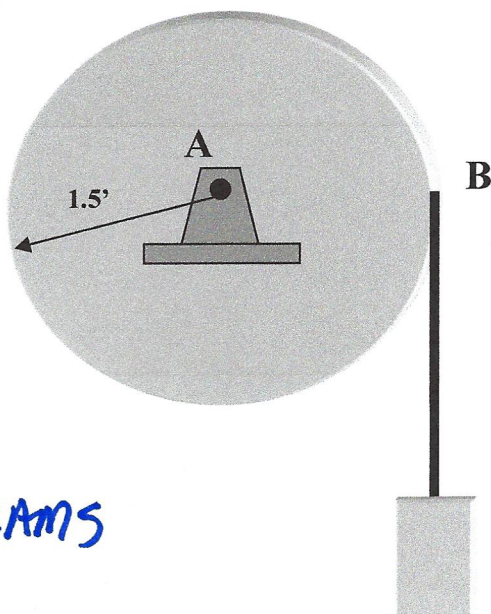## Force Acceleration I – Problem 3

The drum has a weight of 20 lb and a radius of gyration about its mass center of 0.8 ft. If the block has a weight of 12 lb, determine the angular acceleration, α_D, of the drum if the block is allowed to fall freely. Compare this value of α_D with that determined by removing the block and applying a force of 12 lb to the cord. Explain the reason for the difference.
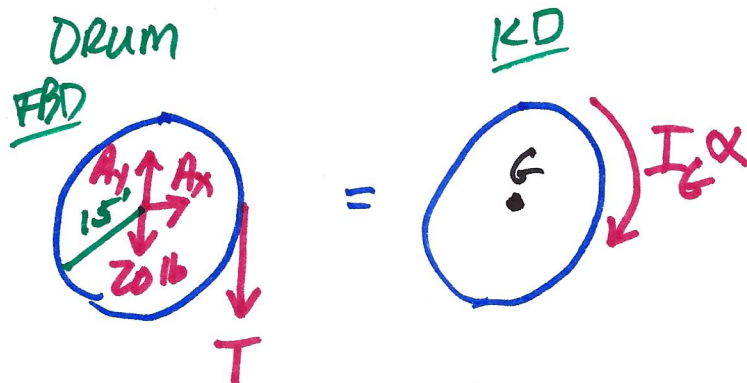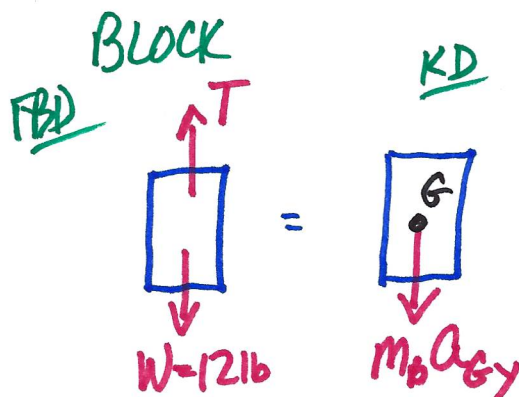
PROPERTIES

$$W_D = 20 \text{ lbs}, \quad K = 0.8 \text{ Ft}$$

$$m_D = \frac{20}{32.2} = 0.621 \text{ SLUG}$$

$$I_D = mk^2 = (.621)(.8)^2$$
$$= 0.397 \text{ SLUG-Ft}^2$$

$$m_B = \frac{12}{32.2} = 0.373 \text{ SLUG}$$

CLASSIFY MOTION

DRUM — RAFA
BLOCK — TRANS

A

B

1.5'

DRAW DIAGRAMS

BLOCK
FBD

T

$W = 12 \text{ lb}$

KD

G

$m_B a_{Gy}$

=

DRUM
FBD

A_y A_x

1.5'

20 lb

T

KD

G

$I_G \alpha$

=

EQNS

$$\sum F_y = -m a_{Gy}$$

$$T - 12 = -(.373) a_{Gy}$$

**3 EQNS
4 UNKS**

THINK RAFA

$$\sum F_x = m a_{Gx} \Rightarrow A_x = 0$$

$$\sum F_y = m a_{Gy} \Rightarrow A_y - 20 - T = 0$$

$$\sum M_G = I_G \alpha \Rightarrow -1.5T = -.397\alpha$$

$$a_T = \alpha r$$

$$a_{BLOCK} = a_B = a_{Gy} = 1.5\alpha$$

Force Acceleration I – Problem 3 continued

REWRITE EQNS

$$T - 12 = -(.373)(1.5\alpha) \qquad\qquad T + .56\alpha = 12$$

$$A_y - 20 - T = 0 \qquad\Rightarrow\qquad -T \qquad\quad + A_y = 20$$
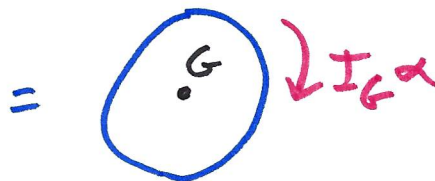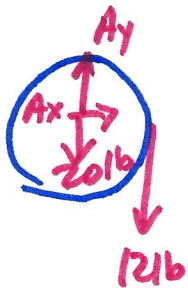
$$1.5T = .397\alpha \qquad\qquad\qquad\quad 1.5T - .397\alpha = 0$$

$$\begin{bmatrix} 1 & .56 & 0 \\ -1 & 0 & 1 \\ 1.5 & -.397 & 0 \end{bmatrix} \begin{Bmatrix} T \\ \alpha \\ A_y \end{Bmatrix} = \begin{Bmatrix} 12 \\ 20 \\ 0 \end{Bmatrix}$$

$$\underline{T = 3.85\ lbs} \qquad \underline{\alpha = 14.55\ rps^2}\ \downarrow \qquad \underline{A_y = 23.85\ lb}\ \uparrow$$

REMOVE BLOCK + APPLY 12 lbs FORCE

KD

FBD

$$\sum M_G = I_G\alpha$$

$$1.5(12) = 0.397\alpha$$

$$\underline{\alpha = 45.3\ rps^2}\ \downarrow$$

MORE ACCELERATION BECAUSE LESS MASS
IN SYSTEM TO RESIST ACCELERATION