mel gichane

PHYS 150 – MIDTERM #2

Unit 4 →

1) $U(x) = -k(x^4 - x^2)$

a) $F(x) = -U'(x) = -k(4x^3 - 2x)$

$F(x) = -2kx(2x^2 - 1)$

$0 = -2kx(2x^2 - 1)$

$\boxed{x = 0 \; ; \; x = \sqrt{\frac{1}{2}}}$

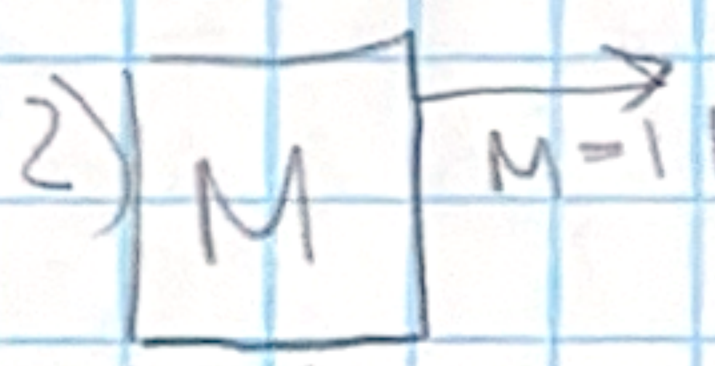
b) $U(0) = -k(0)$

$= 0$

$U\left(\sqrt{\tfrac{1}{2}}\right) = -k\left(\left((1/2)^{1/2}\right)^4 - \left((1/2)^{1/2}\right)^2\right)$

$= -k\left(\tfrac{1}{4} - \tfrac{1}{2}\right)$

$U\left(\sqrt{1/2}\right) = \frac{-k}{4}$ → largest displacement is $x = \sqrt{1/2}$

2) 

$M = 1\,kg$

$\mu_k = 0.5$

a) $\vec{F} = 5\hat{i}\,N$

$\Delta\vec{x} = 1\hat{i}\,N$

$W = ?$

$W = \vec{F} \cdot \Delta\vec{x} = (5\hat{i}\,N)\cdot(1\hat{i}\,N)$

$\boxed{W = 5J}$

b) $\vec{x}_1 = 1\hat{i} + 0\hat{j}$ $\quad W = \vec{F} \cdot \Delta\vec{x}$

$\vec{x}_2 = 1\hat{i} + 1\hat{j}$

$\Delta x = 0\hat{i} + 1\hat{j}$

$W = (5\hat{j}\,N)\cdot(1\hat{j})$

$\boxed{W = 5J}$

c) $\vec{x}_1 = 1\hat{i} + 1\hat{j}$

$\vec{x}_2 = 0\hat{i} + 1\hat{j}$

$\Delta x = -1\hat{i}$

$W = (-5\hat{i})\cdot(-1\hat{i})$

$\boxed{W = 5J}$

d) $\vec{x}_1 = 0\hat{i} + 1\hat{j}$

$\vec{x}_2 = 0\hat{i} + 0\hat{j}$

$= -1\hat{j}$

$W = (-1\hat{j})(-5\hat{j})$

$\boxed{W = 5J}$

e) 20J

d) It should be 0J if force of friction was conservative

Unit 5 →

1) 

