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Física I Teoria Professor: Augusto

Plano de Ensino

- Análise Dimensional
- Cinemática ↔ escalar
  vetorial

P1

P2

- Dinâmica *
- Trabalho Energia Potência *

Revisão Matemática

$\sqrt[9]{(x^4-7).8} = 4$

$(x^4-7).8 = 4^9$

$x^4-7 = \frac{4^9}{8}$

$x^4 = \frac{4^9}{8}+7 \quad x = \sqrt[4]{\frac{4^9}{8}+7}$

$\left(\frac{8.(\sqrt[3]{x^7})+9}{4}\right)^5 = 7 \Rightarrow \frac{8.(\sqrt[3]{x^7})+9}{4} = \sqrt[5]{7}$

$8.(\sqrt[3]{x^7})+9 = \sqrt[5]{7}.4$

$\sqrt[3]{x^7}+9 = \frac{\sqrt[5]{7}.4}{8}$

$\sqrt[3]{x^7} = \frac{\sqrt[5]{7}.4}{8} - 9$

$x = \left(\frac{\sqrt[5]{7}.4}{8} - 9\right)^{\frac{7}{3}}$ ou $\sqrt[7]{\left(\frac{4.\sqrt[5]{7}.-9}{8}\right)^3}$

$M1\ [\mu] = ML^{-1}T^{-1}$ (Viscosidade dinâmica)

$N1\ V = \frac{\mu}{\rho}$

$[v] = \frac{ML^{-1}T^{-1}}{ML^{-3}} = L^2T^{-1}$ (Viscosidade cinemática)

Homogeneidade dimensional

$M^aL^bT^c = M^AL^BT^C$

$a = A$

$b = B$

$c = C$

"TODA equação física é homogênea"

Exemplo:

$F = \sqrt[3]{\frac{S^2 \cdot \rho}{2 \cdot D^4}}$

$[F] = MLT^{-2}$

$[S] = L^2$

$[\rho] = ML^{-1}T^{-2}$

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

$[D] = L$

$\sqrt[3]{\frac{(L^2)^2 \cancel{ML^{-1}T^{-2}}}{\cancel{ML^2T^{-2}} \cdot L^4}} = \sqrt[3]{\frac{L^4 \cdot L^{-1}}{L^6}}$ (Não homogênea)

$h = \frac{1}{2}gt^2$

"Nunca as fórmulas de físicas serão válidas"

$[h] = L$

homogênea

$\left[\frac{1}{2}gt^2\right] = (1)(LT^{-2})(T)^2$

$= LT^2T^2$

$= (L)$

- Todo expoente é adimensional, que é igual a 1

$A = p.Q.\pi^{\frac{D.p}{Q}} + B$

$[A] =$
$[B] =$
$[D] =$

$\left[\frac{D.p}{Q}\right] = 1 \quad [D] = \frac{[Q]}{[p]} \Rightarrow [D] = \frac{MLT^{-1}}{ML^{-1}T^{-2}} \quad [D] = L^2T$

$[A] = [p.Q.\pi^1] =$
$1 = [ML^{-1}T^{-2}MLT^{-1}.1^1] =$
$= M^2T^{-3}.$
$[A] = [B] = M^2T^{-3}$

Ex 1. página 14

a) $v = \sqrt{2gh} \quad [v] = LT^{-1}$

$[\sqrt{2gh}] = LT^{-1}$

$\sqrt{LT^{-2}L} = \sqrt{L^2T^{-2}}.$

Ex 2 $d = K.m^c.g^A.t^B \qquad d = Kgt^2$

$[d] = L$
$L = 1.M^c.(LT^{-2})^AT^B$
$M^0LT^0 = M^cL^AT^{B-2A}$
$C = 0$
$A = 1$
$B - 2A = 0 \mid = B = 2$

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3-

$$\underset{L}{y} = A\cos(\underbrace{\omega t}_{\text{ângulo}} + \underbrace{\phi_0}_{\text{ângulo}})$$

$[A] = L$ $\quad [\omega t] = 1$

$[\phi_0] = 1$ $\quad [\omega] = \frac{1}{[t]}$

$[\omega] = T^{-1}$

$$[\omega] = \frac{1}{T} \therefore [\omega] = T^{-1}$$

4 pág. 15

6-) $L = \frac{L_0}{\gamma}$ $\quad \beta = \sqrt{1 - \frac{1}{\gamma^2}}$

$\gamma = \frac{1}{\sqrt{1-\beta^2}}$ $\quad \beta = \frac{v}{c}$ $\quad [\beta] = 1$

$[\beta =] = \frac{v}{c}$

$[\gamma] = \frac{[L_0]}{L} = \frac{L}{L} = 1$ $\quad [c] = \frac{[v]}{[\beta]}$

$[c] = \frac{LT^{-1}}{1}$

$[\gamma] = 1$

$[\beta] = 1$

$[c] = LT^{-1}$

$Pot = K\rho^a f^b D^c$ $\quad ML^2T^{-3} = 1(ML^{-3})^a (T^{-1})^b \cdot (L)^c$

$ML^2T^{-3} = M^a L^{-3a} T^{-b} L^c$

$[Pot] = ML^2T^{-3}$ $\quad ML^2T^{-3} = M^a L^{c-3a} T^{-b}$

$[\rho] = ML^{-3}$

$[f] = T^{-1}$ $\quad a = 1$ $\quad Pot = K\rho f^3 D^5$

$[D] = L$ $\quad b = 3$

$[Pot] = [K\rho^a f^b D^c]$ $\quad c - 3a = 2$

$c = 5$

$$v = \sqrt[4]{\frac{AB}{aT^2}}$$

$$v^4 = \frac{AB}{aT^2}$$

$$A = \frac{v^4 \cdot aT^2}{b}$$

$$n = \sqrt[3]{\frac{AB}{aT^2}} + \sqrt{\frac{B\,Pot}{\nu\rho^2}}$$

$$n = \sqrt[3]{\frac{AB}{aT}} \qquad n = \sqrt{\frac{B\,Pot}{\nu\rho^2}}$$

$$[A] = \ldots \qquad [B] = \ldots$$

$$v = \sqrt{\frac{K \cdot R_H}{A + \frac{B}{R_H}}} \qquad v^2 = \frac{K \cdot R_H}{A + \frac{B}{R_H}}$$

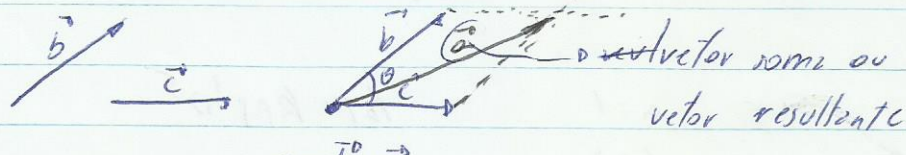
Vetores

Módulo de um vetor

$|\vec{v}| = \|\vec{v}\| = v$

Adição ou soma de vetores

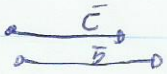
-Não pode realizar divisão de vetores, apenas módulos de vetores ou vetor por módulo.



$\vec{a} = \vec{b} + \vec{c}$

$a^2 = b^2 + c^2 + 2bc \cdot \cos\theta$

$\theta = 0° \Rightarrow \cos 0° = 1$



$\therefore \quad a^2 = b^2 + c^2 + 2ac$

$a^2 = (b+c)^2$

$a = b + c$

$\theta = 180° \Rightarrow \cos 180° = -1$

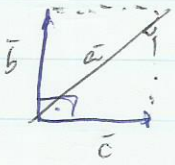
$a^2 = b^2 + c^2 - 2ac$

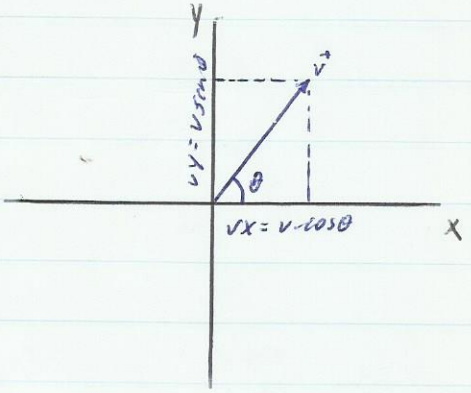
$a^2 = (b-c)^2$

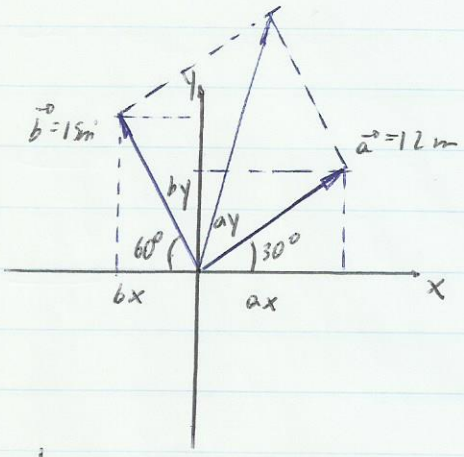
$a = b - c$

$\theta = 90° \Rightarrow \cos 90° = 0$

$a^2 = b^2 + c^2$







$ax = 12 \cdot \cos 30° = 12 \cdot 0{,}866 = 10{,}4$

$bx = 15 \cdot \cos 60° = 7{,}5$

$ay = 12 \operatorname{sen} 30° = 12 \cdot 0{,}5 = 6{,}00$

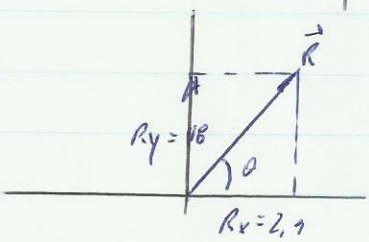
$by = 15 \operatorname{sen} 60° = 15{,}0 \cdot 0{,}866 = 12{,}0$

$Rx = ax - bx = 10{,}4 - 7{,}5$

$Rx = 2{,}9$

$Ry = ay + by = 6{,}0 + 12{,}0$

$Ry = 18$



$tg\,\theta = \frac{18}{3} = 6$

$R = \sqrt{2{,}9^2 + 18^2}$

$R = 18{,}23$

Livro Física I Ex-Cap-Pag.

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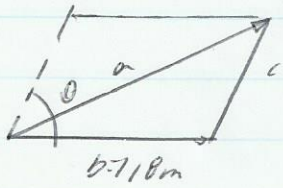
~~EX 30-~~



$a = 4,2\ m$

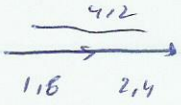
$a = 0,6\ m$

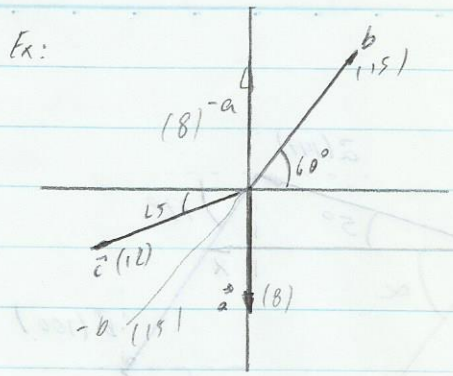
$a = 3,00$

$a^2 = b^2 + c^2 + 2ac \cdot \cos\theta$

$\cos\theta = \frac{a^2 - b^2 - c^2}{2bc}$: $a = 4,2$ $\cos\theta = 1$

$\theta = 0°$





~~1-74~~

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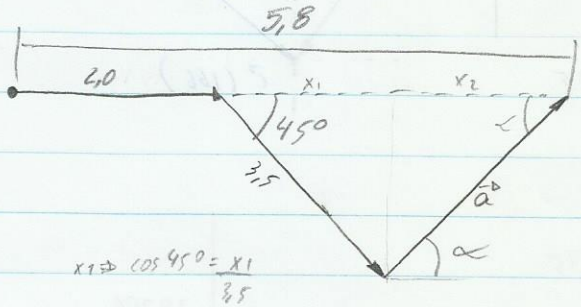
1-74-32



$|\vec{a}| = ?$

$\alpha = ?$

$x_1 \Rightarrow \cos 45° = \frac{x_1}{3,5}$

$x_1 = 3,5 \cdot 0,707$

$x_1 = 2,4748$

$x_2 = 5,8 - 2,0 - 2,4748$

$x_2 = 1,325126$

$\vec{a}^2 = (2,4748)^2 + (1,325126)^2$

$a^2 = 4,2307$

$a = \sqrt{4,2307}$

$|\vec{a}| = 2,05688$

$\operatorname{sen}\alpha = \frac{1,325126}{2,05688} = 0,64424 \quad \alpha = 49,8914$

ou $49°53'18''$

Outro método

"Projetar os eixos x e y"

$rx = 2,0 + 3,5 \cdot \cos 45° + a \cos\alpha = 5,8$

$a \cos\alpha = 5,8 - 2,0 - 3,5 \cdot 0,707$

$a \cos\alpha = 1,325$

$ry = 0 - 3,5 \cos 45 + a \operatorname{sen}\alpha = 0$

$a \operatorname{sen}\alpha = 2,475$

$\frac{a \operatorname{sen}\alpha}{a \cos\alpha} = \frac{2,475}{1,325} = 1,8679$

$\operatorname{tag}\alpha = 1,8679$

$\operatorname{tag} = 61,84°$

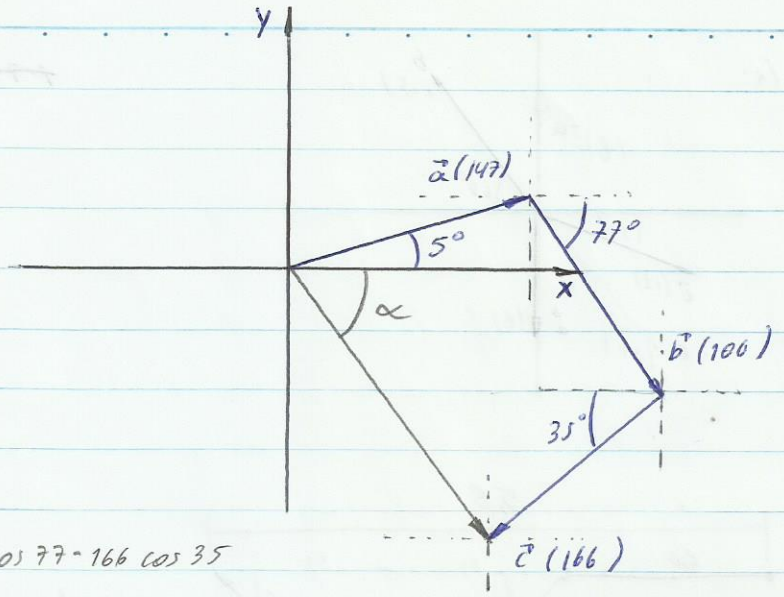
$a \operatorname{sen} 61,84 = 2,475$

$a \cdot 0,8816 = 2,475$

$a = \frac{2,475}{0,8816} = 2,8073$

$|\vec{a}| = 2,8073$

$\alpha = 61,84°$

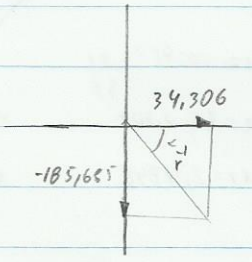


$rx = 147 \cdot \cos 5 + 106 \cdot \cos 77 - 166 \cos 35$

$rx = 34,306193$

$ry = 147 \operatorname{sen} 5 - 106 \cdot \operatorname{sen} 77 - 166 \operatorname{sen} 35$

$ry = -185,685$



$r = \sqrt{rx^2 + ry^2}$

$r = 188,8275$

$\operatorname{sen}\alpha = \frac{185,685}{188,8275} = 0,983357$

$\alpha = 79,53$ ou $79°31'$

Cinemática escalar

Física = estuda como as coisas funciona

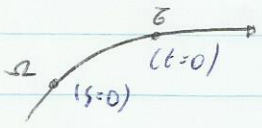
Mecânica = estudo dos movimentos

~~Física~~ Movimento = variação das coordenadas num intervalo de tempo

Cinemática = estudo dos movimentos sem se preocupar com as causas

Dinâmica = " " " envolvendo as causas

Trajetória = Conjunto de pontos orientados numa variação de tempo



Ω = { origem do espaço }

τ = { origem do tempo }

Ω ≠ 0 espaço inicial

a) deslocamento: $\Delta S = S_{(t_2)} - S_{(t_1)}$

b) velocidade escalar média $\{v_m\}$

$$v_m = \frac{S_{(t_2)} - S_{(t_1)}}{t_2 - t_1} = \frac{\Delta S}{\Delta t} \left\{\frac{m}{s}\right\}$$

c) velocidade escalar instantânea $\{v\}$

$$v = \lim_{\Delta t \to 0} \frac{\Delta S}{\Delta t} = \frac{dS}{dt} = \left\{\frac{m}{s}\right\}$$

d) aceleração escalar média $\{a_m\}$

$$a_m = \frac{v_{(t_2)} - v_{(t_1)}}{t_2 - t_1} = \frac{\Delta v}{\Delta t} = \left\{\frac{m}{s^2}\right\}$$

e) aceleração escalar instantânea $\{a\}$

$$a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$$

Classificação dos movimento

a) progressivo $\{v > 0\}$ [P]

b) regressivo $\{v < 0\}$ [R]

c) acelerado $\{|v|$ aumenta$\}$ [A] $(v \cdot a > 0)$

d) retardado $\{|v|$ diminui$\}$ [R] $(v \cdot a < 0)$

MU: $\{v = \text{constante}\}$

$$S = S_0 + vt$$

MUV: $\{a = \text{constante}\}$

$$S = S_0 + v_0 t + \frac{1}{2} a t^2$$

$$v = v_0 + at$$

$$v^2 = v_0^2 + 2a(s - s_0)$$

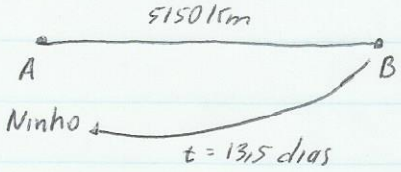
Queda livre $\Rightarrow$ MUV $\Rightarrow \begin{cases} S = y \\ a = g \end{cases}$

$$y = y_0 + v_0 t + \frac{1}{2} g t^2$$

$$v = v_0 + gt$$

$$v^2 = v_0^2 + 2g(y - y_0)$$

2.2.-59



$5150000\,m = 5,15.10^6\,m$

$13,5\ dias . 86400\,s = 1,1664.10^6$

$Vm_{B \to A} = ?$

$Vm_{A+B \to A} = ?$

a) $Vm_{B \to A} = \frac{\Delta S}{\Delta T} = \frac{S_{(t2)} - S_{(t1)}}{t_2 - t_1} = \frac{0 - 5,15.10^6}{1,1664.10^6} = -4,42\ m/s$

b) $vm = \frac{0.0}{\Delta t} = 0$

2.-44-63

$v_0 = 5\,m/s$

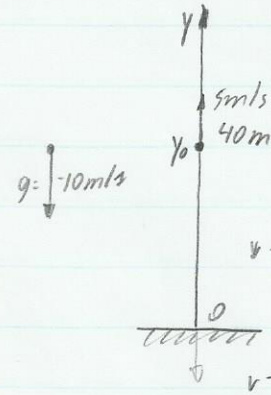
$y_0 = 40\,m$

$g = 10\,m/s^2$

$t = ?$

$v = ?$

$y_{max} = ?$



$v = v_0 + gt = 5 + (-10)t$

$v = 5 - 10t$

$v = 5 - 10.3,37$

$v = 5 - 33,7$

$v = -28,7\ m/s$

$y = 40 + 5t + \frac{1}{2}(-10)t^2$

$y = 40 + 5t - 5t^2$

ao atingir o solo $y = 0$

$0 = 40 + 5t - 5t^2$

$8 + t - t^2 = 0 \Rightarrow -t^2 + t + 8$

$x = \frac{+1 \pm \sqrt{1+32}}{2}$

$x_1 = -2,37$ ~~x_1~~

$x_2 = 3,37\ s$

t

ao atingir a altura máxima $v = 0$

$v = 5 - 10t$

$0 = 5 - 10t$

$t = \frac{-5}{-10} = \frac{1}{2} = 0,5\ s$

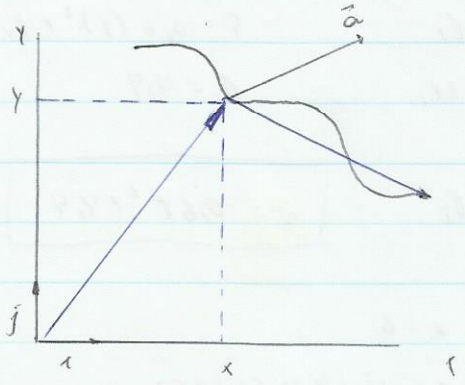
Neste instante

$y = y_{máx} = 40 + 5.0,5 - 5.(0,5)^2$

$= 40 + 1,25$

$y_{máx} = 41,25\,m$

Vetor posição ($\vec{r}$)



$\vec{r} = x\hat{i} + y\hat{i}$

$\vec{v} = \frac{d\vec{r}}{dt} \rightarrow \vec{r} = \int \vec{v}\,dt + \vec{C}$

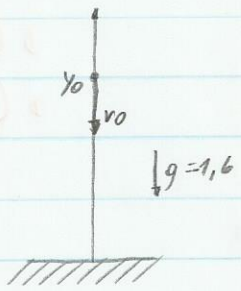
$\vec{a} = \frac{d\vec{v}}{dt} \rightarrow \vec{v} \int \vec{a}\,dt + \vec{C}$

2-40-63

$y_0 = 5\,m$

$v_0 = 0{,}8\,m/s$

$g = 1{,}6\,m/s^2$



$y = y_0 + v_0 t + \frac{1}{2} g t^2$

$y = 5 - 0{,}8t - 0{,}8t^2$

ao atingir o solo $y = 0$

$0 = 5 - 0{,}8t - 0{,}8t^2$

$t^2 + t - 6{,}25 = 0$

$t = \frac{-1 \pm \sqrt{1 + 25}}{2}$

$t_1 = 2{,}049\,s$

$t_2 = -3{,}04\,s$

$v = v_0 + gt$

$v = -0{,}8 - 1{,}6 \cdot 2{,}049$

$v = 2{,}622\,m/s$

Cálculo integral

$y = x^2 + 27 \rightarrow \frac{dy}{dx} = x^2$

$y = x^m \rightarrow \frac{dy}{dx} = m x^{x-1}$

derivada

$y = x^2 \longrightarrow \frac{dy}{dx} = 2x$

integração $\int$

~~$y = m$~~

$y = x^m \rightarrow \frac{dy}{dx} = m x^{m-1}$

$\int x^m dx = \frac{x^{m+1}}{m+1}$

$\int x^m dx = \frac{x^{m+1}}{m+1}$

$\int x^2 dx = \frac{x^3}{3}$

$y = \frac{x^3}{3} \rightarrow \frac{dy}{dx} = \frac{3x^2}{3} = x^2$

$\int x^2 dx + Bx = \frac{x^3}{3} + B$

$v = \frac{ds}{dt} \rightarrow s = \int v\,dt + C$

$a = \frac{dv}{dt} \rightarrow v = \int a\,dt + C$

2-8-60

$x = 1,5t^2 - 0,05t^3$

$v_{m_{0 \to 2}} = ?$

$$v_m = \frac{x_{(2)} - x_{(0)}}{2-0} \qquad v_m = \frac{1,5.2^2 - 0,05.2^3}{2}$$

$$= \frac{6 - 0,4}{2}$$

$v_m = 2,8 \text{ m/s}$

2-9-60 $x(t) = 6t^2 - ct^3$

$x(t) = 2,4t^2 - 0,12t^3$

b) ,) $t = 0$

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

$v = 4,8t - 0,36t^2$

$$a = \frac{dv}{dt}$$

$a = 4,8 - 0,72t$

2-18-61 $x = 3 + 0,1t^2$

$$a_{m_{0 \to 5}} = \frac{v_{(5)} - (v_0)}{5-0}$$

$$a_m = \frac{3 + 0,1(5)^2 - 3}{5-0}$$

$a_m = 0,5 \text{ m/s}^2$

b) $a = \frac{dv}{dt}$

$a = 0,2t$

MU: $\{\vec{v} = const\}$ MUV: $\{\vec{a} = cont$

$\vec{r} = \int \vec{v}\,dt + \vec{C}$ $\vec{v} = \int \vec{a}\,dt + \vec{C}$

$\vec{r} = \vec{v}t + \vec{C}$ $\vec{v} = \vec{a}t + \vec{C_1}$

$t=0 \Rightarrow \vec{r} = \vec{0} = \vec{r_0}$ $t=0 \Rightarrow \vec{v} = \vec{0_1} = \vec{V_0}$

$\vec{r} = \vec{r_0} + \vec{v}t$ $\vec{v} = \vec{v_0} + \vec{a}t$

$S = S_0 + vt$ $v = v_0 + at$

$\vec{v} = \frac{d\vec{r}}{dt} \Rightarrow \vec{r} = \int \vec{v}\,dt + \vec{C}$

$\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \vec{v} = \int \vec{a}\,dt + \vec{C}$

$y = x^n \Rightarrow \frac{dy}{dx} = nx^{n-1}$

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

$\vec{r} = \int \vec{v}\,dt + \vec{C_2}$

$\vec{r} = \int (\vec{v_0} + \vec{a}t)\,dt + \vec{C_1}$

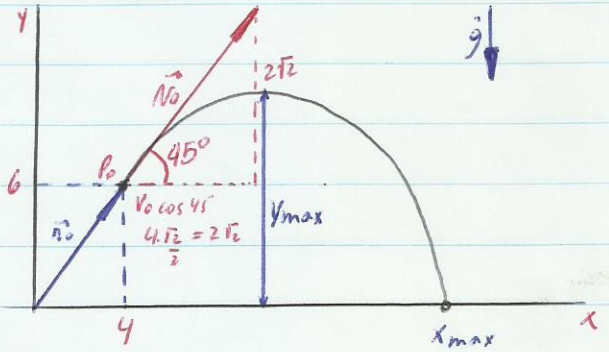
$\vec{r} = \int \vec{v_0}\,dt + \int \vec{a}t\,dt + \vec{C_1}$

$\vec{r} = \vec{v_0}t + \frac{1}{2}\vec{a}t^2 + \vec{C_1}$

$t=0 \Rightarrow \vec{r} = \vec{C_1} = \vec{r_0}$

$\vec{r} = \vec{r_0} + \vec{v_0}t + \frac{1}{2}at^2$ $S = S_0 + vt + \frac{1}{2}at^2$

- Uma pedra é lançada da posição $P_0 = (4;6)m$ com velocidade inicial $v_0 = 4\,m/s$ a qual forma ângulo $\theta = 45°$ com a horizontal. Determinar:
  - O instante que a pedra atinge a altura máxima.
  - A altura máxima
  - O instante em que a pedra atinge o eixo x
  - O máximo alcance horizontal



$\vec{r_0} = 4i + 6j$

$\vec{g} = -10j$

$\vec{v_0} = 2\sqrt{2}i + 2\sqrt{2}j$

$\vec{r} = \vec{r_0} + \vec{v_0}t + \frac{1}{2}gt^2$

$\vec{r} = 4i + 6j + 2\sqrt{2}ti + 2\sqrt{2}tj + \frac{1}{2}(-10j)t^2$

$\vec{r} = \underbrace{(4 + 2\sqrt{2}t)}_{x}\vec{i} + \underbrace{(6 + 2\sqrt{2}t - 5t^2)}_{y}\vec{j}$

$\vec{v} = \frac{d\vec{r}}{dt} \rightarrow \vec{v} = \underbrace{2\sqrt{2}}_{v_x}\vec{i} + \underbrace{(2\sqrt{2} - 10t)}_{v_y}\vec{j}$

1) ao atingir a altura máxima: $v_y = 0$

$2\sqrt{2} - 10t = 0$

$t = \frac{\sqrt{2}}{5}$ s

2) Nesse instante:

$\vec{r} = (4 + 0{,}8)i + (6{,}4)j$

$\vec{r} = 4{,}8i + 6{,}4j$

$y_{max} = 6{,}4$ m

3) ao atingir o solo:

$6 + 2\sqrt{2}t - t^2 = 0$

$t = \sqrt{2}$ s

4) Nesse instante

$\vec{r} = (4 + 2\sqrt{2}t)i + 0j$

$\vec{r} = (4 + 2\sqrt{2} \cdot 2\sqrt{2})i + 0j$

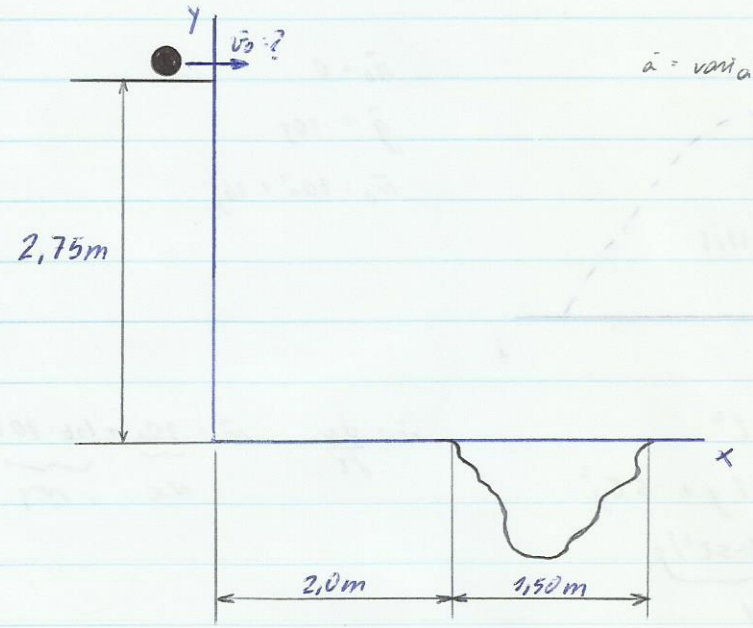
$\vec{r} = 8i$

$x_{max} = 8$ m

3.14.99

$\vec{a}$ = const : $\begin{cases} \vec{r} = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2} a t^2 \\ \vec{v} = \vec{v}_0 + at \end{cases}$

$\vec{a}$ = variável $\begin{cases} \vec{v} = \frac{d\vec{r}}{dt} \Rightarrow \vec{r} = \int \vec{v}\, dt + \vec{C} \\ \vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \vec{v} = \int \vec{a}\, dt + \vec{C} \end{cases}$



$\vec{g} = -10\vec{j}$

$\vec{r}_0 = 2{,}75\vec{j}$

$\vec{v}_0 = \vec{v}_0 \vec{i}$

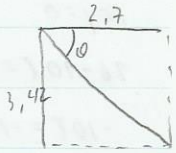
$\vec{r} = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{g}t^2$

$\vec{r} = 2{,}75\vec{j} + \vec{v}_0 t\,\vec{i} + -5t^2\vec{j}$

$\vec{r} = \underbrace{\vec{v}_0 t\,\vec{i}}_{x} + \underbrace{(2{,}75 - 5t^2)\vec{j}}_{y}$

$\vec{r} = 2{,}7t\,\vec{i} + (2{,}75 - 5t^2)\vec{j}$

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



a bolinha atinge o chão : $y = 0$

$\vec{v} = 2{,}7\vec{i} - 10t\vec{j}$

$\vec{v} = 2{,}7\vec{i} - 10 \cdot 0{,}7416\vec{j}$

$\vec{v} = 2{,}7\vec{i} - 7{,}42\vec{j}$

$2{,}75 - 5t^2 = 0$

$-5t^2 = -2{,}75$

$t^2 = 2{,}75 / 5$

$t = 0{,}7416\ s$

a bola atinge o buraco (nesse instante $x = 2m$)

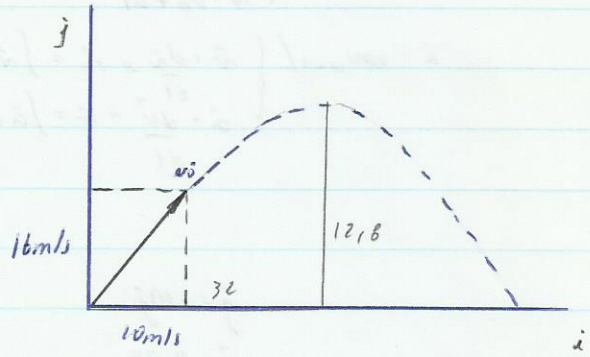
$\vec{r} = \vec{v}_0 t\,\vec{i}$ $\qquad$ $\vec{r} = \vec{v}_0 t\,\vec{i}$

$2 = \vec{v}_0 \cdot 0{,}7416$ $\qquad$ $3{,}5 = \vec{v}_0 \cdot 0{,}7416$

$\vec{v}_0 = 2{,}696\ m/s$ $\quad$ ou $\quad$ $\vec{v}_0 = 4{,}71\ m/s$

$2{,}7 \leq v_0 \leq 4{,}7\ m/s$

3-16-97



$\vec{r_0} = 0$

$\vec{g} = -10\vec{j}$

$\vec{v_0} = 20\vec{i} + 16\vec{j}$

$\vec{r} = \vec{r_0} + v_0 t + \frac{1}{2} g t^2$

$\vec{r} = 0 + 20t\vec{i} + 16t\vec{j} + -5t^2\vec{j}$

$\vec{r} = \underbrace{20t\vec{i}}_{Vx} + \underbrace{(16t - 5t^2)\vec{j}}_{Vy}$

$\vec{v} = \frac{d\vec{r}}{dt}$ $\quad \vec{v} = \underbrace{20\vec{i}}_{Vx} + \underbrace{(16 - 10t)\vec{j}}_{Vy}$

a) ao atingir a altura máxima

$Vy = 0$

$16 - 10t = 0$

$-10t = -16$

$t = 1,6\ s$

b) nesse instante

$\vec{r} = 20 \cdot 1,6\vec{i} + (16 \cdot 1,6 - 5 \cdot 1,6^2)$

$\vec{r} = 32\vec{i} + 12,8\vec{j}$

$y_{max} = 12,8\ m$

c) ao atingir o solo

$y = 0$ $\qquad 16 - 5t = 0$

$16t - 5t^2 = 0$ $\qquad -5t = -16$

$t(16 - 5t) = 0$ $\qquad t = 16/5$

~~$t = 0$~~ $\qquad \boxed{t = 3,2\ s}$

d) nesse instante

$\vec{r} = 20t\vec{i}$ $\qquad x_{max} = 64\ m$

$\vec{r} = 20 \cdot 3,2\vec{i} + 0\vec{j}$

$\vec{r} = 64\vec{i}$

Movimento circular

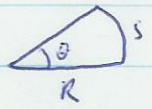
MCU: $S = S_0 + vt$

$\frac{v}{R} = w$ { velocidade angular }

$S = S_0 + vt$

$\frac{S}{R} = \frac{S_0}{R} + \frac{v}{R}t$

$\theta = \theta_0 + \frac{v}{R}t$



$\theta = \frac{S}{R}$ radiano = rad

$\theta = \theta_0 + wt$

MCUV: $\frac{S}{R} = \frac{S_0}{R} + \frac{v_0}{R}t + \frac{1}{2}\frac{a}{R}t^2$ $\quad \frac{a}{R} = \alpha$ (aceleração angular)

