HT #2 4-9-09

10/10

1. a) Work energy theorem states that the work done by the net force on an object moving from point A to point B on a particular path, is equal to the change in Kinetic energy

5/5

$$W_{net} = \int_A^B \vec{F}_{net} \cdot d\vec{s} = \frac{1}{2} m v_B^2 - \frac{1}{2} m v_A^2$$

this is true whether the forces are conservative or not.

3/3

b) If the forces are all conservative, then a potential energy can be defined that is independent of the path from $A \to B$

$$W_{net} = \int_A^B \vec{F}_{net} \cdot ds = U(A) - U(B)$$

in this case $U(A) + KE(A) = U(B) + KE(B) \equiv E$

example: the force of gravity mechanical Energy

2/2

c) If a force is non conservative the mechanical energy is not constant. The integral $\int \vec{F} \cdot d\vec{s}$ depends on the path, and a potential energy can not be defined

Exam 2 4-9-04 1230-1530

1. a: work energy theorem:

5/5 For a particle travelling in a trajectory determined by the net force $\vec{F}_{Net}$, The change in kinetic energy is equal to the work performed by $\vec{F}_{NET}$

$$\int_A^B \vec{F}_{Net} \cdot \vec{dl} = \frac{1}{2} m v_B^2 - \frac{1}{2} m v_A^2$$

net force	2 pts
KE ch.	2 pts
work	1 pt

if pot'l energy is mentioned, and work de-emphasized, then 2/5

work A → B = pot'l En A → B, forgets KE → 2/5

b) Example with conservative forces

3/3 A: if the external force is gravitational, and the internal forces do no work, then the change in KE (from A → B) does not depend on the path between A & B

2/3 if change in KE is not mentioned.

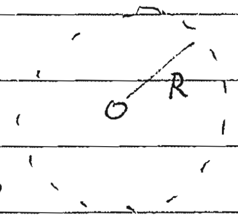
c) Example with a non conservative force

2/2 A: the change in KE will depend on path. Friction.

1/2 If states that friction is non conservative, but nowhere a good definition of why it is non conservative.

11/11 2. Planet circling Sun

a)



$$\frac{m v^2}{R} = \frac{m M G}{R^2}$$ (2)

centrip accel

4/4

$$\frac{1}{2} m v^2 = \frac{1}{2} \frac{m M G}{R}$$

$$= \frac{\frac{1}{2} \times 0.330 \times 10^{6} \times 1.99 \times 10^{30} \times 6.67 \times 10^{-11}}{57.6 \times 10^{9}}$$ (2)

$$\boxed{KE = 3.84 \times 10^{14}\ J}$$

2/4 if remembers wrong formula
2/4 if $E = F \cdot r$
2/4 " KE is negative

b) Gravit'l Pot'l En $= U = -\frac{m M G}{R} = -7.68 \times 10^{14}$ J

3/3

2/3 if − sign missing

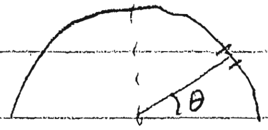
c) Total E = $U + KE = -\frac{1}{2}\frac{m M G}{R} = -3.84 \times 10^{14}$ J

2/2

d) Physical Sign: The Total energy is negative, which means that unless additional KE is given to the planet, it cannot escape the attachement to the sun.

2/2 1/2 if states: PE is larger than KE

3.



$dm = \lambda\, ds$ $\cancel{2}$ 1

$ds = r\, d\theta$ $\cancel{2}$ 1

set up

4

$\int y\, dm = y_{cm} \cdot m$ 2

$\overline{4}$

execution :

6

$m = \frac{2\pi r}{2} \times \lambda$ 1

$y = r \sin\theta$ 1

5

$\int y\, dm = \int_{\theta=0}^{\pi} r \sin\theta \cdot \lambda \cdot r\, d\theta = r^2 \lambda \underbrace{\int \sin\theta\, d\theta}_{-\cos\theta \big|_0^{\pi} = 2}$ 2

1

$\int y\, dm = y_{cm} \cdot m$

$2r^2 \cancel{\lambda} = y_{cm} \cdot \pi r \times \cancel{\lambda}$ 1

$y_{cm} = \frac{2r^2}{\pi r} = \frac{2}{\pi} r$ QED

Factor r left out $-2- \rightarrow 8/10$

If treats like a straight rod, ~~4/10~~ 3/10

integral is wrong: -2 8/10

4/10 has trouble with dm, & integ

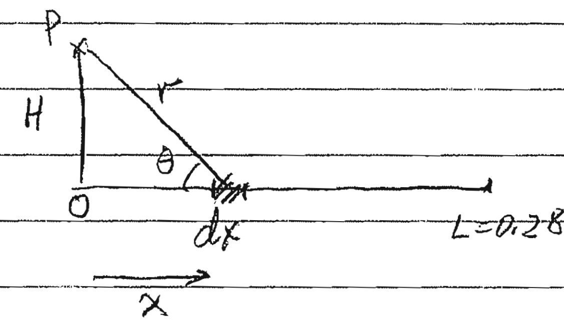
3/10 if curvature not taken into acct

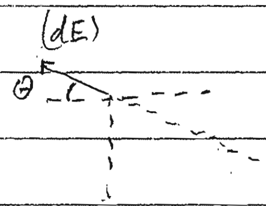
Bonus +4

+1 up to the point where $dm = (\lambda r\, d\theta)$ no longer val.

