Jens Christian Hoffmann
10/13/24
Midterm 1

* 9

Section 1: Unit 0

1. C. $11 g\ cm^{-3}$

2. 60 Km/hr → 600 Km N

$$\frac{600\ \cancel{Km}}{hr} \cdot \frac{1 hr}{60\ \cancel{Km}} = 10\ hrs$$

C 10 hrs

3. $$\frac{25\ \cancel{m}}{\cancel{sec}} \cdot \frac{1\ Km}{1000\ \cancel{m}} \cdot \frac{3600\ \cancel{sec}}{1\ hr} = \frac{90\ Km}{1\ hr}$$

D. $90\ Km\ hr^{-1}$

4. $0\ Km\ hr^{-1} \rightarrow 10\ Km\ hr^{-1}$ (60 seconds

$$\frac{\Delta v}{t} = a \quad \frac{(10-0)}{60} = \frac{1\cancel{0}}{6\cancel{0}} \quad \frac{1}{6}\ Km\ hr^{-1} s^{-1}$$

C $\frac{1}{6}\ Km\ hr^{-1} s^{-1}$

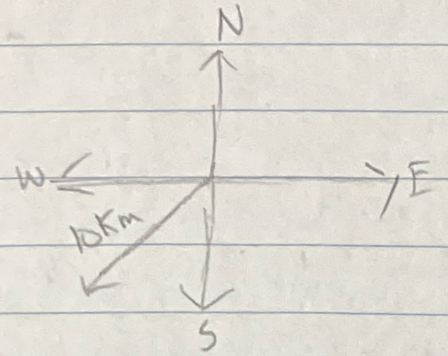
5. A $5000\ m^2$

6. $1\ cm^3 = 1\ mL$ $.5\ cm^3 \rightarrow .5\ mL$ $2L = 2000mL$

$$\frac{2000}{.5} = 4000$$ coffee beans in a 2 L bottle

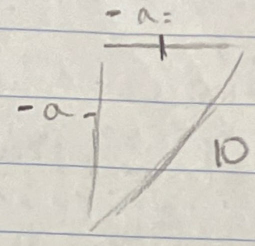
C 4×10^3

7.



$\vec{v} = v_x\hat{i} + v_y\hat{j}$

10 r



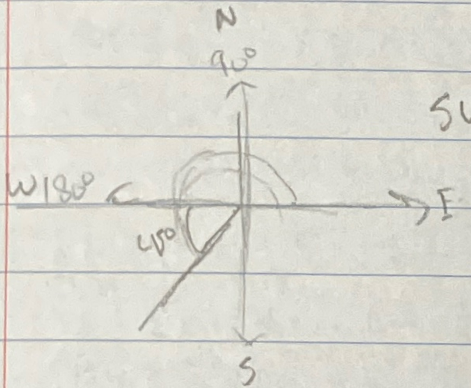
$10^2 = a^2 + b^2$ — $\left(\frac{10^2}{2} = \frac{2a^2}{2}\right)$

$\sqrt{50}$ $\sqrt{a^2}$

-7.1 ←

D: -7.1 & -7.1 Km/hr

8.