$\theta = \theta_0 + w_0 t + \frac{1}{2}\alpha t^2$

$\frac{v}{R} = \frac{v_0}{R} + \frac{a}{R}t$

$w = w_0 + \alpha t$

$S \to \theta$

$v \to w$

$a \to \alpha$

$\frac{v^2}{R^2} = \frac{v_0^2}{R^2} + 2\frac{a}{R}(S - S_0)$

$w^2 = w_0^2 + 2\alpha(\theta - \theta_0)$

$v = \frac{ds}{dt} \to w = \frac{d\theta}{dt}$

$a = \frac{dv}{dt} \to \alpha = \frac{dw}{dt}$

$v = \int a\,dt + C \Rightarrow w = \int \alpha\,dt + C$

$S = \int v\,dt + C \Rightarrow \theta = \int w\,dt + C$

DATA / /

$a_c = \frac{v^2}{R} = w^2 R$

$\theta = \theta_0 + wt$

Período {T} - É o tempo que o corpo demora para efetuar uma volta

Frequência {f} - É o número de voltas que o corpo ou o ponto material executa na unidade de tempo.

unidade

$1 \frac{\text{volta}}{s} = 1 \frac{\text{rotação}}{s} = 1 \text{ hertz} = 1 Hz$

$1 KHz = 10^3 Hz$

$1 MHz = 10^6 Hz$

$1 GHz = 10^9 Hz$

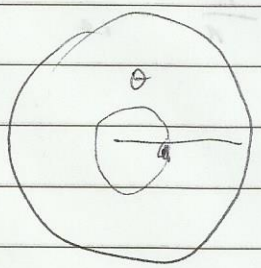
$1 THz = 10^{12} Hz$

Tempo — nº de voltas

$T \quad 1$

$1 \quad f$

$f = \frac{1}{T}$



$\theta_0 = 0 \rightarrow \theta = wt$

$2\pi = wT$

$w = \frac{2\pi}{T} = 2\pi f$

$a_c = \frac{v^2}{R} = \frac{(wR)^2}{R} = \frac{w^2R^2}{R} = w^2R$

$a_c = \left(\frac{2\pi}{T}\right)^2 R = \frac{4\pi^2 R}{T^2}$

$a_c = (2\pi f)^2 R = 4\pi^2 f^2 R$

DATA / /

3-28-98

$a_{c1} = (2\pi f_1)^2 R$ $\quad \frac{a_{c1}}{a_{c2}} = 3 \quad \frac{(2\pi f_1)^2 R}{(2\pi f_2)^2 R} = 3$

$a_{c2} = (2\pi f_2)^2 R$

$f_2^2 = 3 f_1^2$

$f_2 = \sqrt{3} f_1$

3-30-98

$R = 3{,}40\ m$ $\quad f = \frac{550\ r/o}{60s} = \frac{55}{6}$

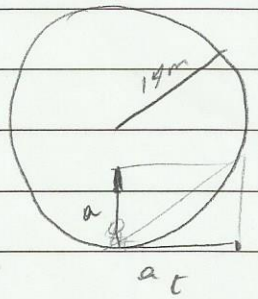
$f = 550\ rpm$

$v = \omega R = 2\pi f R$

$v = 2\pi \frac{55}{6} \cdot 3{,}40$

$v = 195{,}8\ \frac{m}{s}$

3-34-98



$v = 3\ m/s$

$a_t = 0{,}5\ m/s$

$a = ?$

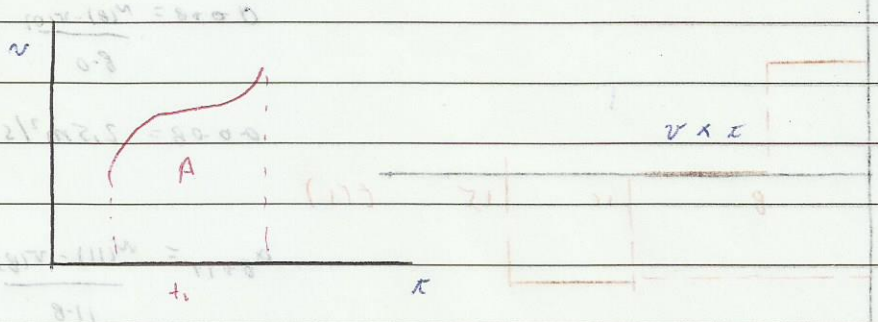
$a_c = \frac{v^2}{R} = \frac{3^2}{14} = 0{,}64\ m/s^2$

$a = \sqrt{0{,}642^2 + 0{,}5^2}$

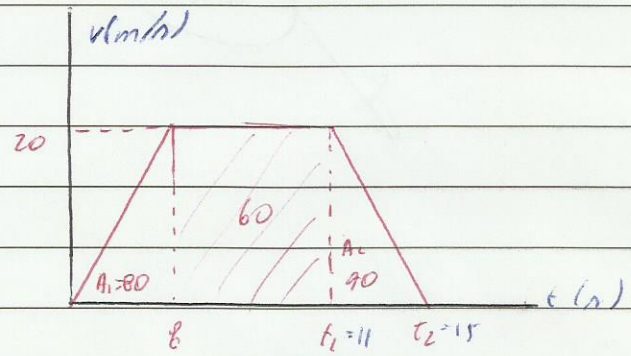
$a = 0{,}81$

A velocidade é máxima quando a aceleração é nula

" posição " " " " velocidade " "



2-30-62



$A_1 = \frac{20 \cdot 8}{2} = 80$

$A_2 = A_{TOTAL} - (A_1 + 60) =$

$A_2 = 40$

$\Delta S_{8 \to t_1} = 60m$

$\Delta S_{8 \to t_2} = 100m$

$20\,(t_1 - 8) = 60$

$t_1 = 11s$

$A_{8 \to t_1} = \Delta S_{8 \to t_1}$

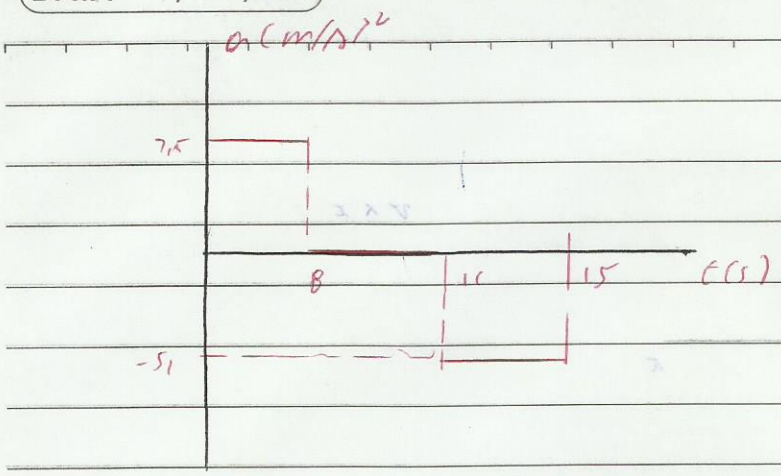
$A_{11} \to t_2 \cong \Delta S$

$40 = \frac{20}{2}(t_2 - 11)$

$t_2 = 15s$

A de homa da velocidade

DATA / /

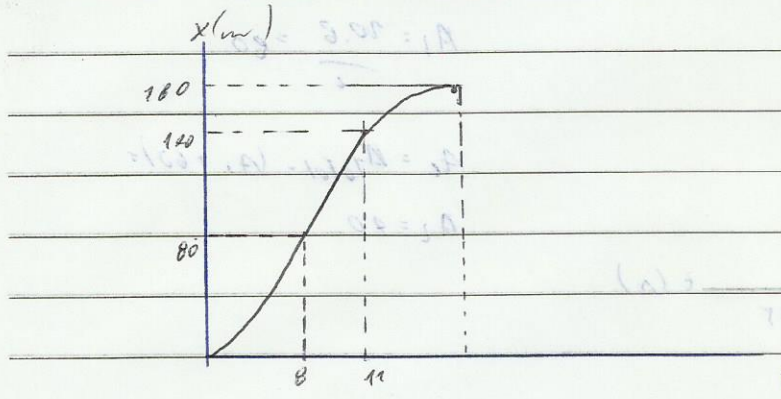


$a_{0 \to 8} = \frac{v_{(8)} - v_{(0)}}{8-0} = \frac{20-0}{8}$

$a_{0 \to 8} = 2{,}5\ m^2/s$

$a_{8 \to 11} = \frac{v_{(11)} - v_{(8)}}{11-8} = \frac{20-20}{3} = 0$

$a_{11-15} = \frac{v_{(15)} - v_{(11)}}{15-11} = \frac{0-20}{4} = -5\ m/s^2$



3.44.99

$a_x = 2{,}5t^2$

$a_y = 9 - 1{,}4t$

$t=0 \begin{cases} x=y=0 \\ \vec{v} = 7\vec{i} + 7\vec{j} \end{cases}$

$\vec{a} = a_x \vec{i} + a_y \vec{j}$

$\vec{a} = 2{,}5t^2\vec{i} + (9 - 1{,}4t)\vec{j}$

$\vec{v} = \int \vec{a}\,dt + \vec{C}_1$

$\vec{v} = \int [2{,}5t^2\vec{i} + (9 - 1{,}4t)\vec{j}]\,dt + \vec{C}_1$

$\vec{v} = \frac{2{,}5t^3}{3}\vec{i} + (9t - 0{,}7t^2)\vec{j} + \vec{C}_1$

$t=0$

$\vec{i} + 7\vec{j} = \vec{C}_1$

$\vec{v} = \underbrace{\left(\frac{2{,}5t^3}{3} + 1\right)}_{v_x}\vec{i} + \underbrace{(7 + 9t - 0{,}7t^2)}_{v_y}\vec{j}$

$\vec{r} = \int \vec{v}\,dt + \vec{C}_2$

$\vec{r} = \left(\frac{2{,}5}{12}t^4 + t\right)\vec{i} + \left(7t + 4{,}5t^2 - \frac{0{,}7}{3}t^3\right)\vec{j} + \vec{C}_2$

$\vec{r} = \underbrace{(0{,}208t^4 + t)}_{x}\vec{i} + \underbrace{\left(7t + 4{,}5t^2 - 0{,}233t^3\right)}_{y}\vec{j}$

Leis de Newton

só o corpo pode haver força

1ª) Lei da Inércia - Um corpo não pode por si só alterar seu estado de repouso ou de movimento

2ª) $\sum \vec{F} = m\vec{a}$ $\quad F = Kg.\frac{m}{s^2}$ ou newton ou N

3ª) Lei da ação e da reação

"Se um corpo A exerce uma força $\vec{F}_{AB}$ (ação) num corpo B, o corpo B exerce no corpo A uma força $\vec{F}_{BA}$ (reação) de modo que $\vec{F}_{AB} = -\vec{F}_{BA}$".

- Um corpo não exerce corpo nele mesmo

Forças de atrito {fat} $\quad \sum \vec{F}_{ext} = m\vec{a}$

Força centrípeda: $a_c = \frac{v^2}{R} = w^2 R \quad F_c = m\frac{v^2}{R} = mw^2R$

Lei do atrito

1) Forças de atrito são forças de solicitação, isto é, elas só aparecem quando solicitadas

2) Forças de atrito sempre se opõe ao deslizamento ou à tendência de deslizamento

Formulário

$$\sum \vec{F}_{ext} = m\vec{a}$$

$$0 \leq fat_e \leq \mu_e N$$

$$fat_D = \mu_D N$$

$$F_c = m\frac{v^2}{R} = mw^2R$$

S T Q Q S S D

/ /

4-12-30

$a = \frac{F}{m} = \frac{140}{32,5} = 4,31\ m/s^2$

$m = 32,5\ Kg$

$x = \frac{1}{2} a t^2 \quad x = \frac{1}{2} \cdot 4,31 \cdot 10^2 \quad x = 215,38\ m$

$v_0 = 0$

$F = 140\ N$

$v = at = 4,31 \cdot 10 = 43,1\ m/s$

$a = ?$
$x = ?$
$v = ?$
$\Big\}\ t = 10s$

1-) Um elevador tem $m = 1000\ kg$. Determinar a força de tração do cabo no cabo do elevador. quando este

a) esta parado

b) sobe em MRU com velocidade $v = 2m/s$

c) desce " ". " " $v = 2m/s$

d) sobe em MRUA com aceleração $a = 2m/s^2$

e) desce em MRUA com aceleração $a = 2m/s^2$

f) sobe em MRUR com aceleração $a = 2m/s^2$

g) desce em MRUR com aceleração $a = 2m/s^2$

h) desce em MRUA com aceleração $a = 10m/s^2$

(a-) $m = 1000\ Kg$

$v = 0$

$a = 10\ m/s^2$

$\sum \vec{F}_{ext} = m\vec{a}$

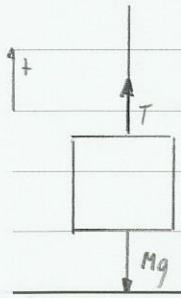
$T - P = Ma$

$T = Mg + Ma$

$T = M(g + a)$

1a) $T = 1000 \cdot 10$

$= 10\,000\ N$



/ /

(b) sobe $v = 2\,m/s$ — $va > 0$ = acelerado

$a = 0$ — $va < 0$ = retardado

$T = 10\,000\,N$

(c) desce $v = 2 \Rightarrow a = 0$

$T = 10\,000\,N$

(d) sobe acelerado — $va > 0$ - acelerado

$a = 2\,m/s^2$ — Portanto $v > 0$, $a > 0$

$a = 2\,m/s^2$

$T = M(g + a)$

$T = 1000(10 + 2)$

$T = 12\,000\,N$

(e) desce acelerado, para $va > 0$ acelerado, como o $v < 0$, então $a < 0$

$a = -2$

$T = M(g + a)$

$T = 1000(10 + (-2))$

$T = 8000\,N$

(f) sobe retardado — $va < 0$ - retardado

$v > 0$ — $v > 0$ $a < 0$

$a = -2$

$T = M(g + a)$

$T = 1000(10 + (-2))$

$T = 8000\,N$

/ /

(g) desce retardado

$v<0$ $\quad$ $v\,a<0$ · retardado

$a = 2\ m/s$ $\quad$ $v<0\ \ a>0$

$T = M(g+a)$

$= 1000(10+2)$

$= 12000$

(h) desce acelerado $\quad$ $v\,a>0$ · acelerado

$v<0$ $\quad$ $v<0\ \ a<0$

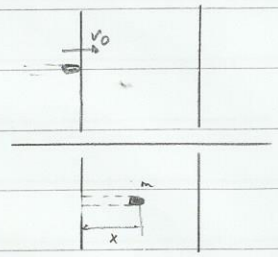
$a = -10$

$T = M(g+a)$

$= 1000(10-10)$

$T = 0$

9-34-131



$m = 1,8\ g$

$v_0 = 350\ m/s$

$x = 0,13\ m$

$t = ?$

$F_{AB} = ?$

$\sum F_{ext} = m\,a$

Cálculo da aceleração

$v^2 = v_0^2 + 2a(x - x_0)$

$a = -\frac{v_0^2}{2}$ $\quad$ $a = -\frac{350^2}{2 \cdot 0,13}$

$a = -9,71 \cdot 10^5\ m/s^2$

$t = ?$

$v = v_0 + at$

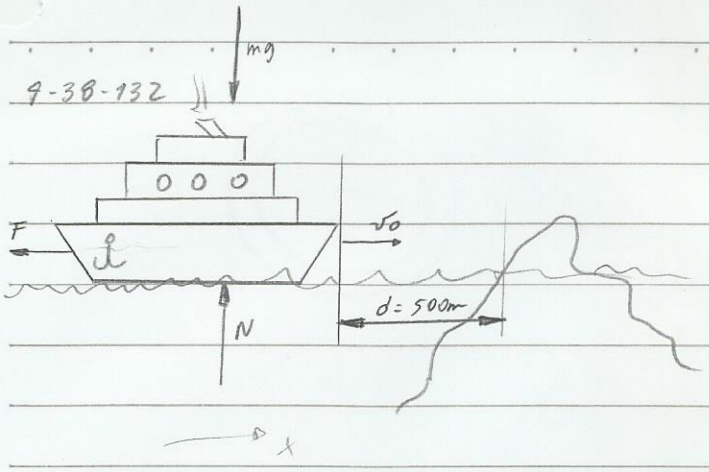
$t = -\frac{v_0}{a}$ $\quad$ $t = -\frac{350}{-9,71\,10^5} = 7,43 \cdot 10^{-4}\ s$ ou $0,74\ ms$

$F_{AB} = m\,a$

$= 1,8 \cdot 10^{-3} \cdot (-9,71 \cdot 10^5)$

$= -848,07\ N$

9-38-132



$m = 3{,}6 \cdot 10^7\ kg$

$v_0 = 1{,}5\ m/s$

$F = 8 \cdot 10^4\ N$

$g = 10\ m/s^2$

$$\sum \vec{F}_{ext} = m \cdot \vec{a}$$

$$-F = ma$$

$$a = -\frac{F}{m}$$

$$a = -\frac{8 \cdot 10^4}{3{,}6 \cdot 10^7} = -2{,}22 \cdot 10^{-3}\ m/s^2$$

até parar, o navio percorre x

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$x = -\frac{v_0^2}{2a} \qquad x = -\frac{1{,}5^2}{2(-2{,}22)10^{-3}} \qquad x = 506{,}25\ m$$

houve colisão

ao atingir o iceberg

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$v^2 = 1{,}5^2 + 2 \cdot (-2{,}22 \cdot 10^{-3}) \cdot 500$$

$$v^2 = 2{,}25 - 2{,}22$$

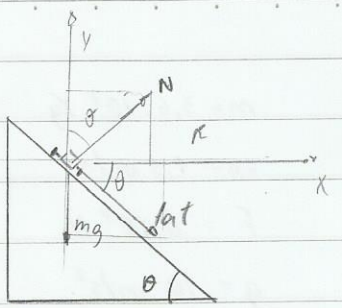
$$v = \sqrt{0{,}03}$$

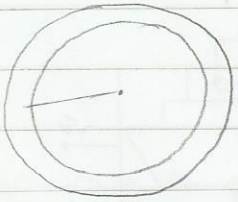
$$v = 1{,}7 \cdot 10^{-1}$$

$$v = 0{,}17 < 0{,}2\ m/s$$

não há vazamento

5-50-171





$$\sum \vec{F}_{ext} = m\vec{a}$$

y: $N\cos\theta - f_{at}\operatorname{sen}\theta - mg = 0$

$N\cos\theta - \mu N \operatorname{sen}\theta = mg$

$$N = \frac{mg}{\cos\theta - \mu \operatorname{sen}\theta}$$

x: $N\operatorname{sen}\theta + f_{at}\cos\theta = m\frac{v^2}{R}$

$N\operatorname{sen}\theta + \mu N\cos\theta = m\frac{v^2}{R}$

$N(\operatorname{sen}\theta + \mu\cos\theta) = m\frac{v^2}{R}$

$$\frac{\operatorname{sen}\theta + \mu\cos\theta}{\cos\theta - \mu\operatorname{sen}\theta} mg = m\frac{v^2}{R}$$

$$v^2 = Rg\,\frac{\frac{\operatorname{sen}\theta}{\cos\theta} + \mu\frac{\cos\theta}{\cos\theta}}{\frac{\cos\theta}{\cos\theta} - \mu\frac{\operatorname{sen}\theta}{\cos\theta}}$$

$$v = \sqrt{Rg\,\frac{\operatorname{tg}\theta + \mu}{1 - \mu\operatorname{tg}\theta}}$$

a) $\theta = 0$; $\mu \neq 0$

$v = \sqrt{\mu Rg}$

b) $\theta \neq 0$; $\mu = 0$

$v = \sqrt{Rg\operatorname{tg}\theta}$

c) $\mu = 0$; $\theta = 0$

$v = 0$

/ /

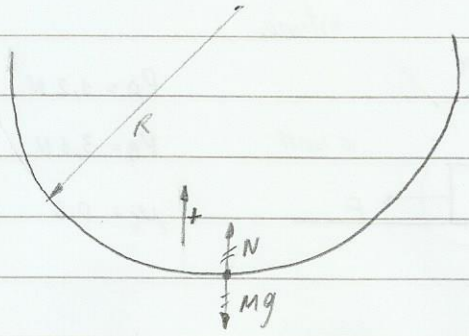
(5-58-172)

$m = 50\ Kg$

$v = 95\ m/s$

$R = ?$

$a_c \leq 4g$



$\sum \vec{F} = m\vec{a}_c$

$N - mg = m.a_c$

ou

$N - mg = m\frac{v^2}{R}$

$N = m4g + mg$

$N = m(4g + g)$

$N = 5mg$ (Peso aparente)

$\frac{v^2}{R} \leq 4g$

$\frac{95^2}{40} \leq R$

$R \geq 225{,}625\ m$

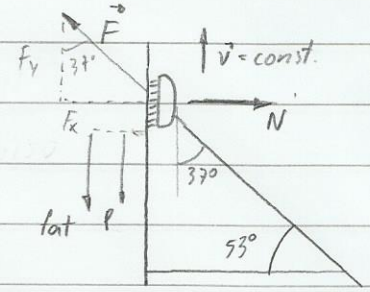
5-68-173 (Relaxar)

$P = 12\ N$

$\mu_c = 0{,}15$

$\cos 37° = 0{,}8$

$\operatorname{sen} 37° = 0{,}6$



$\sum \vec{F} = m\vec{a}$

$x: N - F\operatorname{sen}37 = m.a \quad (a=0)$

$N = F\operatorname{sen}37$

$y: F\cos 37 - fat - p = m.a \quad (a=0)$

$F\cos 37 - \mu N = P$

$F\cos 37 - \mu F \operatorname{sen}37 = P$

$F(\cos 37 - \mu \operatorname{sen}37) = P$

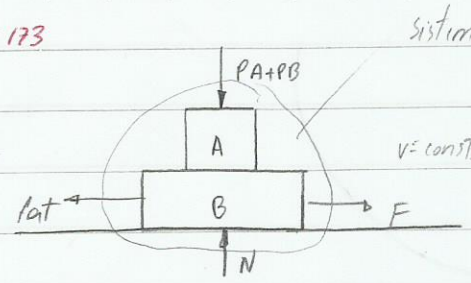
$F = \frac{P}{\cos 37 - \mu \operatorname{sen}37}$

$F = \frac{12}{0{,}8 - 0{,}6 \cdot 0{,}15}$

$F = 16{,}9\ N$

/ /

5-67-173



$P_A = 1,2\ N$ $\quad F = ?$

$P_B = 3,6\ N$

$\mu_c = 0,3$

(A) $\sum \vec{F} = m \cdot \vec{a}$

y: $N - (P_A + P_B) = m \cdot a \quad (a = 0)$

$N = P_A + P_B$

x: $F - fat = m \cdot a \quad (a = 0$

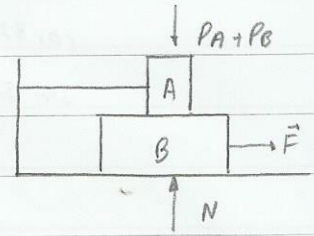
$F = fat = \mu N$

$F = \mu (P_A + P_B)$

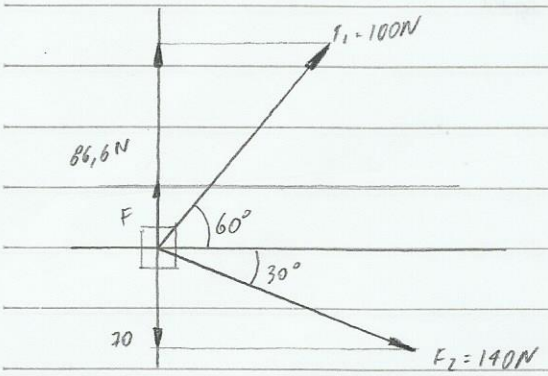
$F = 0,3 (1,2 + 3,6) = 1,44\ N$

$4,8 \times 0,3 = 1,44$

(B)



4.37 - 132



a) $\Sigma \vec{F} = m\vec{a}$

y: $F + 86,6 - 70 = m.a$

$F + 16,6 = 0$

$F_{MIN} = -16,6\ N$

b) $F_1 \cos 60 + F_2 \cos 30 = ma = \frac{P}{g} a$

$100 . 0,5 + 140 . 0,866 = \frac{P}{10} . 2$

$P = 856,2\ N$

4-58 - 134

D → S → V → a → I

$\vec{r} = (0,020\ t^3)\vec{i} + (2,2\ t)\vec{j} - (0,060\ t^2)\vec{K}$

$\vec{v} = 0,06\ t^2\ \vec{i} + 2,2\ \vec{j} - 0,12\ t\ \vec{K}$

$\vec{a} = 0,12\ t\ \vec{i} - 0,12\ \vec{K}$

No instante $t = 5s$

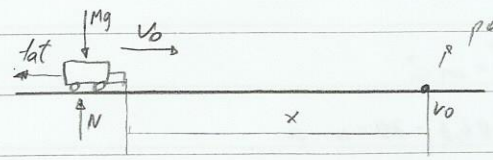
$\vec{a} = 0,12 . 5\ \vec{i} - 0,12\ \vec{K}$

$\vec{a} = 0,6\ \vec{i} - 0,12\ \vec{K}\ (m/s^2)$

$\Sigma \vec{F} = m.\vec{a} = \frac{P}{g}\vec{a}$ $\quad \frac{2,75.10^3}{10} . a = 2,75\ 10^2 . (0,6\vec{i} - 0,12\vec{K}) N$

/ /

5-34-170



(A)

$\mu_0 = 0,8$

$v_0 = 28,7$

$x_{min} = ?$

$\sum \vec{F} = m.\vec{a}$

y: $N - Mg = m.0$

$N = Mg$

x: $-fat = m.a$

$-\mu N = ma$

$-\mu mg = ma$

$a = -\mu g$

$v^2 = v_0^2 + 2a(x - x_0)$

$0 = v_0^2 + 2ax$

$x = \frac{-v_0^2}{2a}$ $\quad X = \frac{-v_0^2}{2(-\mu g)}$ $\quad x = \frac{28,7^2}{2.0,8.10} = 51,98m$

(B) $\mu = 0,25$

$a = -\mu g$

$a = -(0,25).10$

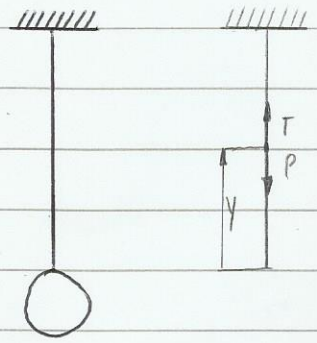
$a = -2,5 m/s^2$

$x = \frac{v_0^2}{5}$

$v_0 = \sqrt{51,98.5}$

$v_0 = 16,09 m/s$

5-3-167



$P_B = 735\,N$

$M_{corrente} = 26\,Kg$

$P_C = 26 \cdot 9{,}81$

$P_C = 255{,}06\,N$

$T = p = \frac{P_C}{L} y$

$y = 0 \Rightarrow T = \frac{P_C}{L} = 0$ $\quad T_{MIN} = 0$

$y = L \Rightarrow T = \frac{P_C}{\cancel{L}} \cdot \cancel{L}$ $\quad T_{MÁX} = P_C = 255\,N$

$T_{MIN} = P_B = 735\,N$

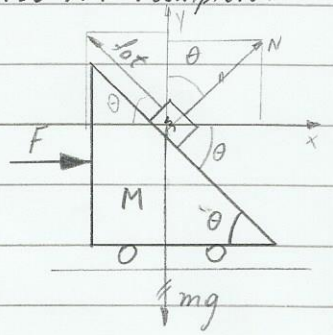
$T_{MÁX} = 255 + 735 = 990\,N$

Se $y = \frac{3}{4} L$

$T = \frac{P_C}{\cancel{L}} \cdot \frac{3}{4} \cancel{L}$

$T = \frac{3}{4} P_C + P_B = 926{,}25\,N$

5-120-179 (completo)



$F = ?$ Para que não deslize para baixo

$\sum \vec{F}_{ext} = m\vec{a}$

y: $fat \operatorname{sen}\theta + N\cos\theta - mg = m \cdot 0$, $\vec{a} = 0$

$N\cos\theta + \mu N \operatorname{sen}\theta = mg$

$N = \frac{mg}{\cos\theta + \mu \operatorname{sen}\theta}$

Observações:
Proj. as forças no xOy

$\sum \vec{F}_{ext} = m\vec{a}$

$F = (M+m) \cdot a$

x: $-fat\cos\theta + N\operatorname{sen}\theta = ma$

$N\operatorname{sen}\theta - \mu N\cos\theta = m \cdot a$

$N(\operatorname{sen}\theta - \mu\cos\theta) = ma$

$\frac{\operatorname{sen}\theta - \mu\cos\theta}{\cos\theta + \mu \operatorname{sen}\theta} \cdot mg = ma$

$\frac{\frac{\operatorname{sen}\theta}{\cos\theta} - \mu \frac{\cos\theta}{\cos\theta}}{\frac{\cos\theta}{\cos\theta} + \mu \frac{\operatorname{sen}\theta}{\cos\theta}} \cdot g = a \Rightarrow a = \frac{tg\theta - \mu}{1 + \mu tg\theta} \cdot g$

(1-) $\mu = 0$ $\quad a = tg\theta \cdot g$

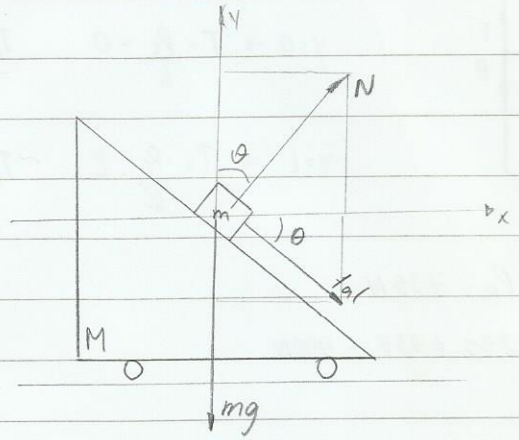
(2-) "Para que ele não suba"

Resolução no outro lado

/ /

HOVER CRAFT
AIR TRACK

2º caso - Para que o [m] não suba



$\sum \vec{F} = m a$

y: $N\cos\theta - fat\,\mathrm{sen}\theta - mg = ma \quad ; a = 0$

$N\cos\theta - fat\,\mathrm{sen}\theta = mg$

$N\cos\theta - \mu N\,\mathrm{sen}\theta = mg$

$N = \dfrac{mg}{\cos\theta - \mu\,\mathrm{sen}\theta}$

x: $N\,\mathrm{sen}\theta + fat\cos\theta = ma$

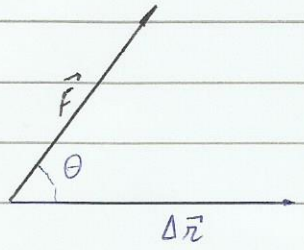
$N\,\mathrm{sen}\theta + \mu N\cos\theta = ma$

$N(\mathrm{sen}\theta + \mu\cos\theta) = ma$

$\dfrac{\mathrm{sen}\theta + \mu\cos\theta}{\cos\theta - \mu\,\mathrm{sen}\theta} \cdot mg = ma \quad \therefore \quad a = \dfrac{tg\theta + \mu}{1 - \mu tg\theta} \cdot g$

- $\mu = 0 \quad a = tg\theta \cdot g$
- $\theta = 0$ e $\mu \neq 0 \quad a = \mu g$
-

Trabalho $\{\tau_F\}$ de uma força



$$\tau_{\vec{F}} = |F| \cdot |\Delta \vec{r}| \cos\theta$$

$$\tau_{\vec{F}} = F \Delta r \cos\theta$$

Unidade {SI ou MKS}

$$\tau = 1\,Nm = 1\,Joule = 1\,J$$

$$\tau_{\vec{F}} = \vec{F} \cdot \Delta \vec{r}$$

$$\tau = \sum_{j=1}^{n} \vec{F}_j \cdot \Delta \vec{r}_j$$

$$\tau = \lim_{n \to \infty} \sum_{j=1}^{n} \vec{F}_j \cdot \Delta \vec{r}_j$$

$$\boxed{\tau = \int \vec{F} \cdot d\vec{r}}$$

Trabalho de peso

$$\vec{P} = -mg\vec{j}$$

$$d\vec{r} = dx\vec{i} + dy\vec{j} + dz\vec{k}$$

$$\tau_{\vec{P}} = \int \vec{P} \cdot d\vec{r}$$

$$\tau = -mg \int \vec{j} \cdot (dx\vec{i} + dy\vec{j} + dz\vec{k})$$

$$\tau = -mg \int_{y_1}^{y_2} dy = -mg\, y \Big|_{y_1}^{y_2}$$

$$\tau_{\vec{P}} = -mg\,(y_2 - y_1)$$

/ /

Energia Potencial (EP=U)

$dU = -d\mathcal{Z}$ $\qquad U\Big|_{U_1}^{U_2} = -\mathcal{Z}$

$\int_{U_1}^{U_2} dU = -\int d\mathcal{Z}$

$U_2 - U_1 = -\mathcal{Z}$

$U_1 - U_2 = \mathcal{Z}$

$U_1 - U_2 = -mgy_2 + mgy_1$

$U_1 - mgy_1 = U_2 - mgy_2 = U - mgy = C$

$U = mgy + C \rightarrow U = mgy$

$EP_g = mgh$

Força elástica (molas)

$F = Kx$

$EP_m = \frac{1}{2} Kx^2$

Trabalho do fat

$fat = \mu N$

$\mathcal{Z}fat = fat \cdot x \cdot \cos 180$

$\mathcal{Z}fat = -\mu N x$

$\mathcal{Z} = \int F dx = \int m \frac{dv}{dt} \cdot dx$ $\qquad \mathcal{Z} = \frac{m}{2}(v_2^2 - v_1^2)$

$\mathcal{Z} = m \int \frac{dx}{dt} dv$ $\qquad \mathcal{Z} = \frac{1}{2} m v_2^2 - \frac{1}{2} m v_1^2$

$\mathcal{Z} = m \int_{v_1}^{v_2} v\, dv$ $\qquad$ ($\frac{1}{2} m v_2^2 = EC_2$, $\frac{1}{2} m v_1^2 = EC_1$)

$\mathcal{Z} = \frac{m}{2} v^2$ $\qquad \mathcal{Z} = EC_2 - EC_1$

TEC - Teorema da energia cinética

/ /

Energia mecânica (EM)

$EM = EC + EP_g + EP_M$

Teorema da energia mecânica (TEM)

$\mathcal{T}_{tot} = EM_2 - EM_1$

Potência de uma força

Potência média

$P = \frac{\mathcal{T}}{\Delta t}$ $\left\{ \frac{J}{s} = watt = W \right\}$

Pot instantânea

$P = \frac{d\mathcal{T}}{dt} = \frac{\vec{F} \cdot d\vec{r}}{dt} = \vec{F} \cdot \frac{d\vec{r}}{dt}$

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

/ /

6-36-206

$m = 4\,Kg$

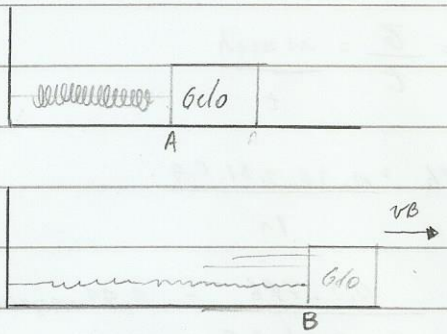
$K = 200\,N/m$

$x = 0{,}025\,m$

$v_A = 0$

$\tau_{mola} =$

$v_2 =$



a) $EP_M = \frac{1}{2} k x^2 = \tau$

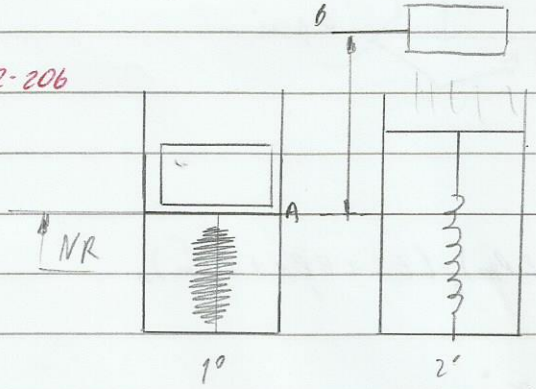
$\tau = \frac{1}{2} 200 \cdot 0{,}025^2 = 0{,}0625\,J$

b) TEC: $\tau_{res} = EC_B - \cancel{EC_A}^{0}$

$0{,}0625 = \frac{1}{2} 4 \cdot v_B^2 \qquad v_B = 0{,}176\,m/s$

NR - Nível de referência

6-42-206



$k = 450\,N/m$

$m = 1{,}8\,kg$

$h_1 = 3{,}6\,m$

$x = ?$

TEM: $\tau_{fat} = EM_B - EM_A \quad ; \quad \tau_{at} = 0$

$EM_B = EM_A$

$(\cancel{EC}^{0} + \cancel{EP_f}^{0} + \cancel{EP_M}^{0})_B = (\cancel{EC}^{0} + \cancel{EP_f}^{0} + EP_M)_A$

