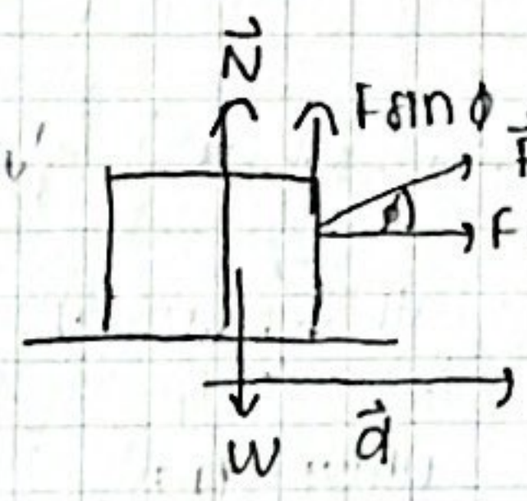
Senin, 21 Okt 24

Usaha dan energi

① Dik: traktor menarik beban
20 m
Total massa = 1200 kg
Fkonstan = 5000 N
$\theta = \tan \theta = 3/4$
koef gesek = 0,25
Dit: a) hitung usaha yg dilakukan!
b) hitung usaha total beban!
c) diam, $v_i = 20$ m/s → Dik!

Jawab =



$(W) = F.d$
$= F. \cos \phi$
(Joule)

$\rightarrow W_F = F \cos \theta_F d$
$= F \cos \phi \, d$
$= 5000 . \frac{4}{5} . 20$
$= 80.000$ J

$W_N = N \cos \theta_N d$
$= N \cos 90° d = 0$

$W_w = W \cos \theta_0 d$
$= W \cos 90° d = 0$

$W_F = F \cos \theta_F d$
$= F \cos 180° d$
$= -F. d = -2250 . 20$
$= -45.000$ J

$F = F_{kinetik} = M_k . N$
$= 0,25 N$
$= 0,25 . 9000$
$= 2250$ N

$\Sigma F_y = 0$
$N - W + F \sin \phi - 0$
$N = W - F \sin \phi$
$= mg - F \sin \theta$
$= 1200 . 10 - 5000 . \frac{3}{5} = 9000$ N

b) $W_{total} = W_F + W_N + W_w + W_f$
$= 90.000 + 0 + 0 - 45000$
$= 35.000$ J

c) $v_i = 0 \longrightarrow v_f = ?$
$d = 20$ m

Teorema usaha energi kinetik

Energi kinetik $K = \frac{1}{2} m v^2$

$W_{total} = \boxed{\Delta K = K_f - K_i}$

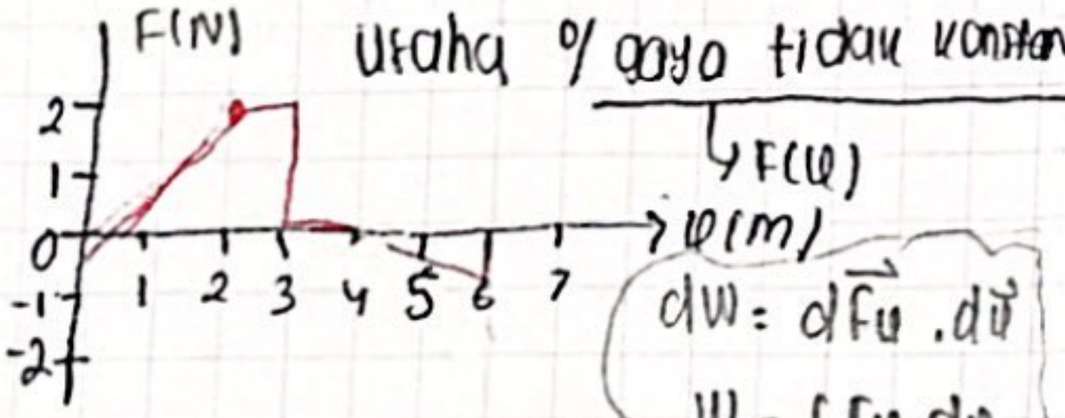
$W_{total} = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$35000 = \left(\frac{1}{2} . 1200 . v_f^2\right) - \left(\frac{1}{2} . 1200 . 0\right)$