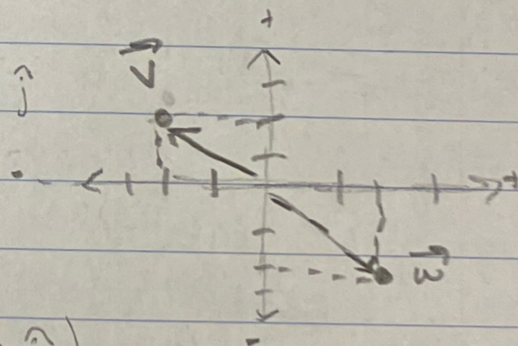


$SW = 45°$

$180+45=225°$

A: 225 degrees

9. $\vec{v} = -2\hat{i} + 2\hat{j}$ $\vec{w} = 2\hat{i} + 2\hat{j}$



b $\vec{v} + \vec{w} = (-2\hat{i} + 2\hat{j}) + (2\hat{i} + 2\hat{j})$

$(-2+2)\hat{i} + (2-2)\hat{j}$

$0\hat{i} + 0\hat{j}$ ⟶ $\vec{v} + \vec{w} = \vec{0}$

c $\vec{v} - \vec{w} = (-2\hat{i} + 2\hat{j}) - (2\hat{i} + 2\hat{j})$

$(-2-2)\hat{i} - (2+2)\hat{j}$

$-4\hat{i} - 4\hat{j}$ ⟶ $\vec{w} - \vec{w} = -4\hat{i} + 4\hat{j}$

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Section 2: Kinematics I & II

1. a) $t=0 \rightarrow 15\,ms^{-1}$ $a=3\,ms^{-2}$
$t=4$ $15+3(4)=27$ $27\,ms^{-1}$

b) $\frac{1}{2}at^2+v_it+x_i \rightarrow$ $x_i=0$ $a=3$ $t=4$ $v_i=15$
$\frac{1}{2}(3)(4^2)+15(4)=84$ $84m$ = displacement

c) $v_{avg}=\frac{\text{displacement}}{\text{time}}$ @ $t=4$ $\frac{84}{4} \rightarrow 21\,ms^{-1}$ Avg vel.
$27\,ms^{-1}$ = instantaneous vel

@ $t=4$ there is a different Avg Vel. than instantaneous vel.

2. a) $v=\frac{\Delta x}{\Delta t} \rightarrow$ $v_P=\frac{988-338}{15-5}=$ $65\,ms^{-1}$
$v_Q=\frac{2900-1500}{30-20}=$ $140\,ms^{-1}$

b) Acceleration is positive
$\frac{140-65\,ms^{-1}}{25-10\,s}=\frac{75}{15}=$ $5\,ms^{-2}$

3. a) $v_f^2 = v_i^2 + 2a\Delta x$

$a = .8\ ms^{-2}$ $v_f = 6$ $v_i = 0$

$6^2 = 0^2 + 2(.8)\Delta x$

$\frac{36}{1.6} = \frac{1.6\Delta x}{1.6}$ $\rightarrow$ $\Delta x = 22.5\ m$ (distance it takes to get airborne)

b) $v(t) = at + v_i$

$v(t) = 6\ ms^{-1}$ $a = .8\ ms^{-2}$ $v_i = 0$

$\frac{6}{.8} = \frac{.8(t) + \cancel{0}}{.8}$ $\rightarrow$ $t = 7.5$ Seconds (time to get airborne)

4. $R = \frac{v_i^2 \sin 2\theta}{g}$ $\theta = 60°$ $R = 60$

$60 = \frac{v_0^2 \sin(2(60))}{9.81}$ $\rightarrow$ $\frac{60(9.81)}{\sin 120} = \frac{v^2 \sin(120)}{\sin 120}$

$\sqrt{\frac{60(9.81)}{\sin 120}} = \sqrt{v^2}$ $\rightarrow$ $v = 26.07\ ms^{-1}$

For the ball to travel 60m

$T = \frac{2v_i \sin\theta}{g}$ $v_i = 26.07$ $\theta = 60$ $g = 9.81$

$T = \frac{2(26.07)\sin 60}{9.81}$ $\rightarrow$ $T = 4.6$ Seconds

An outfielder throws a ball to home plate (60m). I calculated he must release the ball at a 60° angle & using his Robotic Arm the ball left his hand at 26.07 ms^{-1}. It will hit home in 4.6 seconds

Section 2: Kinematics I & II

m=1 $\theta=45°$

drop

5.