$mgh = \frac{1}{2} k x^2$

$x = \sqrt{\frac{2mgh}{K}} = \sqrt{\frac{2 \cdot 1{,}8 \cdot 10 \cdot 3{,}6}{450}} = 0{,}5366\,m$

Prod. escalar $|a| \cdot |b| \cdot \cos\theta$

/ /

6-99-206

$\bar{P}_{ot} = \frac{\tau}{t}$; $P_{ot} = \frac{d\tau}{dt} = \vec{F} \cdot \vec{v}$

$m = 30\,kg$

$h = 0{,}9\,m$

$g = 9{,}81\,m/s^2$

$P_{OT} = 0{,}5\,HP$

$N = ?$

$\bar{P}_{ot} = \frac{\tau}{t} = \frac{n\,mgh}{t}$

$1HP = 746\,W$

$0{,}5 \cdot 746 = \frac{n \cdot 30 \cdot 9{,}81 \cdot 0{,}9}{1}$

$n = \frac{0{,}5 \cdot 746}{30 \cdot 9{,}81 \cdot 0{,}9} = 1{,}41\ rotações/s$

$N = 60 \cdot 1{,}4 = \underline{84{,}99\ rotações/min}$

6-81-209

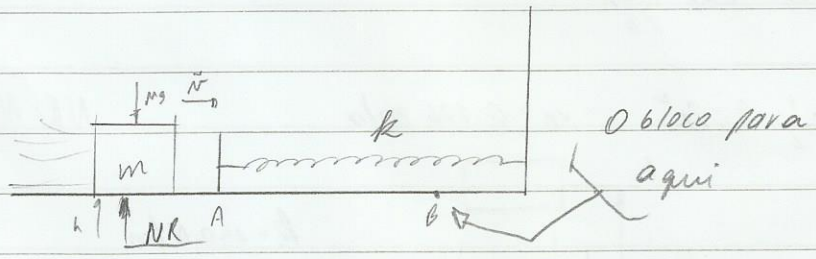
$m = 5\,kg$

$v_A = 6\,m/s$

$k = 500\,N/m$

$\mu = 0{,}5$

$x = ? = AB$



TEM: $\tau_{fat} = EM_B - EM_A$

$-\mu N x = (E_C + E_{Pe} + E_{PM})_B - (E_C + E_{Pe} + E_{Pm})_A$

$-\mu N x = E_{PM} - E_C$

$-\mu mg x = \frac{1}{2} k x^2 - \frac{1}{2} m v_A^2$

$25x = 250x^2 - 90$

Se $\mu = 0$

$250x^2 - 25x - 90 = 0$

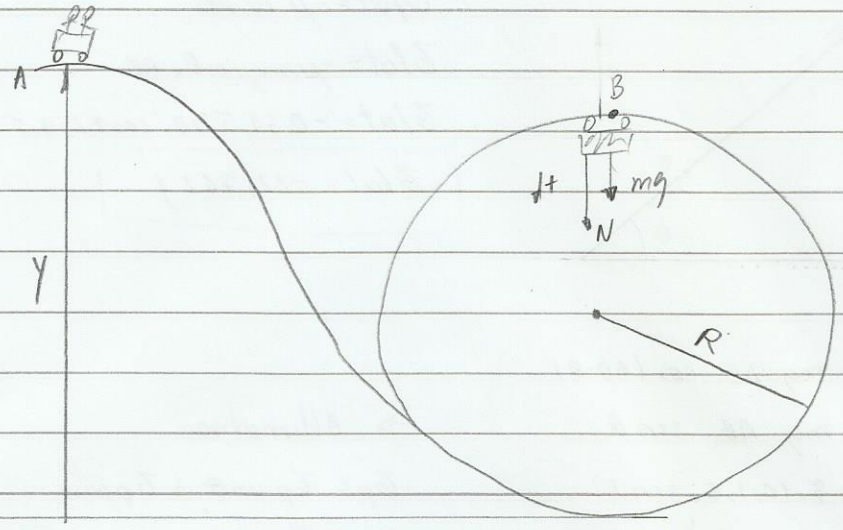
$x = 0{,}6$

$x^2 - 0{,}1x - 0{,}36 = 0$

$x = \frac{0{,}1 \pm \sqrt{0{,}01 + 1{,}44}}{2}$

$x_1 = \underline{0{,}55\,m}$

Determinar a mínima altura da qual deve ser abandonado a partir do repouso o carrinho do playcenter para que ele faça o loop



TEM: $\tau_{fat} = EM_B - EM_A$

$EM_A = EM_B$

$(EC + EP_g)_A = (EC + EP_g)_B$

$mgh = \frac{1}{2} m v_B^2 + mg2R$

$mgh = m\left(\frac{1}{2} v_B^2 + g2R\right)$

$gh = \frac{1}{2} v_B^2 + 2Rg$

$gh = \frac{1}{2} \cdot Rg + 2Rg$

$gh = g\left(\frac{1}{2} R + 2R\right)$

$h = 2{,}5R$

$\sum \vec{F}_{ext} = m \cdot \vec{a}$

$N + mg = ma$

$N + mg = m \cdot \frac{v_B^2}{R}$; $(N = 0)_{Mim}$

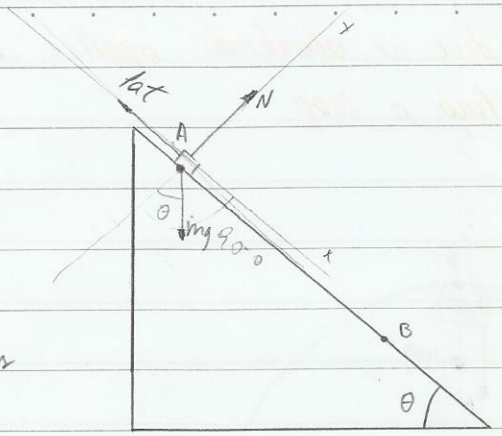
$mg = m\frac{v_B^2}{R} \Rightarrow g = \frac{v_B^2}{R}$

$v_B^2 = Rg$

/ /

Estudar

6-62-207



$m = 5\ Kg$

$\theta = 12°$

$\mu = 0,31$

$v_A = 2,2\ m/s$

$AB = 1,5\ m$

$\tau_{fat} = ?$

$\tau_P = ?$

$\tau_N = ?$

$v_B = ?$

$\tau_{fat} = -\mu . N . AB$

$\tau_{fat} = -\mu . mg\cos\theta . AB$

$\tau_{fat} = -0,31 . 5 . 10 . \cos 12 . 1,5$

$\tau_{fat} = -22,742\ J$

$\tau_P = mg . AB . \cos(90-\theta)$

$\tau_P = mg . AB . \operatorname{sen}\theta$

$\tau_P = 5 . 10 . 1,5 . \operatorname{sen} 12$

$\tau_P = 15,593\ J$

→ Alternativa

$\tau_P = \tau_P \operatorname{sen}\theta + \tau_P \cos 0$

$\tau_P = \tau_P \operatorname{sen}\theta = P \operatorname{sen}\theta AB$

$\tau_P = mg . \operatorname{sen}\theta . AB$

$\tau_N = N . AB . \cos 90$

$\tau_N = 0$

TEC: $\tau_{res} = EC_B - EC_A$

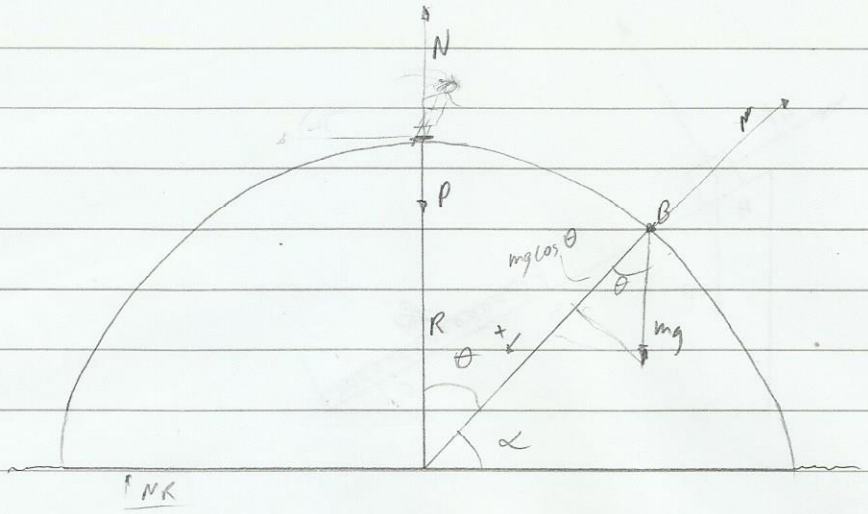
$\tau_{fat} + \tau_P + \tau_N = \frac{1}{2} m v_B^2 - \frac{1}{2} m v_A^2$

$15,593 - 22,742 = 2,5 (v_B^2 - 2,2^2)$

$v_B = 1,91\ m/s$

7-63-243

$\theta = ?$



TEM: $\tau_{fat} = EM_B - EM_A$

$EM_A = EM_B$

$(EC + EP_G + EP_M)_A = (EC + EP_G + EP_M)_B$

$mgR = \frac{1}{2} m v_B^2 + mgR\cos\theta$

$\rightarrow gR = \frac{1}{2} v_B^2 + gR\cos\theta$

$\Sigma \vec{F}_{ext} = m \cdot \vec{a}$

$mg\cos\theta - N = m \cdot \vec{a}$ ($N = 0$, pois perde o contato com o iglu)

$mg\cos\theta = m\vec{a}$

$g\cos\theta = \vec{a}$

$g\cos\theta = \frac{v_1^2}{R} \Rightarrow v_B^2 = g\cos\theta \cdot R$

$Rg = \frac{1}{2} \cdot Rg\cos\theta + Rg\cos\theta$

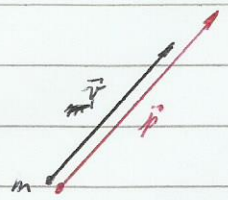
$1 = \frac{3}{2}\cos\theta$ $\qquad \theta = 48°$

$\cos\theta = \frac{2}{3}$ $\qquad \alpha = 42°$

/ /

Erivelton

Momento linear ou quantidade de movimento linear $\{\vec{p}\}$



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

$$\frac{d\vec{p}}{dt} = m\frac{d\vec{v}}{dt} + \vec{v}\frac{dm}{dt}^{0}$$

$$\frac{d\vec{p}}{dt} = m\frac{d\vec{v}}{dt} = m\vec{a} = \Sigma\vec{F}_{ext} = \vec{F}$$

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

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

$$\int_{\vec{p}_1}^{\vec{p}_2} d\vec{p} = \int_{t_1}^{t_2} \vec{F}\,dt$$

$$\vec{p}\Big|_{\vec{p}_1}^{\vec{p}_2} = \int_{t_1}^{t_2} \vec{F}\,dt = \vec{I}$$

{$\vec{I}$ = impulso linear}

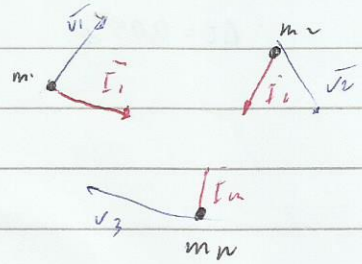
$$\vec{p}_2 - \vec{p}_1 = \vec{I}$$

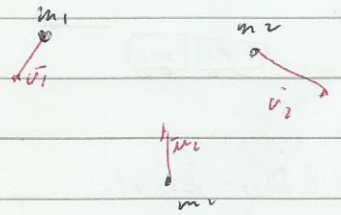
$$\vec{p}_1 + \vec{I} = \vec{p}_2$$

$$\boxed{m\vec{v}_1 + \vec{I} = m\vec{v}_2}$$

TIL = teorema do impulso linear

Sistemas de partículas





$$\boxed{I = F_m \Delta t}$$

$m_1\vec{v}_1 + \vec{I}_1 = m_1\vec{v}_1$

$m_2\vec{v}_2 + \vec{I}_2 = m_2\vec{v}_2$

$\vdots \quad \vdots \quad \vdots$

$m_n\vec{v}_m + \vec{I}_m = m_n\vec{v}_m$

TIL

$$\Sigma m\vec{v}\Big|_1 + \Sigma\vec{I} = \Sigma m\vec{v}\Big|_2$$

$$\Sigma m_j\vec{v}_j + \Sigma\vec{I}_j = \Sigma m_j\vec{v}_j$$

/ /

Formulário

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

$$\sum m\vec{v}|_1 + \sum \vec{I}_{ext} = \sum m\vec{v}|_2$$

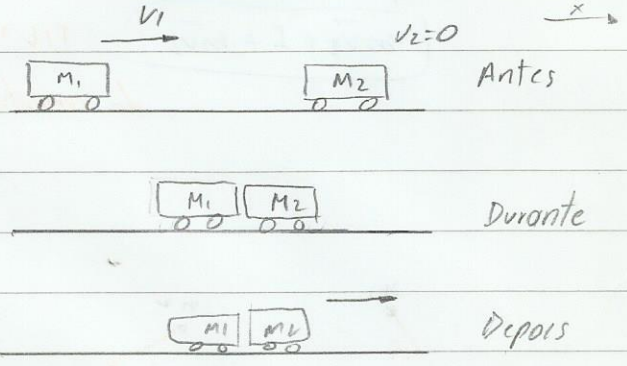
$$\vec{I} = \int_{t_1}^{t_2} \vec{F}\,dt = \vec{F}_m \Delta t$$

- Dois vagões de metro efetua a operação denominada "engate". Um vagão tem massa $m_1 = 1$ tonelada e velocidade $v_1 = 1\,m/s$, o outro tem massa $m_2 = 3$ tonelada que esta em repouso. O engate demora $0{,}05\,s$.

Determinar:

a) A velocidade comum dos vagões após o choque

b) A força média que cada vagão exerce sobre o outro durante o engate



$M_1 = 1t$

$V_1 = 1\,m/s$

$M_2 = 3t$

$V_2 = 0$

$\Delta t = 0{,}05\,s$

a)

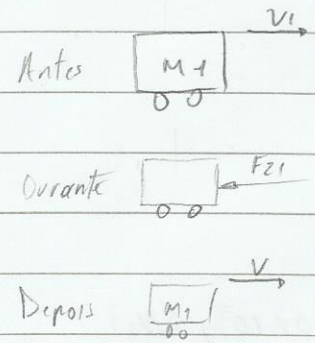
TIL: $\sum m\vec{v}|_1 + \sum \vec{I}_{ext} = \sum m\vec{v}|_2$

$M_1 V_1 + M_2 \cdot 0 = v(M_1 + M_2)$

$$V = \frac{M_1}{M_1 + M_2} \cdot V_1$$

$$V = \frac{1t}{4t} \cdot 1 \Rightarrow \frac{1}{4} = 0{,}25\,m/s$$

Vagão 1 $\{F_{21} = ?\}$



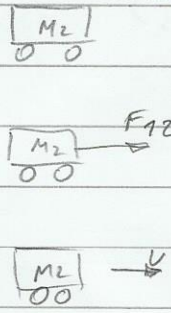
$m\vec{v}_1 + \vec{I} = m\vec{v}_2$

$M_1V_1 + \vec{F}_{21}\Delta t = M_2V$

$F_{21} = \frac{M_2V - M_2V_1}{\Delta t}$ $\quad F_{21} = \frac{M_2(V - V_1)}{\Delta t}$

$F_{21} = \frac{1000(0,25 - 1,00)}{0,05} = -15000N$ ou $-15kN$

Vagão 2 $\{F_{12} = ?\}$



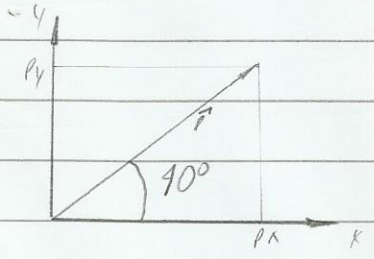
$m\vec{V}_1 + \vec{I} = m\vec{V}_2$

$M.0 + \vec{F}_{12}.\Delta t = M_2V$

$\vec{F}_{12} = \frac{M_2V}{\Delta t}$

$\vec{F}_{12} = \frac{3000.0,25}{0,05} = 15000N$ ou $15kN$

8-9-275



$m = 7,3Kg$

$V = 15m/s$

$p_x =$

$p_y =$

$p_x = mv\cos 40°$

$= 7,3.15\cos 40$

$= 83,86\ Kg\frac{m}{s}$

$p_y = mv\ \mathrm{sen}\ 90°$

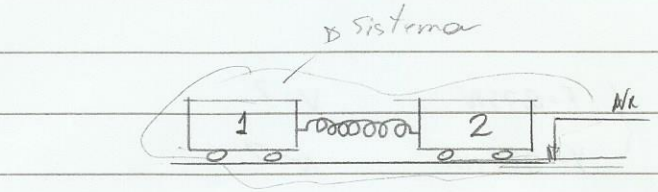
$p_y = 7,3.15\ \mathrm{sen}\ 90$

$p_y = 70,39N$

/ /

$EP_M = \frac{1}{2} k x^2$

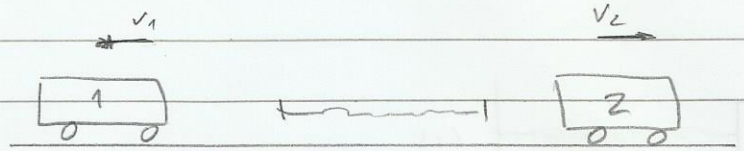
08-20-277



$M_1 = 1\,kg$

$M_2 = 3\,kg$

$V_2 = 1{,}2\,m/s$



$V_1 = ?$

$EP_M = ?$

TIL: $\sum m\vec{v}|_1 + \sum \vec{I}_{ext} = \sum m\vec{v}|_2$

$M_1 0 + M_2 0 = M_1 V_1 + M_2 V_2$

$V_1 = -\frac{M_2 . V_2}{M_1}$ $\quad V_1 = -\frac{3}{1} . 1{,}2 = -3{,}6\,m/s$

TEM: $\tau_{fat} = EM_F - EM_I$

$EM_I = EM_F$

$(\cancel{EC}^{0} + \cancel{EP_g}^{0} + EP_m)_I = (EC + \cancel{EP_g}^{0} + EP_m)_F$

$EP_m = EC$

$EP_m = \frac{1}{2}(M_1 V_1^2 + M_2 V_2^2)$

$EPM = \frac{1}{2}(1.(-3{,}6)^2 + 3.(1{,}2)^2)$

$EP_m = 8{,}64\,J$

/ /

8-75-201

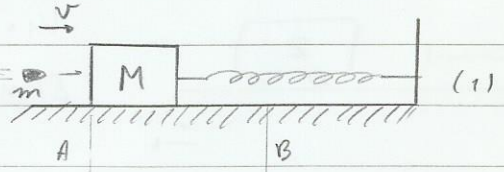
$m = 8g$

$M = 0,992\ kg$

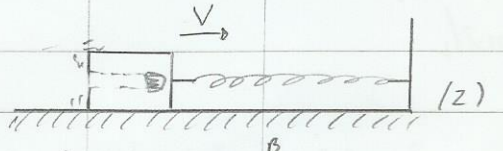
$x = 15\ cm$

$\mu = 0,5$

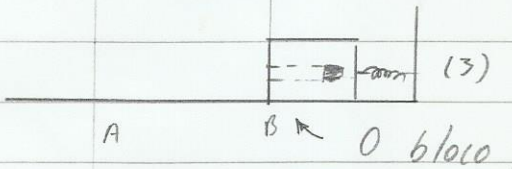
calibração $\begin{cases} F = 0,75N & V = ? \\ y = 0,25\ cm & v = ? \end{cases}$



Antes (1)



durante (2)



depois (3)

O bloco para aqui

(1)→(2) ⇒ TIL: $\Sigma m\vec{v}|_1 + \Sigma \vec{I}_{ext} = \Sigma m\vec{v}|_2$

$mv + M.0 = mV + MV$

$mv = (m+M).V$

(2)→(3): $\tau_{EM} = \tau_{Fat}$

$-\nu (M+m) g\, x = E_{M_B} - E_{M_A}$

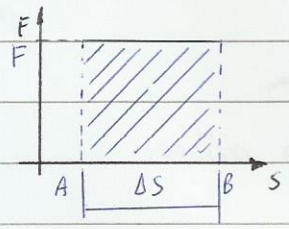
Trabalho e Teorema da Energia cinética (TEC)

Trabalho da força F $W_F = F \cdot d$

Trabalho da força de atrito $W_{at} = -fat \cdot d$

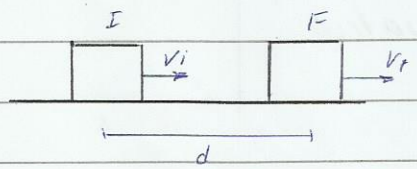
Trabalho resultante $W_R = W_F + W_{at}$

$W = \int F dx \overset{N}{=}$ área



Energia cinética: $e_c = \frac{mv^2}{2}$

Teorema da Energia cinética (TEC) $W_R = \Delta E_C = \frac{mv_f^2}{2} - \frac{mv_i^2}{2}$

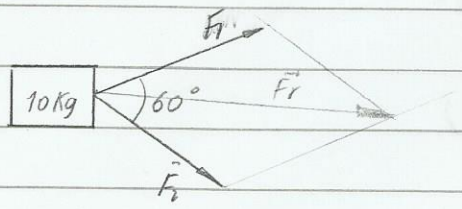


Potência $\frac{W}{\Delta t}$ (W) (média) Potência instantânea $P_i = F \cdot v$

/ /

Exercícios Treino

(1)



$\vec{F_1} = 16N$

$F_2 = 12N$

$\vec{F_r} = \sqrt{16^2 + 12^2 + 2 \cdot 16 \cdot 12 \cdot \cos 60}$

$\vec{F_r} = 29,33N$

a-) aceleração do corpo = $F = ma$

$a = \frac{F}{m} = \frac{29,33}{10} = 2,93 m/s^2$

b) velocidade escalar após 5s

$v = v_0 + at$

$v = 2,93 \cdot 5$

$v = 12,17 m/s$

(2)

$t_{0 \to 5} \rightarrow a = 1,5 m/s^2 \quad F = 800 \cdot 1,5 = 1200N$

$t_{40s} \rightarrow a = 0 \quad F = 0$

$t_{62s} \rightarrow a = 3 \quad F = 800 \cdot 3 = 2400N$

b) $\frac{(65+50) \cdot 15}{2} = 862,5 m$

(13-201) $20 - 15 = 5N \quad a = \frac{F}{m} \quad a = \frac{5}{0,5} = 10 m/s^2$

(14-201) $F_r = \sqrt{16^2 + 12^2} = 120N$

b) $a = \frac{F}{m} \quad a = \frac{20}{4} = 5 m/s^2$

/ /

(15-201)

$m = 2\ Kg$

$F = 4N$

$a = ?$

$a = \frac{F}{m} \rightarrow a = \frac{4}{2} = 2 m/s^2$

$V^2 = V_0^2 + 2a(\Delta s)$

$V^2 = 2.2.4$

$V = \sqrt{16}$

$V = 4\ m/s$

(16-202) $F = m\,a$

$F = 6.4$

$F = 24$

$F_1 + F_2 = 24$

$F_2 = 24 - 20$

$F_2 = 4N$

(17-202) $F = m\,a$

$a = \frac{F}{m} \quad a = \frac{50}{25} = 2 m/s^2$

(18-202)

$T\ 0s \rightarrow 4s \Rightarrow a = 0 \quad F = 0$

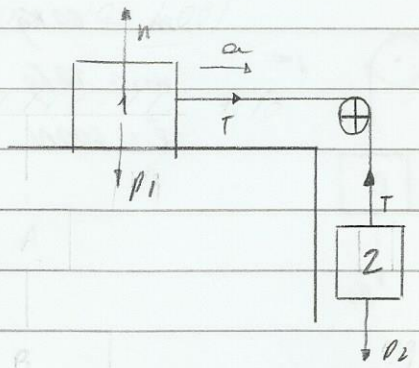
$T\ 4s \rightarrow 6s \Rightarrow a = 10/2 = 5 m/s^2 \quad F = 1200.5$

$F = 6000N$

$T\ 6s \rightarrow 10s \Rightarrow a = \frac{20}{4} = 5 m/s^2 \quad F = 1200.5$

$F = 6000N$

b) $(20.4) + \frac{(20+30).2}{2} + \frac{(10+30).4}{2} = 210\ m$



$m_1 = 2kg$

$m_2 = 8kg$

$\sum \vec{F}_{ext} = m_1 \cdot \vec{a}$

$$\begin{cases} P_2 - T = m_2 a \\ T = m_1 a. \end{cases}$$

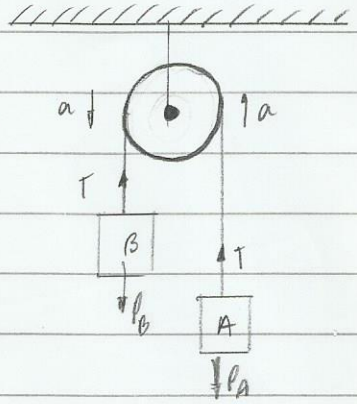
$P_2 = a(m_1 + m_2)$

$a = \frac{P_2}{m_1 + m_2}$; $P_2 = m_2 \cdot g$

$a = \frac{m_2}{m_1 + m_2} \cdot g = \frac{8}{8+2} \cdot 10 = \frac{80}{10} = 8 m/s^2$

$T = m_1 \cdot a$

$T = 2 \cdot 8 = 16N$



$m_B = 8$ $m_A = 4$

$$\begin{cases} P_B - T = m_B a \\ T - P_A = m_a \cdot a \end{cases}$$

$g(m_B - m_A) = a(m_B + m_a)$

$a = \frac{m_B - m_a}{m_B + m_a} \cdot g$

$a = \frac{8-4}{8+4} \cdot 10 = \frac{10}{3} m/s^2$

$T = m_a \cdot g + m_a \cdot \frac{m_B - m_a}{m_B + m_a} \cdot g$

$T = m_a g \left(1 + \frac{m_B - m_a}{m_B - m_a}\right)$

$T = 4 \cdot 10 \left(1 + \frac{8-4}{8+4}\right) = 53,3N$

$T' = 2T = 2 \cdot 53,3 = 106,7N$

Exercícios Treino

R.1 pág. 192

$m = 900Kg$

$V = 72Km/h$

$t = 0$ — $t = 1,21min$

$72 \cdot 1000 = 72000\,m = 20\,m/s$

$1 \cdot 3600 = 3600\,s$

$1,2min = 72s$

$\Sigma \vec{F} = m \cdot \vec{a}$

$a = \frac{20}{72} = 0,28 m/s^2$

$F = 900 \cdot 0,28 = 250N$

R.2

$a = 5m/s^2$

$m = 60Kg$

$g = 10\,m/s^2$

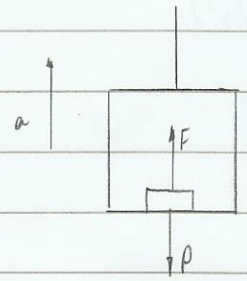
$\Sigma \vec{F} = m.a$

$F - P = m.a$

$F = ma + P$

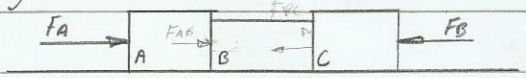
$F = 60.5 + 60.10$

$F = 900N$



R.3

$mA = 4 \quad mB = 3 \quad mC = 2 \quad F_A = 36N \quad F_B = 9N$



$F_A - F_B = m.a$

$a = \frac{F_A - F_B}{m_t} \Rightarrow a = \frac{36-9}{(4+3+2)} = 3(m/s^2)$

$F_{AB} - F_B = (m_B + m_C).a$

$F_{AB} = (mB + mC).a + F_B$

$F_{AB} = (3+2).3 + 9 = 24N$

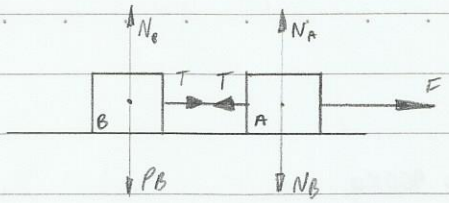
$F_{BC} - F_C = m_C\,a$

$F_{BC} = m_C\,a + F_C$

$F_{BC} = 2.3 + 9 = 15N$

/ /

R.4-



$m_A = 2\,Kg$ $F = 12\,N$

$m_B = 4\,Kg$

Pela terceira lei de Newton

y: $N_B - P_B = 0$

$N_A - P_A = 0$

Pela segunda lei de Newton

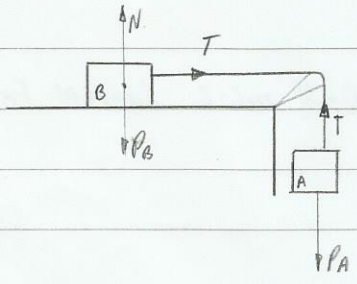
x: $F - T = m_A \cdot a$ $F = a(m_a + m_b)$

$T = m_B \cdot a$ $a = \frac{F}{mA + mB} \Rightarrow a = \frac{12}{2+4} = 2\,(m/s^2)$

$T = mB\,a$

$T = 4.2 = \underline{8N}$

R5-



$m_A = 1\,Kg$

$m_B = 1\,Kg$

$g = 10\,m/s^2$

Pela terceira lei de Newton

$N - P_B = 0$

Pela segunda lei de Newton

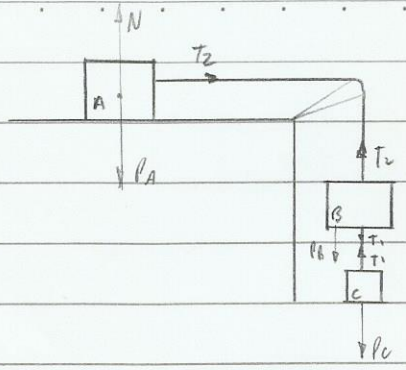
$P_A - T = mA \cdot a$ $a = \frac{P_A}{mA+mB} = 5\,m/s^2$

$T = mB \cdot a$

$T = 1\,5 = 5\,N$

/ /

R6



Pela terceira lei de Newton

$N - P_A = 0$

Pela segunda lei de Newton

$P_C - T_1 = mC \cdot a$

$T_1 + P_B - T_2 = mB \cdot a$

$T_2 = mA \cdot a$

somando: $P_C + P_B = a(mC + mB + mA)$

$$a = \frac{P_C + P_B}{mC + mB + mA} \Rightarrow a = \frac{40 + 60}{10 + 4 + 6} = 5\ m/s^2$$

$T_2 = mA \cdot a \Rightarrow T_2 = 10 \cdot 5 = \underline{50\ N}$

$P_C - T_1 = mC \cdot a \Rightarrow T_1 = P_C - mC \cdot a \Rightarrow T_1 = 40 - 4 \cdot 5 = \underline{20\ N}$

b) Teorema da Energia Mecânica

$W_{at} = EM_2 - EM_1$

$W_{at} = (EC + \cancel{EP} + \cancel{Ee})_2 - (EC + EP + \cancel{Ee})_1$

$W_{at} = \frac{mv_2^2}{2} - \frac{mv_1^2}{2} - mgh$

$v_2^2 = \frac{2}{m}\cdot\left[W_{at} + \frac{mv_1^2}{2} + mgh\right] = \frac{2}{2}\cdot\left[-60 + \frac{2.15^2}{2} + 2.10.6\right] \Rightarrow v^2 = 265$

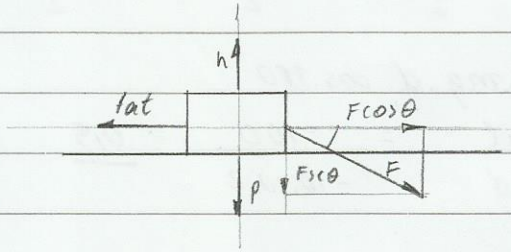
$v = 16,1$

39-) $P = 500N$ $\quad sen15° = 0,259$

$F =$ $\quad cos15° = 0,966$

$\mu c = 0,4$

$\mu d = 0,2$



$n = P + F\,sen\theta$ $\qquad fat_1 = 0,4(500 + 0,259F) = 200 + 0,1036F$

$n = 500 + 0,259F$

$F\cos\theta = fat$ $\qquad 0,966F = 200 + 0,1036F$ $\qquad F = 231,91N$

$fat = 0,966F$

$fat_2 = 0,2(500 + 0,259F) = 100 + 0,0518F$

$F\cos\theta = fat$ $\qquad P = F.\cos\theta . v$

$fat = 0,966F$ $\qquad 0,966F = 100 + 0,0518F$ $\qquad P = 109,385 . 0,966 . 2$

$F = 109,385$ $\qquad P = 211,33W$

/ /

40-) $m = 10\,kg$

$k = 4000\,N/m$

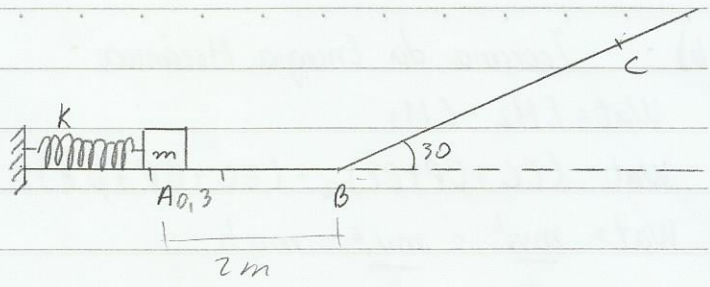
$x_a = 0,3\,m$

$AB = 2\,m$

$BC = v_b = 4\,m/s \quad v_c = 2\,m/s$

$\mu = ?$

$BC = ?$



Teorema da Energia Mecânica

$W_{at} = EM_2 - EM_1$

$W_{at} = (E_C + E_P + E_e)_2 - (E_C + E_P + E_e)_1$

$W_{at} = \frac{mv^2}{2} - \frac{kx^2}{2} = \frac{10.4^2}{2} - \frac{4000.0,3^2}{2} = -100\,N$

$W_{at} = \mu . mg . d . \cos 180$

$\mu = \frac{W_{at}}{-mg.d} = \frac{-100}{-10.10.2} = 0,5$

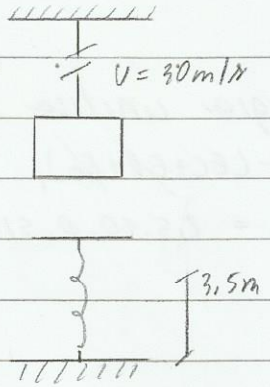
Teorema da Energia Mecânica

$W_{at} = (E_C + E_p + E_c)_2 - (E_C + E_P + E_c)_1$

$W_{at} = \frac{mv_2^2}{2} + mgh - \frac{mv_1^2}{2}$

$h = \left[W_{at} + \frac{mv_1^2}{2} - \frac{mv_2^2}{2} \right] / mg = \left[-100 + \frac{10.4^2}{2} - \frac{10.2^2}{2} \right] / 10.10$

