P2A

(1

10-23-13

Test 2 (Oct 30 2013) (WED.)

see sample test 2

at link "2D motion/Newton's Laws"

or "Newton's Law applications."

Test 2 Resources:

(1) sample test 2

(2) list of every problem I did during lecture

→ from ch 3, 4, 5, 6

and 7 ($KE_i + mgy_i = KE_f + mgy_f$)

and $\Sigma F_R = \frac{mv^2}{R}$

#87, ch 7

CH10

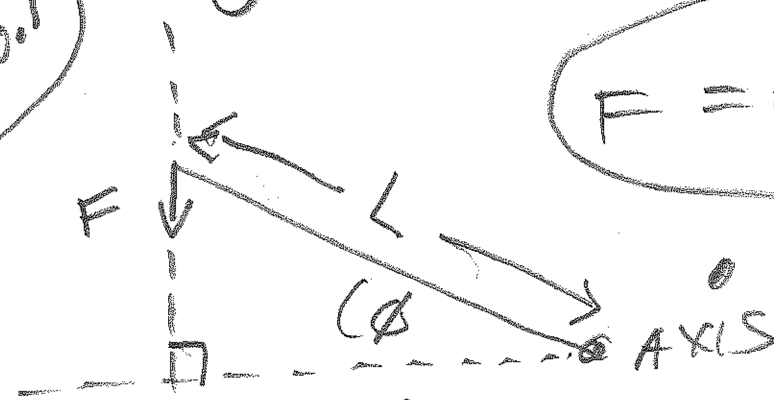
Rotational Dynamics

WHY THINGS ROTATE:

using TORQUE.

Example 10.1

$F = |\vec{F}|$ $\downarrow \vec{F}$



$r_\perp$ = moment ARM

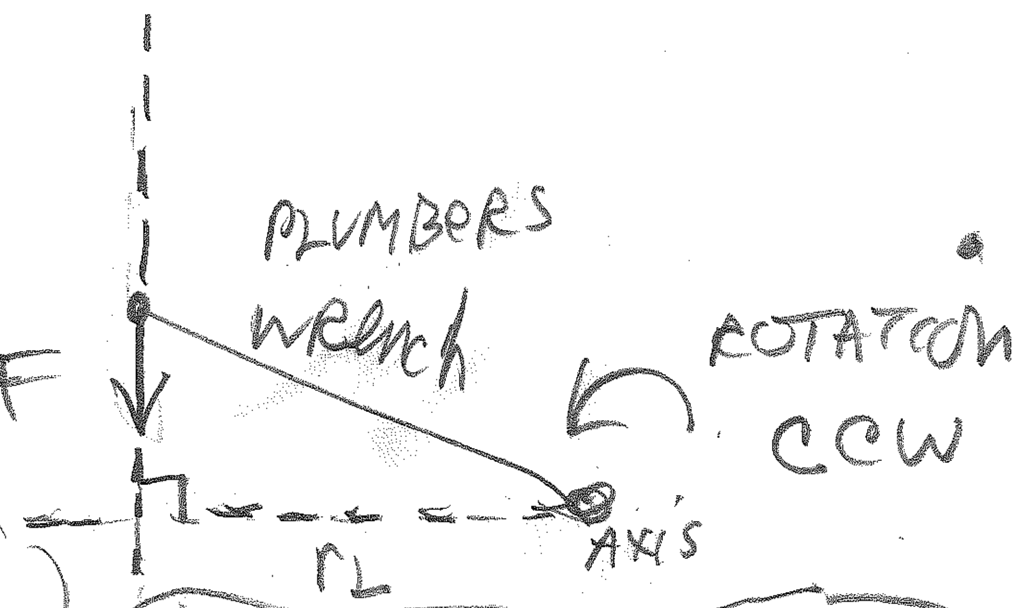
$|\vec{\tau}| = r_\perp \cdot F$

$|\vec{\tau}| = L \cdot \cos\phi \cdot F$

$\vec{\tau}$ = TORQUE

(1) DRAW line of FORCE ACTION

(2) DROP a $\perp$ from AXIS TO line of action.