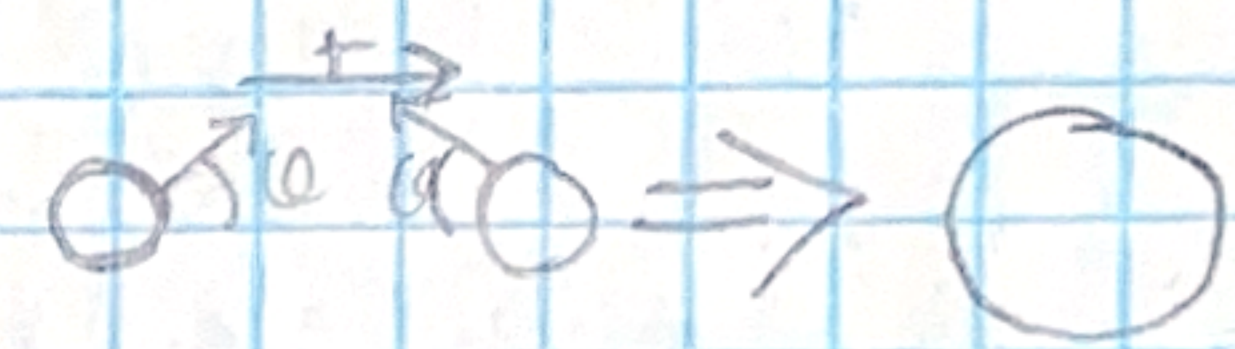
$m = 20 \times 10^{-25}\,kg$

$m \quad m \quad 2m$

$v_1 = 350\,m/s \quad v_2 = -350\,m/s \quad V = ?$

$m(v_1 + v_2) = 2mV$

$\frac{v_1 + v_2}{2} = V = \boxed{0 = C}$

2) 

$m, v, -2+ \quad m \quad 2m$

$V_x = V\cos\theta \quad V_x = -V\cos\theta$

$V_y = V\sin\theta \quad V_y = -V\sin\theta$

$x \rightarrow m(V\cos\theta - V\cos\theta) = 2m\,v_f\cos\beta$

$0 = V\cos\beta$

$0 = \cos\beta$

$\beta = 90°$ or $270°$

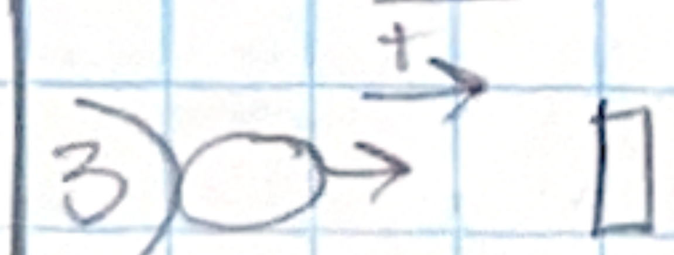
$y \rightarrow m(V\sin\theta + V\sin\theta) = 2m\,v_f\sin\phi$

$2V\sin\theta = 2v_f\sin\phi$

$350 \cdot \frac{\sqrt{2}}{2} = v_f\sin\phi$

$175\sqrt{2} = v_f\sin\beta$

$90° \rightarrow \boxed{175\sqrt{2} = v_f}$

3) 

$F = 4{,}000\,N$

$\Delta t = .2s$

a) $J = (4{,}000N)(.2s)$

$\boxed{J = 800\,N\cdot s}$

b) $v_0 = 2.8\,m/s \quad v_1 = ?$

$m = 200\,kg$

$mv_1 - mv_0 = J$

$m(v_1 - v_0) = 800\,N\cdot s$

$v_1 - 2.8\,m/s = 4\,m/s$

$\boxed{v_1 = 6.8\,m/s}$

4) ○→ ○ ⇒ ○ ○→

C→ elastic collision since there may be energy transfers w/ friction & sand granular

5) □→ ⇒ □→

$m_1 = 30{,}000\,kg$ $m_2 = 110{,}000$ $m_3 = 140{,}000\,kg$

$V_1 = .85\,m/s$ $V_2 = 0\,m/s$ $V_3 = ?$

$m_1V_1 + m_2V_2 = m_3V_3$

$\frac{m_1V_1}{m_3} = m_3V_3$

a) $\frac{(30000)(.85)}{(140{,}000)} = V_3 = .18\,m/s$

b) $\frac{1}{2}m_1V_1^2 + \frac{1}{2}m_2V_2^2 = KE_0$

$\frac{1}{2}(30{,}000)(.85)^2 = KE_0$

$10837.5\,J = KE_0$

$\frac{1}{2}m_3V_3^2 = KE_1$

$\frac{1}{2}(140{,}000)(.18)^2 = KE_1$

$2268\,J = KE_1$

Loss in KE = 8569.5 J

6) ○→ ←○ ⇒ ◯

m	2m	3m
v	v	
x=0	x=X	x=?