$h = 0,4\,m$



(41-) $m = 3000\ kg$

$v = 30\ m/s$

$Fat = 19000\ N$

$Wat = Fat.d = 19000.3,5$

$Wat = 66500\ J$

Teorema da energia Mecânica

$Wat = (\cancel{EC} + \cancel{EP} + Ec)_2 - (EC + EP + \cancel{Ee})_1$

$Wat = \frac{Kx^2}{2} - \frac{mv^2}{2} - mgh$

$K = \left(\frac{mv^2}{2} + mgh + Wat\right) . \frac{2}{x^2}$

$K = \left(\frac{3000.30^2}{2} + 3000.10.45 + 66500\right) . \frac{2}{(3,5)^2}$

$V = V_0 + gt$

$0 = 30 + (-10).t$

$t = \frac{-30}{-10} = 3\ s$

$S = S_0 + v_0 t + \frac{gt^2}{2}$

$0 = S_0 + 30.3 + \frac{(-10.)3^2}{2}$

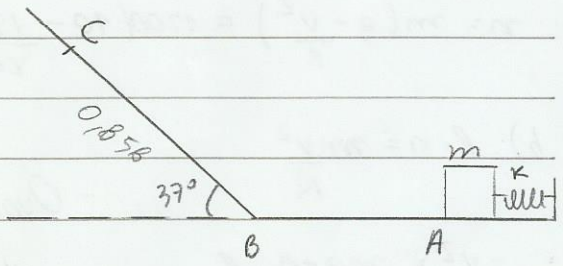
$\Delta S = 45\ m$

(43-) $m = 2,5\ kg$ $\quad \sin 37° = 0,6$

$K = 800\ N/m$ $\quad \cos 37 = 0,8$

$x_A = 0,2\ m$

$BC = 0,858\ m$



Teorema da energia Mecânica

$(EC + \cancel{EP} + \cancel{Ee})_2 = (EC + EP + Ee)_1$

$\frac{mv^2}{2} = \frac{Kx^2}{2}$

$v^2 = \frac{Kx^2}{m} = \frac{800.0,2^2}{2,5} = 12,8$

$v = 3,58\ m/s$

b) Teorema da Energia cinética

$\sin 37 = \frac{H}{x} \Rightarrow H = 0,5148$

$W_{at} = (E_C + E_P + E_e)_2 - (E_C + E_P + E_e)_1$

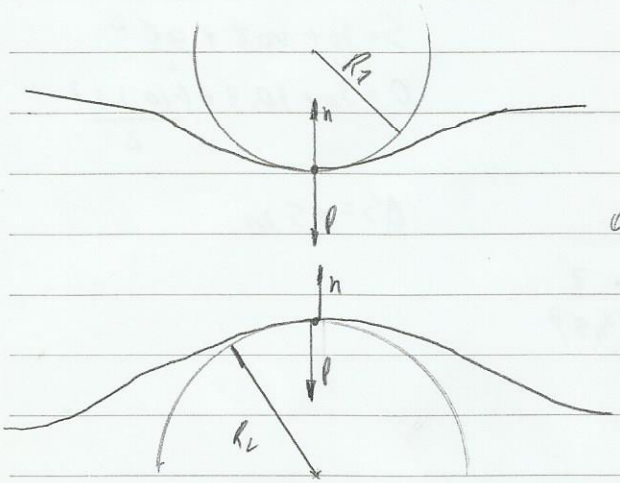
$W_{at} = mgh - \frac{mv^2}{2} = 2,5.10.0,5148 - \frac{2,5.3,58^2}{2} = -3,1505$

$W_{at} = -\mu.m.g.d.\cos\theta$

$W_{at} = -\mu.17,16 \qquad -3,1505 = -17,16\mu$

$\mu = 0,18$

(44-)



$R_1 = 300m \qquad v^2 = 0,5g.R$

$n = 1,5P \;;\; P = 12000 \qquad v^2 = 1500$

$1,5P - P = m.a \qquad v = 38,73\ m/s$

$0,5mg = m\frac{v^2}{R}$

$P - n = m.a$

$mg - n = m\frac{v^2}{R}$

$n = mg - \frac{mv^2}{R}$

$n = m(g - \frac{v^2}{R}) = 1200(10 - \frac{1500}{240}) \;|\; n = 1500\ N$

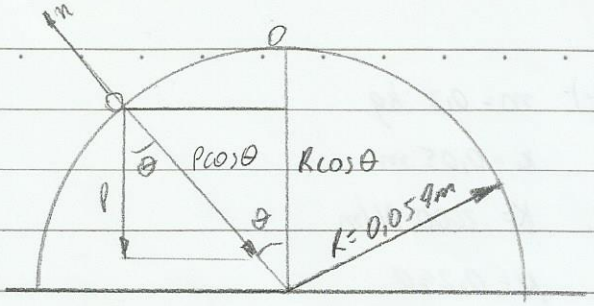
b) $P - n = m\frac{v^2}{R}$ - Quando a normal igual a 0

$v^2 = \frac{mg - n}{m}.R \qquad v^2 = Rg$

$v = \sqrt{Rg} = 98,99\ m/s$

/ /

15) $R = 54\,cm = 0{,}054\,m$



$P\cos\theta - n = m.a$

$mg\cos\theta - n = m\frac{v^2}{R}$

- Como a esfera perde o contato com a esfera, a força normal (n) é igual a 0 (zero).

$mg\cos\theta = m\frac{v^2}{R}$ $\quad v^2 = Rg\cos\theta$ $\quad / R\cos\theta = h \;/ v^2 = hg$

Teorema da energia Mecânica

$(EC + EP + E_e)_2 = (EC + EP + E_e)_1$

$\frac{mv^2}{2} + mgh = mgR$

$\frac{v^2}{2} + hg = Rg$; Como $v^2 = hg$

$\frac{hg}{2} + hg = Rg \Rightarrow \frac{h}{2} + h = R \Rightarrow \frac{3h}{2} = R$

$h = \frac{2R}{3}$; $R = 0{,}054 \Rightarrow h = 0{,}036\,m = 36\,cm$

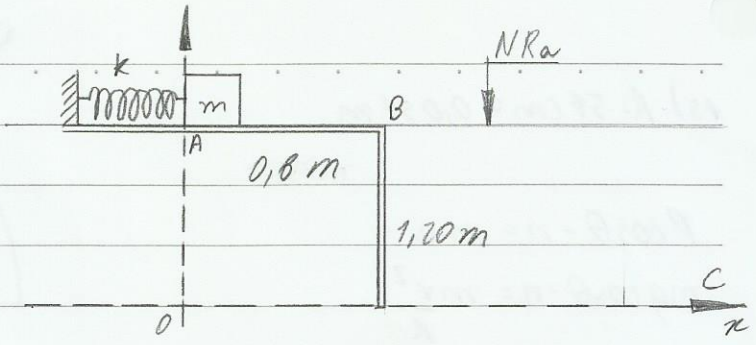
/ /

(96-) $m = 0{,}2$ kg

$x = 0{,}05$ m

$K = 2000$ N/m

$\mu = 0{,}250$



a) Teorema da energia Mecanica

$W_{fat} = (EC + EP + E_e)_2 - (EC + EP + E_c)_1$

$W_{fat} = \frac{mv^2}{2} - \frac{Kx^2}{2}$

$W_{fat} = \mu . m . g . d \cos 180$

$W_{fat} = -0{,}25 . 0{,}2 . 10 . 0{,}8$

$W_{fat} = -0{,}4$

$v^2 = \frac{2}{m} . \left[W_{fat} + \frac{Kx^2}{2} \right]$

$v^2 = \frac{2}{0{,}2} . \left[-0{,}4 + \frac{2000 . 0{,}05^2}{2} \right] = 21 \Rightarrow v = 1{,}58$ m/s

b) $S = S_0 + v_0 t + \frac{1}{2} g t^2$

$t^2 = \frac{2(S - S_0)}{g}$ $\quad t^2 = \frac{2 . (1{,}2)}{10} = 0{,}24 \quad t = 0{,}49$ s

$V = v_0 + a t$

$V = 10 . 0{,}49 = 4{,}9$ m/s

$V = 4{,}58 i - 1{,}9 j$ (m/s)

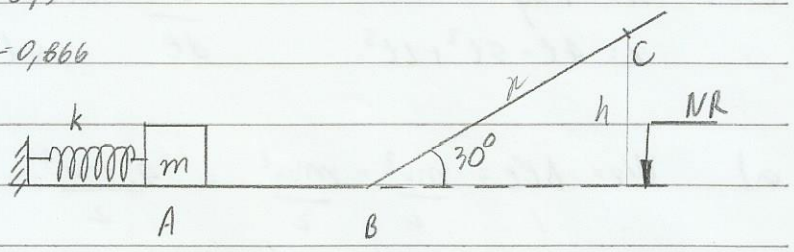
(47-) $m = 2{,}00\ kg$ $\quad sen\,30° = 0{,}5$

$k = 200\ N/m$ $\quad \cos 30° = 0{,}866$

$x_A = 0{,}5\ m$

$\mu = 0{,}250$

$AB = 2{,}00\ m$



a) Teorema da energia Mecanica (TEM) $\quad W_{fat} = \mu . mg . d \cos 180$

$W_{fat} = EM_2 - EM_1$ $\quad W_{fat} = -0{,}25 . 2 . 10 . 2$

$W_{fat} = (EC + EP + E_e)_2 - (EC + EP + E_e)_1$ $\quad W_{fat} = -10\ N$

$W_{fat} = \frac{mv^2}{2} - \frac{Kx^2}{2}$

-10

$$v^2 = \left[W_{fat} + \frac{Kx^2}{2} \right] . \frac{2}{m} = \left[-10 + \frac{200 . 0{,}5^2}{2} \right] . \frac{2}{2} = 15 \Rightarrow v = 3{,}87\ m/s$$

b) $W_{fat} = \mu . mg . d . \cos 30 . \cos 180$ $\quad x = \frac{h}{0{,}5}$ $\quad h = 0{,}5x$

$W_{fat} = 0{,}25 . 2 . 10 . x \cos 30 \cos 180$

$W_{fat} = -5{,}2h \cos 30$

$W_{fat} = -8{,}66\ h$

$W_{fat} = (EC + EP + E_e)_2 - (EC + EP + E_e)_1$

$W_{fat} = mgh - \frac{mv^2}{2}$

$-8{,}66\ h = 2 . 10 . h - \frac{2 . 15}{2}$

$h = 0{,}523\ m$

(98-) $m = 4\,kg$ $\quad x = 4t - 5t^2 + 2t^3$ $\quad \frac{dx}{dt} = v(t) = 4 - 10t + 6t^2$ $\quad v(5) = 104 \quad v(0) = 4$

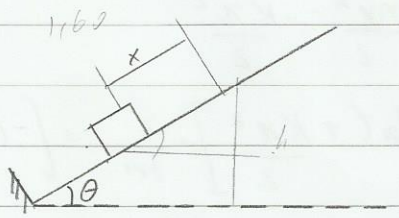
a) $W_r = \Delta E_c = \frac{mv^2}{2} - \frac{mv_0^2}{2} = \frac{4.104^2}{2} - \frac{4.4^2}{2} = 21600\,N$

b) $F(5) = 200.104 = 20800\,W$ $\quad \frac{dv}{dt} = a(t) = -10 + 12t$

$a(5) = 50\,m/s$

$F = ma = 50.4 = 200\,N$

(99-) $m = 6\,kg$ $\quad K = 3000\,N/m$ $\quad \mu = 0,5$ $\quad \sin\theta = 0,6$ $\quad \cos\theta = 0,8$



$\sin\theta = \frac{h}{x}$

$x = \frac{h}{\sin\theta}$

Teorema da Energia Mecânica

$W_{at} = (E_C + E_P + E_C)_2 - (E_C + E_P + E_{C_0})_1$

$W_{at} = mgh - \frac{Kx^2}{2}$

$W_{at} = -\mu . m . g . d . \cos 180 . 1000$

$W_{at} = -0,5 . 6 . 10 . 1,6 . 0,8$

$W_{at} = -38,4$

$-38,4 = 57,6 - \frac{3000x^2}{2}$

$-38,4 = 57,6 - 1500x^2$

$x^2 = \frac{-96}{-1500} = 0,064 \Rightarrow x = 0,253\,m$

(50) $m = 2\,kg$

$x = 0,2\,m$

$hA = 2\,m$

$R = 2\,m$

$E_c = \frac{Kx^2}{2} = \frac{K.0,04}{2} = 0,02K$

Teorema da energia Mecânica

$(E_c + E_p + E_c)_2 = (E_c + E_p + E_c)_1$

$\frac{mv_2^2}{2} + mgh_2 = mgh_1 + \frac{Kx^2}{2}$

$v_2^2 + 80 = 40 + 0,02K$

$K = \frac{40 + v_2^2}{0,02}$

$F = m.a$

$n + p = \frac{m.v^2}{R}$, se $n = 0$

$v^2 = \frac{m.g.R}{m} \Rightarrow v = \sqrt{Rg}$

$v = \sqrt{2.10} = 4,47$

a) $K = \frac{40+10}{0,02} = 2500\ N/m$

b) Teorema da Energia Mecânica

$(E_c + E_p + E_c)_2 = (E_c + E_p + E_c)_1$

$mgh_2 = mgh_1 + \frac{Kx^2}{2}$

$h_2 = h_1 + \frac{Kx^2}{2mg} \Rightarrow h_2 = 2 + \frac{3000.0,2^2}{2.2.10} = 5\,m$

51) $m = 0,2$ — Teorema da Energia Mecânica

$x = 0,2$

$K = 5000\ N/m$

$(EC + EP + \cancel{Ee}) = (\cancel{EC} + \cancel{EP} + Ee)_0$

$\frac{mv^2}{2} + mgh = \frac{Kx^2}{2}$

$\frac{1}{2} \cdot 0,2 \cdot v^2 + 0,2 \cdot 10 \cdot 5 = \frac{5000 \cdot 0,2^2}{2}$

$0,1 v^2 = 90 \quad v^2 = 900 \quad v = 30$

$\sin\theta = \frac{V}{h} \Rightarrow V_y = V_0 \cdot \sin\theta$

$V_y = 30 \cdot 0,6 = 18\ m/s$

$t = +1,8\ s$

$S = S_0 + v_0 t - \frac{1}{2} g t^2$

$S = 5 + 18t + 5t^2$

$S = 5 + 18 \cdot 1,8 + 5 \cdot 1,6^2$

$S = 37,2\ m$

$V = V_0 + at$

$0 = 18 - 10t$

$5 + 18t - 5t^2 = 0$

$-5t^2 + 18t + 5 = 0$

$\sqrt{\Delta} = 20,59 \quad t_1 = 3,659\ s$

$t_2 = -2,59\ s$

$V_x = V_0 \cos\theta$

$V_x = 30 \cdot 0,8 = 24\ m/s$

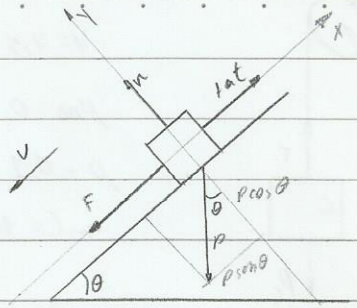
$S = S_0 + vt$

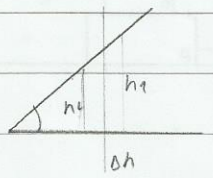
$S = 2 + 6,66 = 8,67$

$S = 8,67 + 24 \cdot 3,659 = 101,29\ m$

/ /

Teste





$\Delta h = \text{sen}\theta . \Delta x$

como $h_2 < h_1$

$\therefore -\text{sen}\theta . \Delta x$

$\therefore -0,6 . 7,5$

$m = 10kg$

$\mu = ?$

$\text{sen}\theta = 0,6$

$\cos\theta = 0,8$

y: $n = P\cos\theta \quad fat = 80\mu$

$n = 80N$

x: $F = fat - P\text{sen}\theta$

$F = 80\mu - 60N$

Teorema da energia cinética

$W_f = \Delta E_c = \frac{mv^2}{2} - \frac{mv_0^2}{2}$

$= \frac{10.4^2}{2} - \frac{10.1^2}{2} = 75N$

Teorema da energia mecânica

$\mathcal{C} fat = EM_2 - EM_1$

$= (EC + EP_{(g)})_2 - (EC + EP_{(g)})_1$

$= \left(\frac{10.4^2}{2} + 100h_2\right) - \left(\frac{10.1^2}{2} + 100h_1\right)$

$= 80 + 100h_2 - 5 - 100h_1$

$= 75 + 100(h_2 - h_1)$

$= 75 + 100(-0,6 . 7,5)$

$= 75 - 450 = -375\ J$

$V^2 = V_0^2 + 2a\Delta x$

$\Delta x = \frac{V^2 - V_0^2}{2a} = \frac{4^2 - 1^2}{2.1} = \frac{15}{2} = 7,5$

$\mathcal{C} fat = fat . d$

$fat = \frac{\mathcal{C} fat}{d} = \frac{375}{7,5} = 50\ N$

$fat = \mu n \Rightarrow \mu = \frac{fat}{n} = \frac{50}{80} = 0,625$

$P(2) = F_2 . v_2$

$P(1) = -10 . 2 = -20W$

$F = 80 . 0,625 - 60 = -10N$

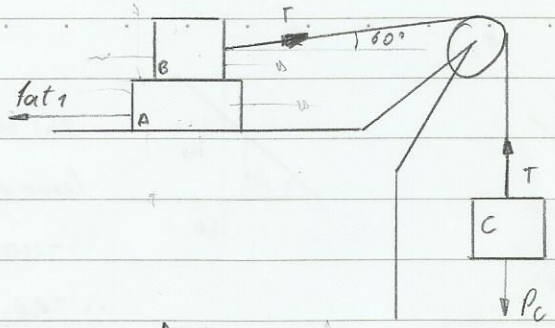
$v = v_0 + at$

$v(t) = 1 + t$

$v(1) = 2$

/ /

4



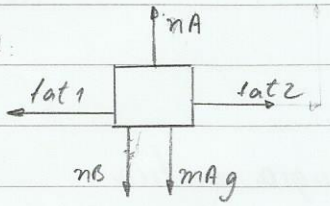
$V = 7{,}5\ m/s$

$\mu_{AB} = 0{,}2$

$\mu = 0{,}1$

$mC = 10\ kg$

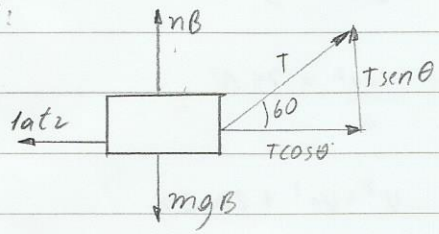
Bloco A:



$y: nA - nB - mAg = 0$ (II)

$x: fat_2 - fat_1 = 0$

Bloco B:



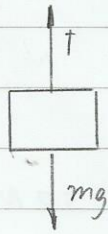
$y: nB + T\,sen\theta - mBg = 0$ (I)

$x: T\cos\theta - fat_2 = 0$

$fat_2 = T\cos\theta \Rightarrow fat_2 = 100.0{,}5 = 50N$

$fat_2 = \mu . nB \Rightarrow nB = \frac{50}{0{,}2} = 250N$

Bloco C:



$y: mCg - T = 0$

$T = mCg$

$T = 10.10 = \underline{100N}$

(I) $nB + T\,sen\theta - mBg = 0$

$250 + 86{,}6 - mB.10 = 0$

$\underline{mB = 33{,}66\ kg}$

$fat_2 = 50N$

$fat_2 - fat_1 = 0$

$fat_2 = fat_1 = 50$

$fat_1 = nA . \mu$

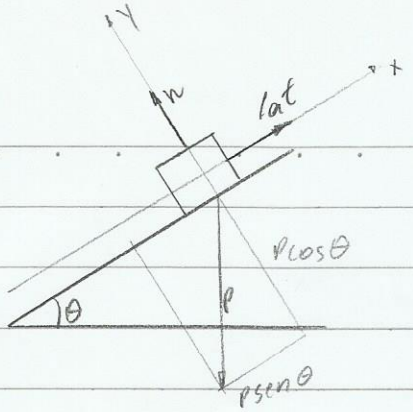
$nA = \frac{fat_1}{\mu} = \frac{50}{0{,}1} = \underline{500N}$

$mA = \frac{nA - nB}{g} = \frac{500 - 250}{10} = \underline{25\ Kg}$

$nA = \underline{500N}$

/ /

(2-)



$m = 1\,kg$

$\mu = 0,15$

$\cos = 0,8$

$\sin = 0,6$

y: $n = P\cos\theta$

$n = 1.10.0,8 = 8\,N$ $\quad lat = \mu . n = 8 . 0,15 \Rightarrow lat = 1,2\,N$

x: $lat - P\,sen\theta = m . a$

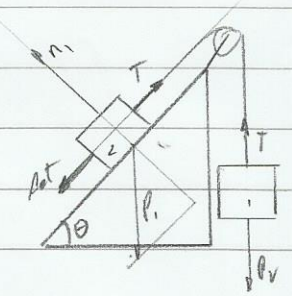
$a = \dfrac{lat - P\,sen\theta}{m} \Rightarrow a = \dfrac{1,2 - 6}{1} = -4,8\,(m/s^2)$

$v^2 = v_0^2 + 2a\Delta S$

$v^2 = 0^2 + 2 . 4,8 . 2$

$v = \sqrt{19,2} = 4,38\,m/s$

(3-)



$m_1 = 4\,kg$ $\quad \sin 37 = 0,6$

$m_2 = 5\,kg$ $\quad \cos 37 = 0,8$

$\theta = 37°$ $\quad \mu = 0,1$

$n = P\cos\theta$

$n = 5.10.0,8 = 40\,N$

$lat = 40.0,1 = 4\,N$

$P_1 - T = m_1 a$

$T - P\,sen\theta - lat = m_2 a$

Somando $\Rightarrow P_1 - P\,sen\theta - lat = a(m_1 + m_2)$

$a = \dfrac{P_1 - P_2\,sen\theta - lat}{m_1 + m_2} = \dfrac{40 - 30 - 4}{9} = 0,67\,(m/s^2)$

$T = P_1 - m_1 a$

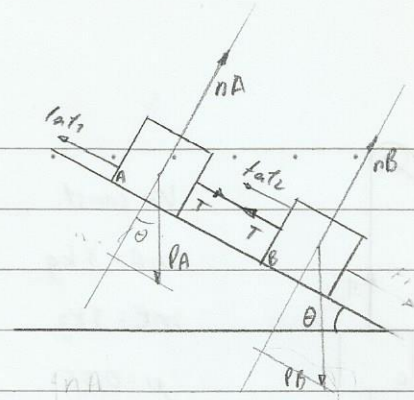
$T = 40 - 4.0,67 = 37,33\,N$

$v = v_0 + at$

$v = at$

$v(2) = 0,67.2 = 1,34\,(m/s)$

4)



$m_A = 3\,kg$ $\quad \cos\theta = 0,8$

$m_B = 7\,kg$ $\quad \sin\theta = 0,6$

$a = 2\,m/s^2$ $\quad \mu = ?$

Bloco A $\quad y: \; n_A = P_A \cos\theta \qquad fat_1 = 24\mu$

$n_A = 3.10.0,8 = 24\,N$

$x: \; T - fat_1 + P_A \sin\theta = m_A . a$

$T - 24\mu + 3.10.0,6 = 3.2$

$T = 24\mu - 12 \quad (I)$

Bloco B: $\quad y: \; n_B = P_B \cos\theta \qquad fat_2 = 56\mu$

$n_B = 7.10.0,8 = 56\,N$

$x: \; -fat_2 - T + P_B \sin\theta = m_B . a$

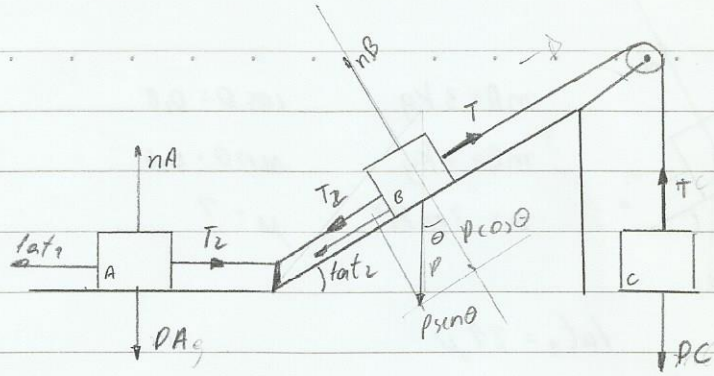
$T = -56\mu + 28 \quad (II)$

Igualando I e II

$24\mu - 12 = -56\mu + 28$

$\mu = 0,5$

5-)



$V = const.$ $\cos\theta = 0,8$

$mA = 3\,kg$ $\sin\theta = 0,6$

$mB = 3\,kg$

$\mu = 0,55$

Bloco A: y: $nA = PA$ $\quad fat_1 = 30 \cdot 0,55 = 16,5\,N$

$nA = 30\,N$

x: $T_2 = fat_1$

$T_2 = 16,5$

Bloco B: y: $nB = P\cos\theta$ $\quad fat_2 = 24 \cdot 0,55 = 13,2$

$nB = 24\,N$

x: $T = T_2 + fat_2 + P\sin\theta$

$T = 16,5 + 13,2 + 18 = 47,7$

Bloco C: y: $PC = T$

$PC = \underline{47,7\,N}$

Bloco C: y: $PC - T = mC \cdot a$

$T - fat_2 - P\sin\theta = mB \cdot a$

$PC - fat_2 - P\sin\theta = a(mB + mC)$

$$a = \frac{PC - fat_2 - P\sin\theta}{mB + mC}$$

$$a = \frac{47,7 - 18 - 13,2}{6} = 2,75\,(m/s^2)$$

$fat_2 = \mu \cdot N_B$

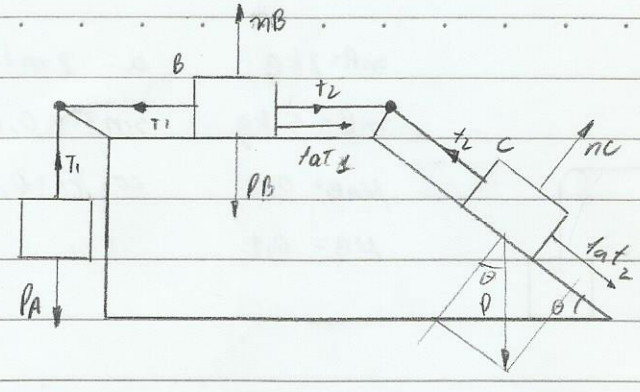
$N_B = P\cos\theta$

$N_B = 3 \cdot 10 \cdot 0,8 = 24$

$fat_2 = 24 \cdot 0,55 = 13,2\,N$

/ /

6.)



$m_A = 10\,kg$ $\quad \cos\theta = 0,8$

$m_B = 5\,kg$ $\quad \operatorname{sen}\theta = 0,6$

$m_C = 3\,kg$ $\quad \mu = 0,5$

Bloco A: y: $P_A - T_1 = m_A \cdot a$

Bloco B: x: $T_1 - T_2 - fat_1 = m_B \cdot a$ $\quad$ y: $n_B = P_B = 50$ / $fat_1 = 50 \cdot 0,5 = 25\,N$

Bloco C: x: $T_2 - fat_2 - P\operatorname{sen}\theta = m_C \cdot a$ $\quad$ y: $n_C = P\cos\theta = 30 \cdot 0,8 = 24\,N$

Somando as equações $\quad fat_2 = 24 \cdot 0,5 = 12\,N$

$$P_A - fat_1 - fat_2 - P\operatorname{sen}\theta = a(m_A + m_B + m_C)$$

$$a = \frac{P_A - fat_1 - fat_2 - P\operatorname{sen}\theta}{m_A + m_B + m_C} = \frac{100 - 25 - 12 - 18}{10 + 5 + 3} = 2,5\ m/s^2$$

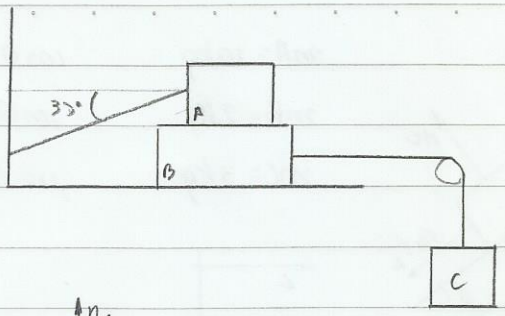
$$T_1 = P_A - m_A \cdot a$$

$$T_1 = 100 - 25 = \underline{75\,N}$$

$$T_2 = m_C \cdot a + P\operatorname{sen}\theta + fat_2$$

$$T_2 = 7,5 + 18 + 12 = \underline{37,5\,N}$$

8-)



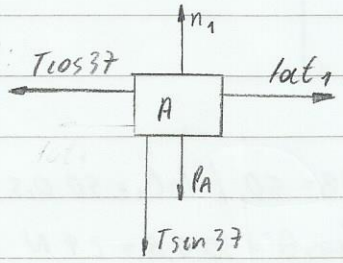
$m_A = 2\,kg$ $\quad a = 2\,m/s^2$

$m_B = 5\,kg$ $\quad \sin 37 = 0{,}6$

$\mu_{AB} = 0{,}4$ $\quad \cos 37 = 0{,}8$

$\mu_B = 0{,}1$

Bloco A:



y: $n_1 = P_A + T\sin 37$

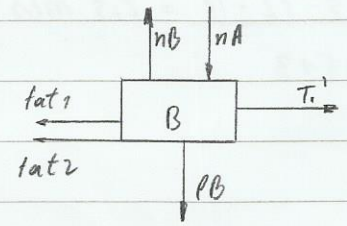
$n_1 = 20 + 0{,}6\,T$

$fat_1 = 0{,}4(20 + 0{,}6T) = 8 + 0{,}24\,T$

x: $T\cos 37 = fat_1$

$0{,}8\,T = 8 + 0{,}24\,T \Rightarrow T = \underline{14{,}29\,N}$

Bloco B:



y: $n_B = n_A + P_B$

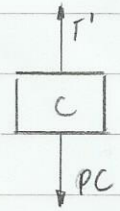
$n_B = 28{,}57 + 50 = 78{,}57\,N$

$fat_2 = 78{,}57 \cdot 0{,}1 = 7{,}86\,N$

x: $T' - fat_1 - fat_2 = m_B \cdot a$

$T' - 11{,}43 - 7{,}86 = 5 \cdot 2 \Rightarrow T' = 29{,}29$

Bloco C:



y: $P_C - T' = m_C \cdot a$

$m_C \cdot 10 - T' = m_C \cdot a$

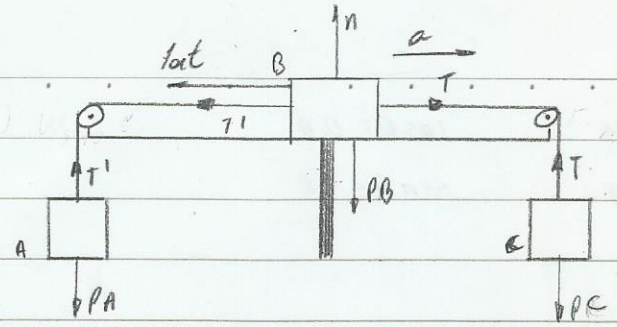
$m_C \cdot 10 - m_C \cdot a = T'$

$m_C (10 - a) = T'$

$m_C = \frac{T'}{10-a} = \frac{29{,}29}{10-2} = \underline{3{,}66\,kg}$

/ /

9-)



$m_A = 9\,kg$ $\quad a = 4\,m/s^2$

$m_B = 10\,kg$

$\mu = 0{,}25$

$P_C - T = m_C \cdot a$ $\qquad n = P_B$

$T - T' - fat = m_B \cdot a$ $\qquad n = 100$ $\qquad fat = 0{,}25 \cdot 100 = 25\,N$

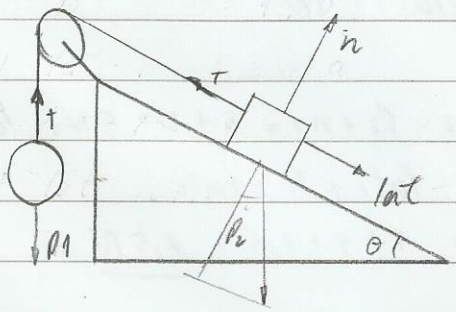
$T' - P_A = m_A\, a \Rightarrow T' = m_A \cdot a + P_A = 70\,N$

$T - T' - fat = m_B \cdot a$

$T = m_B \cdot a + T' + fat = 10 \cdot 4 + 70 + 25 = 135\,N$

$T = P_C - m_C a \Rightarrow T = m_C (10 - a) \Rightarrow m_C = \dfrac{T}{10-a} = \dfrac{135}{6} = 22{,}5\,kg$

10-)



$m_1 = 4{,}00\,kg$ $\qquad \sin\theta = 0{,}574$

$m_2 = 5{,}00\,kg$ $\qquad \cos\theta = 0{,}820$

$\mu = 0{,}2$

$P_1 - T = m_1 \cdot a$ $\qquad n = P_2 \cos\theta$ $\qquad fat = 8{,}2\,N$

$T - fat - P_2 \sin\theta = m_2 \cdot a$ $\qquad n = 5 \cdot 10 \cdot 0{,}82 = 41\,N$

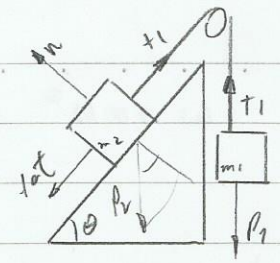
$P_1 - fat - P_2 \sin\theta = a(m_1 + m_2)$

$a = \dfrac{P_1 - fat - P_2 \sin\theta}{m_1 + m_2} \Rightarrow a = \dfrac{40 - 8{,}2 - 28{,}7}{9} = 0{,}35\ (m/s^2)$

$T = P_1 - m_1 \cdot a$

$T = 40 - 4 \cdot 0{,}35 = 38{,}62\,N$

11)



$m_1 = 4\ kg$ $\quad \cos\theta = 0,8$

$m_2 = 3\ kg$ $\quad \operatorname{sen}\theta = 0,6$

$\mu = ?$

$P_1 = T_1$

$T_1 = \underline{40\ N}$

y: $N = P_2 \cos\theta$

$N = 3.10.0,8 = 24\ N$

$fat = 24\mu$

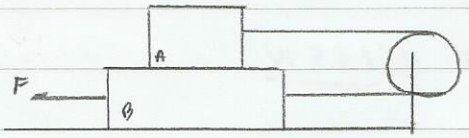
x: $T_1 = fat + P\operatorname{sen}\theta = 0$

$fat = T_1 - P_2\operatorname{sen}\theta$

$fat = 40 - 3.10.0,6 = 22$

$\mu = \frac{22}{24} = \underline{0,916}$

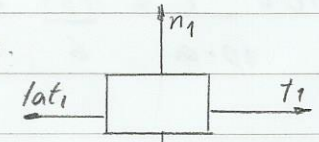
12-)



$m_A = 200g = 0,2\ kg$ $\quad \mu d = 0,4$

$m_B = 300g = 0,3\ kg$ $\quad \mu e = 0,5$

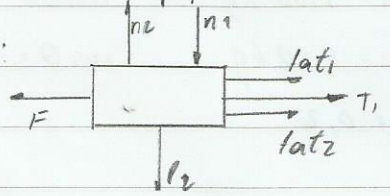
Bloco A:



y: $N_1 = P_1 = 2N$ $\quad fat_e = 2.0,5 = 1\ N$

x: $T_1 = fat_1 = 1N$

Bloco B:



y: $N_2 = P_2 + N_1 = 3 + 2 = 5\ N$ $\quad fat_2 = 5.0,5 = 2,5$

x: $F = fat_1 + T_1 + fat_2$

$F = 1 + 1 + 2,5 = \underline{4,5\ N}$

① $fat_d = 2.0,4 = 0,8N$

② $fat_d = 5.0,4 = 2N$

$F = fat_1 + T_1 + fat_2$

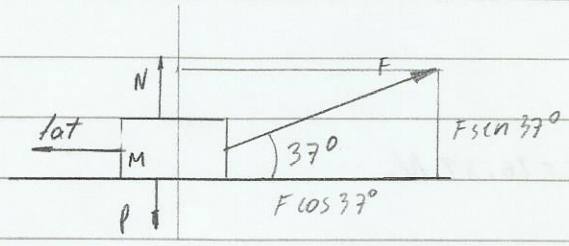
$F = 0,8 + 2 + 0,8 = \underline{3,6\ N}$

14-(P2 - 2º sem - 05 - Diurno)

$m = 10\,Kg$

$\mu_e = 0,4$

$\mu_c = 0,25$



a-)

x: $F\cos 37 - fat = ma \;;\; a = 0$

$F\cos 37 = fat \Rightarrow fat = 35\cos 37 \Rightarrow fat = \underline{27,95\,N}$

y: $N + F\operatorname{sen} 37° - P = m.a \;,\; a = 0$

$N = 10.10 - 35\operatorname{sen}° 37$

$N = 78,93\,N$

$fat_{max} = \mu_e N = 78,93 . 0,4 = \underline{31,57\,N}$

$\therefore$ como $fat < fat_{max}$, o corpo permanece em repouso, então $fat = \underline{27,95\,N}$

b-) x: $F\cos 37 - fat = ma \;;\; a = 0$

$F\cos 37 = fat \Rightarrow fat = 45.\cos 37 = 35,94\,N$

y: $N + F\operatorname{sen} 37 - P = ma \;;\; a = 0$

$N + F\operatorname{sen} 37 = P \quad N = 10.10 - 45\operatorname{sen} 37 = 72,91\,N$

$fat_{max} = \mu_e N = 0,4 . 72,91 = 29,17\,N$

$\therefore$ como $fat > fat_{max}$, o corpo esta em movimento

$\therefore fat_d = \mu_d N = 0,25 . 72,91 = \underline{18,23\,N}$

/ /

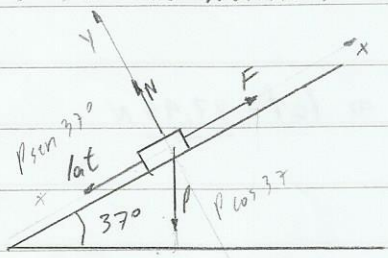
c) x: $F\cos 37° - fat = m.a$; velocidade const $a=0$

$F\cos 37° - \mu_e (P - F\operatorname{sen} 37°) = 0$

$0,8F - 0,25(100 - 0,6F) = 0$

$0,8F - 25 + 0,15F = 0 \quad F = 25/0,95 = 26,31\ N$

15.) (P2 - 2.º sem - 05 Noturno)



$\mu_e = 0,5$

$\mu_d = 0,25$

$m = 20\ Kg$

a) x: $F - fat - P\operatorname{sen}37 = m.a$; $a=0$

$F = fat + P\operatorname{sen}37$

$F = 0,5N + 120,36 \qquad N = P\cos 37 \Rightarrow N = 159,72N$

$F = 0,5.159,72 + 120,36 = 200,22N$

b) $\Sigma F_{ext} = m.a$

$F - fat - P\operatorname{sen}37 = ma$

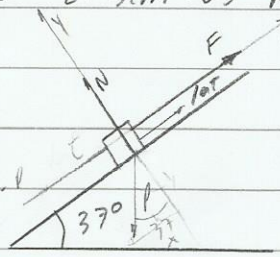
$a = \dfrac{F - fat - P\operatorname{sen}37}{m} \Rightarrow \dfrac{400,44 - 0,25.159,72 - 10\,20.\operatorname{sen}37.}{20}$

$a = \underline{11,98\ m/s^2}$

c) Se $F=0$, a força atuante será a componente do peso, que tende a descer. A $fat_{ex} = 80N$ é a força exercida é 120N, por tanto há movimento, ou seja o corpo desliza.

