Physics 06 LACC Fa24 70/70 TEST 2 Ch 4-6 Name KEY

Each problem is 5 pts. unless otherwise mentioned. Some formulas are on the last pages.

1. Ch4 (10 pts) An 800kg boat traveling at 10 m/s must come to a stop in 350m. What is the average frictional forces needed to act on the boat to get the job done? {Do not use energy - use kinematics and Newton's Law's}

(i) Diagram and Variables

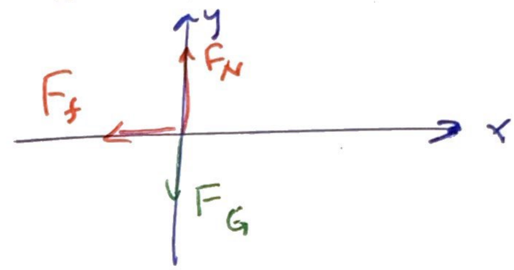

$V_0 = 10\,m/s$

$V_f = 0$

$m = 800\,kg$

$x = 350\,m$

(ii) Freebody Diagram




10 pts

(iii) Equations to use

$F_f = ma$

$v_f^2 = v_0^2 + 2ax$

$\Rightarrow F_f = m\underbrace{\left[\frac{v_f^2 - v_0^2}{2x}\right]}_{a}$

(iv) Do the Math

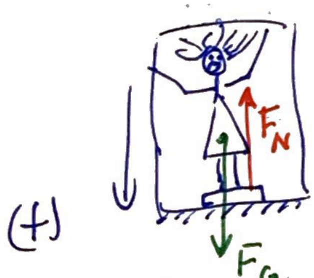
$F_f = 800\,kg\left[\frac{0^2 - (10\,m/s)^2}{2 \cdot 350\,m}\right]$

$= 800\,kg\left[-0.143\,m/s^2\right]$

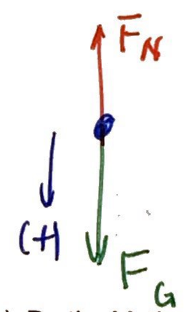
$= \boxed{-114.3\ N}$ opposing motion

2. Ch 4 (10 pts) A 55 kg woman stands on a scale on the floor of an elevator as it starts to descend from rest to a speed of 2 m/s in just 3 seconds. What does the scale's readout show her weight to be? {You get points for following diagram, freebody, equations, solve}.

(i) Diagram and Variables




(ii) Freebody Diagram




10 pts

(iii) Equations to use

- y: $\sum F_y = ma_y$

$-F_N + F_G = ma$

$F_N = F_G - ma$

- $a = \frac{\Delta v}{\Delta t}$

(iv) Do the Math

$a = \frac{V_f - V_0}{\Delta t} = \frac{2\,m/s - 0}{3\,s} = 0.667\,\frac{m}{s^2}$

$F_N = (55\,kg)(9.8\,m/s^2) - (55\,kg)(0.667\,m/s^2)$

$= \boxed{502\,N}$

$\div 9.8 = \boxed{51.3\,kg}$ apparent weight

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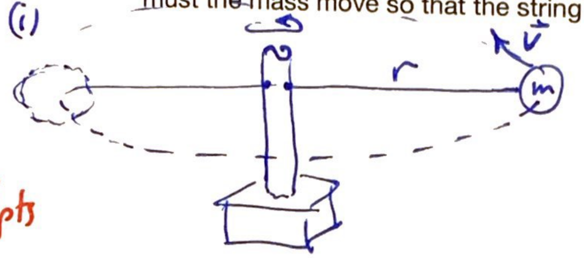
3. Ch 5 (5 pts) A string is used to spin a 1.5 kg mass in a horizontal circle of radius 1.0 m. How fast must the mass move so that the string breaks at it's 100 N limit?

(i)




5pts

(ii)


(iii) $r: \quad \sum F_r = m a_c$

$a_c = v^2/r$

eqn: $F_T - F_c = 0$

(iv) $F_T = m v^2/r$

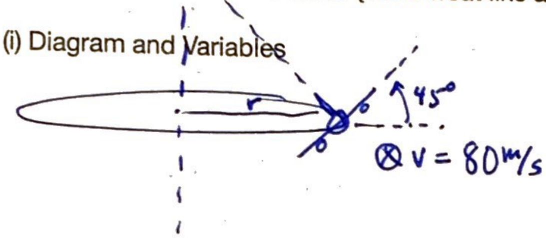
$v = \sqrt{F_T r/m}$

$= \sqrt{(100N)(1.0m)/1.5kg}$

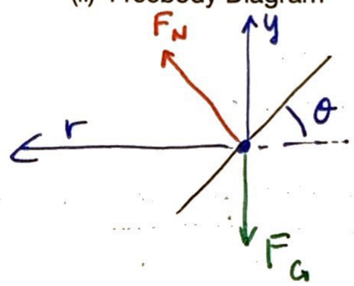
$= \boxed{8.16\ m/s}$

4. Ch 5 (10 pts) A jet fighter traveling at 80 m/s executes a horizontal turn with it's wings banked at 45° inward in such a manner that the pilot is pushed straight down into her seat, perpendicular to her wings. What is the radius of the turn? {Hint: Treat like a compound pendulum}