Pendulum Length (L) m	Period (T) ~ (secs	g (m/s²
.1	.64	9.64
.2	.88	10.2
.3	1.13	9.28
.4	1.31	9.2
.5	1.47	9.13
.6	1.59	9.36
.7	1.72	9.34
.8	1.85	9.22
.9	1.97	9.15
1	2.08	9.13
Average 1.464	.55	9.365

$$\frac{L}{\left(\frac{T}{2\pi}\right)^2} = g \rightarrow \frac{L}{\frac{T^2}{2^2\pi^2}}$$

$$\frac{4\pi^2 L}{T^2} = g$$

$$T = 2\pi\sqrt{L/g}, \quad \left(\frac{T}{2\pi}\right)^2 = \sqrt{Lg}$$

$$g\left(\frac{T}{2\pi}\right)^2 = Lg \quad \frac{L}{\left(\frac{T}{2\pi}\right)^2} = g$$

Error = $\frac{9.365-9.81}{9.81} \times 100 \rightarrow -4.54\%$ error

too low

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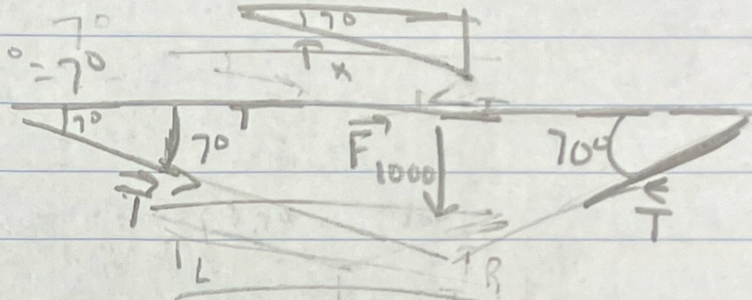
Section 3: Unit 2

1. a) $F \perp = 1000\ N$ $\quad \theta^\circ = 7^\circ$



$$T = \frac{F\perp}{2 \sin\theta}$$

$$T = \frac{1000}{2 \sin(7^\circ)} = 4102.75\ N$$

b) $F_{friction} = \mu_k F_N$ $\quad m = 900 \quad g = 9.81 \quad \mu_k = .05$

$F_f = .05(900 \cdot 9.81) \quad F_f = 441.45$

$F_{Net} = T - F_{friction} \rightarrow 4102.75 - 441.45 = 3661.3$

$F_{Net} = 3661.3$

$F_{Net} = ma \rightarrow \frac{3661.3}{900} = \frac{900a}{900}$

$a = 4.068\ ms^{-2}$

2. $v_f^2 = v_i^2 + 2a\Delta x \quad v_f = 0 \quad a = ? \quad \Delta x = 100 \quad v_i = 120\ km/hr \rightarrow 33.33\ m/s$

$0 = 33.33^2 + 2a\,100$

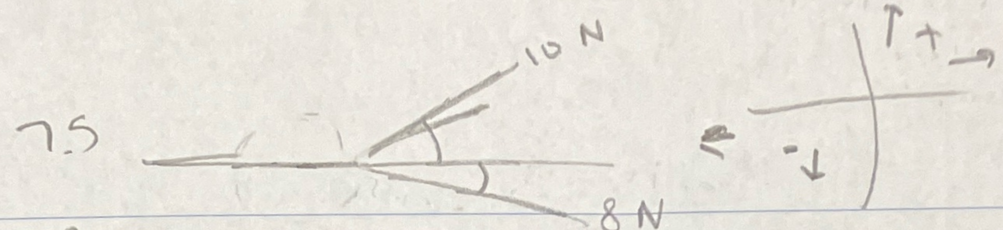
$\left(\frac{-33.33^2}{2}\right) = \frac{2a100}{2} \rightarrow \frac{\left(\frac{-33.33^2}{2}\right)}{100} = a$

$a = -5.56\ ms^{-2}$

b) $F = ma \quad m = 20000\ kg \quad a = -5.56\ ms^{-2}$

$F = (20000)|-5.56| \rightarrow F = 111{,}2000\ N$

Force of tow cable



3. pt 1:

$F_1 = 10\ N \to \uparrow 45°$ $\quad F_2 = 8\ N \to \downarrow$ $\quad$ "F_3" $7.5\ N \leftarrow$