$P\operatorname{sen}37 - fat = ma$	$N = 159,72\ N$	
$a = (P\operatorname{sen}37 - fat)/m$	$fat_{max} = 79,86$ (est)	
$a = P(\operatorname{sen}37 - \mu_d\cos 37)/m$		
$a = -4,02\ (m/s^2)$		

16- (P2 - 2º sem - 05 Noturno)



$\mu e = 0,5$ $\cos 37 = 0,8$

$\mu d = 0,25$ $\sin 37 = 0,6$

$m = 20 Kg$

a.) $F + fat - P\sin 37 = ma$; $a = 0$

$F = P\sin 37 - \mu e P\cos 37$

$F = P(\sin 37 - \mu e \cos 37)$

$F = 40,50\ N$

b) $F + \mu d . P\cos 37 - P\sin 37 = m.a$

$a = (F + \mu d . P\cos 37 - P\sin 37)/m$ $a = [F + P(\mu d \cos 37 - \sin 37)]/m$

$a = [81 + 200(0,2 - 0,6)]/20 = 0,05 \div 0\ m/s^2$

c) $-P\sin 37 + fat = m.a$ $\{ P\sin 37 = 120,36\ N \mid fat = 39,93 \}$

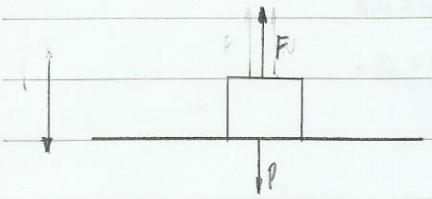
$a = (-P\sin 37 + fat)/m \Rightarrow a = -80,43/20 = -4,02\ (m/s^2)$

$fat_{est.máx} = \mu e N = 0,5 . 200 . 0,8 = 80\ N$

Quando $F = 0$ a força atuante passa a ser a componente do Peso, que equivale a 120,36 N, e também a força de atrito, para que o bloco não se mova a força da componente do peso tem que ser maior que o fat estático máximo, que no caso equivale a 80 N, ou seja $120,36 > 80$, então o corpo esta em movimento com aceleração de $-4,02\ (m/s^2)$

/ /

(17.) (P2 - 1º sem 06 - Diurno)



$P = p/2 = mg/2$

1º caso: $p - 100.10^3 = m.(-a)$ $(x-1)$ $\begin{cases} -p + 100.10^3 = ma. \\ p - 60.10^3 = ma \end{cases}$

2º caso: $p - 60.10^3 = ma$

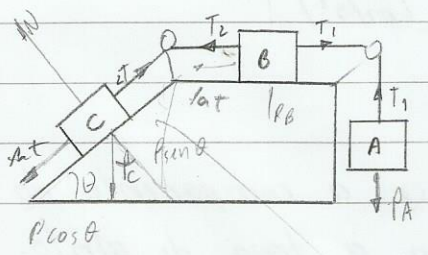
$2ma = 40.10^3$

$ma = 20\,10^3$ $\quad p = 20.10^3 + 60.10^3 = \underline{80.10^3\,N}$

$P = \frac{m.10}{2}$ $\quad P = 5m$ $\quad m = \frac{80.10^3}{5} = 1{,}6.10^3$

$a = \frac{20.10^3}{1{,}6.10^3} = 1{,}25\ (m/s^2)$

(18.) (P2 - 1º sem 06 - Noturno)



$m_a = 5\ Kg$ $\quad \mu d = 0{,}20$

$m_b = 20\ Kg$ $\quad \cos\theta = 0{,}6$

$m_c = 15\ Kg$ $\quad \operatorname{sen}\theta = 0{,}8$

$P_A - T_1 = m_a \cdot a$

$T_1 - T_2 - \mu d P_B = m_b \cdot a$

$T_2 - \mu d P_c \operatorname{sen}\theta - P_c \cos\theta = m_c \cdot a$

$P_A - \mu d P_B - \mu d P_c \operatorname{sen}\theta - P_c \cos\theta = a(m_a + m_b + m_c)$

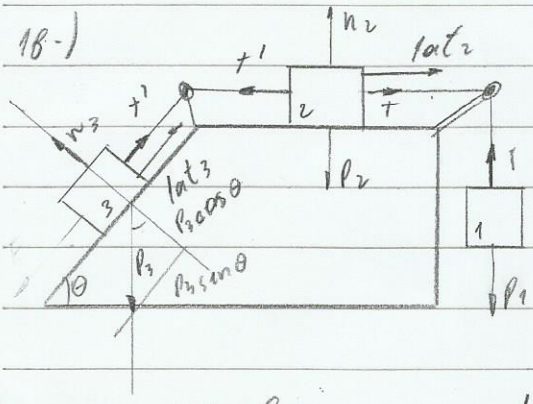
$50 - 40 - 24 - 90 = a \cdot 90$

$a = -2{,}6\ m/s^2$ $\quad T_1 = (5.(-2{,}6) - 5.10).-1 = 63N$

-2,6

Anexo

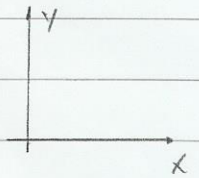
18-)



$m_1 = 5\,kg$ $\mu = 0,2$

$m_2 = 20\,kg$ $\cos\theta = 0,6$

$m_3 = 15\,kg$ $\operatorname{sen}\theta = 0,8$



$n_2 = P_2$ $\quad fat_2 = \mu . n$

$n_2 = 20 . 10 = 200N$ $\quad fat_2 = 0,2 . 200 = 40N$

— 11 —

$n_3 = P_3 \cos\theta$ $\quad fat_3 = \mu . n$

$n_3 = 15 . 10 . 0,8 = 90N$ $\quad fat_3 = 90 . 0,2 = 18N$

— 11 —

$P_1 - T = m_1 . a$

$T + fat_2 - t' = m_2 . a$

$t' + fat_3 - P_3 \operatorname{sen}\theta = m_3 . a$

Somando as equações

$P_1 + fat_2 + fat_3 - P_3 \operatorname{sen}\theta = a(m_1 + m_2 + m_3)$

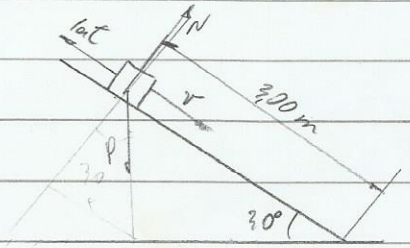
$$a = \frac{P_1 + fat_2 + fat_3 - P_3 \operatorname{sen}\theta}{m_1 + m_2 + m_3} = \frac{50 + 40 + 18 - 120}{5 + 20 + 15} = -0,3\,(m/s^2)$$

$T = P_1 - m_1 a$

$T = 50 - 5 . 0,3 = \underline{51,5\,N}$

/ /

(19) (P2 2º sem 06 Not)



$m = 4\,Kg$

$v = 2\,m/s$

$t = 2\,s$

$S = S_0 + v_0 t + \frac{1}{2} a t^2$

$S = v_0 t + \frac{1}{2} a t^2 \qquad a = \frac{2(S - v_0 t)}{t^2} \Rightarrow a = \frac{2(3 - 2.2)}{4} = \underline{-0,5\,m/s^2}$

$P \sin 30 - fat = m \cdot a$

$fat = P \sin 30 - ma$

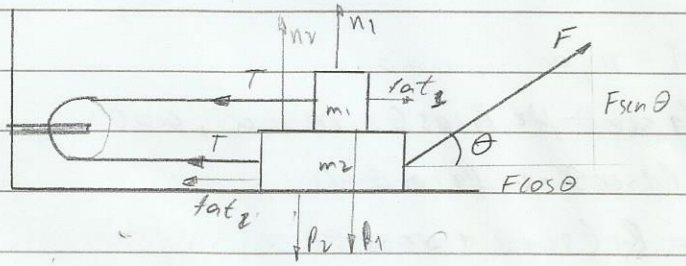
$fat = 40 \cdot 0,5 - 4 \cdot (-0,5) \Rightarrow fat = 22$

$N = P \cos\theta$

$N = 34,64\,N$

$fat = \mu_d \cdot N \Rightarrow \mu_d = \frac{22}{36,64} = \underline{0,635}$

(20-) (P3 2º sem 06 Diurno)



$m_1 = 1,5\,Kg$ $\quad \sin\theta = 0,6$

$m_2 = 15\,Kg$ $\quad \cos\theta = 0,8$

$\mu = 0,4$

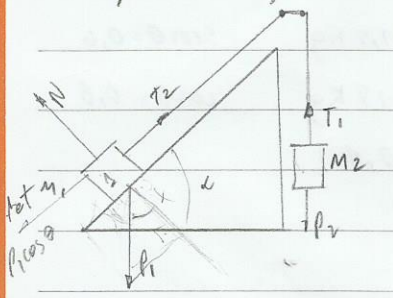
$T - fat_1 = m \cdot a \,;\; a = 0$

$T = fat_1 \Rightarrow T = 0,4 \cdot 1,5 \cdot 10 = \underline{6\,N}$

x: $F \cos\theta -$

(21-) (P3 2° sem 06 · Not)

(22-) $\mu e = 0,5$ $\mu d = 0,4$ $m_1 = 10\,Kg$ $\cos 37° = 0,6$ $\sin 37 = 0,6$



$P_2 - T = m_2 a$; $a = 0$

$T - P_1 \sin\theta - \mu e\, P_1 \cos\theta = m_1 \cdot a$; $a = 0$

$P_2 - P_1 \sin\theta - \mu e\, P_1 \cos\theta = 0$

$P_2 = P_1(\sin\theta + \mu e \cos\theta)$

$m_2 = m_1(\sin\theta + \mu e \cos\theta)$ $m_2 = 10\,(0,6 + 0,8 \cdot 0,5)$

$m_2 = \underline{10\,Kg}$

$P_2 = P_1(\sin\theta + \mu d \cos\theta)$

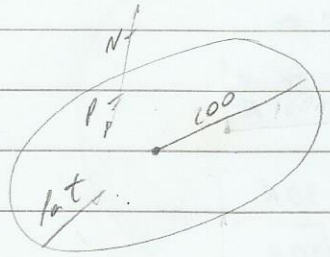
$m_2 = m_1(\sin\theta + \mu d \cos\theta)$

$m_2 = 10(0,6 + 0,4 \cdot 0,8)$

$m_2 = \underline{9,2\,Kg}$

/ /

(23-)



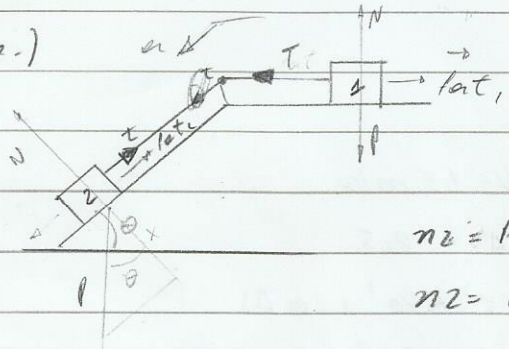
$\mu_e = 0,25$

$\mu_d = 0,15$

$a = \frac{v^2}{R}$ $\quad \mu_e N = m\frac{v^2}{R}$

$v^2 = \frac{0,25 \cdot m \cdot 10 \cdot R}{m} \Rightarrow v^2 = 500 \quad v = 22,36 \text{ m/s}$

(24-)



$n_1 = P_1 \quad fat_1 = 32N \quad \mu n_1 = 80 N$

$n_2 = P\cos\theta \quad fat_2 = 3,2m(N)$

$n_2 = 8m$

$m_1 = 8 Kg$

$m_2 = ?$

$a = 0,8$

$\cos = 0,8$

$\mu_m = 0,6$

$\mu = 0,9$

$T - fat = m_1 a \quad T = m_1 a + fat \Rightarrow T = 6,4 + 32 = 38,4N$

$P\cos\theta - T - fat_2 = m_2 a$

$m \cdot 8 - 38,4 - 3,2m = 0,8m$ ou somando as equações

$4,8m = 38,4$ $\quad P\cos\theta - fat - fat_2 = m_1 a + m_2 a$

$m = 19,6 Kg$ $\quad 8m - 32 - 3,2m = 6,4 + 0,8m$

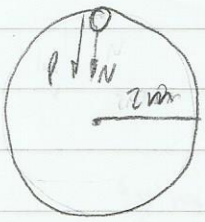
$4m = 38,4$

$m = 9,6$

Dúvida

/ /

25-



$N = 2P$

$F = m \cdot a$

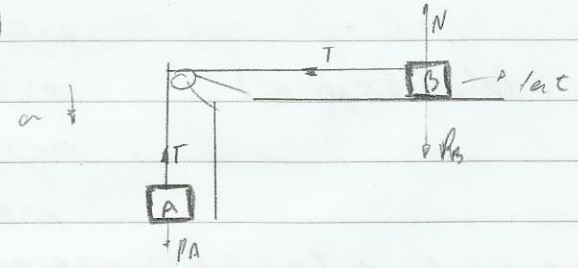
$30 \cdot m = m \frac{v^2}{R}$

$v^2 = 30R$

$v = \sqrt{30R}$

$v = \sqrt{30 \cdot 2} = 7,75 \text{ m/s}$

26-



$V = 1,5 \text{ m/s}$

$\Delta s = 0,5$

$V^2 = V_0^2 + 2a\Delta S$

$0 = 1,5^2 + 2a \cdot 0,5$

$a = -2,25 (m/s^2)$

$T - fat = m_B \cdot a$

$P_A - T = m_A \cdot a$

$P_A - fat = a(m_B + m_a)$

$3 \cdot 10 - fat = -2,25(7+3)$

$-fat = -22,5 - 30$

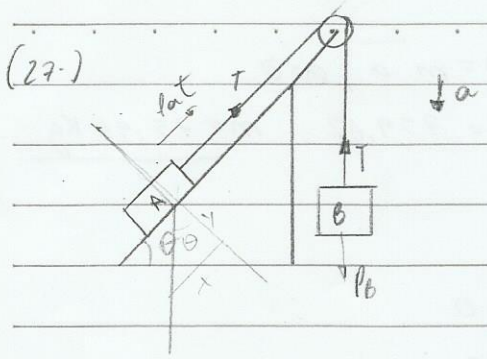
$fat = 52,5$

$fat = \mu \cdot e \cdot N = \mu \cdot 70 = 52,5$

$\mu = 0,75$

/ /

(27-)



$P - T = m_a a$

$T + f_{at} - P \operatorname{sen}\theta = m a$

$P(1 - \operatorname{sen}\theta) + f_{at} = 2ma$

$P(1 - \operatorname{sen}\theta) + \mu . P \cos\theta = 2ma$

$P(1 - \operatorname{sen}\theta + \mu \cos\theta) = 2ma$

$m . 10 (1 - \operatorname{sen}\theta + \mu \cos\theta) = 2ma$

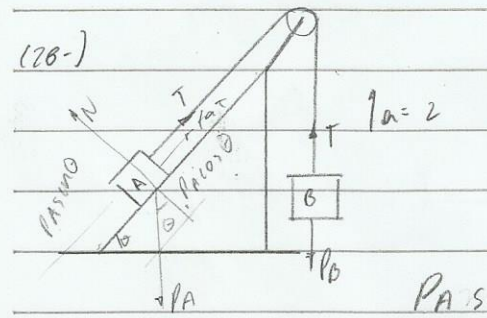
$10 (1 - 0{,}6 + \mu\, 0{,}8) = 1{,}6$

$\mu = \underline{0{,}3}$

$P - T = m.a \Rightarrow m_B . 10 - T = m_B\, 0{,}8$

$T = m_B 10 - m_B : 0{,}8 \Rightarrow 9{,}2\, m_B$

(28-)



$a = 2 m/s^2$

$\mu = 0{,}250$

$T - P_b = m_b . a$

$T - m_b . 10 = m_b . a$

$T = m_b a + m_b 10$

$T = 2m_b + 10 m_b = \underline{12 m_b}$

$P_A \operatorname{sen}\theta - T - \mu . P_A \cos\theta = m_a . g$

$m_a . 10 \operatorname{sen}\theta - 12 m_b - \mu\, m_a . 10 \cos\theta = m_a g$

$6 m_a - 12 m_b - 2 m_a = 2 m_a$

$-12 m_b = -2 m_a$

$m_a = 6 m_b \qquad \frac{m_a}{m_b} = 6$

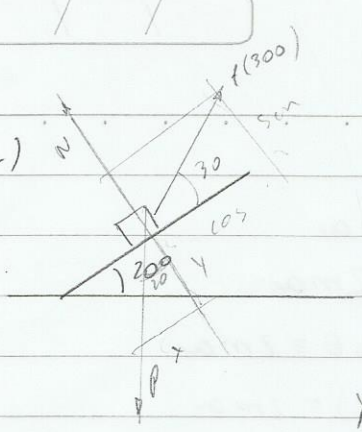
$1 m_a = 6 m_b$

$x = 12 m_b$

$6x = 12$

$x = \underline{2 m_a}$

/ /



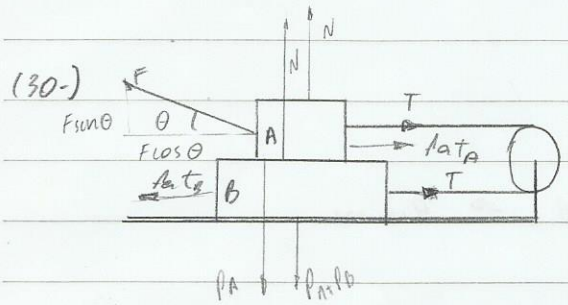
29-) $x: F\cos 30 - P\sin 20 = m.a \;;\; a=0$

$P = \dfrac{F\cos 30}{\sin 20} = 759{,}62 \qquad m = 75{,}96\ Kg$

$y: N + F\sin 30 - P\cos 20 = 0$

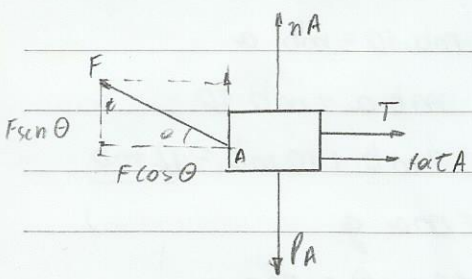
$N = P\cos 20 - F\sin 30$

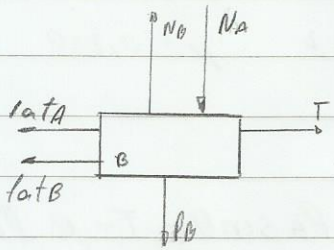
$N = 75{,}96.10.\cos 20 - 150.\sin 30 = 638{,}79\ N$



(30-) $m_A = 2{,}00\ Kg \qquad \mu e = 0{,}4 \qquad \sin\Theta = 0{,}6$

$m_B = 6{,}00\ Kg \qquad \mu c = 0{,}250 \qquad \cos\Theta = 0{,}8$





Bloco A:

$y: F\sin\Theta + nA - P_A = m.a \;;\; a=0$

$F.0{,}6 + nA - 20 = 0$

$nA = 20 - F\,0{,}6$

$x: T + lat_A - F\cos\Theta = m.a \;;\; a=0$

$T + \mu e.N_A - F.0{,}8 = 0$

$T + 0{,}4.(20 - F.0{,}6) - F.0{,}8 = 0$

$T + 8 - 0{,}29F - F.0{,}8 = 0$

$F.1{,}04 = T + 8$

$T = F.1{,}04 - 8$

Bloco B:

$y: N_B - N_A - P_B = m.a \;;\; a=0$

$nB - 20 + F.0{,}6 - 60 = 0$

$nB = 80 - F.0{,}6$

$x: T - lat_A - lat_B = m.a \;;\; a=0$

$T - 0{,}4(20 - F.0{,}6) - 0{,}4(80 - F.0{,}6) = 0$

$T - 8 + 0{,}24F - 32 + 0{,}24F = 0$

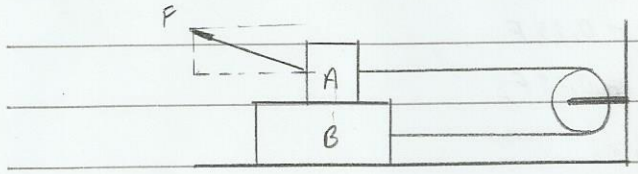
$T = 40 - 0{,}48F$

$F.1{,}04 - 8 = 40 - 0{,}48F$

$F.1{,}52 = 48 \Rightarrow F = 31{,}58\ N$

/ /

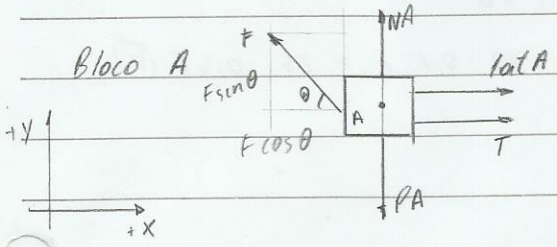
(31) Amarela.



$m_A = 1{,}00\ kg$ $\quad \mu_d = 0{,}25$

$m_B = 3{,}00\ kg$ $\quad \sin\theta = 0{,}6$

$\mu_e = 0{,}4$ $\quad \cos\theta = 0{,}8$



y: $n_A + F\sin\theta - P_A = m.a$; $a = 0$

$n_A + 0{,}6F - 10 = 0$

$\rightarrow n_A = 10 - 0{,}6F$

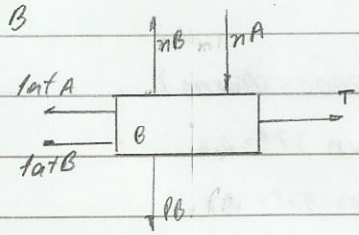
$\rightarrow lat_A = 0{,}4 \cdot (10 - 0{,}6F) = 4 - 0{,}24F$

x: $lat_A + T - F\cos\theta = m.a$; $a = 0$

$4 - 0{,}24F + T - 0{,}6F = 0$

$T = 1{,}04F - 4$

Bloco B



y: $n_B - n_A - P_B = m.a$; $a = 0$

$n_B - 10 + 0{,}6F - 30 = 0$

$n_B = 40 - 0{,}6F$

x: $T - lat_A - lat_B = m.a$; $a = 0$

$T - 4 + 0{,}24F - 0{,}4(40 - 0{,}6F) = 0$

$T = 4 - 0{,}24F + 16 - 0{,}24F \Rightarrow T = 20 - 0{,}48F$

Igualando o T das duas equações

$1{,}04F - 4 = 20 - 0{,}48F \Rightarrow F = 24 / 1{,}52 = 15{,}79\ N$

B-) $lat_A = 0{,}25\,(10 - 0{,}6F) = 2{,}5 - 0{,}15F$

$lat_B = 0{,}25\,(40 - 0{,}6F) = 10 - 0{,}15F$

Bloco A $\Rightarrow lat_A + T - F\cos\theta = 0$

$2{,}5 - 0{,}15F + T - 0{,}8F \Rightarrow T = 0{,}95F - 2{,}5$ (I)

Bloco B $\Rightarrow T - lat_A - lat_B = 0$

$T - 2{,}5 + 0{,}15F - 10 + 0{,}15F \Rightarrow T = 12{,}5 - 0{,}3F$ (II)

Igualando I e II

$0{,}95F - 2{,}5 = 12{,}5 - 0{,}3F$

$1{,}25F = 15 \Rightarrow F = 12\ N$

b) Anterior

$fat_A = 0{,}25(20 - 0{,}6F) \Rightarrow fat_A = 5 - 0{,}15F$

$fat_B = 0{,}25(80 - 0{,}6F) \Rightarrow fat_B = 20 - 0{,}15F$

Bloco A:

$T + fat_A - F\cos\theta = 0$

$T = -5 + 0{,}15F + 0{,}8F$ (I)

Bloco B:

$T - fat_A - fat_B = 0$

$T = 5 - 0{,}15F + 20 - 0{,}15F = 25 - 0{,}3F$ (II)

Igualando I e II

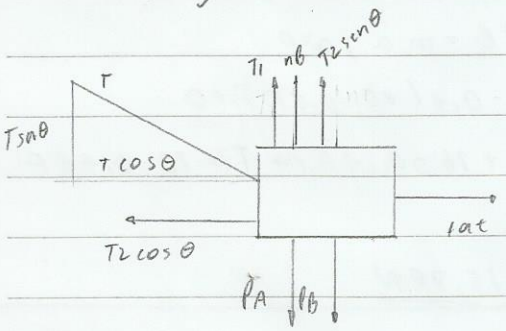
$-5 + 0{,}95F = 25 - 0{,}3F$

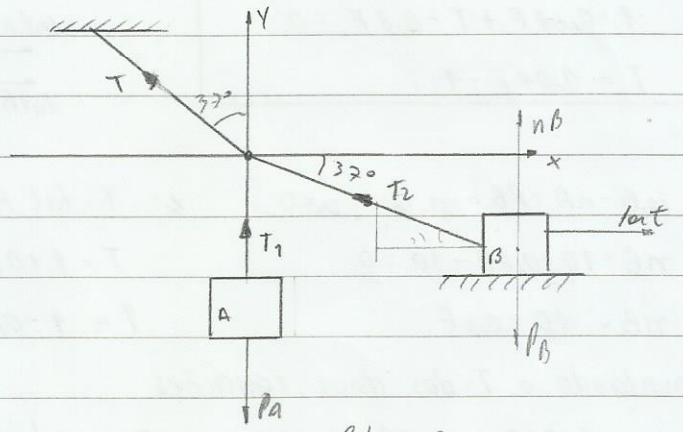
$1{,}25F = 30 \quad F = 24\ N$

37-b) (P3 - 1° Sem 2008 - diurno)

$m_A = 2{,}00\ kg$ $\quad \sin 37° = 0{,}6$

$m_B = 10{,}00\ kg$ $\quad \cos 37° = 0{,}8$





x: $T\cos\theta + T_2\cos\theta - fat = 0$

$0{,}8 \cdot T + 0{,}8 \cdot T_2 - \mu(100 - 0{,}6T_2) = 0$

Bloco B

y: $n_B = P_B - T_2\sin\theta$

$n_B = 100 - 0{,}6T_2$

$fat = \mu(100 - 0{,}6T_2)$

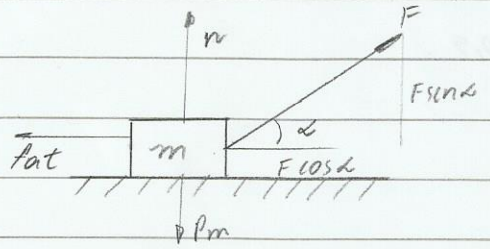
y:

Dica?

Força Peso

/ /

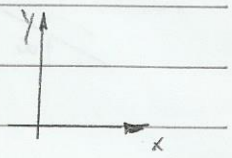
(32-) P2 - 2º sem 08 - diurno



$m = 5\,t$ $\quad \sin\alpha = 0,6$

$\mu_e = 0,4$ $\quad \cos\alpha = 0,8$

$\mu_c = 0,2$



a) Se $F = 15000N$

y: $F\sin\alpha + n - Pm = 0$

$n = Pm - F\sin\alpha$

$n = 5.10^4 - 15.10^3 . 0,6 = 41.10^3$

$fat_{est}\,(máx) = 41\,10^3 . 0,4 = 16,4\,10^3$

x: $F\cos\alpha - fat = 0$

$fat = F\cos\alpha$

$fat = 15\,10^3 . 0,8 = 12.10^3\,N$

O fat atud é menor que o fat_e max, portanto o coeficiente de atrito é estático

---

y: $n = Pm - F\sin\alpha$

$n = 5.10^4 - 20.10^3 . 0,6 = 38.10^3$

$fat_{est}\,(máx) = 38.10^3 . 0,4 = 15,2 . 10^3$

O fat atud é maior que o fat est. máximo por tanto o coeficiente de atrito é dinamico

x: $fat = F\cos\alpha$

$fat = 16.10^3$

— 11 —

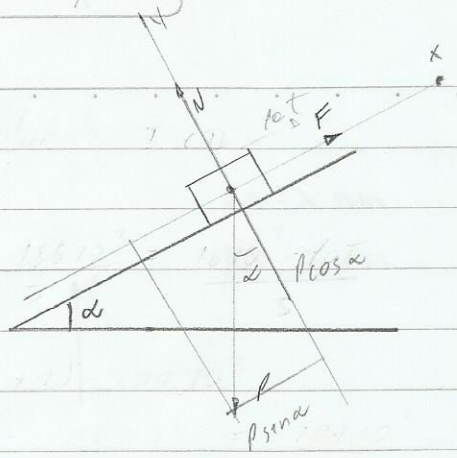
$fat = 0,2 . 38\,10^3$

$fat = 7,6 . 10^3\,N$

/ /

Outros valores

33-



$m = 5\,kg$ $\quad sen\,\alpha = 0,6$

$\mu_e = 0,9$ $\quad \cos\alpha = 0,8$

$\mu_c = 0,5$

a-) Se $F = 0$

$y: \; n - P\cos\alpha = 0$

$n = P\cos\alpha$

$n = 5.10.0,8 = 40N$

$fat = \mu_e N$

$fat_{emax} = 0,9.40 = 36\,N$

como $fat < fat_{emax}$, o corpo esta em repouso, portanto sua força de atrito é 30N

$x: \; fat - P\,sen\,\alpha = 0$

$fat = P\,sen\,\alpha$

$fat = 5.10.0,6 = 30N$

b-) $x: \; F - fat - P\,sen\,\alpha = 0$

$F = fat + P\,sen\,\alpha$

$F = \mu_e . n + 10.m.sen\,\alpha$

$F = 0,9.40 + 10.5.0,6$

$F = 66N$

c-) $F - fat - P\,sen\,\alpha = 0$

$F = fat + P\,sen\,\alpha$

$F = \mu_c . n + P\,sen\,\alpha$

$F = 0,5.40 + 10.5.0,6$

$F = 50N$

Com os valores do Base

$m = 10kg$ $\quad \mu_e = 0,9$ $\quad \mu_c = 0,5$ $\quad sen\,\alpha = 0,6$ $\quad \cos\alpha = 0,8$

$x: \; fat = P\,sen\,\alpha$

$fat = 10.10.0,6 = 60N$

∴ como $fat < fat_{emax}$, o corpo esta em repouso. e o fat é 60N

$y: \; n - P\cos\alpha = 0$

$n = P\cos\alpha$

$n = 10.10.0,8 = 80$

$fat_{emax} = 80.0,9 = 72N$

b) $F = fat + P\sin\alpha$

$F = \mu c \cdot n + P\sin\alpha$

$F = 0,9 \cdot 80 + 10 \cdot 10 \cdot 0,6$

$F = \underline{132N}$

c) $F - fat - P\sin\alpha = 0$

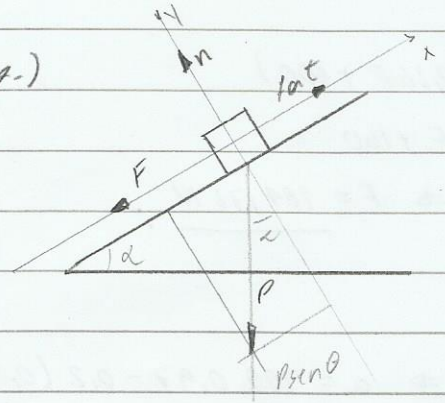
$F = fat + P\sin\alpha$

$F = \mu c \cdot n + P\sin\alpha$

$F = 0,5 \cdot 80 + 10 \cdot 10 \cdot 0,6$

$F = \underline{100N}$

(34.)



