Solusi Tutorial 3 · Fisika Dasar 1B ITB

oleh : Wawan K

A. Pertanyaan

① $k_A > k_B$ $\quad F_{pegas} = -kx$

a) $W = \int F\,dx$

$W = -\int kx\,dx$

$W = -k\left(\frac{1}{2}x^2\right)$

$W_{pegas} = -\frac{1}{2}kx^2$ (tanda minus berarti arah gaya dari perpindahan (x), berlawanan)

jika $x_1 = x_2 = x$

maka $W \sim k$, sehingga $W_A > W_B$ karena $k_A > k_B$

b) $F = -kx$, besarnya gaya, $F = kx$

$F = k_A x_A = k_B x_B$ jadi $x_B = \frac{k_A x_A}{k_B}$

a) Usaha yang dilakukan pada pegas A

$W_A = \frac{1}{2}k_A x_A^2$

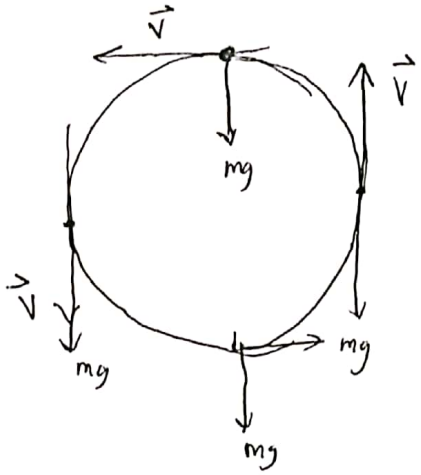
b) Usaha yg dilakukan pegas B

$W_B = \frac{1}{2}k_B x_B^2 = \frac{1}{2}k_B\left(\frac{k_A x_A}{k_B}\right)^2$

$W_B = \frac{1}{2}\frac{k_A^2 x_A^2}{k_B} = \frac{1}{2}k_A x_A^2\left(\frac{k_A}{k_B}\right)$

$k_A > k_B$, sehingga $W_B > W_A$

(2)



$W = F s \cos\theta$

*) pada titik tertinggi dan terendah,

$F \perp \Delta r$

*) pada titik yang lainnya nilai W saling menghilangkan.

Jadi $W_{gravitasi} = 0$ → untuk satu putaran penuh

(3) Daya adalah: $\bar{P} = \frac{W}{t}$

$= F \cdot \frac{s}{t}$

$\bar{P} = F \bar{V}$

- Daya mobil = $F \bar{V}$
- Daya motor = $F \bar{V}$

$m_{mobil} \approx 1400$ kg

$m_{motor} \approx 87$ kg

Sehingga

$F = ma$

maka $F_{mobil} > F_{motor}$

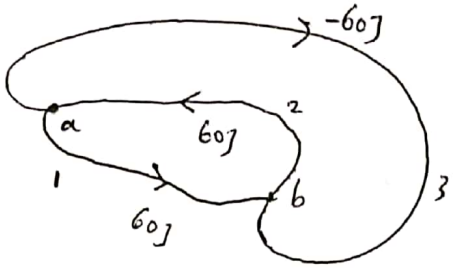
Jadi, meskipun melambat Daya mobil > Daya motor yg cepat

$P = \frac{\Delta K}{t}$ dalam t yg sama,

$P \sim \Delta K$

$\Delta K_{mobil} > \Delta K_{motor}$

④ Bukan F konservatif. karena



•) W lintasan 1

$W_{a\to b} = 60J$

•) Lintasan 2

$W_{a\to b} = -60J$

•) Lintasan 3 : $W_{a\to b} = -60J$

karena $W_{a\to b}$ lintasan 1 $\neq$ lintasan 2,

maka F bukan konservatif.

⑤ $EM = U + K$

a) jika K berkurang, maka U bertambah

$EM = K + U$
EM tetap, K berkurang, U bertambah

b) jika U berkurang, maka K bertambah

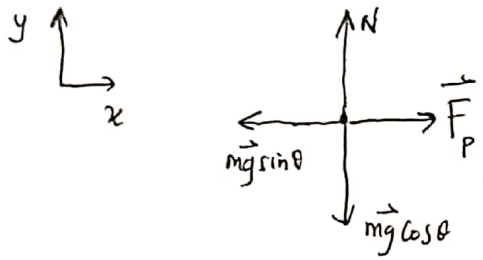
$EM = K + U$
EM tetap, K bertambah, U berkurang

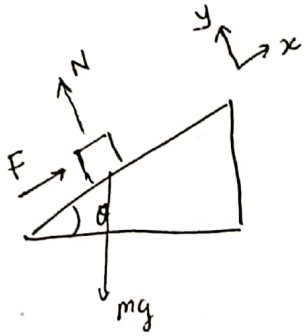
c) jika K tidak berubah, U tidak berubah