$F_{1x} = 10\cos(45°) = 7.07\ N$ $\quad F_{2x} = 8\cos(30) = 6.93\ N$ $\quad F_3 = 7.5\ X \to -7.5$

$F_{1y} = 10\sin(45°) = 7.07N$ $\quad F_{2y} = 8\sin(30) = -4\ N$

X: $(7.07 + 6.93 - 7.5)$
$F_x = 6.5$

Y: $7.07 - 4 - 0 = 3.07$
$F_y = 3.07$

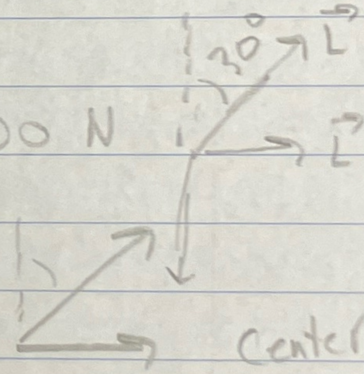
$F_{net} = \sqrt{6.5^2 + 3.07^2} \to \sim 7.19\ N \to a = \frac{F}{m}$

$a = \frac{7.19}{50}$

$a = .1438\ ms^{-2}$

Chapter 6? Pt. 2

a) $m = 6000\ kg$ $\theta° = 30°$ $F_L = 80,000\ N$



$F_{Ly} = 80000\cos(30) = 69282.03\ N$

$F_{Lx} = 80000\sin(30) = 40000\ N$

centripal Force

b) 600 Km/hr 6000 Kg

$r = \frac{mv^2}{F_c}$ $\to$ $\frac{6000 \cdot (166.67)^2}{40000} \to 4166.83\ m$

turn radius

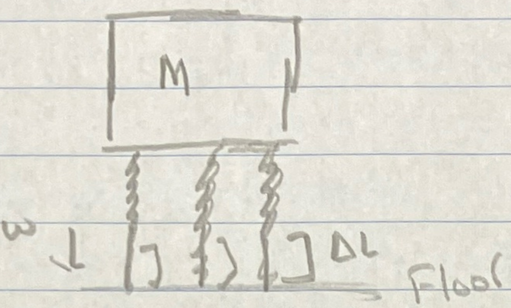
600 Km/hr $\to$ 166.67 m/s

c) $C = 2\pi r \to 2\pi(4166.83) \to 26180.9897$

$\frac{13090.48\ m}{166.67\ ms^{-1}} = 78.54\ s$

Section 3: Unit 2 (Continued)

4. a)



b) Hookes law

$F = K \Delta L$ ⟶ $F = 3K\Delta L$

Constant displacement

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

$F = mg$ ⟶ $\frac{F}{3K} = \Delta L$

⟶ $\frac{mg}{3K} = \Delta L$

c) $\Delta L = \frac{mg}{3K}$ If $K \to \infty$ then $\Delta L \to 0$

If... $mg = 50$ & $K \to \infty$ $\Delta L = \frac{50}{3(100)}$ ⟶ $\Delta L = .167$

$\Delta L = \frac{50}{3(1000)}$ ⟶ $\Delta L = .0167$ $\Delta L = \frac{50}{3(10000)}$ ⟶ 1.67×10^{-3}

$\Delta L = \frac{50}{3(100000)}$ ⟶ $\Delta L = 1.67 \times 10^{-4}$ $\Delta L = \frac{50}{3(1000000)}$ ⟶ 1.67×10^{-5}

as $K \to \infty$ ΔL (displacement) gets smaller & $\Delta L \to 0$

$F_D = \frac{1}{2} C \rho A V^2 \rightarrow$ terminal

5. a) $A = .25 m^2$ $m = 60$ Kg $C = .5$ $\rho = 1.2$

$F_D = mg \rightarrow 9.81 \cdot 60 \rightarrow F_D = 588.6$

$588.6 = \frac{1}{2}(.5)(1.2)(.25) v^2$

$\frac{588.6}{.075} = \frac{.075 v^2}{.075}$

$\sqrt{7848} = \sqrt{v^2} \rightarrow$ $v_{terminal} = 88.59 \ m s^{-1}$

b) $A(100) \rightarrow .25 \cdot 100 \rightarrow 25 \ m^2$ $F_D = \frac{1}{2} C \rho A v_2 \ 100$