ANSWER $Y_{CM} = \frac{4}{3\pi} R$

4.





$$(dE) = k\frac{(dq)}{r^2}\hat{r} \quad ②$$

$$(dE)_x = (dE)\cos\theta = \quad ①$$

$$\cos\theta = \frac{x}{r} \quad ①$$

$$dq = \lambda\, dx \quad ①$$

$$(dE)_x = k\frac{\lambda\, dx}{r^2}\cdot\frac{x}{r} = k\lambda\frac{x\,dx}{(H^2+x^2)^{3/2}}$$

a) $$\underset{②}{E_x =} \int \underset{①}{(dE)_x} = k\lambda\int_0^L \frac{x\,dx}{(H^2+x^2)^{3/2}}$$

8/8

if $E = k\frac{Q}{x^2}$ — 3/8 + ~~terrible time with integrals~~

2/8 if integral not set up properly } 5/8 if $\frac{dQ}{r}$ forgot $\sin\theta$

6/8 if forgot factor x/r

5/8 if $\frac{dx}{(h^2+L^2)^{3/2}}$

b) since $$\int_0^L \frac{x\,dx}{(H^2+x^2)^{3/2}} = -\frac{1}{(H^2+x^2)^{1/2}}\Bigg|_0^L$$

3/3 find $$E_x = k\lambda\left(\frac{1}{H} - \frac{1}{(H^2+L^2)^{1/2}}\right)$$

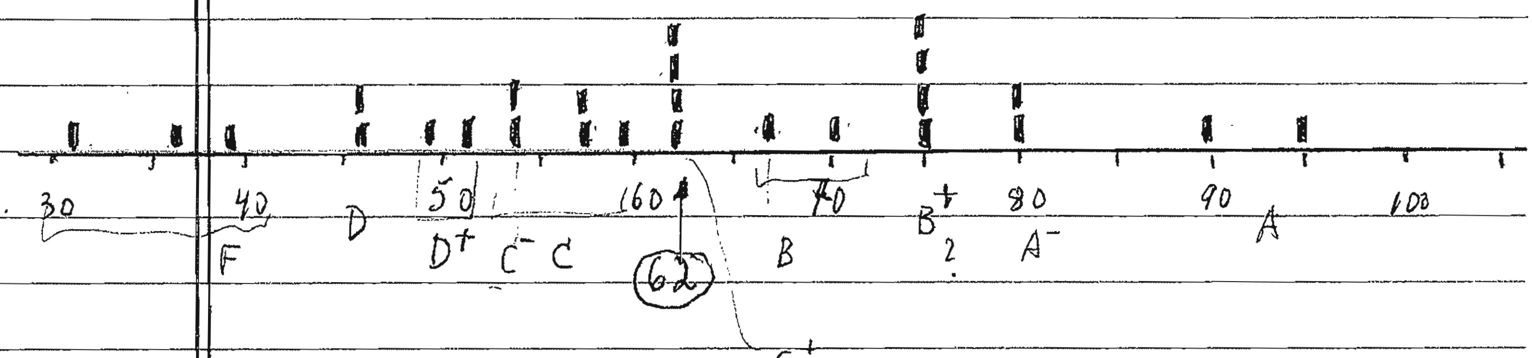
when $H \gg L$ $$\frac{1}{(H^2+L^2)^{1/2}} = \frac{1}{H\left[1+(L/H)^2\right]^{1/2}} = \frac{1}{H}\left[1-\frac{1}{2}\frac{L}{H^2}\right]$$

$$E_x = k\lambda \times \frac{1}{2}\frac{L}{H^3}$$ but $\lambda L = Q$ = charge on rod

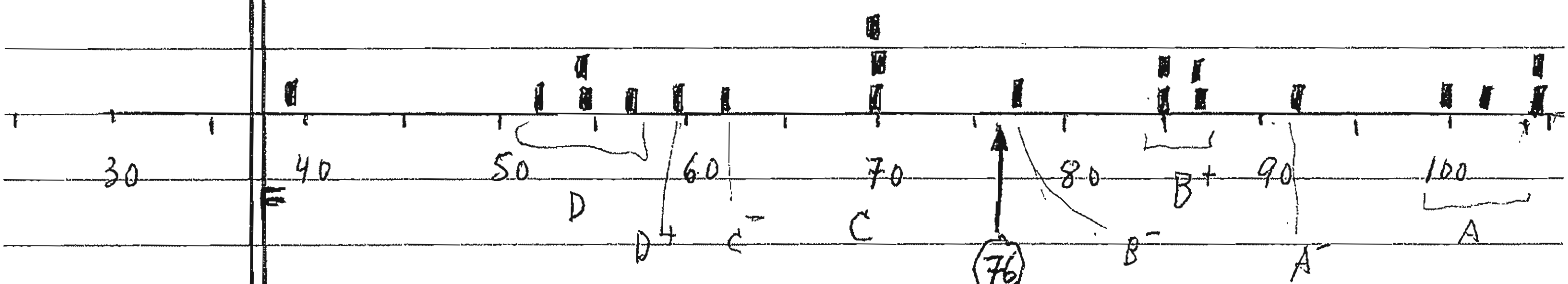
$$\boxed{E_x = \frac{kQ}{2H^3}}$$

HT #2 4-9-09 1230 + 1530

1230



1530



Average $\frac{74 \times 10 + 78 \times 10}{20}$ $\frac{15.2}{20} =$ 76