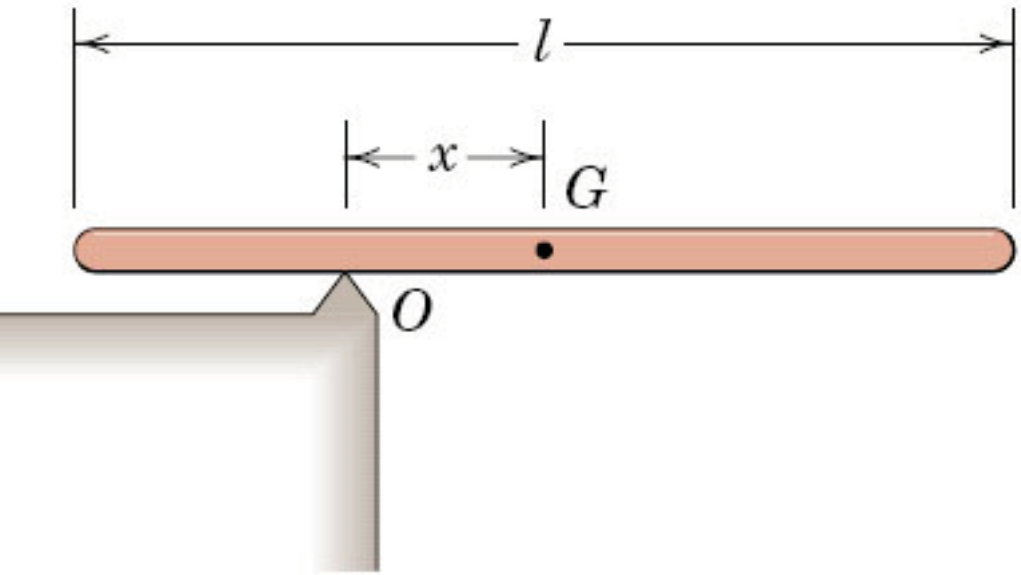
Fixed-Axis Rotation

Lecture 24

ME 231: Dynamics

Question of the Day

The uniform slender bar is released from rest in the horizontal position shown.



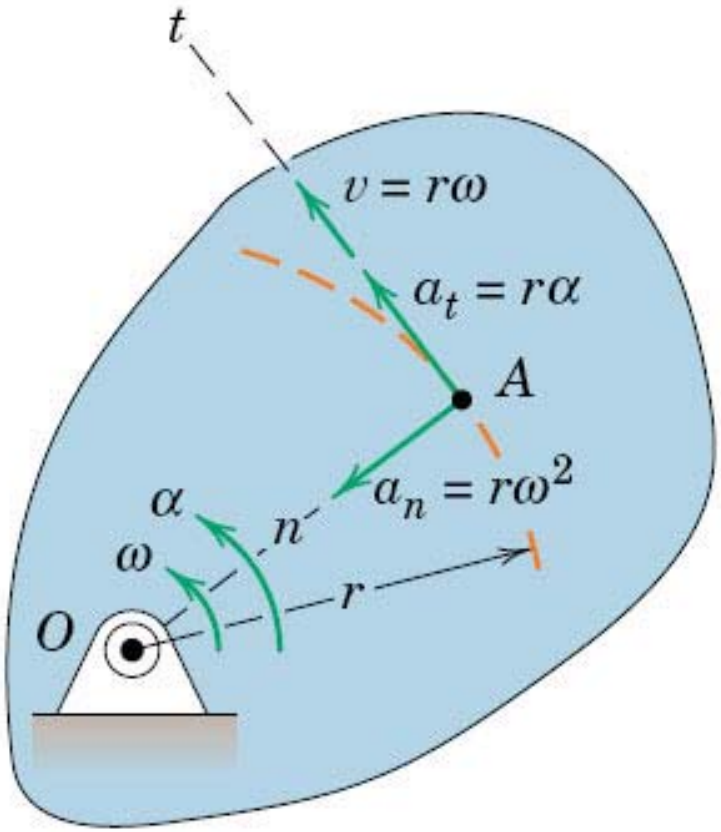
Determine the value of x for which the ***angular acceleration*** α is maximum, and determine α at this x.

Outline for Today

- Question of the day
- Fixed-axis rotation
- Parallel axis theorem
- Center of percussion
- Answer your questions!