$35000 = 600 . v_f^2$

$v_f = \sqrt{\frac{35000}{600}}$ m/s

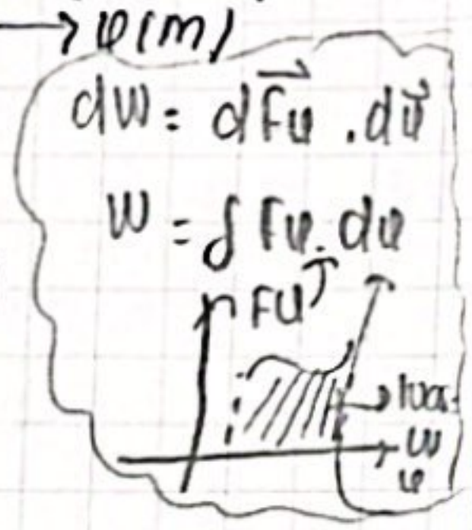
② Usaha % gaya tidak konstan



↳ F(x)

$dW = d\vec{F}_u \cdot d\vec{x}$

$W = \int F_u \, dx$



Dik: massa = 2,0 kg

$x = 0$

$v_3 = 3$ m

$W_{0-3} = \frac{1}{2} m v_3^2 - \frac{1}{2} m v_0^2$

① luas $\square = \frac{(a+b).t}{2}$

$= \frac{(3+1).2}{2} = 4$ m

$4 = \frac{1}{2} . 2 . v_3^2$

$4 = v_3^2 \rightarrow v_3 = 2$ m/s

② $W_{3-4} = \frac{1}{2} m v_4^2 - \frac{1}{2} m v_3^2$

$0 = \frac{1}{2} . 2 . v_4^2 - \frac{1}{2} . 2 . 2^2$

$v_4^2 = 2^2$

$v_4 = 2$ m/s

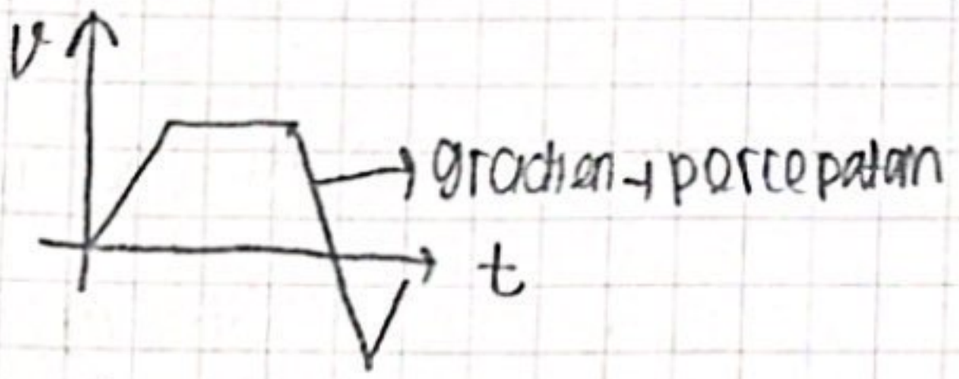
③ $W_{4-7} = \frac{1}{2} m v_7^2 - \frac{1}{2} m v_4^2$

$\square = \frac{1}{2} . 2 v_7^2 - \frac{1}{2} . 2 . 2^2$

$-1 = v_7^2 - 4$

$v_7^2 = 3 \rightarrow v_7 = \sqrt{3}$ m/s

Mengingat lagi
Kinematika



luas → jarak (+)

↳ perpindahan (+ -)

③ Usaha - Energi Potensial (U)