$m = 10kg$ $\quad \sin\alpha = 0,6$

$\mu e = 0,9$ $\quad \cos\alpha = 0,8$

$\mu c = 0,8$

a) Se $F = 5N$ $\quad fat = ?$

y: $n = P\cos\theta$

x: $fat = F + P\sin\theta$

$n = 10 \cdot 10 \cdot 0,8 = 80N$

$fat = 5 + 10 \cdot 10 \cdot 0,6 = \underline{65N}$

$fat_{emax} = 0,9 \cdot 80 = 72N$

Como $fat < fat_{emax}$, então o corpo está em repouso, com a força de atrito $\underline{65N}$.

b) $fat - F - P\sin\theta = 0$

$F = fat - P\sin\theta$

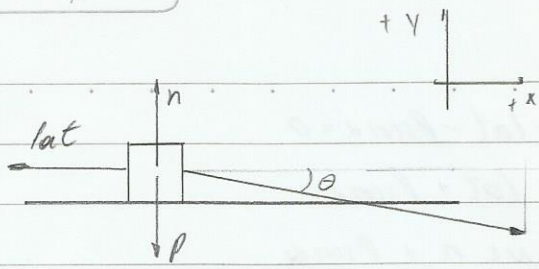
$F = \mu c \cdot n - P\sin\theta$

$F = 0,8 \cdot 80 - 10 \cdot 10 \cdot 0,6$

$F = 4N$

/ /

(35-)



$P = 400N$ $\quad \sin\theta = 0,26$

$\mu e = 0,4$ $\quad \cos\theta = 0,97$

$\mu c = 0,2$

$y: \; n - P - F\sin\theta = 0$

$n = F\sin\theta + P$

$n = 0,26.F + 400$

$x: \; F\cos\theta = fat$

$F\cos\theta = \mu e . n$

$F.0,97 = 0,4(0,26F + 400)$

$0,97F = 0,104F + 160$

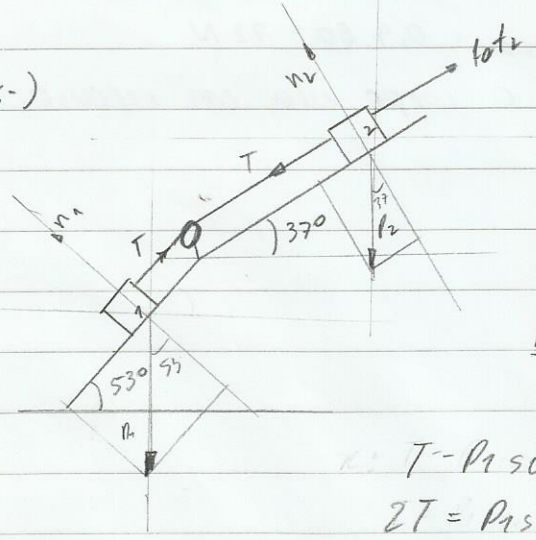
$0,866F = 160 \Rightarrow F = \underline{184,76\,N}$

$F\cos\theta - fat = m.a$

$a = \dfrac{F\cos - fat}{m} \Rightarrow a = \dfrac{F\cos\theta - \mu c\, n}{m} \Rightarrow a = \dfrac{300.0,97 - 0,2(0,26.300 + 400}{40}$

$a = 4,88\,(m/s^2)$

(36-)



$m_1 = m_2 = 10\,kg$

$\mu_2 = 0,250$

Bloco 1 $\Rightarrow \; T - P_1\sin 53 = m_1 a$

Bloco 2 $\Rightarrow \; fat_2 - T - P_2\sin 37 = m_2 a$

(como as massas são iguais)

$T - P_1\sin 53 = fat_2 - T - P_2\sin 37$

$2T = P_1\sin 53 + fat_2 - P_2\sin 37$

$2T = 79,86 + 19,97 - 60,18$

$T = \dfrac{39,65}{2} = 19,82\,N$

$fat_2 = \mu n_2$

$n_2 = P_2\cos 37$

$n_2 = 10.10.\cos 37$

$n_2 = 79,86$

$fat = 0,250.79,86$

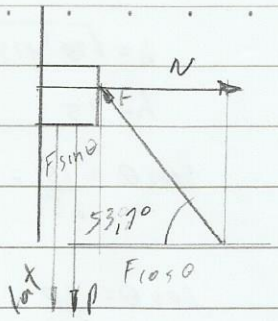
$fat_2 = 19,97N$

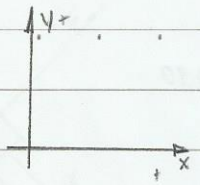
$a = \dfrac{T - P_1\sin 53}{m_1} \Rightarrow \dfrac{19,82 - 10.10.\sin 53}{10} = -6,00\,m/s^2$

$a = 6,00\,(m/s^2)$

/ /

(37-)





$P = 12\,N$

$\mu = 2/3$

y: $F\sin\theta - fat - p = 0$

$0,8.F - fat - 12 = 0$

$fat = 0,8F - 12$

$\mu . n = 0,8F - 12$

$\frac{2}{3} n = 0,8F - 12 \quad n = \frac{3(0,8F-12)}{2}$ (II)

x: $n - F\cos\theta = 0$

$F\cos\theta = n$

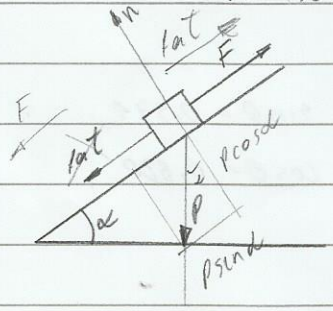
$0,6F = n$ (I)

Igualando I e II $\quad 0,6.F = \frac{3(0,8F-12)}{2} \quad 1,2F = 2,4F - 36$

$F = 30N$ $\quad n = 0,6.F$

$n = 0,6.30 = 18N$

(38-)



$m = 1,00\,kg \quad \sin\alpha = 0,6$

$\mu = 0,2 \quad \cos\alpha = 0,8$

x: $F + fat - P\sin\alpha = m\,a$; $a = 0$; pois a velocidade tem que ser cons.t.

$F = P\sin\alpha - fat$

$F = 6 - 0,2n \quad F = 6 - 0,2.8$

$F = 4,4N$

y: $n - p\cos\alpha = 0$

$n = p\cos\alpha \quad F + P\sin\alpha - fat = m\,a$

$n = 8 \quad a = \frac{F + P\sin\alpha - fat}{m}$

$fat = \mu . n$

$fat = 0,2.8 = 1,6 \quad a = \frac{4,4 + 6 - 1,6}{1} = 8,8\,(m/s^2)$

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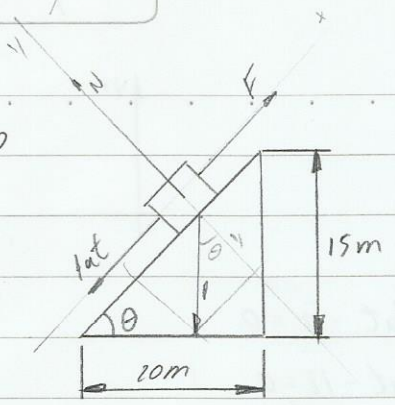
P2-2010



$m = 1600\,Kg$

$V = 1,5\,m/s$

$\mu c = 0,25$

$h = \sqrt{20^2 + 15^2}$

$h = 25$

$\operatorname{sen}\theta = \frac{15}{25} = \frac{3}{5}$

$\cos\theta = \frac{20}{25} = \frac{4}{5}$

y: $N - P\cos\theta = 0$

$N = P\cos\theta$

$N = 12800$

$fat = \mu c \cdot n$

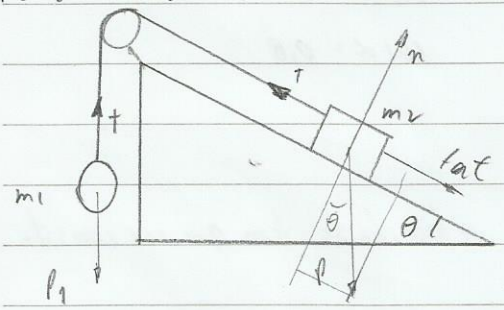
$fat = 0,25 \cdot 12.800 = 3200\,N$

x: $F - fat - P\operatorname{sen}\theta = 0$

$F = fat + P\operatorname{sen}\theta$

$F = 3200 + 9600 = 12800\,N$

P2-2010 Noturno



$m_1 = 4,00\,Kg$

$m_2 = 5,00\,Kg$

$\mu = 0,2$

$\operatorname{sen}\theta = 0,574$

$\cos\theta = 0,820$

$n = P\cos\theta$

$n = 41\,N$

$fat = \mu \cdot n$

$fat = 8,2\,N$

$P_1 - T = m_1 \cdot a$

$T - fat - P\operatorname{sen}\theta = m_2 \cdot a$

$P_1 - fat - P_2\operatorname{sen}\theta = a(m_1 + m_2)$

$a = \frac{P_1 - fat - P\operatorname{sen}\theta}{m_1 + m_2}$

$a = \frac{40 - 8,2 - 28,7}{9} = 0,34\,m/s^2$

$P_1 - T = m_1 \cdot a$

$T = P_1 - m_1 \cdot a$

$T = 40 - 4 \cdot (0,34)$

$T = 38,62\,N$

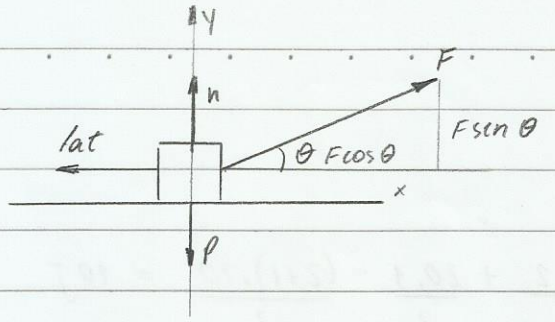
/ /

9) $m = 200\ kg$

$\mu = 0{,}30$

$F = 20x + 1500$

$V = ?$ após $10\ m$



$\text{sen } 37 = 0{,}6$

$\cos 37 = 0{,}8$

y: $n + F\text{sen}\theta - P = 0$

$n + 0{,}6(20x + 1500) - 2000 = 0$

$n + 12x + 900 - 2000 = 0$

$n = 1100 - 12x$

$fat = \mu . n$

$fat = 0{,}3 . (1100 - 12x)$

$fat = 330 - 3{,}6x$

x: $F\cos\theta - fat = 0$

$0{,}8(20x + 1500) - (330 - 3{,}6x) =$

$16x + 1200 - 330 + 3{,}6x$

$19{,}6x + 870 = Rx$

Teorema da energia cinética

$$\int_0^{10} Rx\ dx = \frac{mv^2}{2} - \frac{mv_0^2}{2}$$

$$\int_0^{10} Rx\ dx = \int_0^{10} (19{,}6x + 870)dx = 19{,}6\frac{x^2}{2} + 870x\Big|_0^{10} \Rightarrow$$

$$\Rightarrow \left(19{,}6 . \frac{10^2}{2} + 870 . 10\right) - \left(19{,}6 . \frac{0^2}{2} + 870 . 0\right) = 9680\ J$$

Energia cinética

$$e_c = \frac{mv^2}{2} \qquad v = \sqrt{\frac{e_c . 2}{m}}$$

$$v^2 = \frac{e_c . 2}{m} \qquad v = \sqrt{\frac{9680 . 2}{200}} = \underline{9{,}84\ m/s}$$

/ /

10) $m = 4{,}0\ kg$

$v_0 = 5{,}0\ m/s$

a.) $W = \frac{(10+20).2}{2} + \frac{20.1}{2} - \frac{(2+1).20}{2} = 10\ J$

b.) $P_{x=5m} = ?$ $\quad P = F.v$

$P = -20.5{,}46 = -109{,}59\ W$

Teorema da energia cinética

$W = \frac{mv^2}{2} - \frac{mv_0^2}{2} \Rightarrow 10 = \frac{4v^2}{2} - \frac{4.5^2}{2} \Rightarrow 10 = 2v^2 - 50$

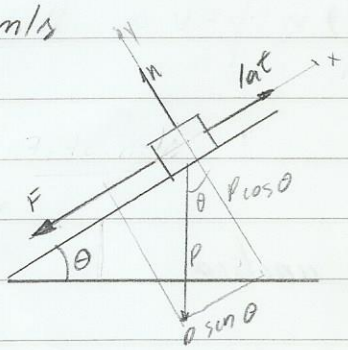
$v^2 = 30 \Rightarrow v = 5{,}48\ m/s$

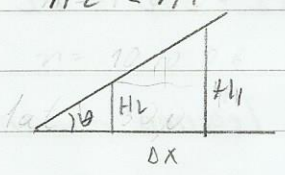
11) $m = 10\ kg$

$\mu = ?$

$\sin\theta = 0{,}6$

$\cos\theta = 0{,}8$





$(h_2 - h_1) = -\Delta X \sin\theta$

Usando o Teorema da Energia Mecânica

$\tau_{lat} = -EM_2 - EM_1$

$\tau_{lat} = (Ec + Ep + \cancel{Ee}^{0})_2 - (Ec + Ep + \cancel{Ee}^{0})_1$

$\tau_{lat}^{0-3} = \left(\frac{mv^2}{2} + mgh\right)_2 - \left(\frac{mv^2}{2} + mgh\right)_1$

$z = \frac{(4+1)\,3}{2} = 7{,}5$

$(h_2 - h_1) = -7{,}5.0{,}6$

$\tau_{lat}^{0-3} = 80 + 10h_2 - 5 - 10h_1$

$\tau_{lat}^{0-3} = 75 + 10(h_2 - h_1)$

$\tau_{lat}^{0-3} = 75 - 10.7{,}5.0{,}6 = 30\ N$

Exemplo:

$m = 10\ kg$

$\mu = ?$

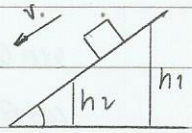
$\sin\theta = 0,8$

$\cos\theta = 0,6$

$\tau_{fat}^{0-3} = ?$

$\mu = ?$

$P(1) = ?$



Teorema da Energia Mecânica

$\tau_{fat} = EM_2 - EM_1$

$\tau_{fat}^{0-3} = (E_c + E_p + \cancel{E_e})_2 - (E_c + E_p + \cancel{E_e})_1$

$\tau_{fat}^{0-3} = \left(\frac{mv^2}{2} + mgh\right)_2 - \left(\frac{mv^2}{2} + mgh\right)_1$

$\tau_{fat}^{0-3} = \frac{10.7^2}{2} + 10.10.h_2 - \frac{10.1^2}{2} - 10.10h_1$

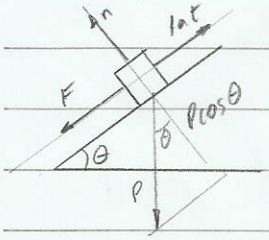
$\tau_{fat}^{0-3} = 245 + 100h_2 - 5 - 100h_1$

$\tau_{fat}^{0-3} = 240 + 100(h_2 - h_1)$

"$h_1 > h_2 \therefore (h_2 - h_1) = -\Delta x \sin\theta$"

$\Delta x = \frac{(7+1).3}{2} = 12\ m \quad \therefore \quad (h_2 - h_1) = -12.0,6 = -9,6$

$\tau_{fat}^{0-3} = 240 + 100.(-9,6) = \underline{-720\ J}$



$y: \ n = P\cos\theta$

$n = 10.10\ 0,6 = 60\ N$

$W_{fat} = fat.d$

$fat = \frac{W_{fat}}{d} = \frac{-720}{12} = -60$

$\mu = \frac{fat}{n} = \frac{-60}{60} = \underline{1,000}$

$P(1) = F.V$

$x: \ fat - F - P\sin\theta = m.a$

$F = fat - P\sin\theta - m.a$

$F = mg\cos\theta.\mu - mg\sin\theta - m.a$

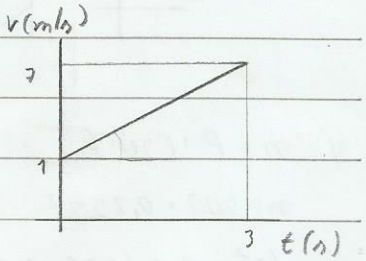
$F = 60 - 80 - 20 = -40$ $\quad P = -40.3 = -120\ W$

Na resolução esta

$F = ma = mg\sin\theta - \mu mg\cos\theta$

$P(1) = 80 - 60 = 20$

$P = 20.3 = \underline{60\ W}$



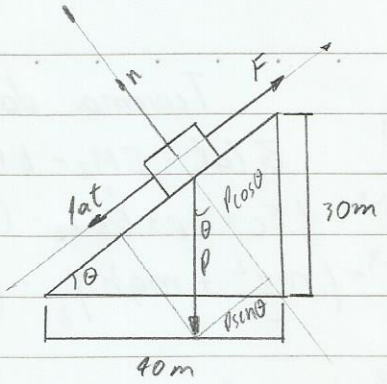
$v(t) = 2x + 1$

$v(1) = 3\ m/s$

Na resolução da Prova eles não consideram o fat

Dúvida

12.)



$m = 1800\,kg$

$v = 1,5\ m/s$

$\mu = 0,25$

$P = ?$

$W_r = ?$

$\sin\theta = 0,6$

$\cos\theta = 0,8$

Teorema da energia cinética: $W_r = \frac{mv^2}{2} - \frac{mv_0^2}{2}$

$W_r = \frac{1800 \cdot 1,5^2}{2} - \frac{1800 \cdot 1,5^2}{2} = 0$

$P = F \cdot v$

$P = 14400 \cdot 1,5$

$P = 2,16 \cdot 10^4\ W$

y: $n = P\cos\theta$

$n = 10 \cdot 1800 \cdot 0,8 = 14400\ N$

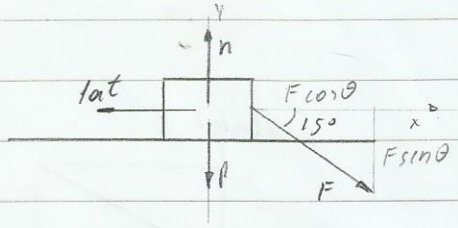
$fat = \mu n \quad fat = 14400 \cdot 0,25 = 3600\ N$

x: $F = fat + P\sin\theta$

$F = 3600 + 10 \cdot 1800 \cdot 0,6$

$F = 14400\ N$

13.)



$P = 500N$

$\mu e = 0,4$

$\mu d = 0,2$

$\sin 15° = 0,259$

$\cos 15° = 0,966$

y: $n = P + F\sin\theta$

$n = 500 + 0,259F$

$fat = 0,4\,(500 + 0,259F)$

x: $F\cos\theta = fat$

$0,966F = 200 + 0,1036F$

$F = 231,91\ N$

$fat = 0,2\,(500 + 0,259F)$

$F\cos\theta = fat$

$0,966F = 100 + 0,0518F$

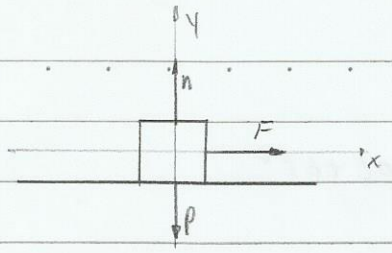
$F = 109,38\ N$

$P = F \cdot v \cdot \cos\theta$

$P = 109,36 \cdot 2 \cdot 0,966 = 211,33\ W$

/ /

14-)



$m = 20\ kg$ a) $\Delta E_c = ?$

$F = 12\ N$ b) $P(5) = ?$

$\Delta E_c = \frac{mv^2}{2} - \frac{mv_0^2}{2}$ $\Delta E_c = \frac{20.(1,8)^2}{2} - \frac{20(1,2)^2}{2} = 18\ J$

$F = m.a$ $V = V_0 + at$ $V = V_0 + at$

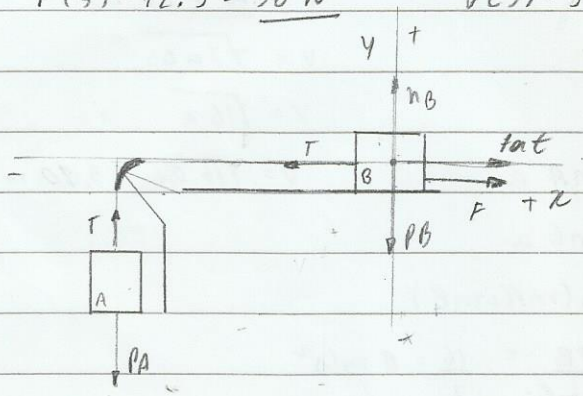
$a = \frac{F}{m} = \frac{12}{20} = 0,6$ $V(2) = 0,6.2$ $V(3) = 0,6.3$

$V(2) = 1,2$ $V(3) = 1,8$

$P(i) = F_i . V_i$ $V(5) = 0,6.5$

$P(5) = 12.3 = 36\ W$ $V(5) = 3$

15-)



$m_A = 1,50\ kg$

$m_B = 3,00\ kg$

$F = 9,00N$

$\mu = 0,4$

Bloco B:

y: $n_B = P_B$ $fat = \mu . n$ $T = m_A . a + P_A$

$n_B = 30N$ $fat = 30.0,4 = 12\ N$ $T = 4,5.(-3,2) + 45 = 30,6N$

x: $fat - T + F = m_B . a$ (I)

Bloco A:

$V^2 = V_0^2 + 2a\Delta s$

$T - P_A = m_A\ a$ (II) $V = \sqrt{2a\Delta s} \Rightarrow V = \sqrt{2.3,2.0,5} = 1,79 m/s$

Somando I e II

$fat + F - P_A = a(m_A + m_B)$ $P = F.v$

$a = \frac{fat + F - P_A}{m_A + m_B}$ $P = 30,6.1,79 = 74,74\ W$

$a = \frac{12 + 9 - 45}{7,5} = -3,2\ m/s^2$

16.) $m = 4\,kg$ $\quad F = m.a$

$x = 4t - 5t^2 + 2t^3$ $\quad \frac{dx}{dt} = v = 4 - 10t + 6t^2$

$W_r^{(0-5)t} = ?$

$P_i\ (5)_t = ?$ $\quad v(0) = 4 \quad (5) = 104$

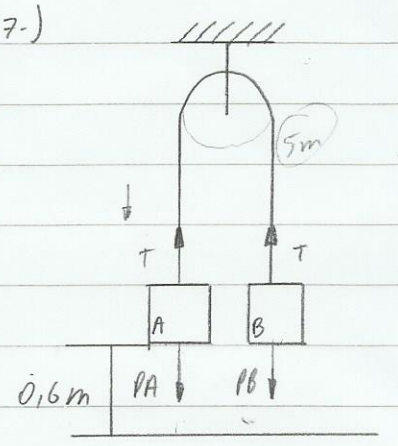
$$W_r - \Delta E_C = \frac{mv^2}{2} - \frac{mv_0^2}{2} = \frac{4.(104)^2}{2} - \frac{4.4^2}{2} = 21600\,N$$

$P(5) = 200.104 = 20800\,W$ $\quad \frac{dv}{dt} = -10 + 12t \quad a(5) = 50$

$F = m.a$

$F = 4.50 = 200\,N$

17.)



$m_A = 1,8\,kg$

$m_B = 0,2\,kg$

$v^2 = v_0^2 + 2a\Delta S$

$v = \sqrt{2a\Delta S}$

$v = \sqrt{16x}$

$v = \sqrt{16.0,6} = 3,10\ m/s$

$P_A - T = m_A\, a$

$T - P_B = m_B\, a$

$P_A - P_B = a(m_A + m_B)$

$$a = \frac{P_A - P_B}{m_A + m_B} = \frac{16}{2} = 8\ m/s^2$$

$v^2 = v_0^2 + 2a\Delta S$

$0 = (3,10)^2 + 2.(-10)\Delta S$

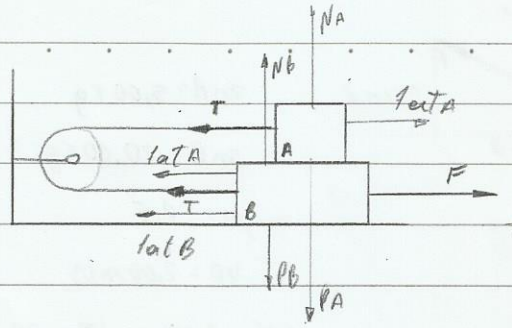
$\Delta S = 0,96$

$h_m = 0,96 + 0,6 + 0,6 = 1,66\ m$

$$E_C(B) = \frac{mv^2}{2} = \frac{0,2.3,10^2}{2} = 0,96\,J$$

/ /

18-)



$m_A = 2{,}00\ kg$ $\mu_A = 0{,}2$

$m_B = 8{,}00\ kg$

$\mu_{AB} = 0{,}4$

Bloco A:

y: $n_A = P_A$ $lat_A = 0{,}4 \cdot 20 = 8N$

$n_A = 20N$

x: $T - latA = 0$

$T = latA = 8N$

Bloco B

y: $n_B - n_A - P_B = 0$ $lat_B = 0{,}2 \cdot 100 = 20N$

$n_B = n_A + P_B$

$n_B = 20 + 80 = 100$

x: $F = latA + T + latB$

$F = 8 + 8 + 20 = 36N$

$F' = 72$ $P(t) = F \cdot v$ $F - T - latA - latB = m_B \cdot a$

$P(0{,}5) = 72 \cdot 1{,}90 = 136{,}61W$ $T - latA = m_A\, a$

$F - 2\,latA - latB = a\,(m_A + m_B)$

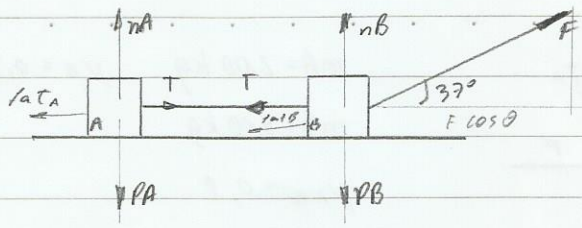
$a = 3{,}6\ m/s^2$

$v^2 = v_0^2 + 2a\Delta S$

$v = \sqrt{2a\Delta S} = \sqrt{2 \cdot 3{,}6 \cdot 0{,}5} = 1{,}90\ m/s$

/ /

(19.)



$m_A = 5{,}00\ kg$

$m_B = 20{,}00\ kg$

$\mu = 0{,}5$

$V_0 = 2{,}00\ m/s$

Após 3,00 m $W = 90\ J$

Bloco B:

y: $n_B + F\sin\theta = P_B$

$n_B + 0{,}6F = 200$

$n_B = 200 - 0{,}6F$

$f_{at\,B} = 0{,}5(200 - 0{,}6F)$

$f_{at\,B} = 100 - 0{,}3F$

x: $F\cos\theta - f_{at\,B} - T = 0$ (I)

$0{,}8F - 100 + 0{,}3F = T$

$T = 1{,}1F - 100$

$W = F.d$ $\quad F' = 30$

$90 = F'.3$

Bloco A:

y: $n_A = P_A$

$n_A = 50$

$f_{at\,A} = 0{,}5.50$

$f_{at\,A} = 25$

x: $T - f_{at\,A} = 0$ (II)

$T = f_{at\,A}$

$T = 25\ N$

Somando I e II

$F\cos\theta - f_{at\,B} - f_{at\,A} = 30$

$0{,}8F - 100 + 0{,}3F - 25 = 30$

$1{,}1F = 155$

$F = 140{,}91\ N$

$P = F.v$

$P = 30.3{,}34$

$P = 100{,}40\ W$

$F = m.a$

$30 = 25a \quad a = 1{,}2$

$v^2 = v_0^2 + 2a\Delta s$

$v = \sqrt{4 + 2.1{,}2.3} = 3{,}34$

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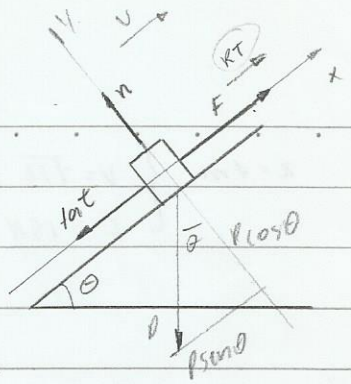


(10-) $m = 15\,kg$

$v_0 = 10\,m/s$

$\mu = 0,3$

$\cos\theta = 0,8$

$\operatorname{sen}\theta = 0,6$

y: $n = P\cos\theta$

$n = 15.10\,0,8 = 120N$

$fat = 120.0,3 = 36N$

x: $F = fat + P\operatorname{sen}\theta$

$F = 36 + 10.15.0,6$

$F = 126\,N$

$F = m.a \Rightarrow a = \frac{F}{m} \Rightarrow a = \frac{126}{15} = -8,40\,m/s$

$v^2 = v_0^2 + 2a\Delta S$

$\Delta S = \frac{-v_0^2}{2a}$ $\Delta S = \frac{-10^2}{2.-8,40} = 5,95\,m$

$W_r = F.d$

$W_r = 126.5,95 = 750J$

Trabalho da Energia cinética

$W_r = \Delta E_c = \frac{mv^2}{2} - \frac{mv_0^2}{2} = \frac{15.0}{2} - \frac{15.10^2}{2} = -750J$

/ /

(21-) $m = 5\ kg$ $\quad x = 4m \begin{cases} v = \sqrt{12}\ m/s \\ F = 15N \end{cases}$

$v = \sqrt{12}\ cm \quad x = 4m$

$W_r = W_F + W_{Fat}$

$W_r = \frac{mv_1^2}{2} + \frac{mv_0^2}{2} \Rightarrow W_r = \frac{(20+10).x}{2} + \frac{(20+5).x}{2} = 65J$

$W_{fat} = -fat.d \Rightarrow -\mu.n.x = -200\mu$

a) $\quad -200\mu = 35 \Rightarrow \mu = 0,175$

b) $\quad TEC$

$W_r = \frac{mv^2}{2} - \frac{mv_0^2}{2} = \frac{5.v^2}{2} - \frac{5.0^2}{2} \Rightarrow W_r = \frac{5.v^2}{2}$

$W_r = W_F + W_{Fat} = 125 + 50.-\mu.8 = 125 - 400\mu$

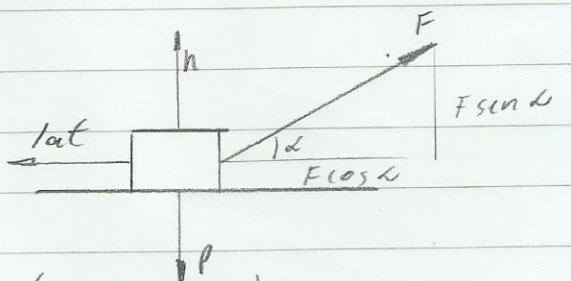
$\frac{5.v^2}{2} = 125 - 400\mu \Rightarrow v^2 = \frac{2(125-400\mu)}{5} \Rightarrow v = \sqrt{\frac{2(125-400\mu)}{5}}$

$v = 4,69\ m/s$

22-) $P = 600N \quad \sin\alpha = 0,342$

$\mu e = 0,4 \quad \cos\alpha = 0,940$

$\mu d = 0,2$



y: $n + F\sin\alpha = p \qquad fat = 0,4(600 - 0,342.F)$

$n = 600 - 0,342.F \qquad fat = 240 - 0,1368F$

x: $F\cos\alpha = fat$

$0,94F = 240 - 0,1368F$

$F = 222,88\ N$

$fat = 0,2(600 - 0,342F) = 120 - 0,0684F$

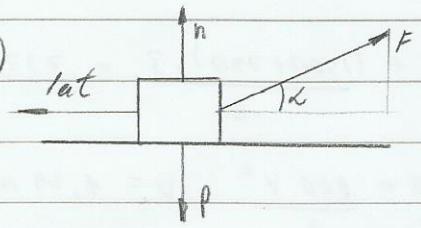
$0,94F = 120 - 0,0684F$

$F = 119\ N$

$P = F.v.\cos\alpha$

$P = 119.1,5.0,94 = \underline{167,80\ W}$

23.)



$m = 12\ kg$ $\quad sen\alpha = 0,6$

$\mu e = 0,5$ $\quad \cos\alpha = 0,8$

$\mu d = 0,3$

a) se $F = 55\ N \rightarrow fat = ?$

y: $n + F\,sen\theta - p = 0$

$n = 120 - 55.0,6 = 87\ N$

$fat_{emax} = 87.0,5 = 43,5\ N$

x: $F\cos\theta - fat = 0$

$fat = 44\ N$

* Como o fat atual é maior que o fat_{emax}, o corpo está em movimento, portanto o atrito é dinamico.

$fat = \mu d.n$

$fat = 0,3.87 = \underline{26,1\ N}$

b) $F\cos\theta - fat = m.a$

$a = \dfrac{F\cos\theta - fat}{m}$

$a = \dfrac{44 - 26,1}{12} = 1,49\ (m/s^2)$

$W_{at} = fat.d.\cos 180$

$= 26,1.1,34 = -34,99\ J$

$V^2 = V_0^2 + 2a\Delta x$

$\Delta x = \dfrac{V^2 - V_0^2}{2a}$

$\Delta x = \dfrac{4}{2.1,49} = 1,34$

/ /

(24-) $m = 800\ kg$

a) $W_{0-13} = \frac{(500+1500).4}{2} + \frac{1500.6}{2} - \frac{(3+1).500}{2} = 7500\ J$

$7500 = \frac{800.v^2}{2} \quad = v^2 = \frac{7500.2}{800} \quad = v = 4,33\ m/s$

b) $P(x) = F_x . v_x$ $\quad W_{0-7} = \frac{(500+1500).4}{2} + \frac{(1500+750).3}{2} = 7375\ J$

$P(7) = 750 . 4,29 = 3,22\ W$

$\frac{mv^2}{2} = W \Rightarrow 7375 = \frac{800.v^2}{2} \quad v = 4,29\ m/s$

25-) $m = 800\ kg$ $\quad W_{0-8} = ?$ $\quad y: \frac{3900}{6} = \frac{y}{2} \Rightarrow y = 1300$

$\mu = 0,3$

$W_{0-8} \cong \frac{(2900+3900).4^2}{2} + \frac{(3900+1300).4^2}{2} = 24000$

$W_F = 24000$ $\quad fat = \mu . m . g = 2400\ N$

$W_{fat} = 19200\ N$

$W_r = 24000 - 19200 = 4800\ J$

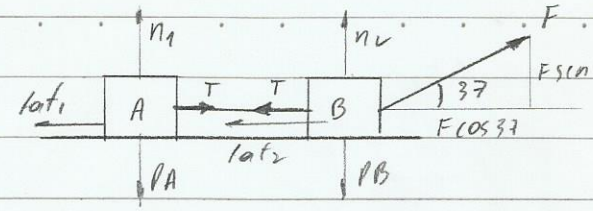
$W_{0-10} = \frac{(2900+3900).4}{2} + \frac{(3900.6)}{2} = 25300$

$W_r = 25300 - 0,3.800.10.10 = 1300$

$1300 = \frac{800\,v^2}{2} \quad v^2 = \frac{1300}{400} \quad v = \sqrt{3,25} = 1,80\ m/s$

/ /

(13.)