B4→ Center of Mass $= \frac{mv + 2mv}{3m}$

$= \frac{mv(1+2)}{3m}$???

$= \frac{3v}{3} = v$

A1→ center of mass $= \frac{3mv_2}{3m}$

$= v$???

location stays the same?

Unit 6→

1) ◯ T = 1.33 s

$\frac{60\,s}{1.33\,s} = 45\,rpm$

$\omega = ?$ $\frac{\Delta\theta}{\Delta t} = \frac{2\pi rad}{1.33\,s}$

B $= 4.72\,rad/s$

2) ◯ $V = r\omega$

$V = (4.72\,rad/s)\,r$

$a_c = \frac{V^2}{r}$

$= \frac{(4.72\,rad/s)^2 r^2}{r}$

$a_c = 22.28\,m/s^2 \cdot r$

$a_c = 2.2\,m/s^2 = D$

3) ◯ ω

$a_{c_0} \rightarrow a_{c_1} \cdot 100$

$a_c = \frac{(r\omega)^2}{r} = \omega^2 r = a_c$

$\omega^2 r = a_c \cdot 100$

(x) $\omega = \sqrt{100}$

$\pm 10\omega = D$

4) $\omega^2 r = a_c$

$\frac{200\,rev}{min} \left| \frac{1\,min}{60\,s} \right| \frac{2\pi\,rad}{1\,rev} = 20.94\,rad/s$

$(20.94)^2(.12\,m) = a_c = 52.64\,rad/s^2$

$F_c = ma_c$

$= (.01\,kg)(52.64\,rad/s^2)$

$F_c = 0.53N = B$

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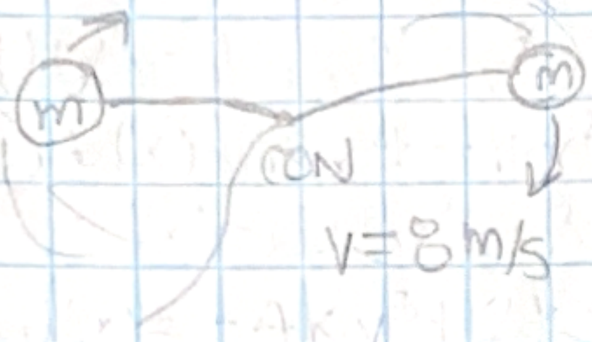
Unit 6 (cont.) →

5) 

a) m = 0.5kg
T = 1/4 s
$KE_{trans} = 1/2(2m)(v^2)$

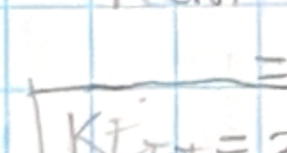
$KE_{trans} = 32J$
$KE_{rot} = 1/2 I\omega^2$

$I = 2mr^2 = 1r^2$
$\omega = 2\pi f = 8\pi$ rad/s
$KE_{rot} = 1/2 r^2 (8\pi rad/s)^2$
$= 32\pi^2 r^2 J$

$\boxed{KE_{Tot} = 32J + 32\pi^2 r^2 J}$ ← radius

b) $L = I\omega$
$= r^2 \cdot 8\pi$ rad/s
$\boxed{L = 8\pi r^2 \ kg \cdot m^2/s}$

c) $h = \frac{v^2}{2g} = \frac{(8m/s)^2}{2(9.8m/s)} = \boxed{3.27m}$

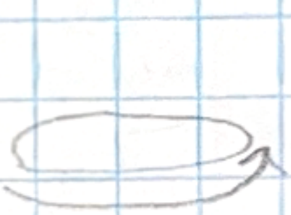
6) 