$W = -\Delta U$

$= -(U_2 - U_1) = U_1 - U_2$

energi potensial → gravitasi: $U_g = mgh$

↳ pegas: $U_p = \frac{1}{2} k x^2$

Dik: jatuh ↓ vertikal

massa = M

awal: diam

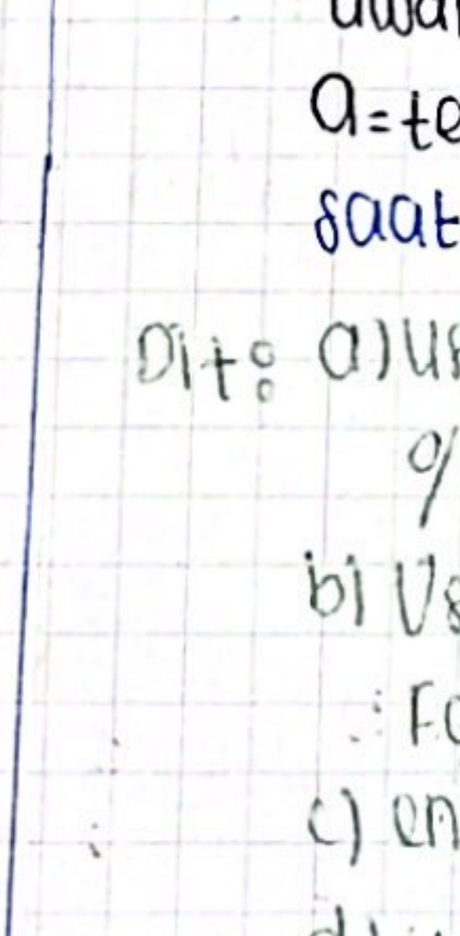
a = tetap = g/4 (g: gravitasi)

saat balok turun d

Dit: a) Usaha yang diberikan % tegangan tali

b) Usaha yang diberikan : F gravitasi + F t

c) energi kinetik balok di lokasi akhir



$W_T = T . \cos \theta_T . d$

$= T . \cos 180^\circ d - Td$

$\Sigma F_y = M . a$

$-T + W = M . \frac{g}{4}$

$\Sigma F_y = m.a$

$-T + W = M.\frac{g}{4}$

$-T + m'.g = \frac{Mg}{4}$

$-T = \frac{Mg}{4} - Mg$

$-T = -\frac{3}{4} Mg$

$T = \frac{3}{4} Mg$

$W_T = -Td$

$= -\frac{3}{4} mgd$

b) $W_w = W \cos \theta_w . d$

$= Mg . \cos 0 . d$

$= Mgd$

c) Energi kinetik?

$W_{total} = \Delta K = K_f - K_i : K_i = \frac{1}{2} \underbrace{V_i^2}_{0} = 0$

$W_T + W_w = K_f - 0$

$-\frac{3}{4} mgd + mad = K_f$

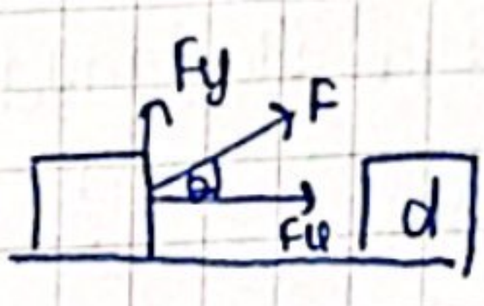
$\frac{1}{4} Mgd = K_f$

d) $\boxed{\text{usaha} = \frac{1}{2} m v_f^2}$

$\frac{1}{4} mgd = \frac{1}{2} M v_f^2$

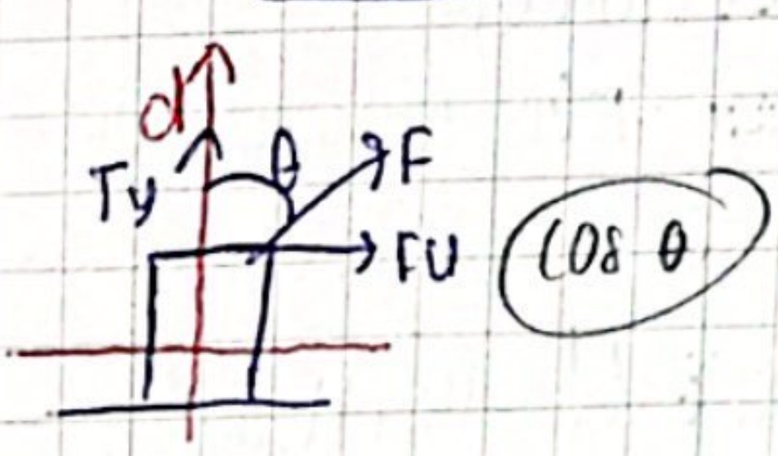
$v_f = \sqrt{\frac{\frac{1}{4} mgd}{\frac{1}{2} mv}}$

$=$ //



$W = F_u d - F \cos \theta . d$

θ = sudut antara F & d



④ Dik: massa = 350 kg

lian

kecadaan tdk gerak di titik A

$g = 10 m/s$

Dit: a) Berapa energi mekanik kereta roller coaster A?

b) Berapa cepat saat di B?

c) Berapa gaya normal yg bekerja pada kereta roller coaster?

