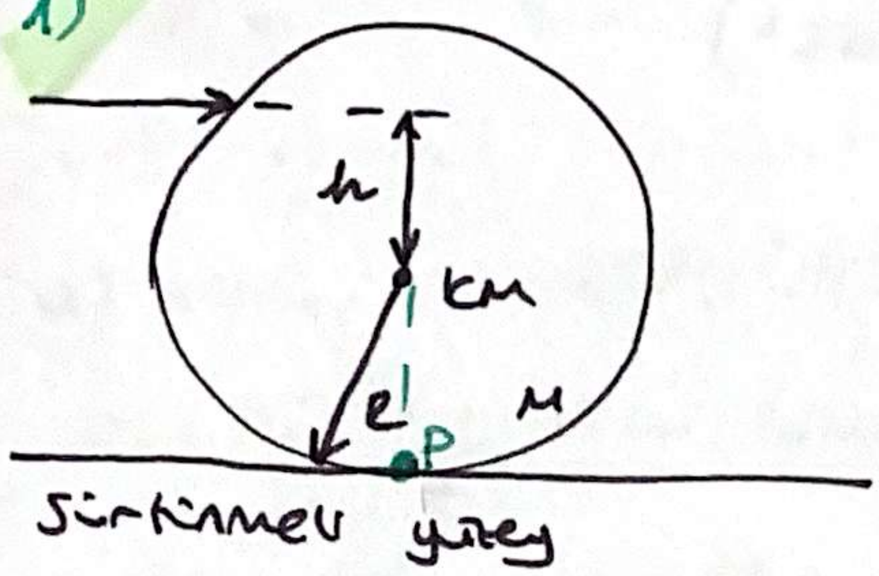
1)



$$I_p = I_{km} + Md^2$$

$$= \frac{2}{5}MR^2 + MR^2$$

$$I_p = \frac{7}{5}MR^2$$

Kaymadan yuvarlanma hareketine sürtünme olmadan başlayabilmesi için onlik yatay F kuvveti KM ağırlık-tan ne kadar h yüksekliğe uygulanmalıdır? $(I = \frac{1}{5}MR^2)$

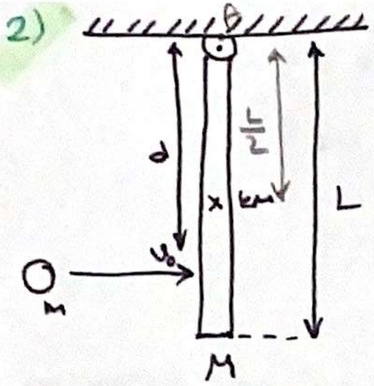
$$\tau_p = I_p \cdot \alpha \Rightarrow F \cdot (R+h) = I_p \cdot \alpha \quad (1)$$

$$\sum \vec{F} = M \cdot \vec{a} \qquad F = M \cdot a_{km} \qquad a_{km} = R\alpha \qquad F = M \cdot R\alpha$$

$$\frac{F}{M \cdot R\alpha \cdot (R+h)} = \frac{I_p}{\frac{7}{5}MR^2 \cdot \alpha} \quad (1)$$

$$R+h = \frac{7}{5}R \qquad \boxed{h = \frac{2}{5}R}$$

2)



$\left(I_{kM}^{Cubuk} = \frac{1}{12} ML^2\right)$

Top carpip yapisiyor.

$$I_A^{Cubuk} = \frac{1}{12} ML^2 + M\left(\frac{L}{2}\right)^2$$

$$I_A^{Cubuk} = \frac{1}{3} ML^2$$

a) Carpisma aninda A noktasindan cubuga itme uygulanmamasi için top hangi d mesafesinden carpmalidir?

Momentum korunumu için $\tau_{dis} = 0$

$L_i = L_s$

$m.v_0.d = I_A^{sistem}.\omega \quad \left(m.v_0 d = [(m.v.d) + (I_A^{cubuk}.\omega)]\right)$

$$m.v_0 = \frac{I_A^{sistem}.\omega}{d} \quad (1)$$

$I_A^{sistem} = \frac{1}{3} ML^2 + m.d^2$

$\sum P_i = \sum P_s \Rightarrow m.v_0 = m.v + M.v_{kM} \quad (\omega \frac{L}{2})$

$$\frac{\left(\frac{1}{3} ML^2 + md^2\right).\omega}{d} = m.d\omega + M.\omega\frac{L}{2}$$

$\frac{1}{3} ML^2 + md^2 = md^2 + M.d\frac{L}{2} \quad \frac{1}{3} ML^2 = Md\frac{L}{2} \quad \boxed{d = \frac{2}{3}L}$

b) Cubuk + top sisteminin carpismeden hemen sonraki acisal hizi?

$Mv_0 d = I_A^{sistem}.\omega \quad m.v_0.\left(\frac{2L}{3}\right) = \left(\frac{1}{3} ML^2 + md^2\right)\omega$

$$\frac{m.v_0\, 2L}{ML^2 + 3m\left(\frac{4L^2}{9}\right)} = \omega \qquad \boxed{\omega = \frac{2mv_0}{\left(M + \frac{4}{3}m\right)L}}$$

3) $m = 1$ (kg) kütleli bir cismin konum vektörü zamana bağlı olarak $\vec{r} = (2t + t^2)\hat{i} + (1 + t^2)\hat{j}$ (m)'dir.

a) $t = 2$ için hız vektörü

$v = \frac{dr}{dt} \qquad \vec{v} = (2 + 2t)\hat{i} + (2t)\hat{j}$ (m/s)

$\boxed{\vec{v}(2) = (6\hat{i} + 4\hat{j})\ m/s}$

b) $t = 2$ için orijine göre açısal momentum

$\vec{L} = \vec{r} \times \vec{p} = \vec{r} \times m.\vec{v} \Rightarrow \vec{r} \times \vec{v}$ $(m = 1$ kg$)$

$\vec{r} \times \vec{v} = \left[(2t + t^2)\hat{i} + (1 + t^2)\hat{j}\right] \times \left[(2 + 2t)\hat{i} + (2t)\hat{j}\right]$

$\vec{L} = (4t^2 + 2t^3)\hat{k} - (2 + 2t + 2t^2 + 2t^3)\hat{k}$

$= (2t^2 - 2t - 2)\hat{k} \Rightarrow \boxed{\vec{L}(2) = 2\hat{k}}$

c) $t = 1$ ve $t = 2$ aralığında etki eden ortalama tork (Nm)?

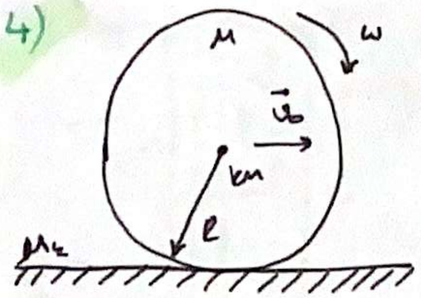
$\vec{\tau} = \vec{r} \times \vec{F} \qquad \vec{F} = m.\vec{a} \qquad \vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \vec{a} = 2\hat{i} + 2\hat{j}$

$\vec{\tau} = \left[(2t + t^2)\hat{i} + (1 + t^2)\hat{j}\right] \times \left[2\hat{i} + 2\hat{j}\right]$

$= (4t + 2t^2)\hat{k} - (2 + 2t^2)\hat{k} \Rightarrow \vec{\tau} = (4t - 2)\hat{k}$

$\frac{\tau_2 - \tau_1}{2 - 1} = \frac{6 - 2}{2 - 1} = 4 \qquad (4\hat{k})$

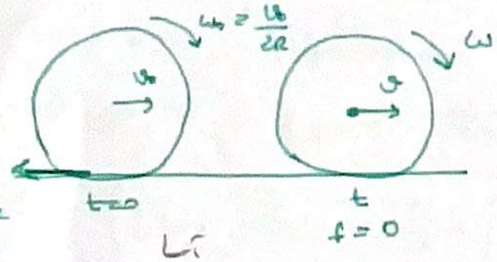
4)



$\omega = \frac{v_0}{2R}$ Topa vurulduktan hemen sonraki hızları verilmiştir.