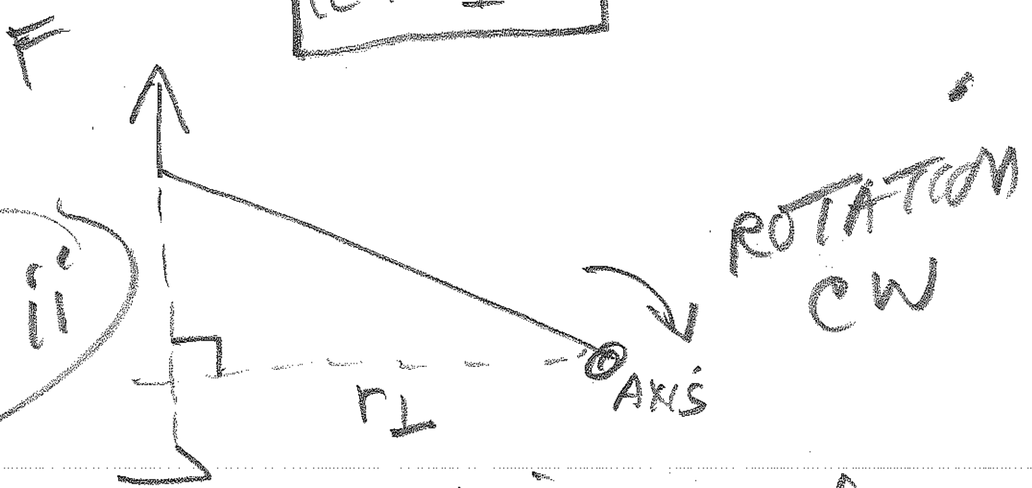


case i

$\hat{\tau}$ points OUTWARD from plane of page

$\odot$ OUT

$|\vec{\tau}| = r_\perp \cdot F$



case ii

$\otimes$ IN

$\hat{\tau}$ points INWARD from plane of page

$\vec{\tau}$ causes ↺ CCW ROTATION: $\vec{\tau}$ is OUT.

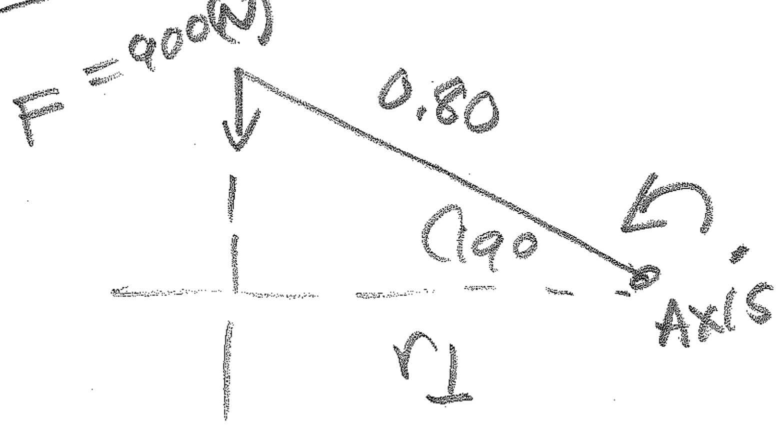
$\vec{\tau}$ causes ↻ CW ROTATION: $\vec{\tau}$ is IN.

$\vec{\tau}$ causes ↺ , τ is positive

$\vec{\tau}$ causes ↻ , τ is negative

τ = "component" IN OR OUT of page.

Example 10.1



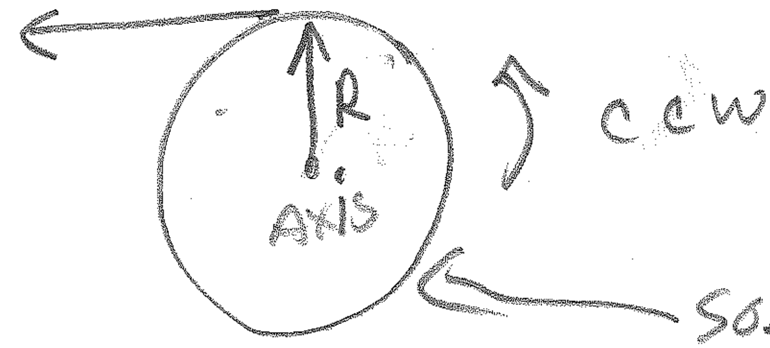
$\tau = r_\perp \cdot F = (0.80)\cos 19° \cdot (900\,N)$