Hukum Konservasi Energi

Jika dalam sistem terdapat gaya non konservatif (gesek, tarik, dorong) (dibidang kasar)

$\Delta EM \neq 0$

Non konservatif = $EM_f - EM_i$

Usaha = $(K_f + U_f) - (K_i + U_i)$

$EM = K + U$ → mgh (gravitasi)

→ $\frac{1}{2} kU^2$ (pegas)

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

$U = U_g + U_p$ U_p

Jika dalam sistem tdk ada gaya non konservatif (bidang licin)

$\Delta EN = 0$

$EN_F = EN_i$

$K_F + U_F = K_0 + U_i$

Lintasan licin → EN kanan dimanapun!

$A = V_A : 0 \quad h_A : 25\ m$

a) $EN_A = K_A + U_A = K_A + U_{gA}$

$= \frac{1}{2} m.V_A^2 + mgh_A$

$= \frac{1}{2}.350.0^2 + 350.10.25$

$= 87500\ J$

b) $V_B = ?$

$EN_A = EN_B$

$EN_A = K_B + U_{gB}$

$EN_A = \frac{1}{2} mV_B^2 + mgh_B$

$87500 = \frac{1}{2} 350.V_B^2 + 350.10.12$

$87500 - (350.10.12) = \frac{1}{2} 350\ V_B^2$

$45500 = 175.V_B^2$

$V_B^2 = \frac{45500}{175}$

$V_B = \sqrt{\frac{45500}{175}}$

Jika dalam hukum tidak ada gaya non konservatif (bidang lain)

$\Delta EN = 0$

$EN_F = EN_i$

$K_F + U_F = K_i + U_i$

c) $V = V_B$

$\Sigma F = m.a_{sp}$

$W + N = m.\frac{V_B^2}{R}$

$N = m.\frac{V_B^2}{R} - W = N = \frac{mV_B^2}{R} = mg$ //

⑤ Diket : $m = 0,200\ kg$

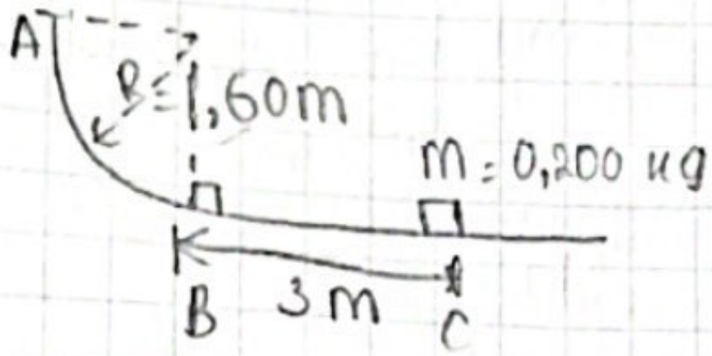
$r = 1,60\ m$

Ukuran balok < 1,60 m

Balok meluncur & mencapai titik B dengan $v = 4,80\ m/s$

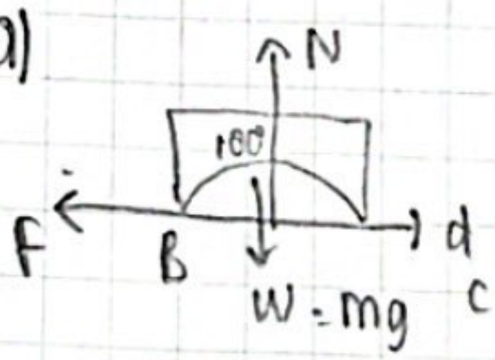
Dit : a) Berapa usaha gaya normal? (B-C)

b) Berapa usaha yang dilakukan thdp balok gaya gesek selama balok meluncur dilintasan lengkung A-B



POSISI	V	h
A	$v_A = 0$	$h_A = 1,6\ m$
B	$v_B = 4,8\ m/s$	$h_B = 0$
C	$v_C = 0$	$h_C = 0$

a)



$\Sigma F = 0$

$N - W = 0$

$N = W = mg$

Mu B-C?