$(I_{km} = \frac{2}{5}MR^2)$

a) Ne kadar süre sonra kaymeden yuvarlanmaya başlar?



Yuvarlanma başladığı anda $f=0$ olur. Anlık kuvvet uygulandığı için açısal momentum korunur

Li = Lf

$M \cdot v_0 \cdot R + \frac{2}{5} MR^2 \left(\frac{v_0}{2R}\right) = MvR + \frac{2}{5} MR^2 \left(\frac{v}{R}\right)$

$\frac{6}{5} v_0 = \frac{7}{5} v \Rightarrow \boxed{\frac{6}{7} v_0 = v}$

$\sum \vec{F} = M \cdot \vec{a}$ $\quad f_k = M \cdot a_{km}$ $\quad \mu_k \cdot M \cdot g = M \cdot a_{km}$ $\quad \boxed{a_{km} = \mu_k \cdot g}$

$v = v_0 - a_{km} \cdot t$ $\quad \frac{6v_0}{7} = v_0 - \mu_k \cdot g \cdot t$ $\quad \boxed{t = \frac{v_0}{7\mu_k g}}$

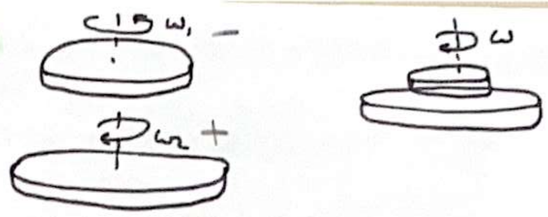
b) Yuvarlanırken km hızı nedir?

$\vec{L} = \vec{r} \times \vec{p}$ $\quad L = I \cdot \omega$

$M v_0 R + \frac{2}{5} MR^2 \frac{v_0}{2R} = M v_{km} R + \frac{2}{5} MR^2 \frac{v_{km}}{R}$

$\boxed{v_{km} = \frac{6v}{7}}$

5)



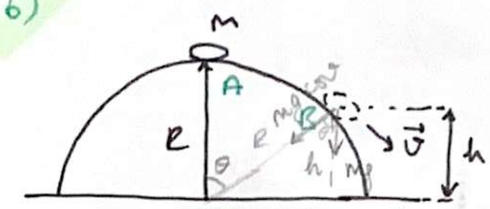
$I_1 = 20$ $\quad \omega_1 = 80$

$I_2 = 40$ $\quad \omega_2 = 60$

Li = Lf $\quad I_1 \cdot \omega_1 + I_2 \cdot \omega_2 = (I_1 + I_2)\,\omega$

$(-20 \cdot 80) + (40 \cdot 60) = 60 \cdot \omega$ $\quad \boxed{\frac{40}{3} = \omega}$

6)



a) Cisim küreyi hangi hızla ve hangi h'de terk eder? (yüzey teğet terk ederken)

$\sum \vec{F_r} = M \cdot \vec{a_r}$ $\quad mg\cos\theta - N = M \cdot a_r$

$mg\cos\theta = M \cdot \frac{v^2}{R}$ $\quad g\underbrace{R\cos\theta}_{h} = v^2$ $\quad v = \sqrt{gh}$

$E_A = E_B$

$K_A + U_A = K_B + U_B$

$0 + M \cdot g \cdot R = \frac{1}{2} M v^2 + Mgh$

$2g(R-h) = gh$ $\quad 2R = 3h$ $\quad \boxed{h = \frac{2}{3}R}$

$\boxed{v = \sqrt{\frac{2gR}{3}}}$

7) BHH yapan cismin konumu $x(t) = 0.08 \sin(\omega t + \varphi)$

Periyot 24(s) $t=0$ anındaki konumu $x(0) = 0.04$ (m);

$(\pi = 3)$

a) $\omega = ?$ b) $\varphi = ?$ c) max $v = ?$

a) $\omega = 2 \cdot \pi \cdot f = \frac{2\pi}{T} = \frac{2 \cdot 3}{24} \Rightarrow \boxed{\omega = \frac{1}{4} \text{ rad/s}}$

b) $0.04 = 0.08 \left(\sin\left(\frac{1}{4}t + \varphi\right)\right) \Rightarrow \frac{1}{2} = \sin\varphi$

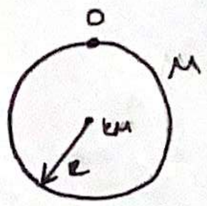
$\boxed{\varphi = \frac{\pi}{6} \text{ rad}}$

c) $v(t) = \frac{dx}{dt} \Rightarrow 0.08 \left[\cos(\omega t + \varphi)\right] \cdot \omega$

$= 0.08 \left[\cos\left(\frac{t}{4} + \frac{\pi}{6}\right)\right] \cdot \frac{1}{4}$

$= 0.02 \left[\cos\left(\frac{t}{4} + \frac{\pi}{6}\right)\right] \Rightarrow \boxed{v_{max} = 0.02 \text{ m/s}}$

8)



(Icember = MR²)

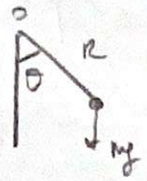
$\alpha = \frac{d^2\theta}{dt^2}$, $\sin\theta \approx \theta$

a) Sayfa düzlemine dik, O noktasından geçen eksene göre eylemsizlik momenti bulunur

$I_O = I_{KM} + Md^2 \Rightarrow I_O = MR^2 + MR^2 \Rightarrow \boxed{I_O = 2MR^2}$

b)

Kanat salınımları için $\omega = ?$



$\tau_O = -Mg \cdot \underbrace{\sin\theta}_{\theta} = I_O \cdot \alpha$

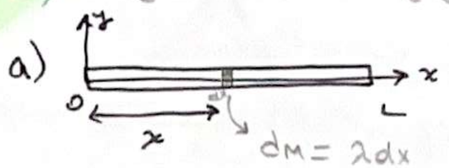
$\frac{I_O \cdot \alpha + Mg\underbrace{\sin\theta}_{\theta} = 0}{I_O}$

$\frac{d^2\theta}{dt^2} + \underbrace{\left(\frac{Mg}{I_O}\right)}_{\omega^2} \cdot \theta = 0 \Big\} \sqrt{\frac{MgR}{2MR^2}} = \sqrt{\omega^2}$

$\omega = \sqrt{\frac{g}{2R}}$

9) Çizgisel kütle yoğunluğu $\lambda = 3x^2$

a)



$I_{KM} = ?$

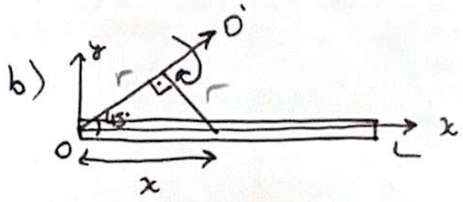
$dM = \lambda dx$

$M = \int_0^L \lambda\, dx \Rightarrow \left(x^3 \Big|_0^L\right) \Rightarrow M = L^3$

$x_{KM} = \frac{1}{M} \int_0^L x\, dM \Rightarrow \frac{1}{M} \int_0^L x \cdot \lambda\, dx = \frac{1}{M} \int_0^L 3x^3 dx$

$\Rightarrow \frac{1}{M} \left(\frac{3}{4} x^4 \Big|_0^L\right) = \frac{1}{L^3} \cdot \frac{3L^4}{4} \Rightarrow \boxed{x_{KM} = \frac{3L}{4}}$

b)



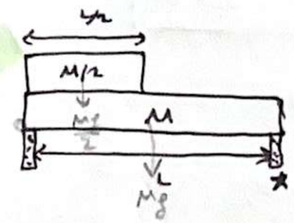
Aynı cubuğun serbestçe O' eksenine göre eylemsizlik momentini (L=1) için bulmuş.

