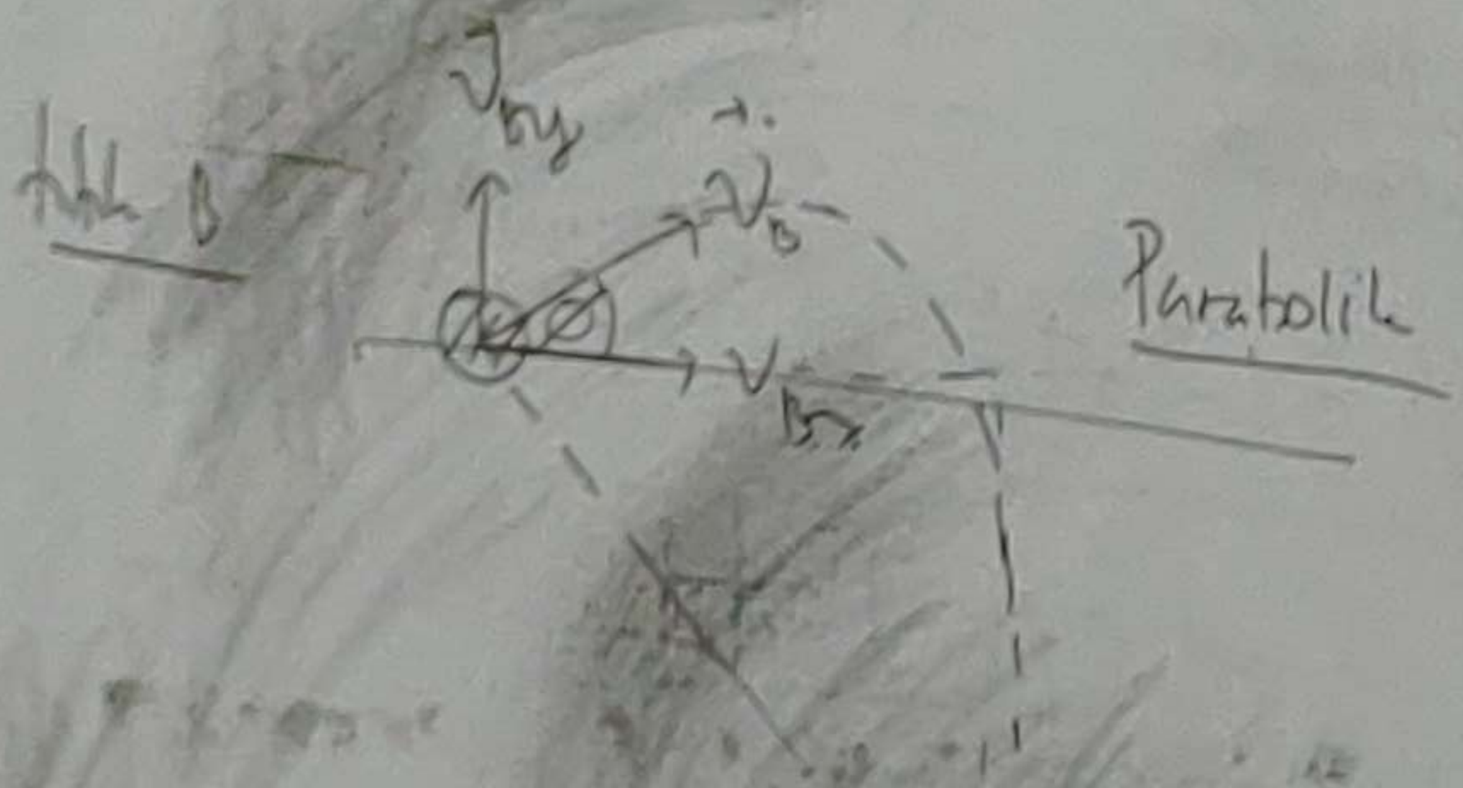
$$gR\sin^2\phi = (6gR - 4gR\cos\phi)\cos\phi$$

$$gR\sin^2\phi = 6gR\cos\phi - 4gR\cos^2\phi$$



Ep(x) ? ⟶ $W = -\int_{x=0}^{x} F_{Total} \cdot dx$.

$-\Delta Ep = W = -\int_{x=0}^{x} (F_{1x} + F_{2x})$.



$$E_p(x) = kx^2 - 2kL\left(L - \sqrt{x^2+L^2}\right) \quad J$$

$$\int \frac{x}{\sqrt{x^2+L^2}}\,dx = \int \frac{x\,dx}{\sqrt{x^2+L^2}} = \int \frac{du/2}{u^{1/2}}$$

$$= \frac{1}{2}\int u^{-1/2}\,du.$$

$$= \frac{1}{2}\cdot\frac{1}{1/2}\,u^{1/2}$$

$$= \sqrt{u} = \sqrt{x^2+L^2}$$

misal: $u = x^2+L^2$

$$\frac{du}{dx} = 2x$$

$$du = 2x\,dx$$