$W_{gesek\ B-C} = (K_C + U_C) - (K_B + U_B)$

$f_k \cos\theta_F . d = \frac{1}{2} mV_C^2 + mgh_C - \frac{1}{2} mV_B^2 - mgh_B$ (0, 0, 0)

$\mu_k N . \cos 180° . d_k = -\frac{1}{2} mV_B^2$

$\mu_k . mg . (-1) . 3 = -\frac{1}{2} m . (4,8)^2$

$-\mu_k . 6 = -0,1 . (4,8)^2$

$\mu_k = \frac{-0,1 . (4,8)^2}{6} = -0,38$

m
apai

b) $W_{gesek\ A\to B} = (K_B + U_B) - (K_A + U_A)$

$W_{gesek\ A\to B} = \frac{1}{2} m v_B^2 + mgh_B - \frac{1}{2} m v_A^2 + mgh_A$

$= \frac{1}{2} . 0,2 \ (4,8)^2 - 0,2 . 10 . 1,6$

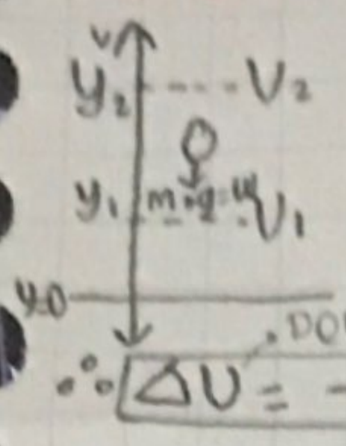
$= -0,8962$ //

B

usaha energi

22/Okt 24

① Usaha & energi potensial
energi potensial (U) berkaitan:
Konfigurasi / reduksiun

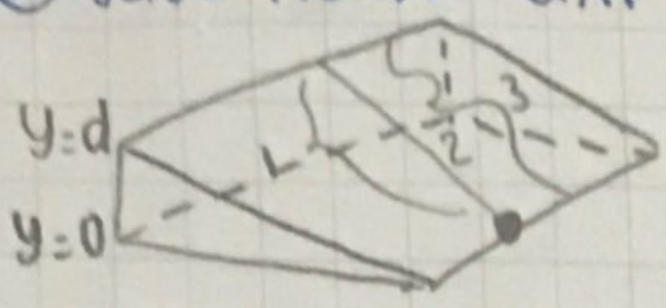


saat bola ↑ & ΔU (+) → W(-)
bola ↓ : ΔU (-) → W(+)

perubahan energi potensial

$\therefore \boxed{\Delta U = -W}$

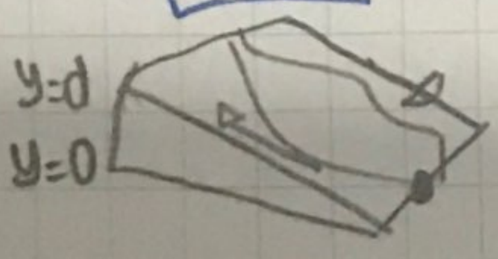
② gaya konservatif & non konservatif



→ Usaha gaya gravitasi = $W_g = -mgd$
↳ $W_g(1) : W_g(2) = W_g(3) : -mgd$
↳ usaha oleh gaya gravitasi
tidak bergantung lintasan
→ Usaha gaya gesek : $W_F = -F_k . d$
$= -N_k N d$
↳ energi kinetik ⇌ energi termal.
↳ usaha oleh gaya gesek
Bergantung pada lintasan

Konservatif
↳ usaha tidak bergantung dengan lintasan
Co: gravitasi

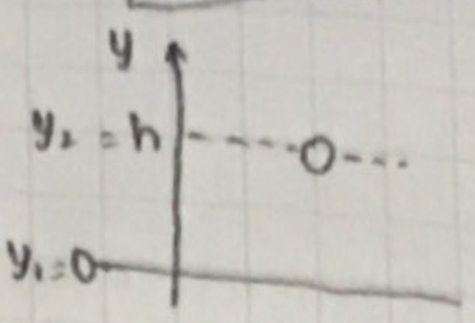
$\boxed{W=0}$



$W_{g,tot} = W_{g,naik} + W_{g,turun}$
$W_{g,tot} = -mgd + mgd$
$W_{g,tot} = 0$

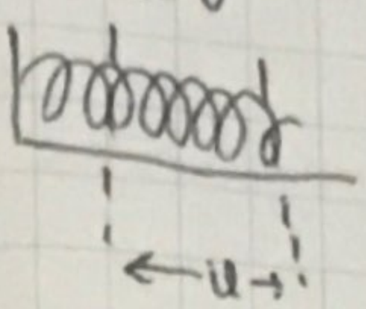
Non konservatif → gaya gesek

③ Menghitung energi potensial
$\boxed{U_g \& U_p}$:



$\boxed{U_g = mgh}$ Ep gravitasi

U = 0



$\boxed{U_p = \frac{1}{2} k U^2}$ Ep pegas

④ Kekekalan energi mekanik
EM adalah (+) energi kinetik & energi potensial
↓
jumlah

$\boxed{EM = K + U}$

Teorema usaha energi kinetik =
$\boxed{W_{total} = \Delta K}$

$\boxed{W_k + W_{nk} = \Delta K}$

hanya ada gaya konservatif yang bekerja:

$\boxed{EM_F = EM_i}$

Misal = jika sistem ada gaya eksternal (non konservatif)

$\boxed{W_{nk} = EM_F - EM_i}$

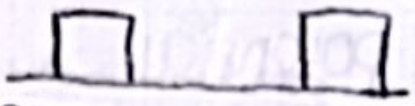
Energi kinetik

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

Joule = Ja

$= 1 \text{ kg m/s}^2$

Kerja/usaha



Dorong → gaya dorong

$v \uparrow \rightarrow K \uparrow$

$\Delta K > 0$

Gesekan → gaya gesek

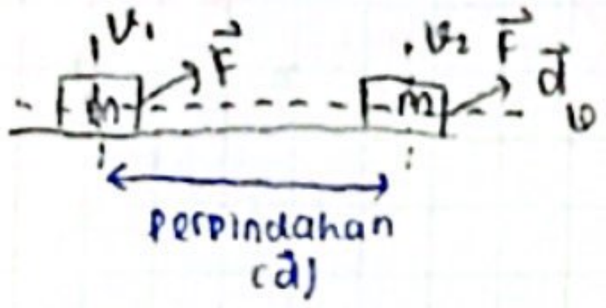
$v \downarrow \rightarrow K \downarrow$

$\Delta K < 0$

Kerja/usaha <W> energi yang di tf

W(+) → ditransfer ke objek

W(-) → ditransfer dari objek



karena perpindahan dalam arah mendatar (sumbu x) hanya dipengaruhi oleh W:

Hukum 2 Newton: $F_x = m \cdot a_x$

$v_2^2 = v_1^2 + 2ad$ (ingat)

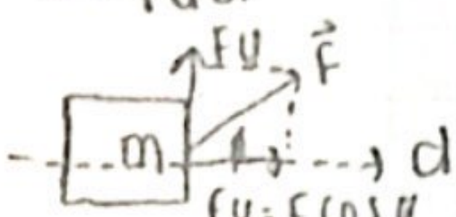
$a = \frac{v_2^2 - v_1^2}{2d}$

$F_x = m\left(\frac{v_2^2 - v_1^2}{2d}\right)$

$F_x d = \frac{1}{2} m (v_2^2 - v_1^2)$

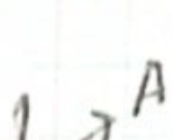
$W = \Delta K = \frac{1}{2} m v_2^2 - \frac{1}{2} m v_1^2$