$I = \int r^2\, dM \qquad dM = \lambda\, dx \qquad x^2 = r^2 + r^2 \qquad r = \frac{x}{\sqrt{2}}$

$I = \int_0^L \left(\frac{x}{\sqrt{2}}\right)^2 3x^2\, dx \Rightarrow I = \frac{3}{2} \left(\frac{x^5}{5} \Big|_0^L\right) \Rightarrow I = \frac{3}{10} L^5 = \frac{3}{10}$

$\boxed{I = \frac{3}{10} \text{ kg} \cdot \text{m}^2}$

10)



Yıldızlı direğe uygulanan kuvveti bulmuş

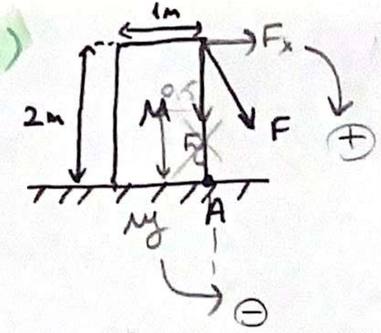
$\sum \tau_O = 0$

O noktasına göre tork

$\frac{Mg}{2} \cdot \frac{L}{4} + Mg \cdot \frac{L}{2} - N_1 \cdot L = 0$

$\frac{5MgL}{8} = N_1 \cdot L \qquad \boxed{N_1 = \frac{5Mg}{8}}$

11)



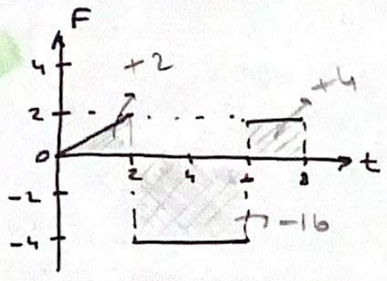
Sürtünmeli yatay düzlem üzerinde duran $M = 3kg$ kütleli bloğa

$\vec{F} = F_x\hat{i} - 20\hat{j}$ (N) kuvveti uygulanıyor.

A noktası etrafında dönmeye başlatacak min F_x = ?

$\sum \tau_A = 0 \quad F_x \cdot 2 - Mg\ 0{,}5 = 0$ $\boxed{F_x = 7{,}5\ N}$

12)



$t=0$ anından 8 m/s

0,5 kg

a) $t=8$ anındaki hızı?

$\sum I = \Delta \vec{P}$

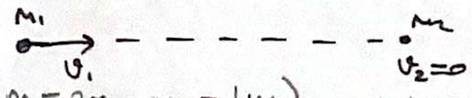
$+2 + 4 - 16 = \frac{1}{2} \cdot (V_5 - 8)$ $\boxed{V_5 = -12\ m/s}$

b) max süreat?

$+2 - 16 = \frac{1}{2}(V - 8)$

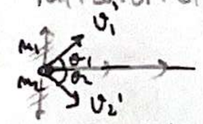
$\vec{V} = -20$ $\boxed{V = 20\ m/s}$

13)



$(m_1 = 2m \quad m_2 = 4m)$

a) Çarpışmadan sonra $\frac{v_2'}{v_1'} = ?$



$m_1 \cdot \sin\theta_1 \cdot v_1'$

$m_2 \cdot \sin\theta \cdot v_2'$

$\Delta \vec{P}_y = 0 \quad 0 = m_1 \cdot \sin\theta_1 \cdot v_1' - m_2 \cdot \sin\theta_2 \cdot v_2'$

$2m \cdot \sin\theta_1 \cdot v_1' = 4m \cdot \sin\theta_2 \cdot v_2'$

$$\boxed{\frac{v_2'}{v_1'} = \frac{\sin\theta_1}{2\sin\theta_2}}$$

b) Çarpışma sonrası $v_1' = ?$

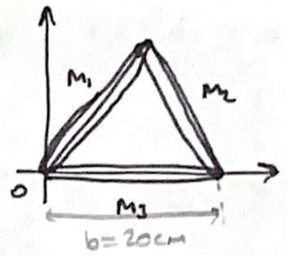
$\Delta \vec{P}_x = 0 \quad m_1 \cdot v_1 = m_1 v_1' \cdot \cos\theta_1 + m_2 \cdot v_2' \cdot \cos\theta_2$

$v_1 = v_1' \cos\theta_1 + 2 \cdot \frac{\sin\theta_1}{2\sin\theta_2} \cdot v_1' \cdot \cos\theta_2$

$v_1 = v_1' \left(\frac{\cos\theta_1 \cdot \sin\theta_2 + \sin\theta_1 \cdot \cos\theta_2}{\sin\theta_2} \right)$

$$\boxed{v_1' = \frac{v_1 \cdot \sin\theta_2}{\cos\theta_1 \cdot \sin\theta_2 + \sin\theta_1 \cdot \cos\theta_2}}$$

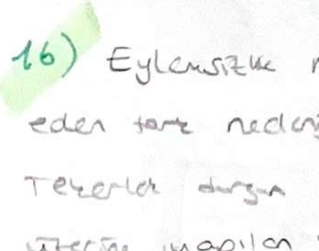
14)



$(\cos 60° = 0{,}5 \ , \ \sin 60° = 0{,}9)$

orijine göre km?

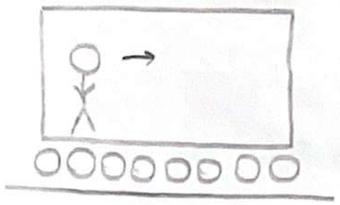
$(2M_1 = 2M_2 = M_3)$ (10,5)



$$x_{km} = \frac{M \cdot 5 + M \cdot 15 + 2M \cdot 10}{4M} = 10$$

$$y_{km} = \frac{M \cdot 9 + M \cdot 9 + 2M \cdot 0}{4M} = 4{,}5 \approx 5$$

15) Duran bir tren vagonunun arka ucunda duran bir kişi öne vagonun önüne kadar yürür. Sonra dönüp vagon arkasında durur. Raylar üzerindeki sürtünmeyi ihmal ederek, vagon hareketi nasıl olur?



Sürtünmeler ortadan sistemin kütle merkezi sabit kalır

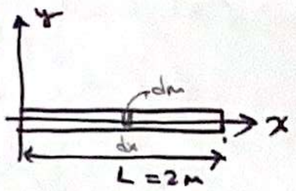
Vagon önce geri sonra bir miktar ileri gider son konum başlangıçla aynıdır.

16) Eylemsizlik momenti $0{,}5\ kgm^2$ olan tekerlek, üzerine etki eden tork nedeniyle $0{,}5\ rad/s^2$ sabit açısal ivmeyle sürtünmesiz. Tekerlek durgun halden başlıyorsa, ilk 8 sn boyunca tekerlek üzerine yapılan iş nedir?