(i) Diagram and Variables




(ii) Freebody Diagram




10 pts

(iii) Equations to use

$r: \quad \sum F_r = m a_c$

$y: \quad \sum F_y = m a_y^{\,0}$

$r: \quad F_N \sin\theta = m \frac{v^2}{r}$

$y: \quad F_N \cos\theta - F_G = 0$

(iv) Do the Math

$\frac{mg}{\cos\theta} \sin\theta = m\frac{v^2}{r}$

$\Rightarrow g\tan\theta = v^2/r$

$$\boxed{r = \frac{v^2}{g\tan\theta}}$$

$$r = \frac{(80m/s)^2}{(9.8m/s^2)\tan 45°}$$

$= \boxed{653\ m}$

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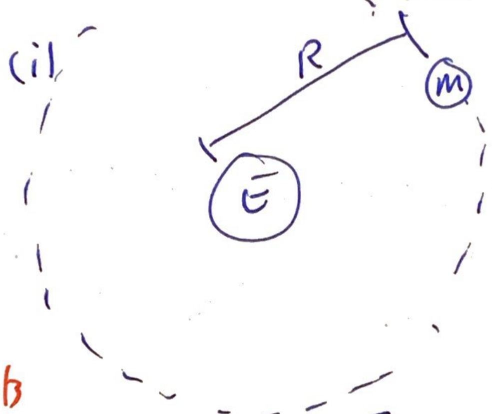
Physics 06 LACC Fa24        TEST 2   Ch 4-6        Name KEY

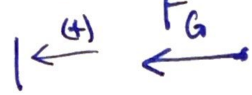
5. Ch 5 (10 pts) The Moon orbits the Earth once every 27.3 days. Calculate the center of the Earth to the center of the Moon? {$M_{earth} = 5.97 \times 10^{24}$ kg, $G = 6.67 \times 10^{-11}$ N m$^2$ /kg$^2$ use Kepler's Law}

(i)




10 pts

(ii)




(iii) • r: $\sum F_r = m a_c$

$\hookrightarrow F_G = m_m \frac{V^2}{R}$

• $G \frac{M_e m_m}{R^2} = m_m \frac{V^2}{R}$

• $V = \frac{2\pi R}{T}$

(iv) $G \frac{M_e}{R^2} = \frac{4\pi^2 R^2}{T^2 R}$

$\Rightarrow \boxed{\frac{G M_e}{4\pi^2} = \frac{R^3}{T^2}}$ ← can start here

Kepler's Law

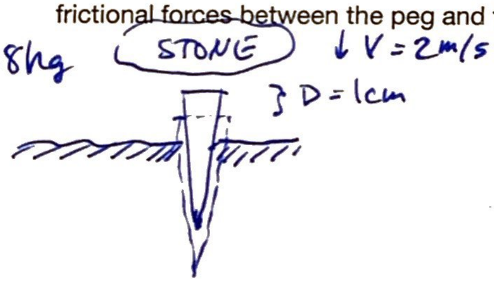
$$R = \sqrt[3]{T^2 \left(\frac{G M_e}{4\pi^2}\right)}$$

$$= \left[\left(27.3d\left(\frac{24hr}{d}\right)\left(\frac{3600s}{hr}\right)\right)^2 \frac{(6.67\times10^{-11})(5.97\times10^{24})}{4\pi^2}\right]^{1/3}$$

$$= \boxed{382,852 \text{ km}}$$

6. Ch 6 (10 pts) A 1.8 kg stone traveling at 2 m/s impacts a tent peg partially embedded in the moist dirt. The stone comes to a halt after driving the peg a further 1 cm into the dirt. What was the average frictional forces between the peg and the dirt? { Now you can use energy and work}

(i)



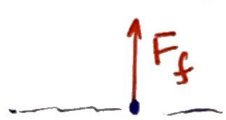

(iii) Before Contact energy

= Work needed to drive peg.

$\boxed{K_0 + P_0 = K_f + P_f + W}$

$\frac{1}{2} m v_0^2 + mgD = 0 + 0 + \overbrace{F_f \cdot D}^{\text{Work by friction}}$

(ii)