$\sqrt{\frac{F_D}{\frac{1}{2} C \rho A} \cdot \frac{1}{100}} = v^2$ $\sqrt{100} = 10$

$v_{terminal} = 8.86$ m/s

$\rightarrow$ 10x smaller b/c the Area's square root is taken to solve for v $\sqrt{100} = 10$

6. 45×10^9 diameter = 20 cm 10m tall 10000 N of weight

$\pi \cdot .1^2 = 1$ $\frac{.2m}{2}$ L_0 F

$\frac{\Delta L}{L_0} = \frac{1}{Y} \frac{F}{A} \cdot 10 \rightarrow \Delta L = \frac{10(10000)}{45 \times 10^9 (\pi \cdot .1^2)}$ $\Delta L = 7.07 \times 10^{-5}$ m or .07 mm

b If new $y = \frac{1}{2}$ old y

$\frac{10(10000)}{45 \times 10^9 (\pi \cdot .1^2) \cdot \frac{1}{2}}$ The new ΔL would be 2x the old one b/c dividing by 1/2 = multiplying by 2

So...

$7.07 \times 10^{-5} \cdot 2 \rightarrow 1.41 \times 10^{-4}$ m or .141 mm

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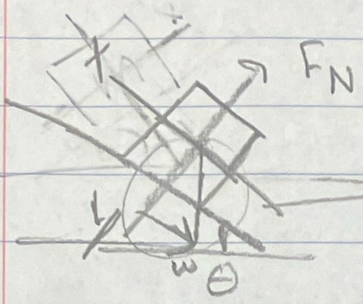
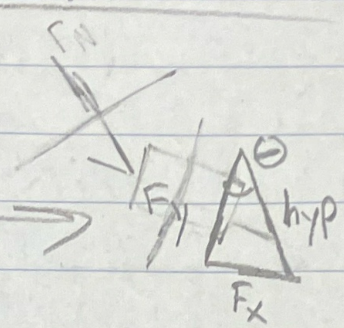
Section 4 Unit 3

1. 



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

$\frac{F_x}{w} = \sin\theta$

$\cos\theta = \frac{a}{h}$

$\cos\theta = \frac{-F_y}{hyp}$

$F_x = w\sin\theta$

~~$F_x = max$~~

opp

$F_y = -w\cos\theta$

$F_N = w\cos\theta$

$f_k = \mu_k F_N$

$f_k = \mu_k w\cos\theta$

$w = mg$

$F_x - f_k = ma_x$

$w\sin\theta - \mu_k w\cos\theta$

$mg\sin\theta - \mu(mg)\cos\theta = ma_x$

$\cancel{m}g(\sin\theta - \mu_k\cos\theta) = \cancel{m}a_x$

$g(\sin\theta - \mu_k\cos\theta) = a_x$

b. $a = g(\sin\theta - \mu\cos\theta)$ $\mu = 0$

$a = g(\sin\theta - \cancel{0\cos\theta})$

$a = g\sin\theta$

12. a) $\theta = 10^\circ$ $\quad g = 9.81$ $\quad \mu_k = .1$ $\quad a = g(\sin\theta - \mu_k \cos\theta)$

$$a = 9.81(\sin 10^\circ - .1 \cos 10)$$

$$a = .737 \text{ ms}^{-2}$$

b) $x(t) = \frac{1}{2}at^2 + v_i t + x_i$ $\quad x_i = 0$ $\quad v_i = 0$ $\quad t = 30\text{s}$ $\quad a = .737 \text{ ms}^{-2}$

$$x(t) = \frac{1}{2}(.737)30^2 + 0$$

$$x(t) = 331.65 \text{ meters}$$ (distance down the slope)