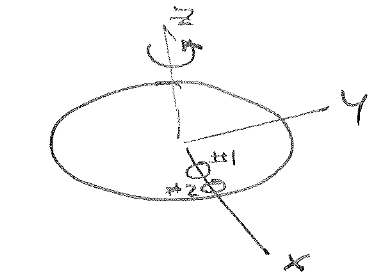
Physics 160

Extra Credit #22

LADYBUGS



a) Angular Speeds? → THE SAME! All points HAVE SAME Angular velocity

b) Ratio of $\frac{V_2}{V_1} = ?$

$V_2 = \omega r_2,\ V_1 = \omega r_1 \Rightarrow \frac{V_2}{V_1} = \frac{\omega r_2}{\omega r_1} = \frac{r_2}{r_1}$

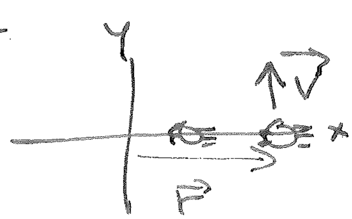
r_2 is twice $r_1 \Rightarrow \frac{V_2}{V_1} = 2$

c) $\frac{a_2}{a_1} = ?$ THE SHOULD HAVE been MORE CAREFUL & let us KNOW THAT THE Angular velocity is Constant OR ONLY wanted LINEAR ACCELERATION to be a_{rad}

$a_{rad} = \frac{V^2}{r} = \omega^2 r \Rightarrow \frac{a_2}{a_1} = \frac{\omega^2 r_2}{\omega^2 r_1} = \frac{r_2}{r_1} = 2$

d) Direction at $\vec{\omega}$. BY RHR, $\vec{\omega}$ is Along +Z AXIS

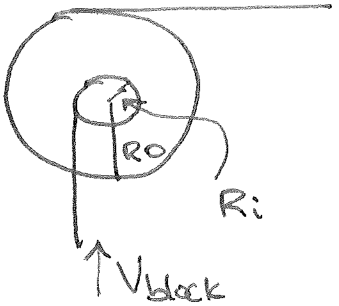
e) Direction of $\vec{a}_{tan}$? THEY ARE Standing ON X-AXIS. So if we just DRAW X/Y plane



$\vec{V}$ is 90° to $\vec{r} \Rightarrow \vec{V}$ is Along Y-AXIS.

Slowing DOWN ⇒ $\vec{a}_{tan}$ opposite to $\vec{V} \Rightarrow -Y$ AXIS

Linear ... Ranking test



Here, THE PULLEY HAS ONE Angular Velocity, SO THE Pulling Rope AND Block's Rope HAVE to HAVE the SAME Angular velocity

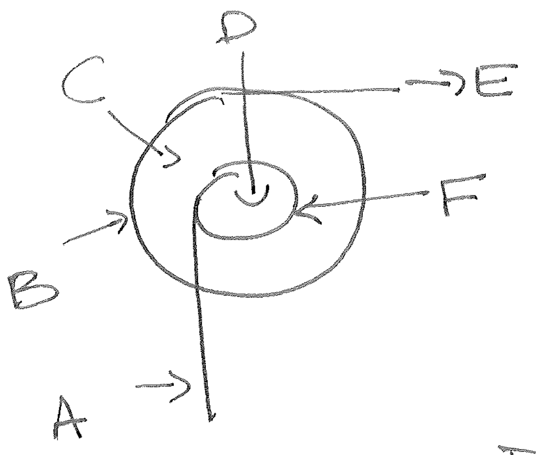
$$V = \omega r \Rightarrow \omega = \frac{V}{r} \Rightarrow \frac{V_{pull}}{R_O} = \frac{V_{BLOCK}}{R_i} \Rightarrow V_{BLOCK} = \frac{R_i}{R_O} V_{pull}$$

(R_O ← outer, R_i ← inner)

So FIND $\frac{R_i}{R_O}$ for each: $\frac{R_i}{R_O} = \frac{0.2}{0.4} = 0.5$, $\frac{R_i}{R_O} = \frac{0.2}{0.6} = 0.33$

$\frac{R_i}{R_O} = \frac{0.5}{0.6} = 0.833$, $\frac{R_i}{R_O} = \frac{0.3}{0.4} = 0.75$, $\frac{R_i}{R_O} = \frac{.1}{.2} = 0.5$, $\frac{R_i}{R_O} = \frac{0.4}{0.8} = 0.5$

Rank Accordingly



RANK BASED ON LINEAR Speeds.

$V = \omega r \Rightarrow$ Bigger $r \Rightarrow$ Bigger v

D at Center $\Rightarrow V = 0$, B ON Edge $\Rightarrow$ largest

F is Between. C is Between F & B.

Finally linear speed of Rope at A must be same As F since it touches pulley at SAME RADIUS.

Pulling Rope at E MUST Be SAME As B SINCE E & B at SAME RADIUS

Largest E B } C } A F } D smallest

RADIAL Acceleration : $a_{rad} = \omega^2 r$ For points that Are going AROUND Circle. A & E ARE going in straight LINE $\Rightarrow$ Zero a_{rad}

$\Rightarrow$ SAME RANKing But with E & A at Smallest

Largest B } C } F } E A D smallest

Acceleration in UltraCentrifuge

$a_{rad} = \omega^2 r$ $\qquad a_{rad} = 6\times10^5 g = 6\times10^5(9.8\,m/s^2) = 5.88\times10^6\,m/s^2$

$r = 3cm = 0.03m$

$\omega^2 = \dfrac{5.88\times10^6\,m/s^2}{0.03m} = 1.96\times10^8/s^2$

$\omega = \sqrt{1.96\times10^8/s^2} = 14000/s$ ← insert RAD when needed

$\omega = 14000\,\dfrac{rad}{s} \times \dfrac{rev}{2\pi\,rad} \times \dfrac{60s}{min} = 133690\,RPM = 134000\,RPM$