$EM = K + U$
EM tetap, K tidak berubah, U tidak berubah

B. SOAL

① Diagram benda bebas





F_p = gaya paralel bidang

$\Sigma F_x = 0 \rightarrow$ (gaya minimum)

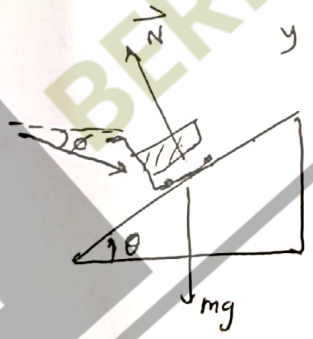
$F_p - mg\sin\theta = 0$

$F_p = mg\sin\theta$

Usaha minimum yang dilakukan F_p pada mobil

$W_p = F_p d\cos 0^\circ = mgd\sin\theta = (950)(9{,}8)(710)\sin 9^\circ = 1\times10^6\ J$

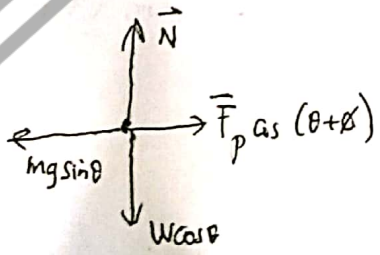
② $\phi = 17^\circ$ dan $\theta = 12^\circ$



$90^\circ + \theta = 102^\circ$

• Sudut perpindahan nya

$\phi + \theta = 29^\circ$



$\Sigma F_x = 0 \rightarrow F_p\cos(\theta+\phi) - mg\sin\theta = 0 \rightarrow F_p = \dfrac{mg\sin\theta}{\cos(\phi+\theta)}$

$W_{mg} = mgd\cos 102^\circ = (16)(9{,}8)(7{,}5)\cos 102^\circ = -244{,}3\ J = -240\ J$

↓ Sudut perpindahan dengan mg

② $W_{normal} = N d \cos 90^\circ = 0$

$$W_p = F_p d \cos 29^\circ = \left(\frac{mg \sin 12^\circ}{\cos 29^\circ} \right) d \cos 29^\circ = mgd \sin 12^\circ$$

$$W_p = (16)(9{,}8)(7{,}5) \sin 12^\circ$$

$$W_p = 244{,}5 \text{ J} \approx 240 \text{ J}$$

③ Usaha yang dilakukan pada mobil adalah sama dengan perubahan energi kinetik.

$$W = \Delta K$$

$$= \frac{1}{2} m V_2^2 - \frac{1}{2} m V_1^2 = 0 - \frac{1}{2}(925 \text{ kg}) \left[95 \text{ km/h} \left(\frac{1 \text{ m/s}}{3{,}6 \text{ km/h}} \right) \right]^2$$

$$W = -3{,}2 \times 10^5 \text{ J}$$

Tanda negatif berarti mobil sedang melambat.

④ $K_1 = \frac{1}{2} K_2 \rightarrow \frac{1}{2} m_1 V_1^2 = \frac{1}{2} \left(\frac{1}{2} m_2 V_2^2 \right)$

$K_{1\,\text{cepat}} = K_{2\,\text{cepat}} \rightarrow \frac{1}{2} m_1 (V_1 + 8)^2 = \frac{1}{2} m_2 (V_2 + 8)^2$

gunakan informasi soal, $m_1 = 2 m_2$,

$\frac{1}{2}(2m_2) V_1^2 = \frac{1}{2} \left(\frac{1}{2} m_2 V_2^2 \right)$; $\frac{1}{2} 2m_2 (V_1 + 8)^2 = \frac{1}{2} m_2 (V_2 + 8)^2$

$2V_1 = V_2$;

$2(V_1 + 8)^2 = (V_2 + 8)^2$

$2(V_1 + 8)^2 = (2V_1 + 8)^2$

$\sqrt{2}(V_1 + 8) = 2V_1 + 8 \rightarrow$

④ $2(V_1+8)^2 = (2V_1+8)^2$

$\sqrt{2}(V_1+8) = (2V_1+8)$

$V_1 = \frac{8}{\sqrt{2}} = 5,657$ m/s dan $V_2 = 11,314$ m/s

Jadi, $V_1 = 5,7$ m/s dan $V_2 = 11,3$ m/s

⑤ Energi potensial pegas adalah : $E_p = \frac{1}{2}kx^2$

Sehingga : $x = \sqrt{\frac{2E_p}{k}} = \sqrt{\frac{2(45)}{88}} = 1,01$ m

⑥ Saat awal $x=0$,

$Ep_{awal} = \frac{1}{2}kx^2 \longrightarrow 60\,J = \frac{1}{2}k(2\,cm)^2 \rightarrow k = 3\,J/cm^2$

$Ep_{akhir} = \frac{1}{2}kx^2 \longrightarrow \frac{1}{2}(3)(6)^2 = 54\,J$

$Ep_{akhir} - Ep_{awal} = 48\,J$

⑦ • karena tidak ada gaya disipasi, Energi mekanik akan kekal.