$F = 100N$ $\quad sen\,37 = 0,6$

$m_A = m_B = 15\,kg$ $\quad \cos 37 = 0,8$

$\mu = 0,2$

Bloco A $\quad x: T - fat_1 = m_A . a$ (I)

$y: n_1 = P_A = 150N$ $\quad fat_1 = 150 . 0,2 = 30N$

Bloco B $\quad x: F\cos 37 - T - fat_2 = m_B . a$ (II)

$y = F\,sen\,37 + n_2 = P_B$

$n_2 = P_B - F\,sen\,37 \Rightarrow n_2 = 15.10 - 100.0,6 = 90N$

$fat_2 = 90.0,2 = 18N$

Somando I e II

$$\begin{cases} T - fat_1 = m_A . a \\ F\cos 37 - T - fat_2 = m_B . a \end{cases}$$

$F\cos 37 - fat_1 - fat_2 = a(m_A + m_B)$

$$a = \frac{F\cos 37 - fat_1 - fat_2}{m_A + m_B} = \frac{80 - 30 - 18}{30} = 1,07\ (m/s^2)$$

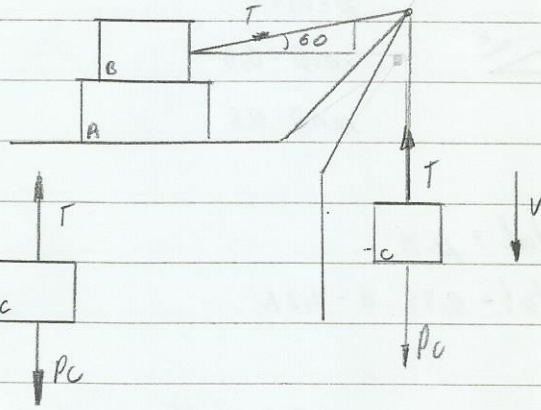
$T - fat_1 = m_A . a$

$T = m_A . a + fat_1$

$T = 15 . 1,07 + 30 = 16N$

Capítulo 4 e 5

1-)



$v = 7,5\ m/s$

$\mu_{ab} = 0,2$

$\mu_a = 0,1$

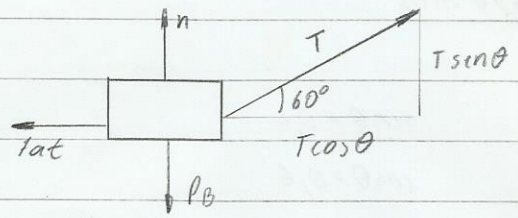
$m_C = 10\ kg$

Bloco C:

$P_C - T = 0 \qquad T = 10.10$

$mg = T \qquad T = 100N$

Bloco B:



$y: \quad n = P_b - T\sin\theta$

$n = 10b - 86,6$

$fat = 0,2(10b - 86,6)$

$fat = 2b - 17,32$ (I)

$x: \quad T\cos\theta = fat$

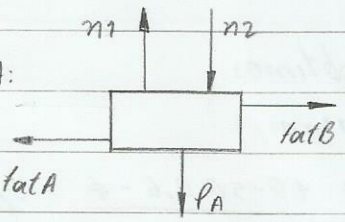
$fat = 10a.0,5 = 50N$ (II)

Igualando os fat (I) e (II)

$2b - 17,32 = 50$

$b = 67,32/2 = 33,66\ kg$

Bloco A:



$y: \quad n_1 = n_2 + P_A$

$n_1 = (10.33,66 - 86,6) + 10A$

$n_1 = 250 + 10A \qquad fatA = 25 + A$

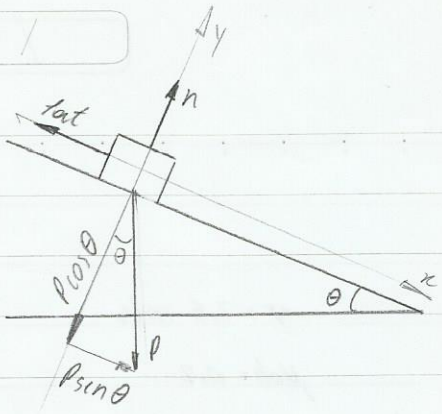
$x: \quad fatB = fatA$

$50 = 25 + A$

$A = 25\ kg$

$n = 250 + 10.25 = 250 + 250 = 500N$

2)



$m = 1kg$

$\mu = 0,15$

$\cos\theta = 0,8$

$\sin\theta = 0,6$

y: $n = P\cos\theta$ $\qquad fat = \mu . n$

$n = 1.10.0,8 = 8N$ $\qquad fat = 0,15 . 8 = 1,2N$

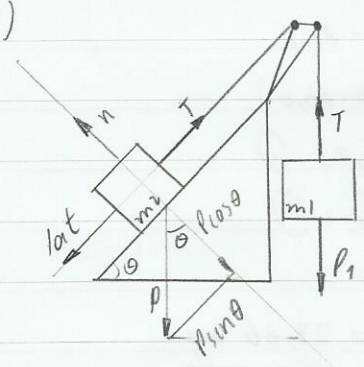
x: $P\sin\theta - fat = m . a$

$$a = \frac{mg\sin\theta - fat}{m} = \frac{1.10.0,6 - 1,2}{1} = 4,8\ (m/s^2)$$

$V^2 = V_0^2 + 2a\Delta x$

$V^2 = 0^2 + 2.4,8.2 = 19,2$ $\qquad V = \underline{4,38\ m/s}$

3)



$m1 = 4\ kg$ $\qquad \sin\theta = 0,6$

$m2 = 5\ kg$ $\qquad \cos\theta = 0,8$

$\mu = 0,1$

$n = P\cos\theta$ $\qquad fat = 40.0,1 = 4N$

$n = 10.5.0,8 = 40N$

$$\begin{cases} P_1 - T = m_1 . a \\ T - P\sin\theta - fat = m_2 . a \end{cases}$$

Somando as equações, obtemos

$P_1 - P\sin\theta - fat = a(m_1 + m_2)$

$$a = \frac{P_1 - P\sin\theta - fat}{m_1 + m_2} = \frac{40 - 50.0,6 - 4}{9} = \underline{0,67\ m/s^2}$$

$T = P_1 - m_1 . a$

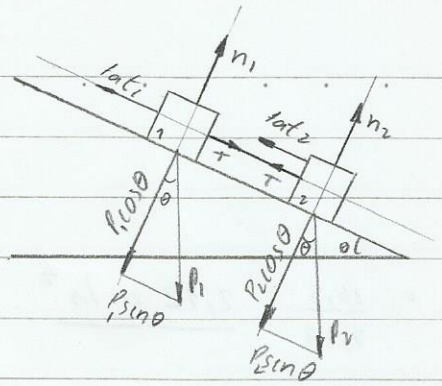
$T = 40 - 4.0,67 = \underline{37,33N}$

$V = V_0 + at$

$V = 0,67.2 = \underline{1,33\ m/s}$

/ /

4)



$m_1 = 3\,kg$ $\quad \cos = 0,8$

$m_2 = 7\,kg$ $\quad \sin\theta = 0,6$

$a = 2\,m/s^2$

$n_1 = P_1\cos\theta$ $\qquad n_2 = P_2\cos\theta$

$n_1 = 3.10.0,8 = 24N$ $\qquad n_2 = 10\ 7.0,8 = 56N$

$fat_1 = 24\mu$ $\qquad fat_2 = 56\mu$

Bloco 1: $T + P_1\sin\theta - fat_1 = m1.a \Rightarrow T = m1.a + fat_1 - P_1\sin\theta$

Bloco 2: $P_2\sin\theta - T - fat_2 = m_2.a \Rightarrow T = P_2\sin\theta - fat_2 - m_2.a$

Igualando os "T"

$m1.a + fat_1 - P_1\sin\theta = P_2\sin\theta - fat_2 - m_2\,a$

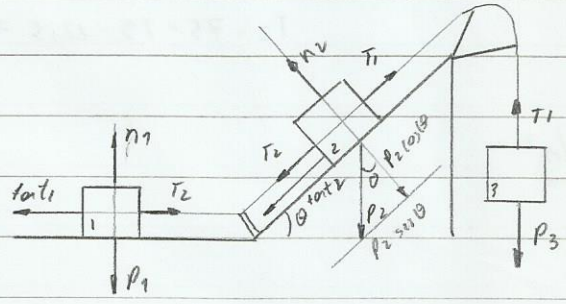
$3.2 + 24\mu - 30.0,6 = 70.0,6 - 56\mu - 7.2$

$24\mu - 12 = 28 - 56\mu$

$80\mu = 40$

$\mu = \frac{40}{80} = 0,5$

5)



$m1 = m2 = 3\,kg$ $\quad \cos\theta = 0,8$

$\mu = 0,55$ $\quad \sin\theta = 0,6$

$$\begin{cases} P_3 - T_1 = 0 \\ T_1 - T_2 - fat_2 - P_2\sin\theta = 0 \\ T_2 - fat_1 = 0 \end{cases}$$

$n_1 = P_1$ $\qquad n_2 = P_2\cos\theta$

$n_1 = 30N$ $\qquad n_2 = 24\,N$

$fat_1 = 30.0,55$ $\qquad fat_2 = 24.0,55$

$fat_1 = 16,5\,N$ $\qquad fat_2 = 13,2\,N$

$P_3 - fat_2 - P_2\sin\theta - fat_1 = 0$

$P_3 = \frac{fat_2 + P_2\sin\theta + fat_1}{10}$

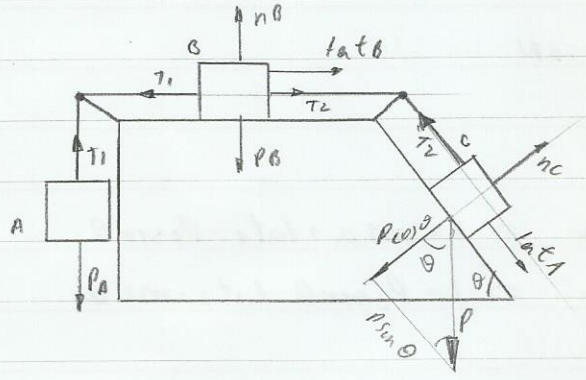
$P_3 = \frac{13,2 + 16,5 + 18}{} = 47,7\,kg$

$$\begin{cases} P_3 - T = m3 . a \\ T - P_2 \operatorname{sen}\theta - fat_2 = m2 . a \end{cases}$$

$$P_3 - P_2 \operatorname{sen}\theta - fat_2 = a(m2 + m3)$$

$$a = \frac{P_3 - P_2 \operatorname{sen}\theta - fat_2}{m2 + m3} = \frac{47,7 - 18 - 13,2}{3 + 4,77} = \frac{16,5}{7,77} = \underline{2,12\ m/s^2}$$

6)



$mA = 10\ kg$ $\cos\theta = 0,8$

$mB = 5\ kg$ $\operatorname{sen}\theta = 0,6$

$mC = 3\ kg$ $\mu = 0,5$

$nB = PB$ $fatB = 50 . 0,5$ $nC = P . \cos\theta$ $fatC = 24 . 0,5$

$nB = 50N$ $fatB = 25N$ $nC = 24N$ $fatC = 12N$

$$\begin{cases} P_A - T_1 = mA . a \\ T_1 - T_2 - fatB = mB . a \\ T_2 - fatA - P \operatorname{sen}\theta = mC . a \end{cases}$$

$$T_1 = PA - mA . a$$

$$T_1 = 10 . 10 - 10 . 2,5 = \underline{75\ N}$$

$$P_A - fatB - fatA - P\operatorname{sen}\theta = a(mA + mB + mC)$$

$$T_2 = T_1 - fatB - mB . a$$

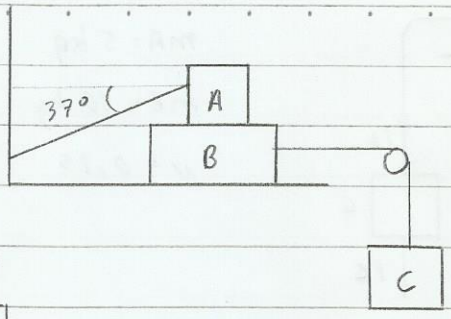
$$a = \frac{PA - fatB - faL - P\operatorname{sen}\theta}{mA + mB + mC}$$

$$T_2 = 75 - 25 - 12,5 = \underline{37,5N}$$

$$a = \frac{100 - 25 - 12 - 18}{18} = \frac{45}{18} = \underline{2,5\ m/s^2}$$

/ /

8-)



$m_A = 2\ kg$ $\quad \sin\theta = 0,6$

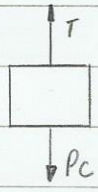
$m_B = 5\ kg$ $\quad \cos\theta = 0,8$

$\mu_{AB} = 0,4$

$\mu_B = 0,1$

$a = 2\ m/s^2$

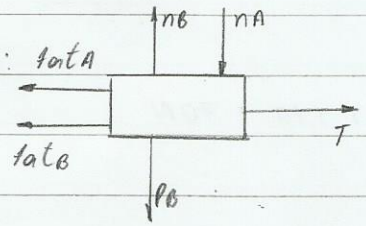
Bloco C:



$m_C \cdot g - T = m_C \cdot a$

$10 m_C - T = 2 m_C \qquad T = 8 m_C$

Bloco B:



y: $n_B = n_A + P_B$

$n_B = 50 + 28,57 = 78,57\ N$

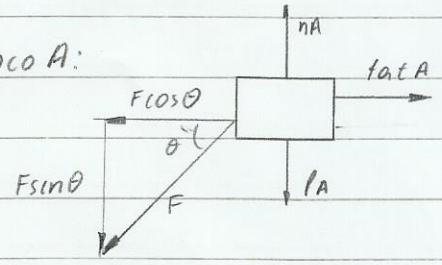
$fat_B = 7,86\ N$

x: $T - fat_A - fat_B = m_B \cdot a$

$T = 5,2 + 7,86 + 17,43 = 29,29$

$m_C = \frac{29,29}{8} = \underline{3,66\ kg}$

Bloco A:



$n_A = P_A + F\sin\theta$

$n_A = 20 + 0,6F \qquad n_A = 28,57$

$fat_A = 0,4(20 + 0,6F) = 8 + 0,24F$

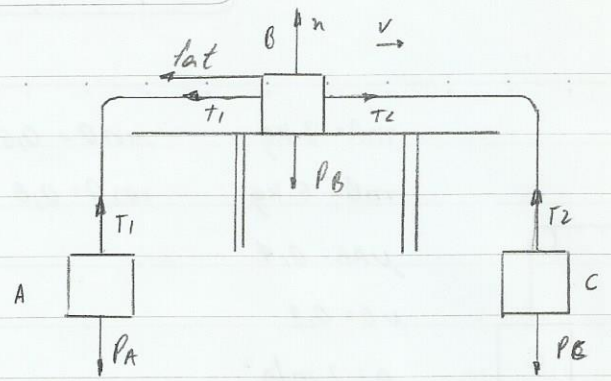
$fat_A = 17,43\ N$

$fat_A = F\cos\theta$

$8 + 0,24F = 0,8F$

$0,56F = 8 \Rightarrow \underline{F = 14,29\ N}$

9-)



$m_A = 5\,kg$

$m_B = 10\,kg$

$\mu = 0{,}25$

a) $m_C = ?$ $\quad a = 4\,m/s^2$ $\quad n = P_B$ $\quad fat = 25\,N$

$n = 100\,N$

$P_C - T_2 = m_C \cdot a$

$T_2 - T_1 - fat = m_B \cdot a$

$T_1 - P_A = m_A\, a \quad \Rightarrow T_1 = m_A\, a + P_A = 5 \cdot 4 + 5 \cdot 10 = 70\,N$

$T_2 = m_B \cdot a + fat + T_1$

$T_2 = 40 + 25 + 70 = 135\,N$

$P_C - m_C a = T_2$

$m_C g - m_C a = T_2$

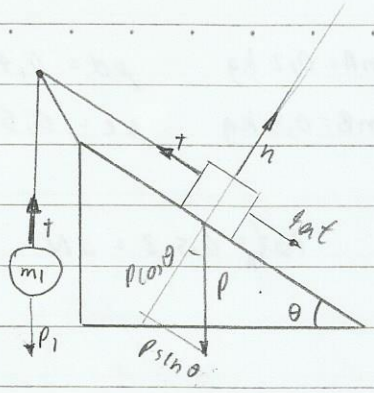
$m_C = \dfrac{T_2}{g - a} = \dfrac{135}{6} = 22{,}5\,kg$

$T_1 = 70\,N$

$T_2 = 135\,N$

/ /

10-)



$m_1 = 4{,}00\ kg$ $\quad \sin\theta = 0{,}574$

$m_2 = 5{,}00\ kg$ $\quad \cos\theta = 0{,}820$

$\mu = 0{,}2$

$n = P\cos\theta$ $\quad fat = n.0{,}2$

$n = 5.10.0{,}82 = 41\ N$ $\quad fat = 8{,}2\ N$

$$\begin{cases} P_1 - T = m_1.a & (I) \\ T - fat - P\sin\theta = m_2.a & (II) \end{cases}$$

Somando I e II

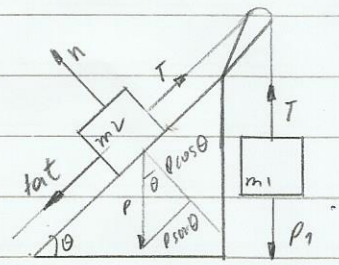
$P_1 - fat - P\sin\theta = a(m_1+m_2)$

$$a = \frac{P_1 - fat - P\sin\theta}{m_1+m_2} = \frac{40 - 8{,}2 - 28{,}7}{9} = \underline{0{,}34\ m/s^2}$$

$T = P_1 - m_1.a$

$T = 4.10 - 4.0{,}34 = \underline{38{,}62\ N}$

11-)



$m_1 = 4\ kg$ $\quad \sin\theta = 0{,}6$

$m_2 = 3\ kg$ $\quad \cos\theta = 0{,}8$

$\mu = ?$

$n = P_2\cos\theta$ $\quad fat = 24\mu$

$n = 3.10.0{,}8 = 24\ N$

$T = P_1 \Rightarrow T = 40$

$T = fat + P\sin\theta \Rightarrow T = 24\mu + 18$

$T = T$

$40 = 24\mu + 18$

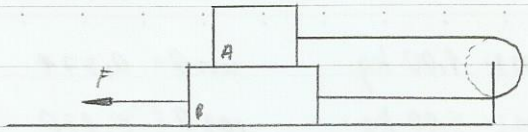
$24\mu = 22$

$\mu = \frac{22}{24}$

$\mu = \underline{0{,}92}$

$T = \underline{40N}$

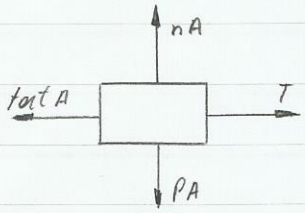
12-)



$m_A = 0,2\ kg$ $\mu_d = 0,4$

$m_B = 0,3\ kg$ $\mu_e = 0,5$

Bloco A:



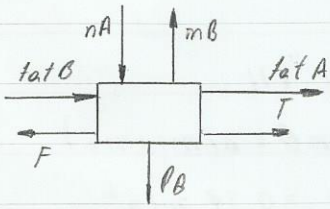
y: $nA = PA$ $fat_A = 0,5.2 = 1N$

$nA = 2\ N$

x: $T = fat\ A$

$T = 1$

Bloco B:



y: $nB = nA + PB$ $fatB = 5.0,5 = 2,5\ N$

$nB = 2 + 3 = 5\ N$

x: $F = T + fat\ A + fat\ B$

$F = 1 + 1 + 2,5 = \underline{4,5\ N}$

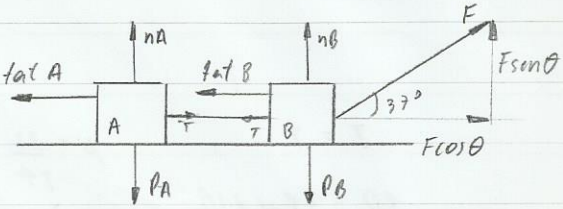
$fat\ A = 2.0,4 = 0,8\ N$

$fat\ B = 5.0,4 = 2\ N$

$F = T + fat\ A + fat\ B$

$F = 0,8 + 0,8 + 2 = \underline{3,6\ N}$

13-)



$F = 100N$ $\mu = 0,2$

$m_a = m_b = 15\ kg$ $sen\Theta = 0,6$ $cos\Theta = 0,8$

$nA = PA$ $fat\ A = 150.0,2$

$nA = 10.15 = 150N$ $fatA = 30\ N$

$nB = PB - F sen\Theta$ $fatB = 90.0,2$

$nB = 10.15 - 100.0,6 = 90N$ $fatB = 18N$

$a = \dfrac{80 - 30 - 18}{30} = \underline{1,07\ m/s^2}$

$T - fat\ A = m_A . a$

$F cos\Theta - fatB - T = m_B . a$

$F cos\Theta - fat\ A - fatB = a(m_A + m_B)$

$a = \dfrac{F cos\Theta - fat\ A - fat\ B}{m_A + m_B}$

$T = m_A\ a + fat\ A$

$T = 15.1,07 + 30 = \underline{46N}$

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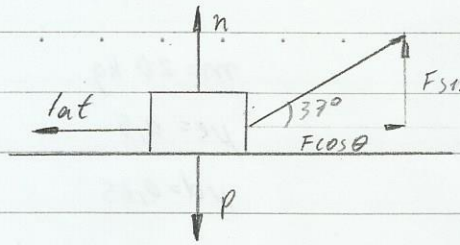
(14-) $m = 10\ kg$

$\mu e = 0,4$

$\mu d = 0,25$



$\sin\theta = 0,6$

$\cos\theta = 0,8$

Se $F = 35N$:

y: $n = P - F\sin\theta$ $\qquad fat_{(max)} = 79 \cdot 0,4 = 31,6\ N$

$n = 10 \cdot 10 - 35 \cdot 0,6 = 79N$

x: $F\cos\theta = fat$ - como fat é menor que fat_{max},

$fat = 35 \cdot 0,8 = \underline{28\ N}$ a mala esta em repouso.

Se $F = 45N$

y: $n = P - F\sin\theta$ $\qquad fat_{max} = 73 \cdot 0,4 = 29,2$

$n = 10 \cdot 10 - 45 \cdot 0,6 = 73N$

x: $fat = F\cos\theta$ $\therefore$ como $fat > fat_{max}$, o coeficiente de

$fat = 45 \cdot 0,8 = 36\ N$ atrito é dinâmico.

$fat = 73 \cdot 0,25 = \underline{18,25\ N}$

$n = P - F\sin\theta$ $\qquad fat = 0,25(100 - 0,6F) = 25 - 0,15F$

$n = 100 - 0,6F$

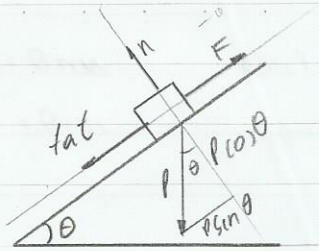
$F\cos\theta = fat$ $\qquad$ Igualando os fat

$fat = 0,8F$ $\qquad 0,8F = 25 - 0,15F$

$0,95F = 25$

$F = \underline{26,32\ N}$

15-)



$m = 20\ kg$ $\quad \cos\theta = 0,8$

$\mu e = 0,5$ $\quad \sin\theta = 0,6$

$\mu d = 0,25$

$n = P\cos\theta$ $\qquad fat = 0,5 . 160 = 80N$

$n = 10 . 20 . 0,8 = 160\ N$

$F = -fat + P\sin\theta$

$F = 80 + 200 . 0,6 = \underline{200N}$

Se $F = 100N$

$fat = 0,25 . 160 = 40N$

$F - fat - P\sin\theta = m\,a$

$a = \dfrac{F - fat - P\sin\theta}{a} \Rightarrow a = \dfrac{100 - 40 - 120}{20} = \underline{1^2\ m/s^2}$

Se F igual a zero "0", a força atuante será apenas a do peso, e a força de atrito irá conter a força de atrito

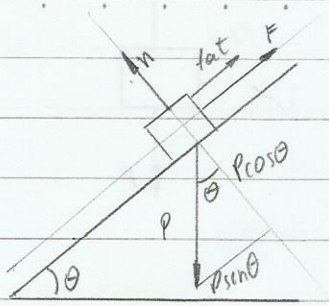
$fat = P\sin\theta$ $\qquad fat_{max} = 0,5 . 160 = 80N$

$fat = 20 . 10 . 0,6 = 120\ N$ - como o $fat > fat_{max}$ o corpo entra em movimento

$fat - P\sin\theta = m . a$ $\quad (fat = 160 . 0,25 = 40N)$

$a = \dfrac{fat - P\sin\theta}{m} = \dfrac{40 - 120}{20} = \underline{-4\ m/s^2}$

(16-)



$m = 20\ kg$ $\quad \cos\theta = 0,8$

$\mu e = 0,5$ $\quad \sin\theta = 0,6$

$\mu d = 0,25$

$n = P\cos\theta \Rightarrow n = 20.10.0,8 = 160N$

$fat_{emax} = 0,5.160 = 80N$

x: $F = P\sin\theta - fat$

$F = 10.20.0,6 - 80 = \underline{40N}$

Se $F = 80N$

$fat_{emax} = 80N$ $\quad fat_d = 160.0,25 = 40N$

$F + fat - P\sin\theta = m.a$

$a = \frac{F + fat - P\sin\theta}{m} \Rightarrow a = \frac{80 + 40 - 120}{20} = \frac{0}{20} = \underline{0\ m/s^2}$

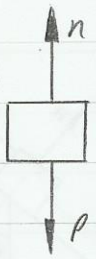
Se $F = 0$

$a = \frac{fat - P\sin\theta}{m} \Rightarrow a = \frac{40 - 120}{20} = \underline{-4\ m/s^2}$

Se $F = 0$, a única força atuante será a força peso e força de atrito, e ela tenderá a cair, ou seja, a escorregar durante o movimento.

(17-) $F = 100\,kN \Rightarrow$ velocidade diminui

$F = 60\,kN \Rightarrow$ velocidade aumenta



$$\begin{cases} P - 100.10^3 = m.(-a) & (x-1) \\ P - 60\,10^3 = m.a \end{cases}$$

$$\begin{cases} -P + 100.10^3 = m.a \\ P - 60.10^3 = m.a \end{cases} \qquad 2m.a = 40.10^3 \qquad ma = 20.10^3$$

$$P = m.a + 60.10^3$$

$$P = 20.10^3 + 60.10^3 = \underline{80.10^3 N}$$

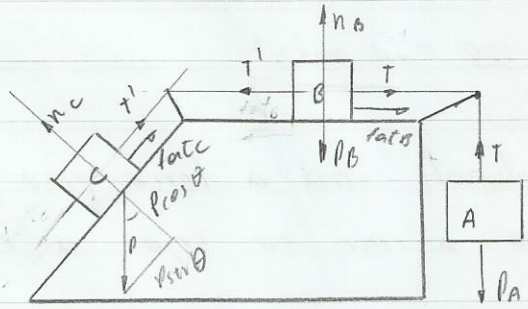
$$m.a = 20\,10^3$$

$$a = \frac{20\,10^3}{m} = \frac{20.10^3}{16.10^3} = 1{,}25\ m/s^2$$

$$mg = 2P$$

$$m = \frac{2P}{g} = \frac{2.80.10^3}{10} = 16000$$

18-)



$m_A = 5\,kg$ $\quad \mu = 0{,}20$

$m_B = 20\,kg$ $\quad \cos\theta = 0{,}6$

$m_C = 15\,kg$ $\quad \sin\theta = 0{,}8$

$n_B = P_B \Rightarrow n_B = 200N \quad fat_B = 200.0{,}2 = 40\,N$

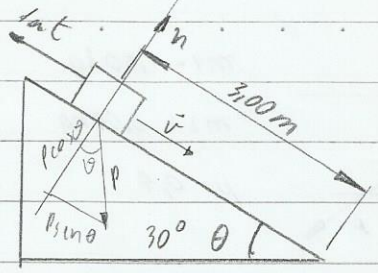
$n_C = P\cos\theta \Rightarrow n_C = 90N \quad fat_A = 90.0{,}2 = 18N$

$$P_A - T = m_A.a \qquad a = \frac{P_A + fat_B + fat_A - P\sin\theta}{m_A + m_B + m_C}$$

$$T + fat_B - T' = m_B.a$$

$$T' + fat_A - P\sin\theta = m_C.a \qquad a = \frac{50 + 40 + 18 - 120}{40} = -0{,}3\ m/s^2$$

(19-)



$m = 4{,}00\ kg$ $\quad sen\,30° = 0{,}5$

$v_0 = 2{,}00\ m/s$ $\quad cos\,30° = 0{,}87$

$t = 2s$

$n = P\cos\theta$ $\qquad fat = 34{,}64\,\mu$

$n = 10.4\ 0{,}866 = 34{,}64$

$$S = S_0 + v_0 t + \frac{1}{2} g t^2$$

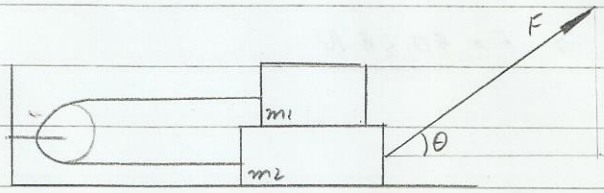
$$a = \left(\frac{S - S_0 + v_0 t}{t^2}\right).2 \Rightarrow a = \left[\frac{3 - 0 - 2.2}{2^2}\right].2 = -0{,}5\ (m/s^2)$$

$P\sin\theta - fat = m.a$ $\qquad 34{,}64\,\mu = 22$

$fat = P\sin\theta - m.a$ $\qquad \mu = \frac{22}{34{,}64} = \underline{0{,}635}$

$fat = 4.10.0{,}5 - 4.(-0{,}5) = 22\ N$

(20-)

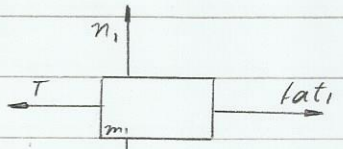


$m_1 = 2{,}00kg$ $\quad sen\,\theta = 0{,}6$

$m_2 = 7{,}00kg$ $\quad cos\,\theta = 0{,}8$

$\mu = 0{,}4$

Bloco m1:

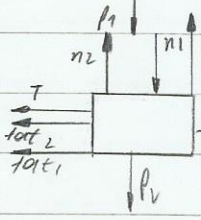


$y: n_1 = P_1$ $\qquad fat = 20\ 0{,}4$

$n_1 = 2.10 = 20N$ $\qquad fat = 8N$

$x: T = fat_1 \Rightarrow \underline{T = 8N}$

Bloco m2



$y: n_2 = n_1 + P_2 - F\sin\theta$ $\qquad fat_2 = 0{,}4\,(90 - 0{,}6F)$

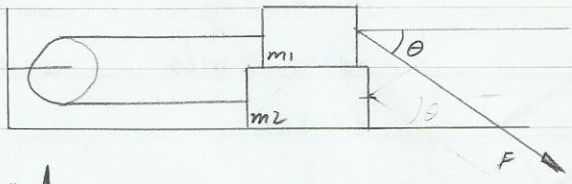
$n_2 = 20 + 7.10 - 0{,}6F = 90 - 0{,}6F$ $\qquad fat_2 = 36 - 0{,}24F$

$x: fat_2 = F\cos\theta - fat_1 - T$ $\qquad 0{,}8F - 16 = 36 - 0{,}24F$

$fat_2 = 0{,}8F - 16$ $\qquad 1{,}04F = 52$

$F = 50N$

21)

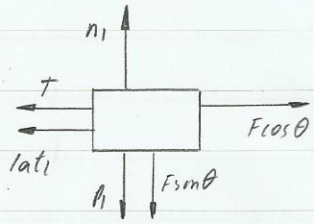


$m_1 = 1{,}50\,kg$ $\quad \sin\theta = 0{,}6$

$m_2 = 6{,}00\,kg$ $\quad \cos\theta = 0{,}8$

$\mu = 0{,}4$

Bloco m1:



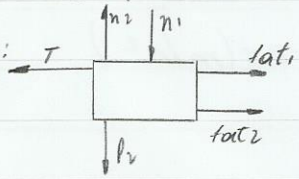
$y: \quad n_1 = P_1 + F\sin\theta \qquad fat_1 = 6 + 0{,}24F$

$n_1 = 15 + 0{,}6F$

$x: \quad T = F\cos\theta - fat_1$

$T = 0{,}8F - 6 - 0{,}24F = -6 - 0{,}56F \quad (I)$

Bloco m2:



$y: \quad n_2 = 15 + 0{,}6F + 6{,}10 \Rightarrow n_2 = 75 + 0{,}6F$

$fat_2 = 0{,}4(75 + 0{,}6F) \Rightarrow fat_2 = 30 + 0{,}24F$

$x: \quad T = fat_1 + fat_2$

$T = 6 + 0{,}24F + 30 + 0{,}24F \Rightarrow T = 36 + 0{,}48F \quad (II)$

Igualando I e II

$-6 - 0{,}56F = 36 + 0{,}48F$

$1{,}04F = 42 \Rightarrow F = \underline{40{,}38\,N}$

22-) $\mu_e = 0,5$ $m_1 = 10\,kg$

$\mu_d = 0,4$ $\cos\theta = 0,8$ $\sin\theta = 0,6$

$$\begin{cases} T - P_2 = 0 \\ P\sin\theta + fat - T = 0 \end{cases}$$

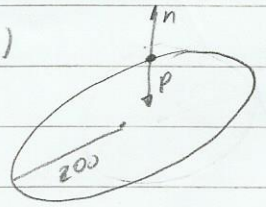
$P\sin\theta + fat - P_2 = 0$

$10.10.0,6 + 10.10.0,8.0,5 - P_2 = 0 \Rightarrow P_2 = 100 \Rightarrow m = 100/10 = \underline{10\,kg}$

$P\sin\theta + fat - P_2 = 0$

$100.0,6 + 100.0,8.0,4 - P_2 = 0 \Rightarrow P_2 = 92 \Rightarrow m_2 = 92/10 = 9,2\,kg$

23-)



$\mu_e = 0,25$

$\mu_d = 0,15$

$\mu . n = m\frac{v^2}{R}$ $\quad \{ n = mg$

$\mu . mg = m\frac{v^2}{R} \Rightarrow v = \sqrt{Rg\mu} = \sqrt{200.10.0,25}$

$\underline{v = 22,36\ m/s}$

24-) $\mu = 0,4$ $\quad \cos\theta = 0,8$ $\quad n_1 = mg \Rightarrow n_1 = 10.8 = \underline{80N}$

$m_1 = 8,00\,kg$ $\quad \sin\theta = 0,6$ $\quad fat_1 = 80.0,4 \Rightarrow fat_1 = \underline{32N}$

$a = 0,8\ m/s^2$ $\quad n_2 = mg\cos\theta = 10.0,8m = 8m$

$mg\sin\theta - fat_2 - T = ma$ ① $\quad fat_2 = 3,2m$

$T - fat_1 = m_1 . a$

$T = m_1 . a + fat_1 = 8.0,8 + 32 = \underline{38,4\,N}$

① $m = \frac{T}{g\sin\theta - 3,2 - a} = \frac{38,4}{10.0,6 - 3,2 - 0,8} = \underline{19,2\,N}$

25) $n = 2P$ $\quad n + p = \frac{mv^2}{R} \Rightarrow 3mg = \frac{mv^2}{R} \Rightarrow v = \sqrt{3gR} \Rightarrow$

$\Rightarrow v = \sqrt{3.10.2} = \underline{7,75\ m/s}$

26.) $m_1 = 3\ kg$ $\quad x = 0,5\ m$ $\quad n = mg = 10.7 = 70N$

$m_2 = 7\ kg$ $\quad fat = 70\mu$

$v = 1,5\ m/s$

$v^2 = v_0^2 + 2a\Delta x$

$a = \frac{v^2 - v_0^2}{2\Delta x} = \frac{0^2 - 1,5^2}{2.0,5} = -2,25\ (m/s^2)$

$\begin{cases} m_1 g - T = m_1 . a \\ T - fat = m_2 . a \end{cases}$ $\quad m_1 g - fat = a(m_1 + m_2)$

$fat = m_1 g - a(m_1 + m_2)$

$fat = 3.10 - (-2,25)(3+7)$

$fat = 52,5N$

$70\mu = 52,5 \Rightarrow \mu = 52,5/70 \Rightarrow \mu = \underline{0,75}$

27.) $m_A = m_B$ $\quad \sin\alpha = 0,6$ $\quad n = m_A g \cos\theta$ $\quad fat = 8m\mu$

$a = 0,8\ m/s^2$ $\quad \cos\alpha = 0,8$ $\quad n = 8m$

$\begin{cases} mg - T = ma \\ T - fat - mg\sin\theta = m.a \end{cases}$ $\quad mg - fat - mg\sin\theta = a(m+m)$

$fat = mg - mg\sin\theta - 2am$

$fat = m(10 - 10.0,6 - 2.0,8) \Rightarrow fat = 2,4m$

$8m\mu = 2,4m \Rightarrow \mu = 2,4m/8m = \underline{0,3}$

$T = mg - ma$

$T = m(g - a) = m(10 - 0,8)$

$\underline{T = 9,2m_A}$

(28.) $a = 2{,}00\ m/s^2$ $\quad \sin\theta = 0{,}6$ $\quad n = m_A g \cos\theta$ $\quad f_{at} = 2m_A$

$\mu = 0{,}250$ $\quad \cos\theta = 0{,}8$ $\quad n = 8m_A$

$$\begin{cases} m_A g \sin\theta - f_{at} - T = m_A \cdot a \Rightarrow T = 6m_A - 2m_A - 2m_A = \boxed{2m_A} \\ T - m_B g = m_B \cdot a \Rightarrow T = m_B(a+g) \Rightarrow T = 12\,m_B \end{cases}$$

$6m_A - 2m_A - 12m_B = 2m_A$

$12m_B = 2m_A \qquad \frac{12m_B}{2m_A} = \boxed{6}$

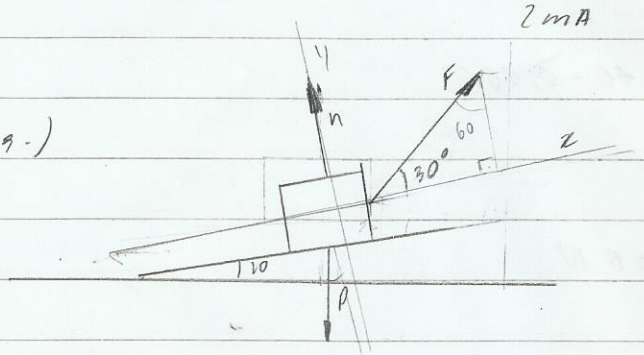
ou

$m_A \sin\theta - f_{at} - m_B g = 2m_A + 2m_B$

$6m_A - 2m_A - 10m_B = 2m_A + 2m_B$

$-12m_B = -2m_A \qquad \frac{12m_B}{2m_A} = \boxed{6}$

29.)