$= +\ 680\ N \cdot m > 0$

↺ CCW ROTATION

sec. 10.2

TOP VIEW



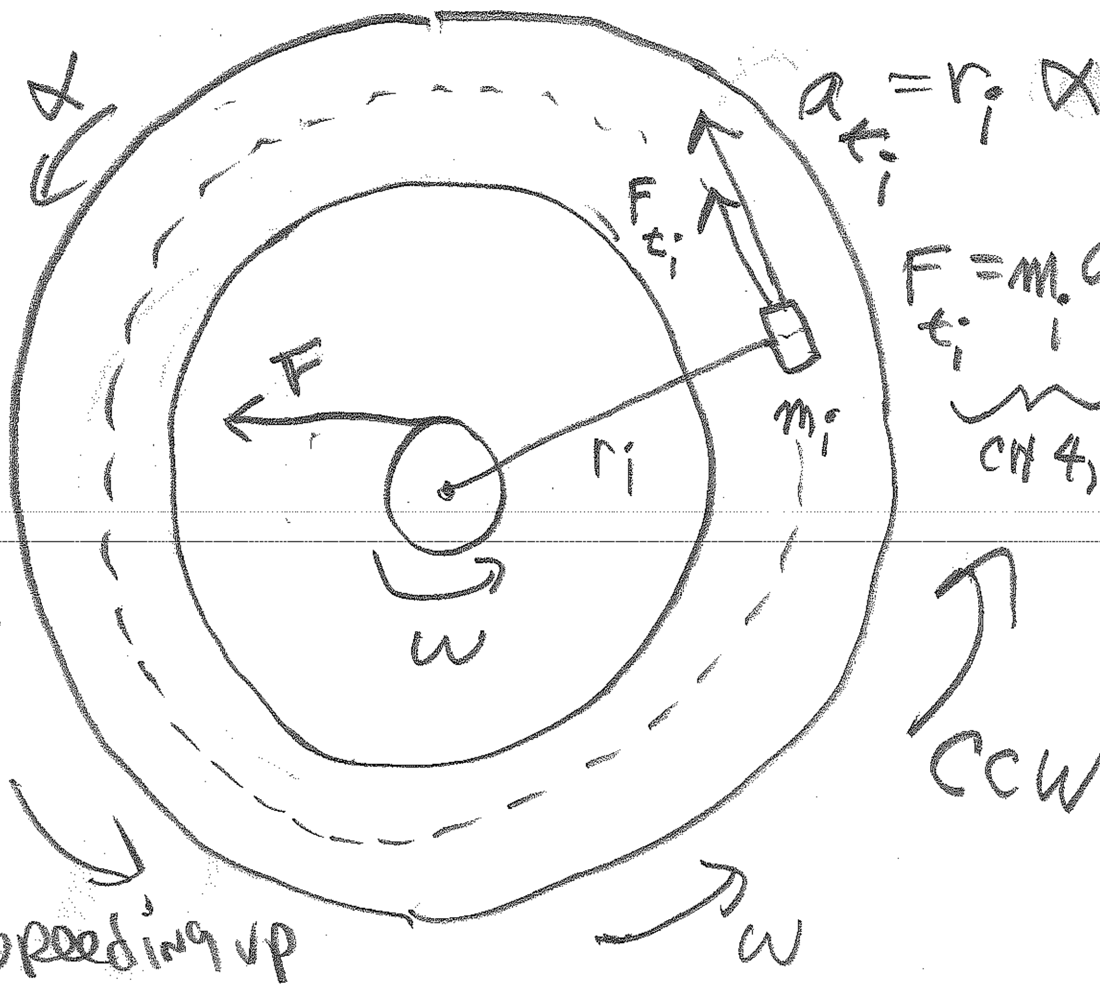
we derive newton's 2ND LAW

i_{th} Fe molecule

m_i = MASS molecule

$i = 1, 2, \ldots 6 \times 10^{25}$

F speeds up system



$a_{t_i} = r_i \alpha$

$F_{t_i} = m_i a_{t_i}$

CH 4,5

$\tau_i = r_i \cdot F_{t_i}$ CH 10 (TORQUE)