• ketinggian titik 2, $h_2 = 0$, $V_1 = 0$ dan $y_1 = 32m$

Titik 2 : $\frac{1}{2}mV_1^2 + mgy_1 = \frac{1}{2}mV_2^2 + mgy_2$; $y_2 = 0$ $V_1 = 0$, maka

$mgy_1 = \frac{1}{2}mV_2^2$

$V_2 = \sqrt{2gy_1} = \sqrt{2(9,8)(32)} = 25$ m/s

(7)

•) Titik 3 : $\frac{1}{2}mv_1^2 + mgy_1 = \frac{1}{2}mv_3^2 + mgy_3$; $y_3 = 26\ m$, $v_1 = 0$

$$mgy_1 = \frac{1}{2}mv_3^2 + mgy_3$$

$$v_3 = \sqrt{2g(y_1 - y_3)}$$

$$v_3 = \sqrt{2(9{,}8)(32-26)}$$

$$v_3 = 11\ m/s$$

•) Titik 4 :

$$\frac{1}{2}mv_1^2 + mgy_1 = \frac{1}{2}mv_4^2 + mgy_4 \quad ; \quad y_4 = 14m \ , \ v_1 = 0$$

$$mgy_1 = \frac{1}{2}mv_4^2 + mgy_4$$

$$v_4 = \sqrt{2g(y_1 - y_4)} = \sqrt{2(9{,}8)(32-14)} = 19\ m/s$$

(8) a) $E_{hilang} = E_{awal} - E_{akhir}$

$E_{hilang} = mgy_{awal} - mgy_{akhir}$

$$\frac{E_{hilang}}{E_{awal}} = \frac{mgy_{awal} - mgy_{akhir}}{mgy_{awal}} = \frac{y_{awal} - y_{akhir}}{y_{awal}} = \frac{2m - 1{,}6m}{2m} = 0{,}20$$

$= 20\%$

$$\frac{E_{hilang}}{E_{awal}} = 20\%$$

(8) b) $EP_{awal} + K_{awal} = EP_{sebelum\ mantul} + K_{sebelum\ mantul}$

$K_{awal} = 0$; $EP_{sebelum\ mantul} = 0$

$$EP_{awal} = K_{sebelum\ mantul}$$

$$mgy_{awal} = \frac{1}{2} m V^2_{sebelum\ mantul}$$

$$V_{sebelum\ mantul} = \sqrt{2gy_{awal}} = \sqrt{2(9,8)(2)} = 6,3\ m/s$$

$$K_{akhir} + EP_{akhir} = K_{setelah\ mantul} + U_{setelah\ mantul}$$

$K_{akhir} = 0$; $U_{setelah\ mantul} = 0$

$$mgy_{akhir} = \frac{1}{2} m V^2_{setelah\ mantul}$$

$$V_{setelah\ mantul} = \sqrt{2gy_{akhir}} = \sqrt{2(9,8)(1,6)} = 5,6\ m/s$$

c) Energi "hilang" berubah menjadi energi panas. temperatur bola dan tanah akan bertambah perlahan setelah pantulan, beberapa energi mungkin berubah menjadi energi akustik (gelombang suara).

(9) Energi terdisipasi (hilang) akibat gesekan, maka :

$$W_{external} = \Delta EM + W_{gesek}$$

$$0 = \Delta V + \Delta K + E_{gesekan}$$

$$E_{gesekan} = -\Delta U - \Delta K$$

$$E_{gesek} = mg(y_1 - y_2) + \frac{1}{2} m (V_1^2 - V_2^2)$$

(9) $E_{gesek} = -\Delta K - \Delta EP$

$E_{gesek} = \frac{1}{2} m (v_1^2 - v_2^2) + mg(y_1 - y_2)$

$= \frac{1}{2}(66)\left(0 - (11)^2\right) + 66(9{,}8)(230) = 1{,}4 \times 10^5$ J

(10) $W = F d \cos 0^\circ = mgh$

$P = \frac{W}{t} = \frac{mgh}{t}$

$t = \frac{mgh}{P} = \frac{385(9{,}8)(16)}{2750} = 22$ s

11

Selamat Belajar

Wawan K

Koordinator MESC