$\tau = I \cdot \alpha \qquad w_s = w_i + \alpha \cdot t \qquad w_s = 0{,}5 \cdot 8 \Rightarrow w_s = 4$

$\Delta K = W = \frac{1}{2} I w_s^2 - \frac{1}{2} I w_i^2 \Rightarrow \frac{1}{2} \cdot \frac{1}{2} \cdot 16 \Rightarrow \boxed{W = 4\ J}$

17)



$\lambda = a - bx \quad a = 0,3 \quad b = 0,1$

$T = 0,4 \quad (\pi = 3)$

$dm = \lambda\, dx \qquad dm = \left(\frac{3}{10} - \frac{1}{10}x\right) dx$

a) Dönme eksenine göre eylemsizlik momenti?

$$I = \int_0^L x^2\, dm \Rightarrow I = \int_0^L x^2 \left(\frac{3}{10} - \frac{1}{10}x\right) dx$$

$$I = \frac{1}{10}\left(x^3 - \frac{x^4}{4}\Big|_0^L\right) = \frac{1}{10}\,\frac{L^3(4-L)}{4} \qquad L=2$$

$I = 0,4 \ (kg\,m^2)$

b) Çubuğun dönme kinetik enerjisi?

$$E_0 = \frac{1}{2}\cdot I\cdot \omega^2 = \frac{1}{2}\cdot\frac{4}{10}\cdot\left(2,3\cdot\frac{10}{4}\right)^2 = 45\ (J)$$

18)

$\left(I_{km}^{makara} = \frac{1}{2}MR^2\right)$

a) $T_1 = ?$

b) $m_1/m_2 = ?$

$T_2 = m_2 \cdot \frac{g}{2}$

$m_1 g - T_1 = m_1 \frac{g}{2}$

$T_1 = m_1 \frac{g}{2}$

$T_2 = m_2 \frac{g}{2}$

$T_1 = m_1 \frac{g}{2} \Rightarrow \boxed{T_1 = \frac{5 m_2 g}{8}}$

$(T_1 - T_2)R = I\cdot\alpha \rightarrow \frac{a}{R} = \frac{g}{2R}$

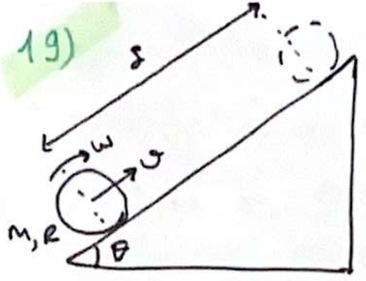
$(T_1 - T_2)R = \frac{1}{2}\frac{m_2}{2}R^2\cdot\frac{g}{2R}$

$\frac{g}{2}(m_1 - m_2) = \frac{g}{2}\left(\frac{m_2}{4}\right)$

$m_1 = \frac{5m_2}{4}$

$\boxed{\frac{m_1}{m_2} = \frac{5}{4}}$

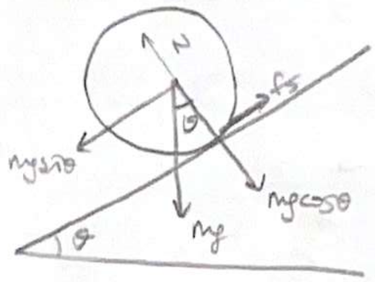
19)



$m = 50gr \quad R = 3cm \quad \theta = 30°$

$v = 10 m/s \quad \left(I = \frac{1}{2}MR^2\right) \quad (\pi = 3,\ g = 10,\ \sin 30 = 0,5)$

Durana kadar kaç devir yapar?



$mg\sin\theta - f_s = M\cdot a_{km}$

$\tau = R\cdot f_s = I\cdot\alpha = I\cdot\frac{a_{km}}{R}$

$mg\sin\theta - \frac{I a_{km}}{R^2} = M\cdot a_{km}$

$Mg\sin\theta\cdot R^2 - \frac{1}{2}MR^2\cdot a_{km} = R^2\cdot M\cdot a_{km}$

$\frac{2g\sin\theta}{3} = \frac{3}{2}a_{km} \qquad a_{km} = \frac{10}{3}$

$v_s^2 - v_i^2 = 2\cdot a\cdot\Delta x \Rightarrow 0 - 100 = 2\cdot\frac{10}{3}(-s) \qquad \boxed{s = 15\ m}$

$s = R\cdot\theta \Rightarrow 15 = 0,03\cdot\theta \Rightarrow 500\ rad = \theta$

2π rad — 1 dev

500 — ?

$\frac{500}{2\pi} \Rightarrow \boxed{\frac{500}{6}}$

20) $m = 2kg, \ \vec{r}(t) = (t-2)\hat{i} + (2t+1)\hat{j}$

a) $t = 3$ için orijine göre açısal momentum?

$\vec{L} = \vec{r}\times\vec{p} = \vec{r}\times m\vec{v} \qquad \boxed{\vec{v} = \hat{i} - 2\hat{j}}$

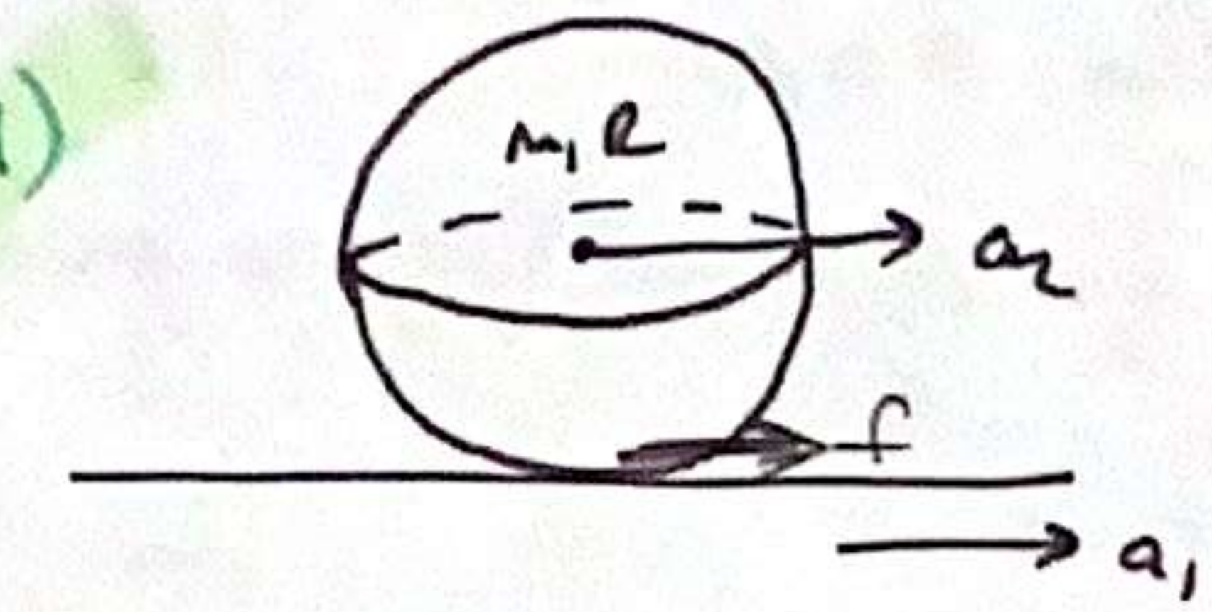
$\vec{L} = 2\left[(t-2)\hat{i} + (2t+1)\hat{j}\right]\times\left[\hat{i} + 2\hat{j}\right] = 2\left[(2t-4)\hat{k} - (2t+1)\hat{k}\right]$

$\vec{L} = -10\hat{k}\ (kg\,m^2/s)$

b) Orijine göre uygulanan tork nedir?