$\tau_i = r_i \cdot m_i a_{t_i}$

$\tau_i = r_i \cdot m_i \cdot r_i \alpha$

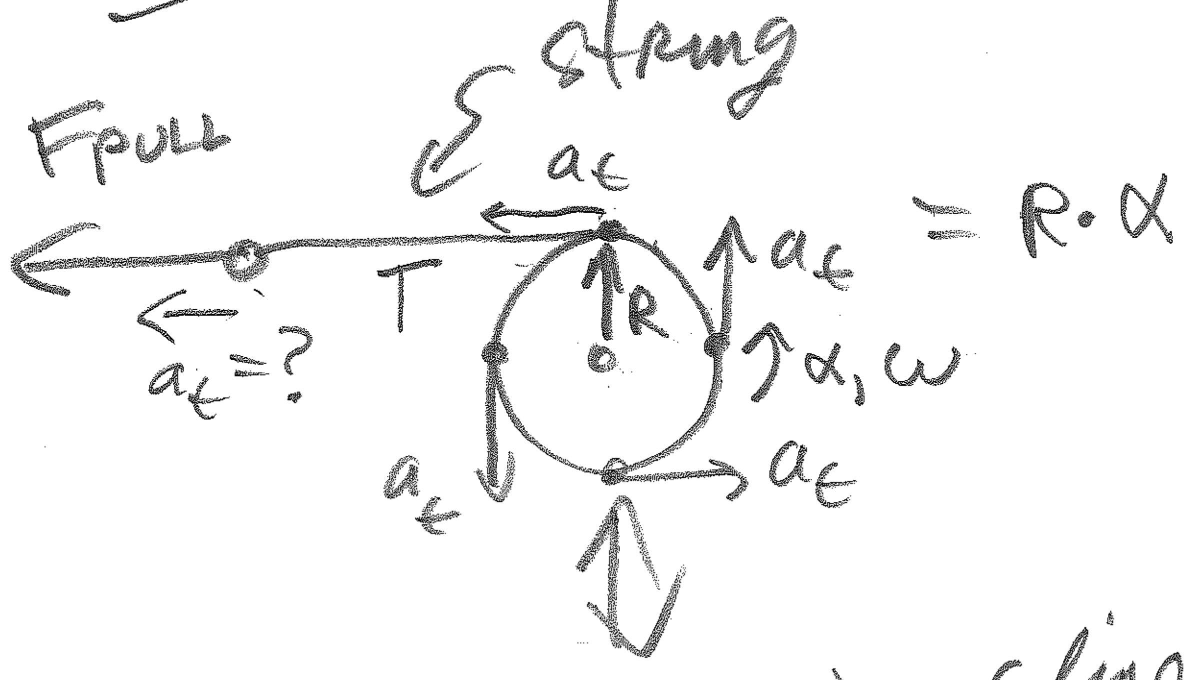
$\tau_i = r_i^2 \cdot m_i \cdot \alpha$

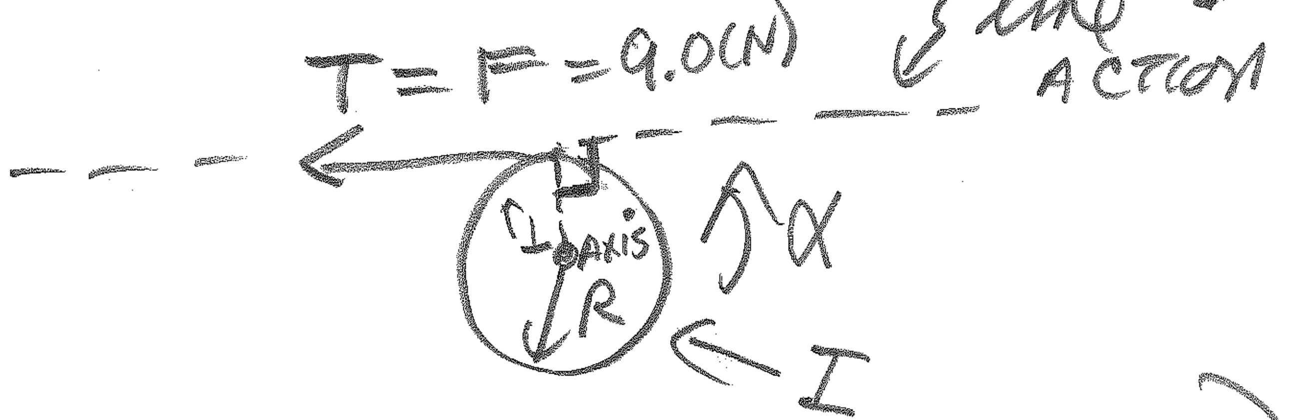
TOTAL TORQUE $= \sum_{i=1}^{N} \tau_i$; $N = 6 \times 10^{25}$