$\vec{r} = 5\hat{i} + 5\hat{j}$ cm
$\vec{F} = -10\hat{i} + 10\hat{j}$ N
$\tau = ?$

$\tau = (.05\hat{i} + .05\hat{j}) \times (-10\hat{i} + 10\hat{j})$
$\tau = 0 + .5\hat{k} + .5\hat{k} + 0$
$\boxed{\tau = 0}$

b → $(.1\hat{i} + .1\hat{j}) \times (-10\hat{i} + 10\hat{j})$
$\tau = 0 + 1k - 1k + 0 = \boxed{0}$

7) $I = 1/2 MR^2$
$\omega(t) = 10t + 60$ rpm
$\tau = ?$
$\omega(t) = (10t + 60 \frac{rot}{min} | \frac{1min}{60s} | \frac{2\pi rad}{1rot}$
$\omega(t) = 1.0472t + 2\pi$ rad/s
$\omega(t) = 1.0472$ rad/s$^2 = \alpha$
$\tau = I\alpha$
$= 1/2 MR^2 \cdot (1.0472$ rad/s$^2)$
$\boxed{\tau = .52MR^2 \ N \cdot m}$

8) 
$I = 1/2 MR^2$

M = 100kg
R = 1.5m
$\omega = \frac{30r}{m} | \frac{2\pi}{60s} = \pi$ rad/s
$L = I\omega$
$= 1/2(100)(1.5)^2(\pi$ rad/s$)$
$\boxed{L_0 = 112.5\pi \ kg \cdot rad/s}$

b) $I_C = MR^2$
$= 40(1.5)^2$
$= 90 \ kg \cdot m^2$
$I_{tot} = 112.5 + 90 = 202.5 \ kg \cdot m^2$
$L_0 = L_1$
$I_0\omega_0 = I_{tot}\omega_1$
$\omega = \frac{112.5\pi}{I_{tot}} = \frac{112.5\pi}{202.5} = \boxed{.55\pi \ rad/s}$

c) $\tau = .3 \ N \cdot m$
$\boxed{\vec{F} = (3\hat{i} + 3\hat{j})}$
$\tau = (3\hat{i} + 3\hat{j})(.05\hat{i} + .05\hat{j})$
$= 0 + .15k + .15k + 0 = .3$

Unit 7 →

1)

$\tau = F \cdot x$

$\tau_{bricks} = (40\,kg)(10\,m)(3\,m)$

$= 1200\,kg\,m^2/s^2$

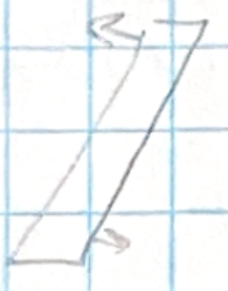
balloon ccl

$\tau_{con} = (60\,kg)(10\,m/s)(2m)$

$= 1200\,kg\,m^2/s^2$

A → remain motionless

2)

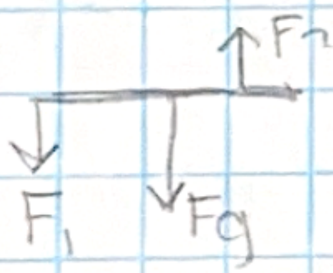


$r = 2.00\,m$

$r_1 = 0\,m$

$r_2 = 1.5\,m$

$m = 20\,kg$



$F_2 - F_1 - F_g = F_y = 0$

$F_2 - F_1 = mg = (20\,kg)(9.8\,m/s^2)$

$F_2 - F_1 = 196\,N$

$.5F_2 - mg(1\,m) = 0$

$.5F_2 = 196\,N$

$\boxed{F_2 = 392\,N}$

$F_2 - F_1 = 196$

$F_1 = 196 - F_2$

$F_1 = 196 - 392\,N$

$\boxed{F_1 = -196\,N}$