$\vec{\tau} = \frac{d\vec{L}}{dt} \Rightarrow \frac{d(-10\hat{k})}{dt} = 0$ (0)

21)



Yüzey a_1 ivmesi ile sağa doğru hareket ederken, kürenin kaymadan döndüğü varsayılırsa a_2 nedir?

$\left(I_{km}^{küre} = \frac{2}{5} MR^2\right)$

$f = M . a_2$ ①

$\tau_0 = f . R = I . \alpha$

$a_1 = a_2 + \alpha . R$

$f . R = \frac{2}{5} MR^2 . \alpha$

$\frac{(a_1 - a_2)}{R} = \alpha$

$f . R = \frac{2}{5} MR^2 \frac{(a_1 - a_2)}{R}$

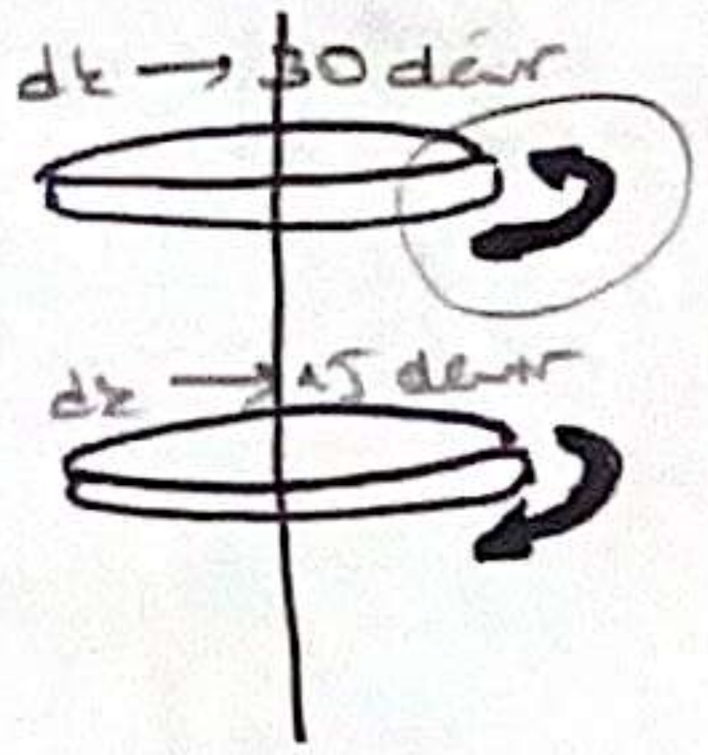
$f = \frac{2}{5} M (a_1 - a_2)$ ②

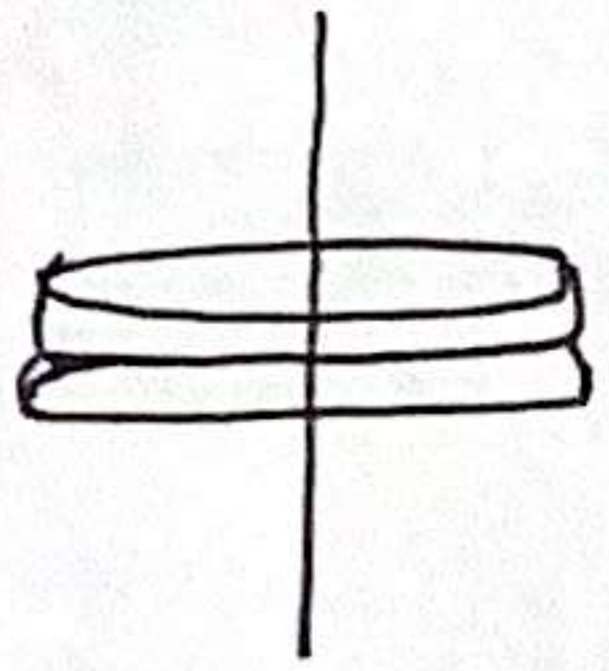
③ $5M . a_2 = 2Ma_1 - 2Ma_2$

$7a_2 = 2a_1$

$\boxed{a_2 = \frac{2a_1}{7}}$

22)





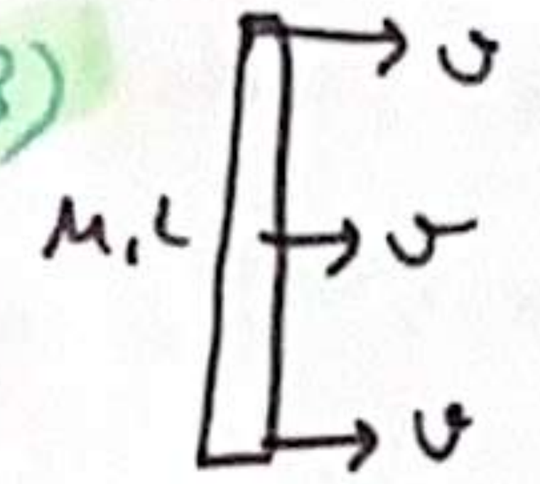
yeni devir?

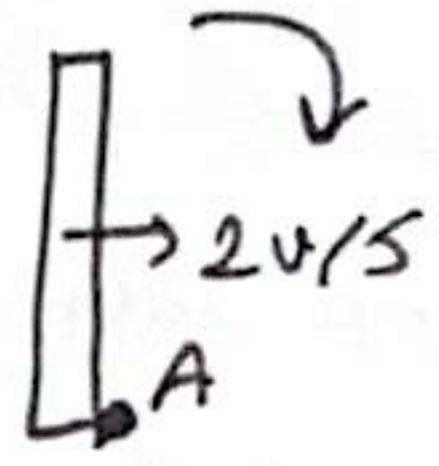
$\vec{L_1} = \vec{L_2}$

$I . 30 - I . 15 = (I + I) . w_{ort}$

$\boxed{7,5 \text{ (ters yön) (ter/dk)}}$

23)





$\left(I_{km}^{çubuk} = \frac{1}{12} ML^2\right)$

Çarpışmadan sonra çubuğun kütle merkezinin hızı 2v/5 ise, buna göre w = ?

A noktasına göre:

$L_i = L_s$

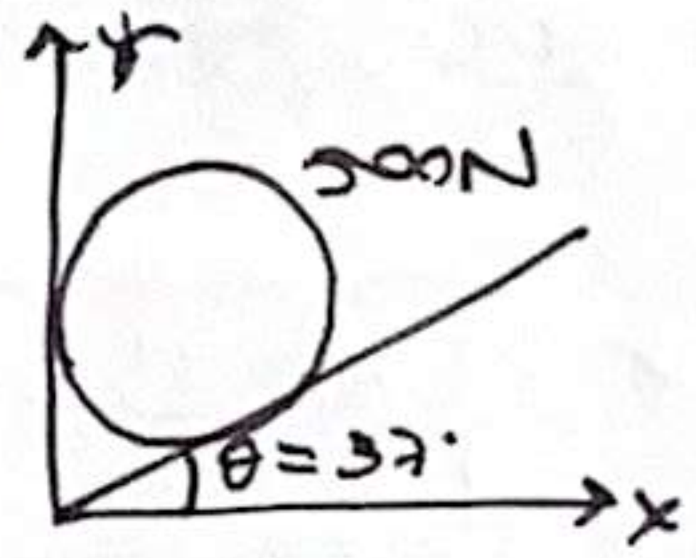
$\frac{L}{2} . Mv = \frac{L}{2} . M \frac{2v}{5} + I_{km} . w$