TOTAL TORQUE $= \sum_{i=1}^{N} r_i^2 m_i \alpha = \boxed{\alpha \cdot \sum_{i=1}^{N} m_i r_i^2}$

BUT $I = \sum m_i r_i^2 \rightarrow$ $\boxed{\text{TOTAL TORQUE} = I \cdot \alpha}$

Example 10.2 pg 299



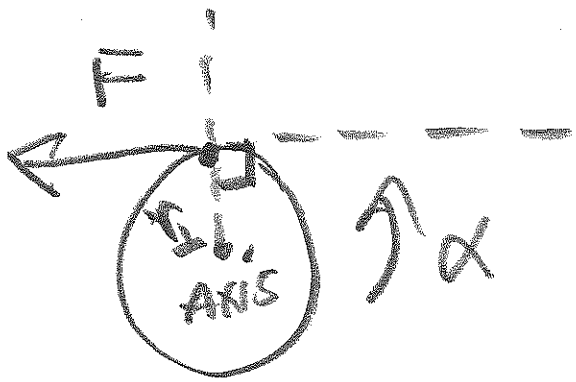


$$\tau = r_\perp \cdot F \leftrightarrow (r_\perp = R)$$

$$\tau = R \cdot F$$

$$\boxed{R \cdot F = I \cdot \alpha}$$

18



$\sum \tau = ↺ - ↻$

$\sum \tau = \text{pos} - \text{neg}$

$I \cdot \alpha = r_\perp \cdot F - 0$

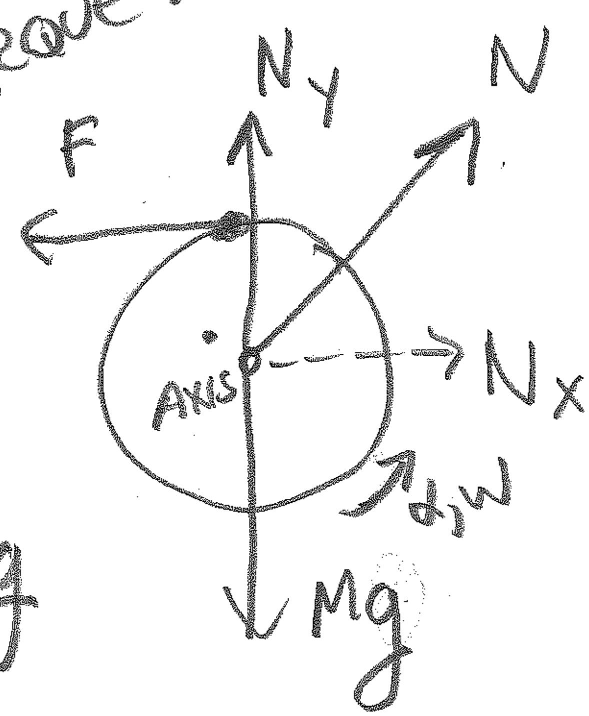
$I \cdot \alpha = R \cdot F$

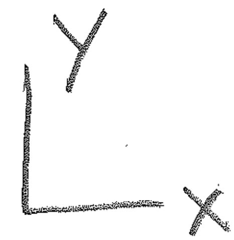
$$\alpha = \frac{R \cdot F}{I} = \frac{(0.06\,m)(9.0\,N)}{\frac{1}{2}(50\,kg)(0.06\,m)^2}$$

$$= \frac{2 \cdot (9)}{(50)(0.06)} = \boxed{6 \frac{RAD}{s^2}}$$

Net FORCE = 0

Net TORQUE ≠ 0





$\Sigma F_y = 0$

$0 = N_y - Mg$

$N_Y = Mg$

$\Sigma F_x = 0$

$0 = F - |N_x|$

$|N_x| = F$

SINCE $\vec{N}$ and $\vec{Mg}$ act at AXIS, they DO <u>NOT</u> cause TORQUE about AXIS:

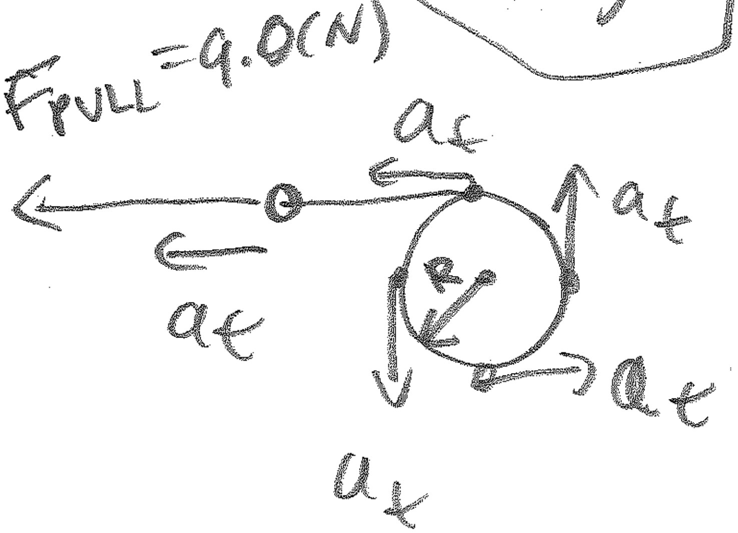
<u>ignore</u> N and Mg.

ONLY F acting at <u>RIM</u> causes TORQUE.

$a_t = R \cdot \alpha$

$a_t = (0.060\,m)\left(6\,\frac{RAD}{s^2}\right)$

$a_t = 0.36\,\frac{m}{s^2}$



Example 9.7: WORK = F·S

$F \cdot S = (9N)(2m) = 18J$

$18J = \frac{1}{2} I\omega^2 \Rightarrow \omega = 20\,RAD/s$

$V_t = R \cdot \omega = (0.060\,m)\left(20\,\frac{RAD}{s}\right) = 1.2\,m/s$

$V_t^2 = 2 \cdot a_t \cdot \Delta X \Rightarrow a_t = \frac{V_t^2}{2\Delta X} = \frac{(1.2)^2}{(2)(2)} = 0.36\,\frac{m}{s^2}$