$W = F_x d$



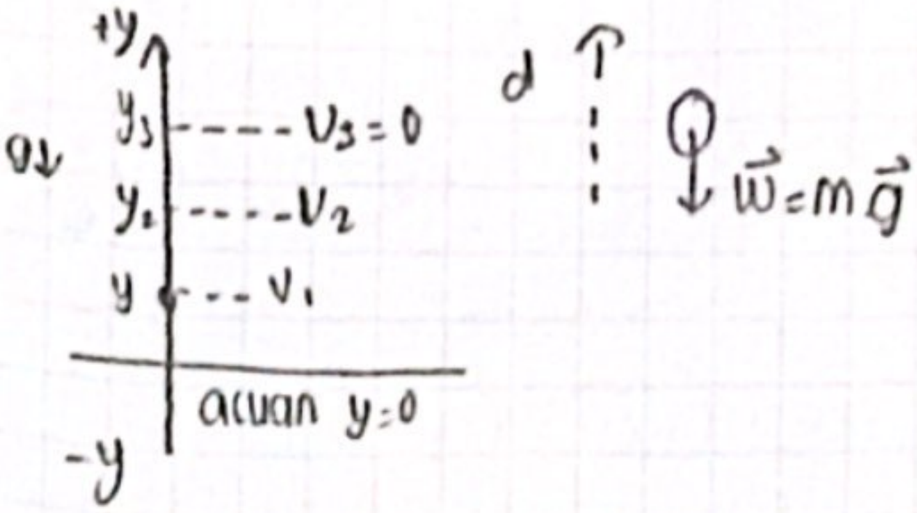
$\boxed{W = F\cos\phi d}$

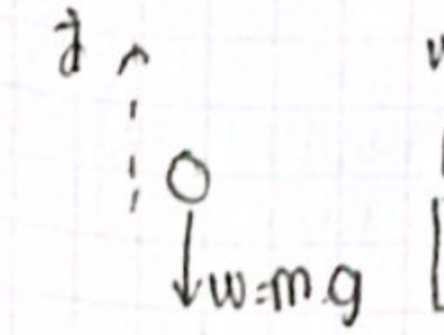
$W = \vec{F} \cdot \vec{d}$



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

Kerja oleh gravitasi

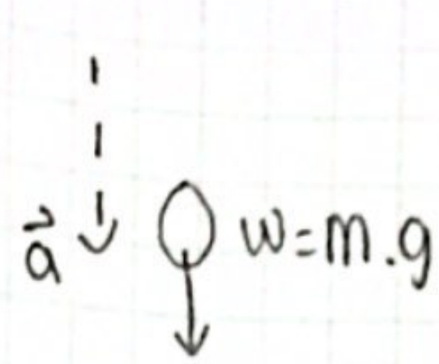




$W_g = mg\cos\phi d$

$W_g = mg\cos 180° d$

$\boxed{W_g = -mgd}$

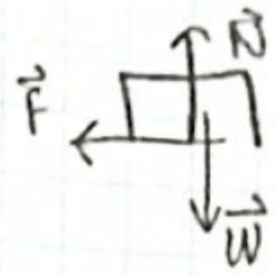


$W_g = mg\cos\phi d$

$W_g = mg\cos 0° d$

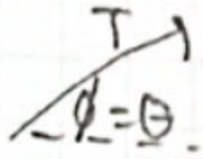
$\boxed{W_g = mgd}$

Menghitung kerja total



$\boxed{W_{total} = W_F + W_N + W_m + W_F}$

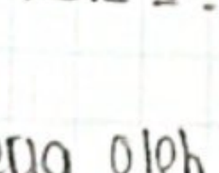
Kerja oleh gaya tegangan:



$W_T = T\cos\phi d$

$= Td\cos\theta$

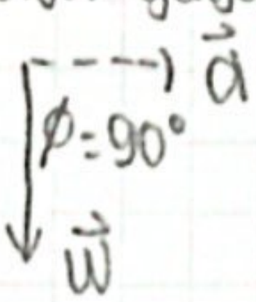
Kerja oleh gaya normal:



$W_N = N\cos\phi d$

$= Nd\cos 90$

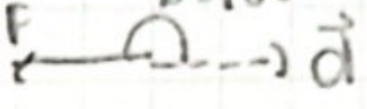
Kerja gaya berat:



$W_w = W\cos\phi d$

$= wd\cos 90° = 0$

Kerja gaya gesek:



$W_f = F\cos\phi d$

$= Fd\cos 180°$

$= -Fd$

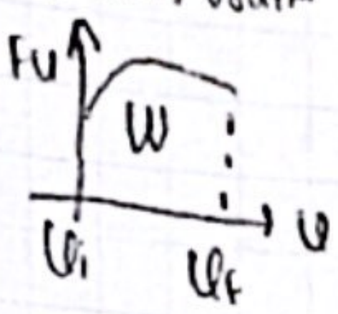
Teorema Usaha Energi Kinetik

Perubahan energi kinetik:

$$W_{total} = \Delta k$$

$$W_{tot} = \frac{1}{2} m v_2^2 - \frac{1}{2} m v_1^2$$

→ Kerja / Usaha gaya tidak konstan



$$W = \int_{v_i}^{v_f} F(v)\,dv$$

→ gaya pegas:

Hukum Hooke : $\vec{F_s} = -k\vec{d}$

$$W_{pegas} = -\frac{1}{2} k v^2$$

DAYA

$\langle P \rangle = \frac{W}{\Delta t}$ $\langle P \rangle$: Daya rata²

$$P = \lim_{\Delta t \to 0} \frac{W}{\Delta t} = \frac{dW}{dt}$$

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

$$P = \frac{d(\vec{F} \cdot \vec{v})}{dt}$$

$$= F \cdot \frac{d\vec{v}}{dt} = \vec{F} \cdot \vec{v}$$

Satuan : Joule / detik : watt