$\frac{L}{2} . M . v = \frac{L}{2} . M . \frac{2v}{5} + \frac{1}{12} . ML^2 . w$

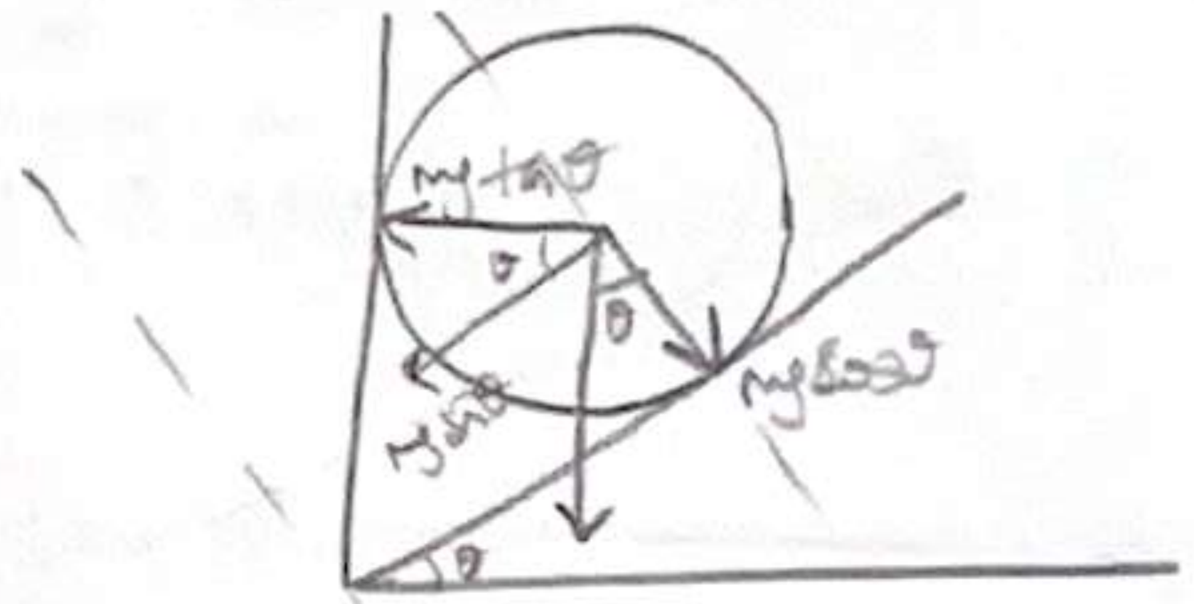
$\frac{3v}{5} = \frac{wL}{6}$

$\boxed{w = \frac{18v}{5L}}$

24)

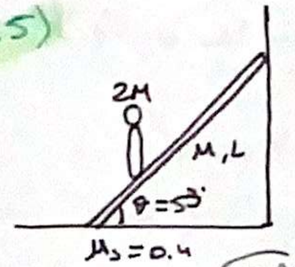


Düşey duvarın uyguladığı kuvvet?

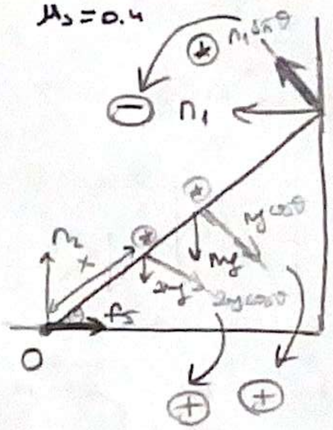


$500 . \frac{3}{4} = 375N$

25)



Merdiven zeminde basıldığında cocuk alt uçtan ne kadar uzaktadır?



$n_1 = f_s$

$n_2 - mg - 2mg = 0 \quad \boxed{n_2 = 3mg}$

① $\tau_o = -n_1 . L . \sin\theta + 2mg \cos\theta . x + mg \cos\theta \cdot \frac{L}{2} = 0$

$f_s = n_2 . \mu_s \Rightarrow f_s = 3mg . 0.4$

$\boxed{n_1 = f_s = 1.2\,mg}$

① $1{,}2\,mg \sin\theta . L = 2mg \cos\theta . x + mg \cos\theta . \frac{L}{2}$

$0{,}96L = 1{,}2x + 0{,}3L \qquad 0{,}66L = 1{,}2x \qquad \boxed{x = \frac{11}{20} L}$

26) $x(t) = 6 \cos\left(3\pi t + \frac{\pi}{3}\right), \pi = 3$

a) $t = 3$'teki faz? b) $t = 2$'deki hız c) $T = ?$

$faz = 3\pi t + \frac{\pi}{3}$

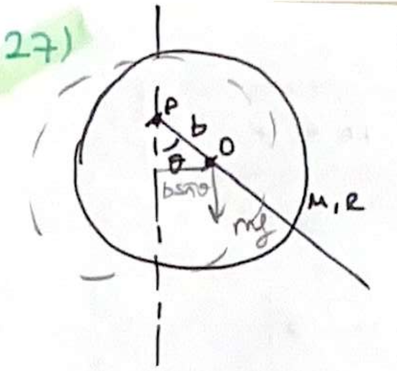
$\boxed{faz = 28 (rad)}$

b) $-6 \sin\left(3\pi t + \frac{\pi}{3}\right) . 3\pi = v(t)$

$-6 \cos\left(3\pi t + \frac{\pi}{3}\right) . 3\pi . 3\pi = a(t) = \boxed{-486 \cos(19)\ (m/s^2)}$

c) $3\pi = \omega \qquad \frac{2\pi}{T} = 3\pi \qquad \boxed{T = \frac{2}{3}\,(s)}$

27)



$\left(I_{kütle} = \frac{1}{2} MR^2\right) \quad T = ?$

$I_P = I_{km} + MD^2$

$I_P = \frac{1}{2} MR^2 + M b^2 \Rightarrow \boxed{I_P = M\left(\frac{R^2}{2} + b^2\right)}$

$\left(\sin\theta = \theta \;,\; \alpha = \frac{d^2\theta}{dt^2}\right)$

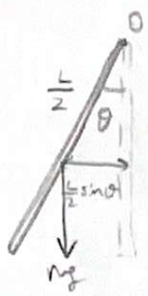
$mg\, b \sin\theta = I_P . \alpha$

$Mg . b . \theta = M . \left(\frac{R^2}{2} + b^2\right) . \frac{d^2\theta}{dt}$

$\underbrace{\frac{d^2\theta}{dt^2}}_{\alpha} = \frac{2gb}{R^2 + 2b^2} . \theta \qquad \omega^2 = \frac{2gb}{R^2 + 2b^2} \Rightarrow \omega = \sqrt{\frac{2gb}{R^2 + 2b^2}}$

$\omega = \frac{2\pi}{T} \Rightarrow \boxed{T = \frac{2\pi\sqrt{R^2 + 2b^2}}{\sqrt{2gb}}}$

28) M kütleli L uzunluğundaki ucundan bağlanarak asılmış fiziksel sarkaç çubuk T periyotlu bir. Uzunluğu nedir? $\left(I_{uç} = \frac{1}{3} ML^2\right)$