$F = 300N$

x: $F\cos\theta - P\sin\theta = m \cdot a$; $a = 0$

$F\cos\theta - mg\sin\theta = 0$

$m = \frac{F\cos\theta}{g\sin\theta} = \frac{300 \cdot 0{,}866}{3{,}42} = \underline{75{,}97\ kg}$

Se $F = 150\ N$

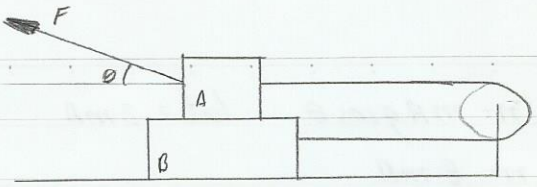
y: $n = mg\cos 20 - F\sin 30$

$n = 10 \cdot 75{,}97 \cos 20 - 150 \sin 30$

$n = \underline{638{,}88\ N}$

/ /

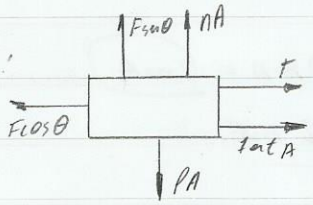
(30-)



$m_A = 2{,}00\ kg$ $\mu_e = 0{,}4$ $\sin\theta = 0{,}6$

$m_B = 6{,}00\ kg$ $\mu_c = 0{,}25$ $\cos\theta = 0{,}8$

Bloco A:



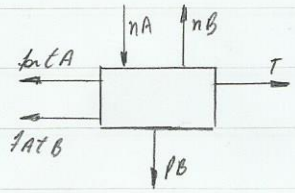
$nA = PA - F\sin\theta$ $fat\,A = 8 - 0{,}24F$

$nA = 20 - 0{,}6F$

x: $T = F\cos\theta - fat\,A$

$T = 0{,}8F - 8 + 0{,}24F \Rightarrow T = 1{,}04F - 8$

Bloco B:



$nB = nA + PB$

$nB = 20 - 0{,}6F + 60 \Rightarrow nB = 80 - 0{,}6F$

$fat\,B = 32 - 0{,}24F$

x: $T = fat\,A + fat\,B$

$T = 8 - 0{,}24F + 32 - 0{,}24F \Rightarrow T = 40 - 0{,}48F$

Igualando as traçães

$1{,}04F - 8 = 40 - 0{,}48F$

$1{,}52F = 48 \Rightarrow F = 31{,}58\ N$

$fat\,A = 5 - 0{,}15F$

$fat\,B = 20 - 0{,}15F$

$T = fat\,A + fat\,B$

$T = 5 - 0{,}15F + 20 - 0{,}15F \Rightarrow T = 25 - 0{,}3F$ (I)

$T = 0{,}8F - 5 + 0{,}15F \Rightarrow T = -5 + 0{,}95F$

Igualando I e II

$25 - 0{,}3F = -5 + 0{,}95F$

$30 = 1{,}25F$

$F = 24N$

DE

/ /

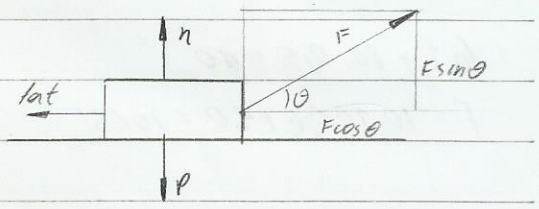
(31-)

Fazer Depois

(32-) $m = 5000\ kg$ $\mu_n \theta = 0,6$

$\mu_e = 0,4$ $\cos\theta = 0,8$

$\mu_d = 0,2$



- Se $F = 15000$

y: $n = mg - F\sin\theta$

$n = 10.5000 - 15000.0,6 = 41000\ N$

$fat_{(max)} = 41000.0,4 = 16400\ N$

x: $fat = F\cos\theta$

$fat = 12000\ N$ ∴ como o fat atual é menor que o $fat_{(max)}$ ele permane em repouso, como fat igual a 12000 N ou 12kN

- Se $F = 20000\ N$ ∴ como o fat atual > $fat_{(max)}$ a massa esta em movimento

y: $n = mg - F\sin\theta$

$n = 5.10^3.10 - 20.10^3.0,6 = 38000$

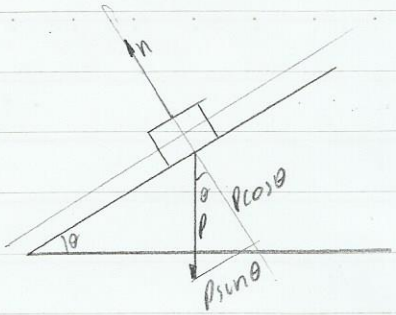
$fat_{(max)} = 15200\ N$

$fat = 38000.0,2 = \underline{7600\ N}$

x: $fat = F\cos\theta$

$fat = 16000\ N$

33-)



$m = 10\,kg$ $\quad sen\alpha = 0,6$

$\mu e = 0,9$ $\quad \cos\alpha = 0,8$

$\mu d = 0,5$

y: $n = P\cos\theta$ $\quad fat_{emax} = 80.0,9 = 72N$

$n = 10.10.0,8 = 80N$

x: $P\sin\theta = fat$

$fat = 10.10.0,6 = \underline{60N}$

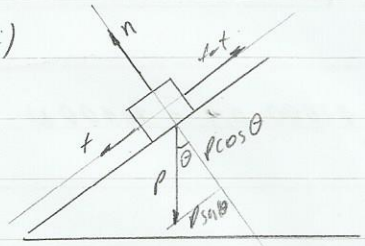
x: $F = P\sin\theta + fat$

$F = 10.10.0,6 + 72 = \underline{132N}$

$fat = 80.0,5 = 40$

$F = 10.10.0,6 + 40 = \underline{100N}$

34-)



$m = 10\,kg$ $\quad sen\theta = 0,6$

$\mu e = 0,9$ $\quad \cos\theta = 0,8$

$\mu d = 0,8$

y: $n = P\cos\theta$ $\quad fat_{emax} = 72N$

$n = 10.10\,0,8 = 80N$

x: $fat = f + P\sin\theta$ $\quad fat = 80\,0,8 = 64N$

$fat = 5 + 60 = \underline{65N}$

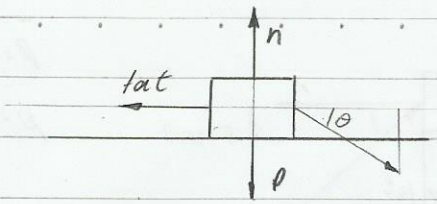
$F = fat - P\sin\theta$

$F = 64 - 60 = \underline{4N}$

(35.) $P = 900N$ $\quad \sin\theta = 0,26$

$\mu_c = 0,9$ $\quad \cos\theta = 0,97$

$\mu_d = 0,2$



y: $n = P + F\sin\theta$ $\quad fat = 160 + 0,104F$

$n = 900 + 0,26F$

x: $F\cos\theta = fat$ $\quad 160 + 0,104F = 0,97F$

$fat = 0,97F$ $\quad 0,866F = 160$

$F = 184,76\,N$

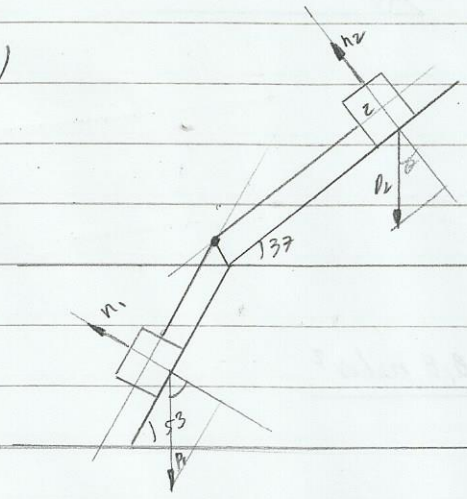
n: $P + F\sin\theta$ $\quad fat = 95,6\,N$

$n = 400 + 300.0,26 = 478N$

x: $F\cos\theta - fat = m.a$

$a = \dfrac{F\cos - fat}{m} = \dfrac{300.0,97 - 95,6}{40} = 4,88\,m/s^2$

(36.)



$m_1 = m_2 = 10\,kg$

$\mu_2 = 0,250$

$n_2 = P_2\cos 37 = 80N$

$fat = 80.0,25 = 20N$

$n_1 = P\cos 53 = 60N$

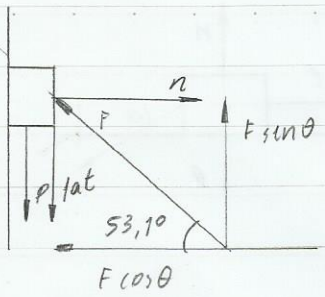
$$\begin{cases} P_1\sin 53 - T = m_1.a \\ T + P_2\sin 37 - fat = m_2.a \end{cases}$$

$a = \dfrac{P_1\sin 53 + P_2\sin 37 - fat}{m_1 + m_2}$ $\quad \rightarrow a = \dfrac{80 + 60 - 20}{20} = 6\,m/s^2$

$T = P_1\sin 53 - m_1.a$

$T = 10.10.0,8 - 10.6 = 20N$

(37-)



$P = 12\,N$

$\mu = 2/3 = 0,67$

$n = F\cos\theta$ $\quad fat = \frac{2}{3} \cdot 0,6F = 0,4F$ $\quad n = 0,6 \cdot F$

$n = 0,6F$ $\quad n = 0,6 \cdot 30$

$n = \underline{18\,N}$

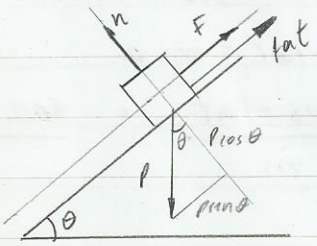
$fat = F\sin\theta - P$ $\quad 0,4F = 0,8F - 12$

$fat = 0,8F - 12$ $\quad -0,4F = -12$

$F = \underline{30\,N}$

(38-) $m = 1,00\,kg$ $\quad sen = 0,6$

$\mu = 0,2$ $\quad cos = 0,8$



$n = P\cos\theta$

$n = 1.10.0,8 = 8N$ $\quad fat = 1,6\,N$

$F = P\sin\theta - fat$

$F = 1.10.0,6 - 1,6 = \underline{4,4\,N}$

$F + P\sin\theta - fat = m.a$

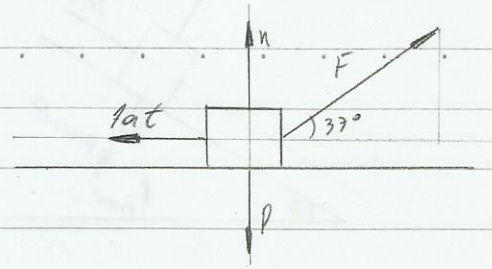
$a = \dfrac{F + P\sin\theta - fat}{m} = \dfrac{4,4 + 6 - 1,6}{1} = \underline{8,8\,m/s^2}$

(9-) $m = 200\ kg$

$\mu = 0,30$

$F = 20x + 1500$

$v = ?$ após $10\ m$



$N = P - F\sin 37$

$N = 200.10 - (20x + 1500).0,6$

$N = 1100 - 12x$

$f_{at} = 0,3\ (1100 - 12x)$

$f_{at} = 330 - 3,6x$

$F\cos\theta = f_{at} = F_x$

$(20x + 1500).0,8 - 330 + 3,6x = F_x$

$19,6x + 870 = F_x$

$$\int_0^{10} F_x\,dx \Rightarrow \int_0^{10} (19,6x + 870)\,dx = 9,8x^2 + 870x = \frac{mv^2}{2} - \frac{mv_0^2}{2}$$

$$F_x(10) = 9,8(10)^2 + 870.10 = 9680 = \frac{mv^2}{2}$$

$$v = \sqrt{\frac{9680.2}{200}} = \underline{9,84\ m/s}$$

(10-) $m = 4,0\ kg$

$v = 5,0\ m/s$

$$W_{0-5} = \frac{(10+20).2}{2} + \frac{20.1}{2} - \frac{20.1}{2} - 20.1 = \underline{10\ J}$$

$P(i) = F_i . v_i$

$P(5) = -20 . 5,48 = \underline{-109,54\ W}$

$$W_r = \frac{mv^2}{2} - \frac{mv_0^2}{2} \Rightarrow$$

$$v^2 = \left(W_r + \frac{mv_0^2}{2}\right).\frac{2}{m} = \left(10 + \frac{4.5^2}{2}\right).\frac{2}{4}$$

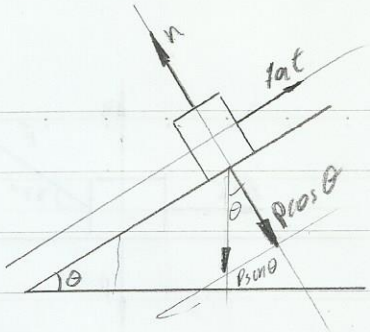
$$v = \sqrt{30} = 5,47\ m/s$$

11-) $m = 10\,kg$

$\mu =$

$\sin\theta = 0{,}6$

$\cos\theta = 0{,}8$



$\Delta h = \Delta x \sin\theta$

$\Delta h = 7{,}5 \cdot 0{,}6 = 4{,}5$

$V^2 = V_0^2 + 2a\Delta x$

$\Delta x = \frac{V^2 - V_0^2}{2a}$

$\Delta x = \frac{4^2 - 1^2}{2} = \frac{15}{2} = 7{,}5$

Trabalho da energia mecânica

$W_{fat} = (EC+EP)_2 - (EC+EP)_1$

$W_{fat} = \frac{mv^2}{2} + mgh - \frac{mv_0^2}{2} - mgh_0$

$W_{fat} = \frac{10 \cdot 4^2}{2} + 100h - \frac{10 \cdot 1^2}{2} - 100h_0$

$W_{fat} = 75 + 100(h - h_0)$

$W_{fat} = 75 + 100 \cdot (-4{,}5) = -375\,J$

$W_{fat} = mg\cos\theta \cdot \mu \cos 180 \cdot \Delta x$

$W_{fat} = -10 \cdot 10 \cdot 0{,}8 \cdot \mu \cdot 7{,}5 = -600\mu$

$-600\mu = -375 \Rightarrow \mu = 0{,}625$

$P(i) = F_i \cdot v_i$

$P(1) = 10 \cdot 2 = 20\,W$

$v(t) = t + 1$

$V(1) = 1 + 1 = 2\,m/s$

$n = P\cos\theta$

$n = 10 \cdot 10 \cdot 0{,}8 = 80\,N$ $\quad fat = 80 \cdot 0{,}625 = 50$

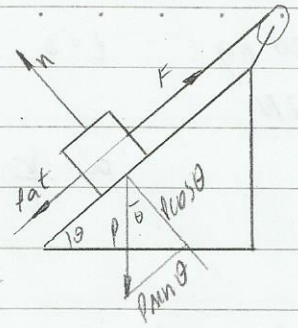
Fx: $P\sin\theta - fat = 0$

$10 \cdot 10\,0{,}6 - 50 = 10$

(12-) $m = 1800\ kg$ $\quad \sin\theta = 0,6$

$v = 1,5\ m/s$ $\quad \cos\theta = 0,8$

$\mu = 0,25$



$$W_r = \frac{mv^2}{2} - \frac{mv_0^2}{2} = \frac{1800 \cdot 1,5^2}{2} - \frac{1800 \cdot 1,5^2}{2}$$

$W_r = 0$

$n = P\cos\theta$ $\qquad fat = 14400 \cdot 0,25 = 3600\ N$

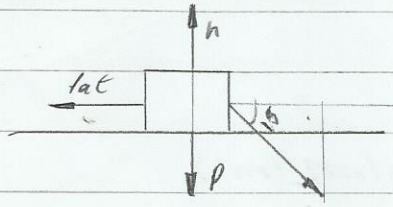
$n = 1800 \cdot 10 \cdot 0,8 = 14400\ N$

$F = fat + P\sin\theta$

$F = 3600 + 10 \cdot 1800 \cdot 0,6 = 14400\ N$

$P = 14400 \cdot 1,5 = \underline{21600\ W}$

(13-)



$P = 500N$ $\qquad \sin 15° = 0,259$

$\mu e = 0,4$ $\qquad \cos 15° = 0,966$

$\mu d = 0,2$

$n = P + F\sin\theta$

$n = 500 + 0,259F$ $\qquad fat = 0,4(500 + 0,259) = 200 + 0,1036F$

$F\cos\theta = fat$

$0,966F = 200 + 0,1036F$ $\qquad fat' = 0,2(500 + 0,259F) = 100 + 0,0518F$

$0,8624F = 200$ $\qquad 0,966F = 100 + 0,0518F$

$F = \underline{231,91\ N}$ $\qquad 0,9142F = 100$

$F = 109,385$

$P = 109,385 \cdot 2 \cdot \cos 15 = \underline{211,33W}$

14-) $m = 20\ kg$ $t=2$ $t=3$ $F = m.a$

$F = 12N$ $a = \frac{F}{m} = \frac{12}{20} = 0,6\ m/s^2$

$a = \frac{v}{t}$

$v(2) = 0,6.2 = 1,2$

$v(3) = 0,6.3 = 1,8$

$W_v = \frac{mv^2}{2} - \frac{mv_0^2}{2} = \frac{20.(1,8)^2}{2} - \frac{20.(1,2)^2}{2} = 18\ J$

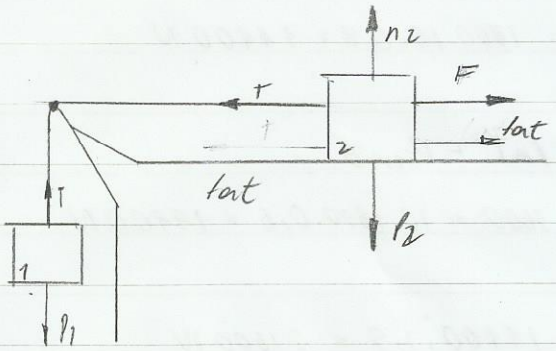
$P = 12.3 = 36\ W$ $v(5) = 0,6.5 = 3$

15-) $m_1 = 1,5\ kg$

$m_2 = 3,00\ kg$

$F = 9,00N$

$\mu = 0,4$



$n_2 = P_2 = 3.10 = 30\ N$

$fat = 30.0,4 = 12N$

$\begin{cases} F - T + fat = m2.a \\ T - P_1 = m1.a \end{cases}$ $F + fat - P_1 = a(m1 + m2)$

$a = \frac{F + fat - P_1}{m1 + m2} = \frac{9 + 12 - 45}{7,5} = -3,2\ m/s^2$

$T = m1.a + P_1$

$T = 1,5.(-3,2) + 45 = 30,6N$

$V = \sqrt{V_0^2 + 2a\Delta x}$

$V = \sqrt{2.(3,2).0,5} = 1,78$

$P = 30,6.1,78 = 54,73W$

16.) $m = 4\,kg$ $\quad W_{\Pi\,0-5} = ?$

$x = 4t - 5t^2 + 2t^3$

$\frac{dx}{dt} = v(t) = 4 - 10t + 6t^2$

$v(0) = 4 \quad v(5) = 104$

$W_v = \frac{mv^2}{2} - \frac{mv_0^2}{2}$

$= \frac{4 \cdot (104)^2}{2} - \frac{4 \cdot 4^2}{2} = 21600\,J$

$\frac{dv}{dt} = a(t) = -10 + 12t$

$a(5) = 50$

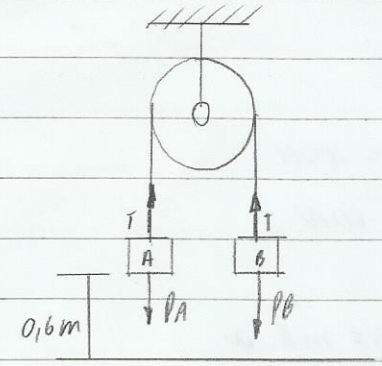
$F = m \cdot a$

$F = 4 \cdot 50 = 200$

$P = F \cdot v$

$P = 200 \cdot 104 = 20800\,W$

17.)



$m_A = 1,6\,kg$

$m_B = 0,2\,kg$

$\begin{cases} P_A - T = m_A a \\ T - P_B = m_B \cdot a \end{cases}$

$a = \frac{P_A - P_B}{m_A + m_B}$

$a = \frac{16 - 2}{2} = 8\,m/s^2$

$V = \sqrt{2 \cdot 8 \cdot 0,6} = 3,10\,m/s^2$

$v^2 = v_0^2 + 2a\Delta x$

$\Delta x = \frac{v^2 - v_0^2}{2a}$

$\Delta x = \frac{0 - 9,6}{2 \cdot 10} = 0,48$

$h_m = 0,98 + 0,6 + 0,6 = 1,68\,m$

$W_v = \frac{mv^2}{2} - \frac{mv_0^2}{2}$

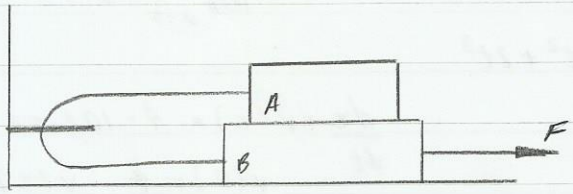
$= \frac{0,2 \cdot 9,6}{2} - \frac{0,2 \cdot 0}{2} = 0,96\,J$

18.) $m_A = 2{,}00\ kg$

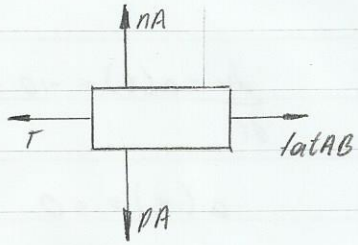
$m_B = 8{,}00\ kg$

$\mu_{AB} = 0{,}4$

$\mu_B = 0{,}2$



Bloco A:



y: $n_A = P_A = m_A \cdot g$

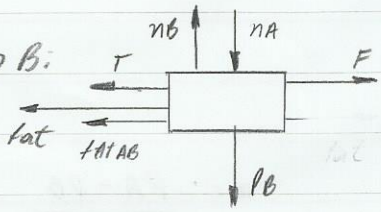
$n_A = 20\ N$

$fat_{nB} = 20 \cdot 0{,}4 = 8\ N$

x: $T = fat_{AB}$

$T = 8\ N$

Bloco B:



y: $n_B = n_A + P_B$

$n_B = 20 + 80 = 100N$

$fat = 0{,}2 \cdot 100 = 20N$

x: $F = T + fat_{AB} + fat$

$F = 8 + 8 + 20 = \underline{36N}$

$$\begin{cases} T - fat_{AB} = m_A \cdot a \\ F - T - fat_{AB} - fat = m_B \cdot a \end{cases}$$

$F' = 72$

$P = 72 \cdot 1{,}89 = \underline{136{,}71\ W}$

$F - 2fat_{AB} - fat = a(m_A + m_B)$

$$a = \frac{F - 2\,fat_{AB} - fat_A}{m_A + m_B}$$

$$a = \frac{72 - 2 \cdot 8 - 20}{10} = 3{,}6\ m/s^2$$

$V = \sqrt{0^2 + 2 \cdot 3{,}6 \cdot 0{,}5} = 1{,}89$

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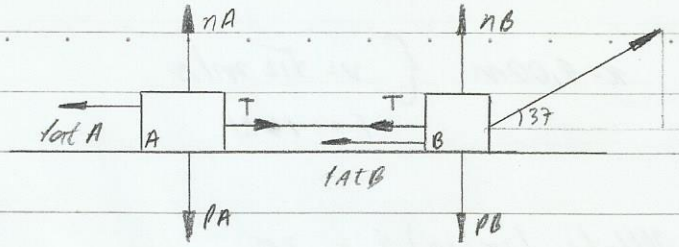
(19-)



$m_A = 5{,}00\ kg$ $\quad sen = 0{,}6$

$m_B = 20{,}00\ kg$ $\quad cos = 0{,}8$

$\mu = 0{,}5$

$v_0 = 2{,}00\ m/s$

$n_A = P_A = 50\ N$

$fat_A = 50 \cdot 0{,}5 = 25\ N$

após 3m = 90 J

$n_B = P_B - F\,sen\theta$ $\quad fat_B = 0{,}5(100 - 0{,}6F) = 100 - 0{,}3F$

$n_B = 200 - 0{,}6F$

$W_r = F \cdot d$

$F = \frac{W_r}{d} = \frac{90}{3} = 30$

$$\begin{cases} T - fatA = 0 \\ F\cos\theta - T - fatB = 0 \end{cases} \Rightarrow F\cos\theta - fatA - fatB = 0$$

$0{,}8F - 100 + 0{,}3F - 25 = 0$

$1{,}1F - 125 = 30$

$F = 140{,}91\ N$

$F = m \cdot a$

$a = \frac{F}{m} = \frac{30}{25} = 1{,}2\ m/s^2$

$P = F \cdot v$

$P = 30 \cdot 3{,}35 = 100{,}4\ W$

$v = \sqrt{2^2 + 1{,}2 \cdot 3{,}2} = 3{,}35$

(20-) $m = 15\ kg$ $\quad cos = 0{,}8$

$v = 10\ m/s$ $\quad sen\theta = 0{,}6$

$\mu = 0{,}3$

$v^2 = v_0^2 + 2a\Delta x$

$\Delta x = \frac{v^2 - v_0^2}{2a}$

$\Delta x = \frac{0 - 10^2}{2 \cdot 6{,}4} = 5{,}95\ m$

$N = P\cos\theta$ $\quad fat = 120 \cdot 0{,}3 = 36\ N$

$N = 15 \cdot 10 \cdot 0{,}8 = 120\ N$

$F = fat + P\,sen\theta$

$F = 36 + 10 \cdot 15 \cdot 0{,}6 = 126\ N$

$W_r = \frac{mv^2}{2} - \frac{mv_0^2}{2} \Rightarrow$

$F = m \cdot a$

$= \frac{15 \cdot 0^2}{2} - \frac{15 \cdot 10^2}{2} = -750\ J$

$a = \frac{126}{15} = 8{,}4\ m/s^2$

(21-) $m = 5{,}00\ kg$ $x = 4{,}00\ m$ $\begin{cases} v = \sqrt{12}\ m/s \\ F = 15\ N \end{cases}$

$n = mg = 10.5 = 50N$

$fat = 50\mu$ $W_{fat} = \frac{(15+10)}{2} \cdot 2 = 35$

$W_{fat} = -50\mu \cdot 4 = -200\mu = 35$

$\mu = 0{,}175$

$W_{F\ 0-8} = \frac{(10+20)}{2} \cdot 2 + \frac{(20+15)}{2} \cdot 2 + 115.4) = 125$

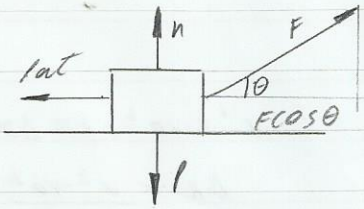
$W_r = \frac{mv^2}{2} - \frac{mv_0^2}{2} \Rightarrow v = \sqrt{\left(W_r + \frac{mv_0^2}{2}\right) \cdot \frac{2}{m}}$

$v = \sqrt{\left(155 + \frac{5{,}0^2}{2}\right) \cdot \frac{2}{5}} = 9{,}69\ m/s$

$W_r = W_F + W_{at}$ $W_{fat} = -50 \cdot 8 \cdot \mu = -70$

$W_r = 125 - 70 = 55\ J$

(22-)



$P = 600N$ $\sin\alpha = 0{,}342$

$\mu c = 0{,}4$ $\cos\alpha = 0{,}94$

$\mu d = 0{,}2$

$n = mg - F\sin\theta$ $fat = 0{,}4(600 - 0{,}342F)$

$n = 600 - 0{,}342F$ $fat = 240 - 0{,}1368F$

$F\cos\theta = fat$

$fat = 0{,}94F$ $240 - 0{,}1368F = 0{,}94F \Rightarrow 1{,}0768F = 240$

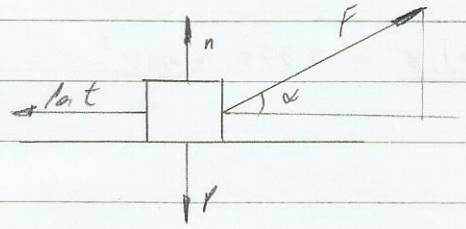
$F = 222{,}89\ N$

$fat = 0,2(600 - 0,342F) = 120 - 0,0684F$

$fat = F\cos\theta$ $\quad 120 - 0,0684F = 0,99F$ $\quad P = 119 \cdot 1,5 \cdot 0,94 = 167,79\,N$

$fat = 0,99F$ $\quad F = \frac{120}{1,0084} = 119\,N$

(23-)



$m = 12\,kg$ $\quad \sin\alpha = 0,6$

$\mu e = 0,5$ $\quad \cos\alpha = 0,8$

$\mu d = 0,3$

$n = P - F\sin\theta$ $\quad fat_{max} = 87 \cdot 0,5 = 43,5\,N$

$n = 120 - 33 = 87\,N$

$\therefore$ como $fat > fat_{max}$, o bloco está em movimento, com força de atrito de:

$Fat = f\cos\theta$ $\quad fat = 87 \cdot 0,3 = 26,1\,N$

$fat = 55 \cdot 0,8 = 44\,N$

$Fat - f\cos\theta = ma$

$a = \frac{Fat - f\cos\theta}{m} \Rightarrow a = \frac{26,1 - 44}{12} = 1,5\,m/s^2$

$V^2 = V_0^2 + 2a\Delta x$

$\Delta x = \frac{V^2 - V_0^2}{2a} = \frac{2^2 - 0^2}{2 \cdot 1,5} = \frac{4}{3} = 1,33$

$W = 26,1 \cdot 1,33 \cdot 0,8 \cdot \cos 180 = -34,6\,J$

(24-) $m = 800\ kg$

$$W_{r\,0-13} = \frac{(1500+500).4}{2} + \frac{1500.6}{2} - \frac{(3+1).500}{2} = 7500$$

$$\frac{mv^2}{2} = 7500 \qquad v = \sqrt{\frac{7500.2}{800}} = \underline{4{,}33\ m/s}$$

$$W_{r\,0-7} = \frac{(1500+500).4}{2} + \frac{(1500+750).3}{2} = 7375 = \frac{mv^2}{2}$$

$$v^2 = 18{,}4375 \Rightarrow v = 4{,}29$$

$$P = 750.4{,}29 = \underline{3{,}22\ 10^3\ W}$$

(25-) $m = 800\ kg$ $\qquad W_{fat} = -\mu.mg.\Delta x = -0{,}3.10.800.8 = -19200\ J$

$\mu = 0{,}3$

$$W_F = \frac{(2900+3900).4}{2} + \frac{(3900+1300).4}{2} \qquad \frac{3900}{6} = \frac{y}{2}$$

$$W_F = 13600 + 10400 = 24000 \qquad y = 1300$$

$$W_r = 24000 - 19200 = \underline{4800\ J}$$

$$W_{F\,0-10} = \frac{(3900+2900).4}{2} + \frac{(3900.6)}{2} = 25300$$

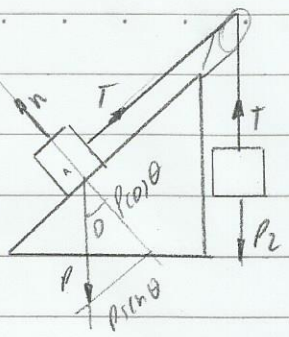
$$W_{fat\,0-10} = -0{,}3.800.10.10 = -24000$$

$$W_r = 25300 - 24000 = 1300 = \frac{mv^2}{2}$$

$$v = \sqrt{\frac{1300\,2}{800}} = \underline{1{,}8\ m/s}$$

/ /

(26-1)



$n = P\cos\theta$ $\quad$ $m_A = m_B = 3\,kg$

$n = 3.10.0,8 = 24\,N$

$P_2 - T = m_2 . a$

$T - P\sin\theta = m_1 a$

$P_2 - P\sin\theta = a(m_1 + m_2)$

$$a = \frac{P_2 - P\sin\theta}{m_1 + m_2} = \frac{30 - 18}{6} = 2\ m/s$$

$W = P\sin\theta . 2 = 36\,N$

$T - P\sin\theta = m_1 a$

$W_T = m_1 . a + P\sin\theta$

$T = 3.2 + 3.10.0,6 = 24$

$W_T = 24 . 2 = 48$

$W = 48 - 36 = 12\,J$