10 pts

(iv) $F_f = \frac{\frac{1}{2} m V_0^2 + mgD}{D}$

$= \frac{\frac{1}{2}(1.8)(2)^2}{0.01m} + (1.8)(9.8)$

$= 360 \text{ N} + 17.6 \text{ N}$

$= \boxed{377 \text{ N}}$

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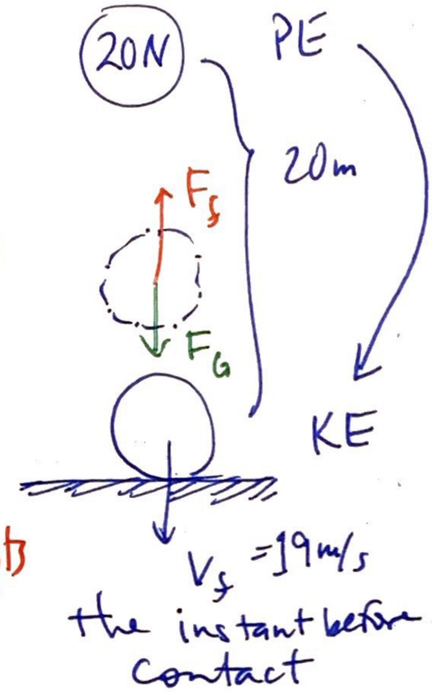
7. Ch 6 (10 pts) A 20-N stone is dropped from a height of 20 m and strikes the ground with a speed of 19 m/s. What was the average force of air friction acting on the stone as it fell? {Hint: use energy balance between the initial state and the final state}

(i)

(ii)




10pts

(iii)

$$\boxed{PE_0 + KE_0 = PE_f + KE_f + Work}$$

$$mgH + 0 = 0 + \tfrac{1}{2}mv^2 + F_f \cdot H$$

would be zero if no friction

(iv)

$$F_f = \frac{mgH - \frac{1}{2}mv^2}{H}$$

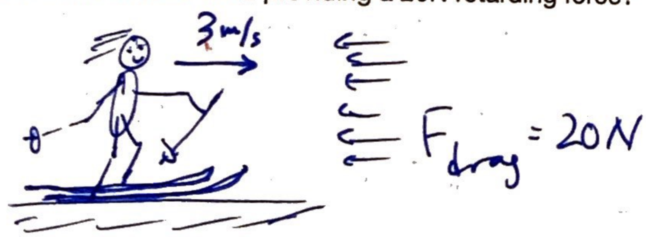
$$= \underbrace{mg}_{F_G} - \frac{\frac{1}{2}\left(\frac{F_G}{g}\right)(v^2)}{H}$$

$$= 20N - \frac{\frac{1}{2}\left(\frac{20N}{9.8}\right)(19)^2}{20m}$$

$$= 20N - 18.42N$$

$$= \boxed{-1.58N} \text{ opposing motion}$$

8. Ch 6 ( 5 pts) What is the average net power a cross country skier's body needs to expend while skiing 3 m/s into a head wind providing a 20N retarding force?




$$\boxed{P = Fv}$$

$$= (20N)(3m/s)$$

$$= 60 \text{ J/sec}$$

$$= \boxed{60 \text{ Watts}} \text{ expended}$$

to maintain 3m/s ground speed

5pts

15

# EQUATIONS

Chpt 4,5,6

- Newt's Laws: $\sum F_x = ma_x$, $F_{spring} = -k\Delta x$
  $\sum F_y = ma_y$
- Friction: $f = \mu N$
- Centripetal acc'ln: $a = \frac{V_{Tan}^2}{R}$, $V_{Tan} = \frac{2\pi R}{T}$, $f = \frac{1}{T}$
  frequency
  ← period of rot'n.
- Gravitation: $F = G\frac{Mm}{R^2}$   Kepler's Law: $\frac{GM}{4\pi^2} = \frac{R^3}{T^2}$
- Work: $W = Fd\cos\theta$

$KE = \frac{1}{2}mv^2$, $PE_{grav} = mgh$, $PE_{spring} = \frac{1}{2}k\Delta x^2$

$$\boxed{PE_1 + KE_1 + W_{applied} = PE_2 + KE_2}$$ Cons. of Energy

- Power: $P = \frac{Energy}{time}$, Efficiency: $e = \frac{P_{out}}{P_{in}}$

$$P = \frac{W}{t} = \frac{Fd}{t} = F\vec{v}$$

EQUATIONS    Chpt 2-3

ave vel: $\bar{v} = \frac{\Delta x}{\Delta t}$

ave acc'ln: $\bar{a} = \frac{\Delta v}{\Delta t}$

1-Dim

$V = V_0 + at$

$x = x_0 + V_0 t + \frac{1}{2}at^2$

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

$\bar{V} = \frac{V + V_0}{2}$

2-Dim

| x-comp | y-comp't. |
|---|---|
| $V_x = V_{0x} + a_x t$ | $V_y = V_{0y} + a_y t$ |
| $x = x_0 + V_{0x} t + \frac{1}{2}at^2$ | $y = y_0 + V_{0y} t + \frac{1}{2}at^2$ |
| $V_{fx}^2 = V_{0x}^2 + 2a\Delta x$ | $V_{fy}^2 = V_{0y}^2 + 2a\Delta y$ |
| $\bar{V}_x = \frac{V_x + V_{0x}}{2}$ | $\bar{V}_y = \frac{V_y + V_{0y}}{2}$ |

Range Eqn: $R = \frac{V_0^2 \sin 2\theta}{g}$

Time of Flight from ground to ground: $t = \frac{2V_{0y}}{g}$

- Hieght Eqn: $H = \frac{V_{0y}^2}{2g}$
- Relative Velocity:

$$\sin\theta = \frac{V_{\text{water wrt. shore}}}{V_{\text{Boat wrt. water}}}$$