$Mg . \frac{L}{2} . \sin\theta = I . \alpha$

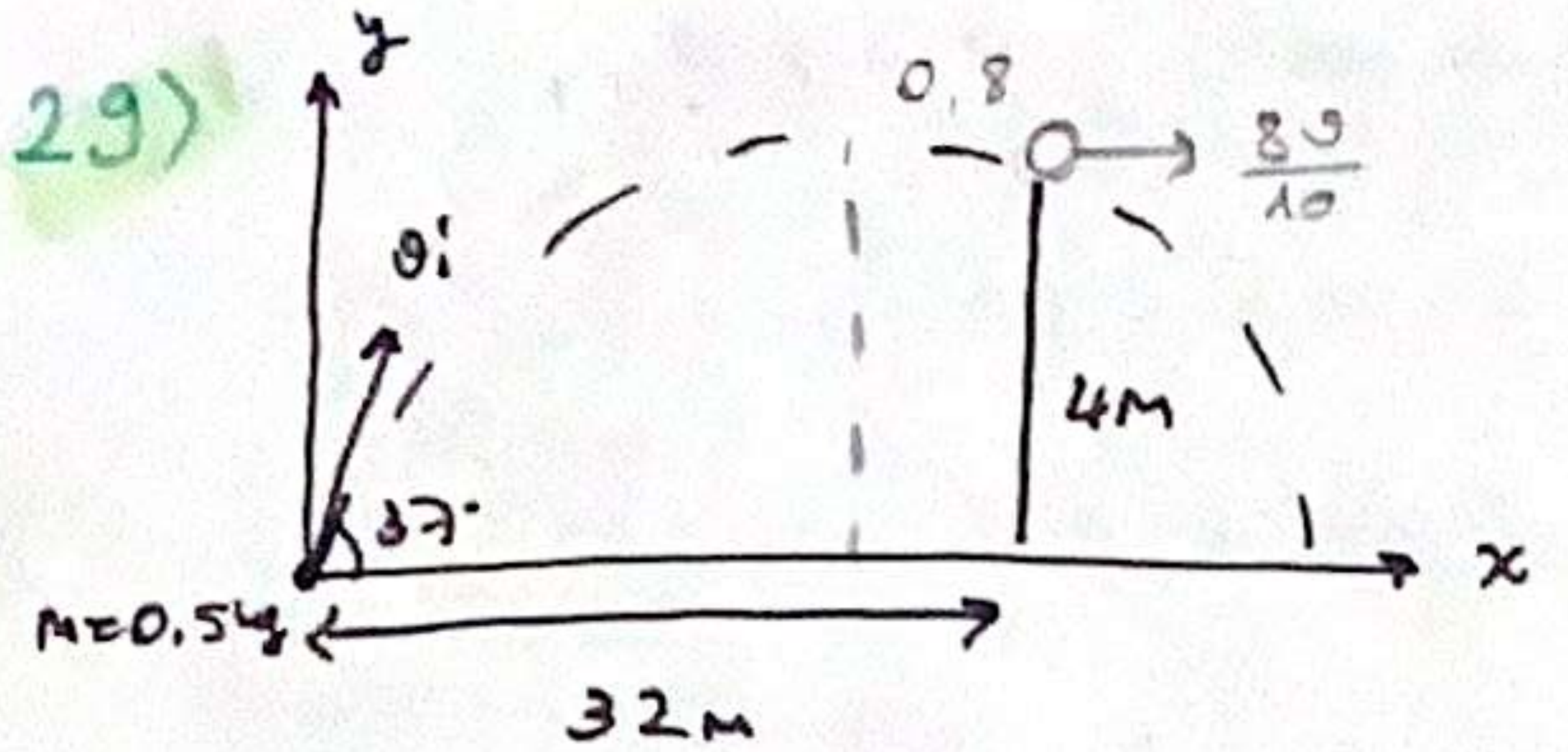
$Mg \frac{L}{2} . \theta = \frac{1}{3} ML^2 . \frac{d^2\theta}{dt^2} \qquad \frac{d^2\theta}{dt^2} = \underbrace{\frac{3g}{2L}}_{\omega^2} \theta$

$\omega = \frac{\sqrt{3g}}{\sqrt{2L}} \qquad \boxed{\frac{2\pi\sqrt{2L}}{\sqrt{3g}} = T}$

Basit sarkaç

$T = 2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{2L}{3g}} \Rightarrow \boxed{l = \frac{2}{3} L}$

29)



a) $v_i = ?$

$\boxed{\vec{v}_i = 16\hat{i} + 12\hat{j}}$

b) Duvarı geçtikten kaç s sonra yere çarpar?

$\boxed{t = 0,4 (s)}$

c) O noktasına göre açısal momentum tam duvar üstünden geçerken kaç?

$\boxed{\vec{L} = -160\hat{k}}$

d) Tam duvar üstünden geçerken sahip olduğu mekanik enerji? $\boxed{E = 100 J}$

a) $\frac{8v}{10} \cdot t = 32 \qquad vt = 40$

$h = v_{0y} \cdot t + \frac{1}{2} \cdot g \cdot t^2$

$4 = \frac{6v}{10} t + \frac{1}{2} \cdot 10 \cdot t^2 \qquad t = 2 \qquad v = 20$

$t_{ilk} = 1,2 \qquad t_{1ms} = 0,8 \qquad$ b) $t_{2ms} = 0,4 s$

c) $\vec{L} = \vec{r} \times \vec{p} \Rightarrow (32\hat{i} + 4\hat{j}) \times \left[\frac{1}{2}(16\hat{i} - 8\hat{j})\right]$