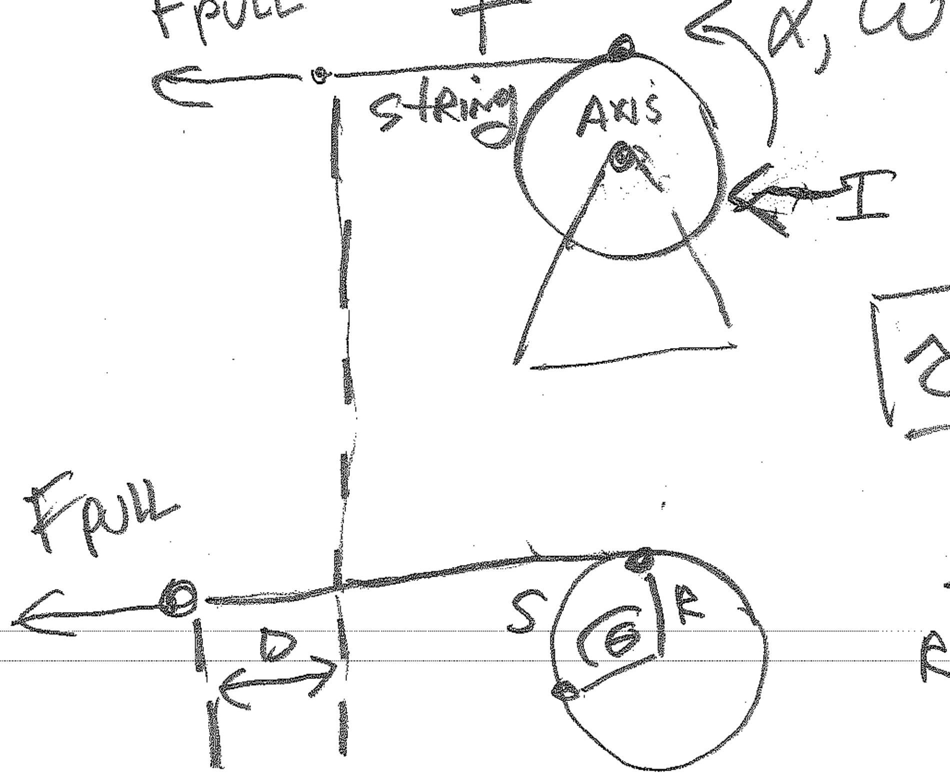
eNZ

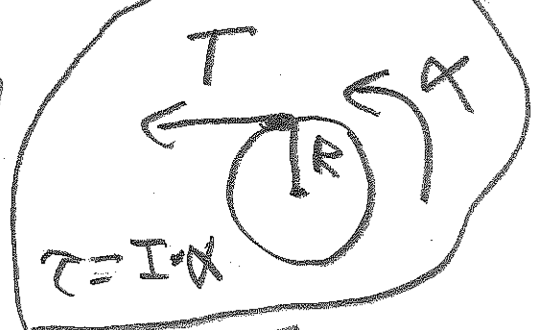
compare: example 10.2

and example 9.7 (see previous page at bottom)

<u>sec 10.3</u>

$F_{PULL} = T$ = tension in string





$$\boxed{\tau = R \cdot T}$$

$$S = D$$

$$R \cdot \theta = D$$

$\tau \cdot \theta$ = ROTATIONAL WORK $= W_{ROT}$

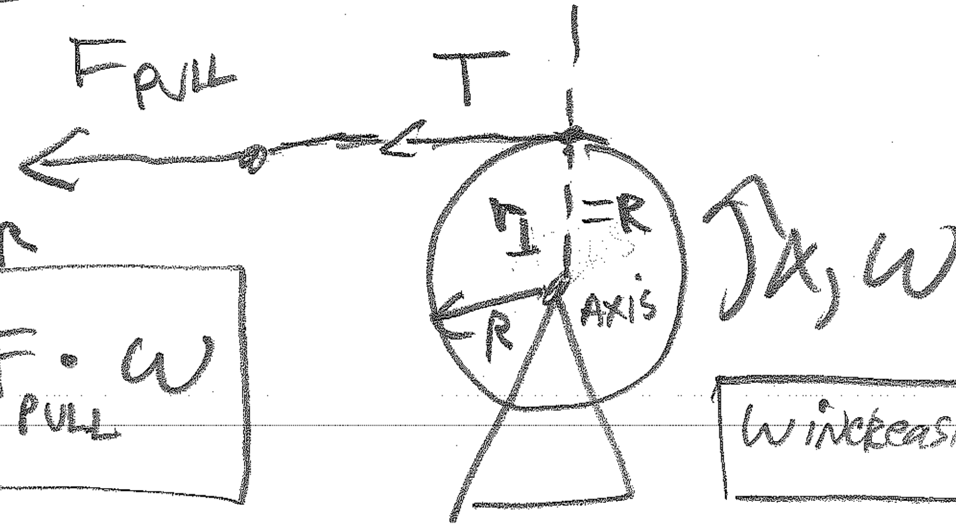
$$W_{ROT} = \tau \cdot \Delta\theta \quad (\theta = \Delta\theta)$$

$$\text{Power} = \frac{W_{ROT}}{\Delta t}$$

$$\text{Power} = \frac{\tau \cdot \Delta\theta}{\Delta t} = \tau \cdot \frac{\Delta\theta}{\Delta t}$$

$$\frac{\Delta\theta}{\Delta t} = \omega$$

$$\boxed{\text{Power} = \tau \cdot \omega}$$



Power

$$\boxed{P = R \cdot F_{PULL} \cdot \omega}$$

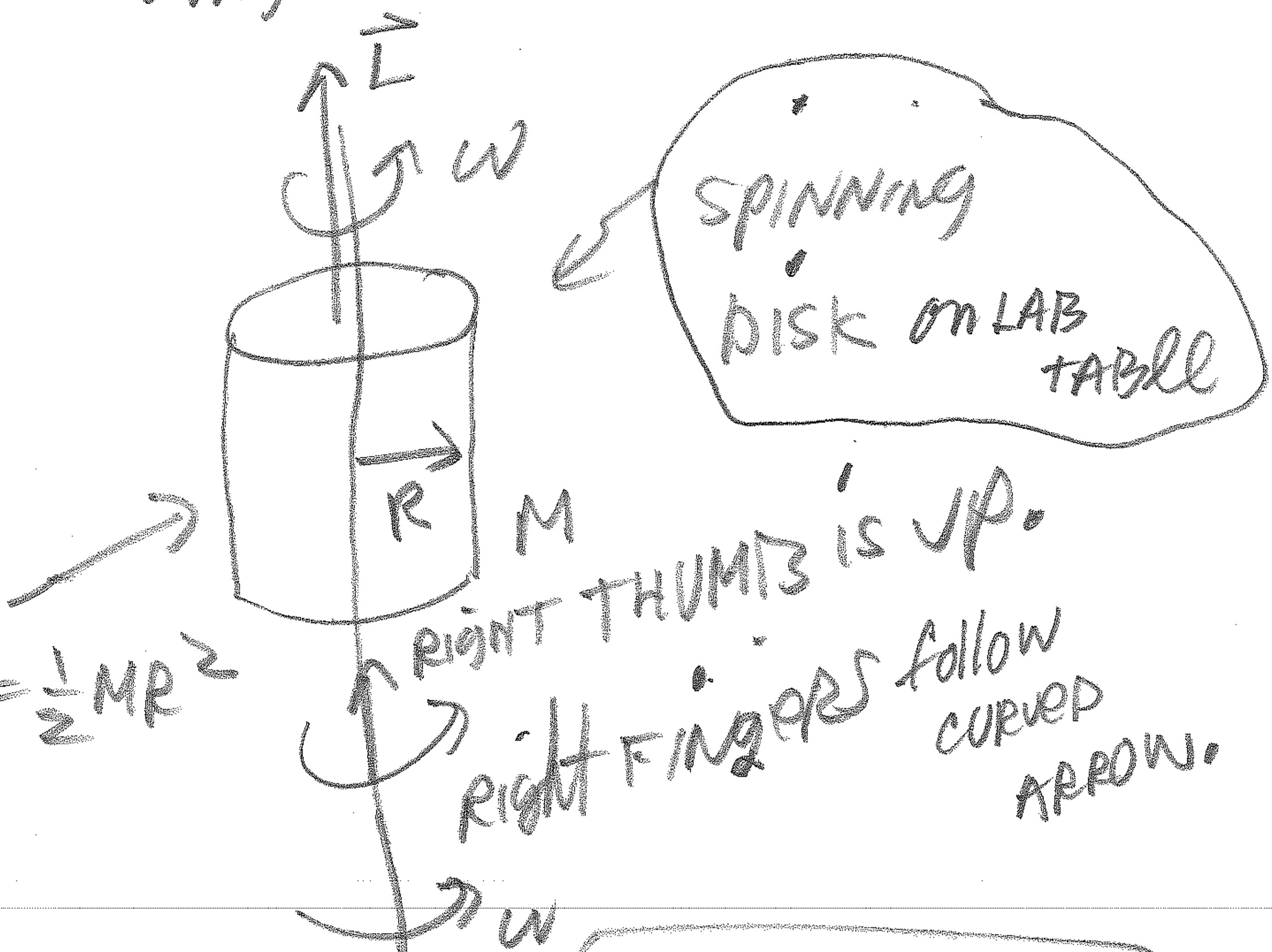
ω increasing

$$\text{Power} = \tau \cdot \omega = (R \cdot T) \cdot \omega$$

$$P = (r_\perp \cdot T) \cdot \omega$$

10.4

Angular momentum = $\underline{I\omega}$



$I = \frac{1}{2} M R^2$

$\vec{L}$ is up ; $|\vec{L}| = I \cdot \omega$

Lab FRI

(14)

Read CH 11

sec <u>11.2</u>, <u>11.3</u>

Oscillations Lab