$(8\hat{i} - 4\hat{j})$

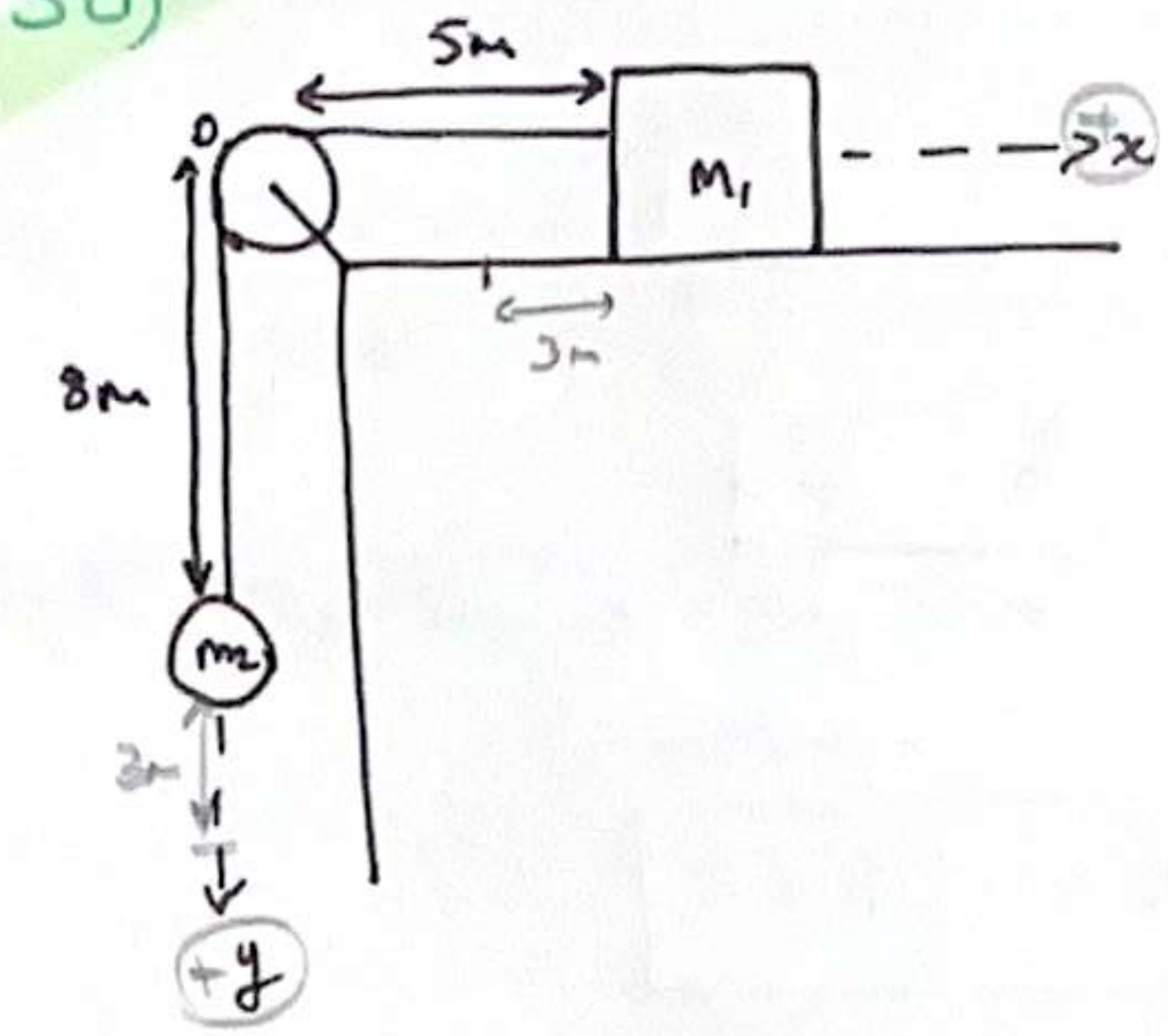
$h = h_0 + v_0 t + \frac{1}{2} a t^2$

$-128\hat{k} - 32\hat{k} = -160\hat{k}$

d) $mgh + \frac{1}{2} m v^2 = \frac{1}{2} \cdot 10 \cdot 4 + \frac{1}{2} \cdot \frac{1}{2} \cdot 320 = 100 J$

$v^2 = 16^2 + 8^2 = 320$

30)



$M_1 = 2 kg, \quad M_2 = 3 kg$

$2\hat{i} + 4,8\hat{j}$

a) t=1 için kütle merkezi (vektör)?

$\boxed{\vec{r}_{km} = 0,8\hat{i} + 6,6\hat{j}}$

b) t=1 için km ivme vektörü?

$\boxed{\vec{a}_{km} = -2,4\hat{i} + 3,6\hat{j}}$

c) Net dış kuvvet vektörü?

$\boxed{\vec{F}_{net} = -12\hat{i} + 18\hat{j}}$

a) $T = 2 \cdot a$

$mg - T = m \cdot a$

$30 - T = 3a$

$a = 6$

$x = \frac{1}{2} \cdot 6 \cdot 1 \Rightarrow x = 3$

$M_1 \Rightarrow (2,0) \qquad m_2 \Rightarrow (0, 11)$

$X_{km} = \frac{2 \cdot 2 + 3 \cdot 0}{5} = 0,8 \qquad Y_{km} = \frac{2 \cdot 0 + 3 \cdot 11}{5} = 6,6$

b) $\vec{r}_{km} = \vec{r}_{0km} + \vec{v}_0 t + \frac{1}{2} \vec{a}_{km} t^2$

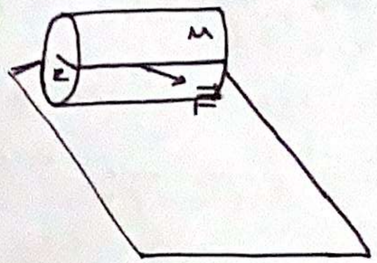
$0,8\hat{i} + 6,6\hat{j} = (2\hat{i} + 4,8\hat{j}) + \frac{1}{2} \cdot \vec{a}_{km} \cdot 1$

$-1,2\hat{i} + 1,8\hat{j} = \frac{1}{2} \vec{a}_{km} \qquad \vec{a}_{km} = -2,4\hat{i} + 3,6\hat{j}$

c) $\vec{F}_{net} = (\Sigma M) \cdot \vec{a}_{km} \Rightarrow F = 5 \cdot (-2,4\hat{i} + 3,6\hat{j})$

$F = -12\hat{i} + 18\hat{j}$

31)



$\left(I_{km}^{silindir} = \frac{1}{2}MR^2\right)$

a) Kütle merkezinin ivmesi?

$$a_{km} = \frac{2F}{3M}$$

b) Sürtünme katsayısı?

$$f_s = \frac{F}{3}$$

c) Herhangi bir t anındaki KM göre açısal momentum?

$$L = \frac{1}{3}FRt$$

a) $\tau = I \cdot \alpha_{km} = F \cdot R$

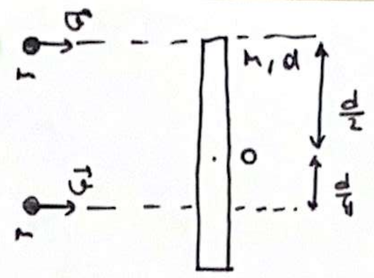
$$\left(\frac{1}{2}MR^2 + MR^2\right) \cdot \frac{a_{km}}{R} = F \cdot R \qquad a_{km} = \frac{2F}{3M}$$

b) $f_s = \frac{1}{2} M \cdot a_{km} \Rightarrow f_s = \frac{1}{2} M \cdot \frac{2F}{3M} \Rightarrow f_s = \frac{F}{3}$

c) $L = I_{km}\omega \Rightarrow L = \frac{1}{2}MR^2 \cdot \alpha \cdot t$

$$\frac{1}{2}MR^2 \cdot \frac{a_{km}}{R} \cdot t \Rightarrow \frac{1}{2}MR^2 \cdot \frac{2F}{3MR} \cdot t = \frac{1}{3}FRt$$

32)



$\left(I_{km}^{Cubuk} = \frac{1}{12}Md^2\right)$

Çarpışma sonrası yapışıklardır.

a) $\frac{K \text{ çarpışma son.}}{K \text{ çarp önce}} = ?$ $\qquad \frac{K_s}{K_i} = \frac{3}{38}$

b) Açısal hız (çarp sonrası)? $\qquad \omega = \frac{12v}{19d}$

a)

$$I_s = M\cdot\left(\frac{d}{4}\right)^2 + M\left(\frac{d}{2}\right)^2 + \frac{1}{12}\cdot M\cdot d^2 = \frac{19}{48}Md^2$$

$$K_s = \frac{1}{2}\cdot\left(\frac{19}{48}\cdot Md^2\right)\cdot\omega^2$$

$$K_i = \frac{1}{2}mv^2 + \frac{1}{2}Mv^2 = Mv^2$$

$\vec{L}_i = \vec{L}_s \qquad \vec{L} = \vec{r}\times\vec{p}$

$$L_i = \frac{d}{2}\cdot mv - \frac{d}{4}Mv = \frac{d}{4}Mv$$

$$L_s = I_s\cdot\omega$$

$$\Rightarrow \frac{19}{48}Md^2\cdot\omega = \frac{d}{4}Mv$$

$$\frac{\omega^2}{v^2} = \frac{12^2}{19^2d^2}$$

$$\frac{K_s}{K_i} = \frac{\frac{1}{2}\cdot\left(\frac{19}{48}\cdot Md^2\right)\omega^2}{Mv^2} = \frac{1}{2}\cdot\frac{19}{48}d^2\cdot\frac{12^2}{19^2d^2} = \frac{3}{38}$$

b) $\omega^2 = \frac{12^2\cdot v^2}{19^2\cdot d^2} \Rightarrow \omega = \frac{12v}{19d}$