Recall: Rotation About a Fixed Axis

- All ***points*** (*other than those on the axis*) move in ***concentric circles*** about the axis
- ***Point A*** moves in a circle of ***radius r***
- ***Angular motion*** of ***normal line*** is the ***angular motion*** of the ***rigid body***

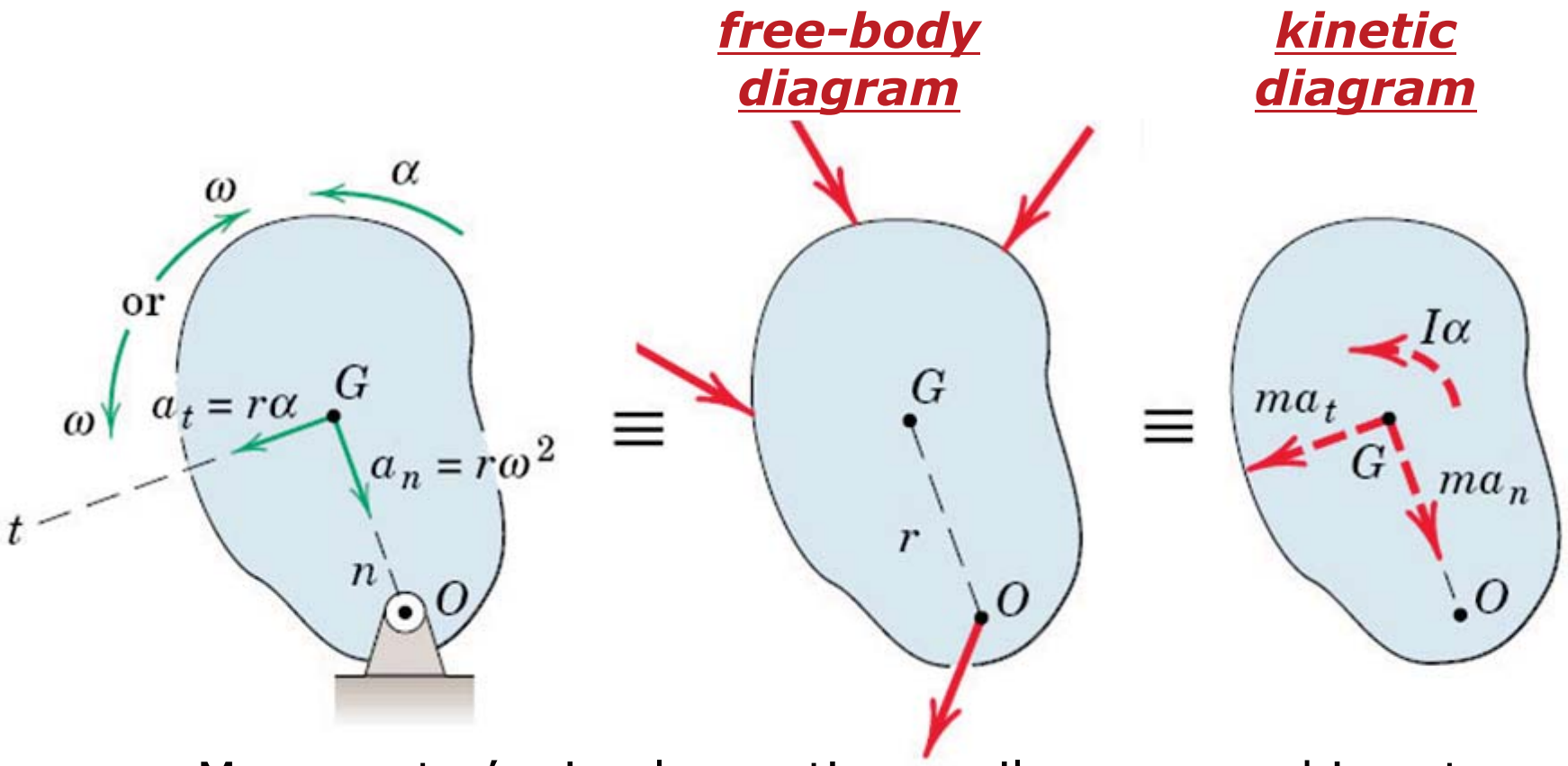


$$v = r\omega$$

$$a_n = r\omega^2 = \frac{v^2}{r} = v\omega$$

$$a_t = r\alpha$$

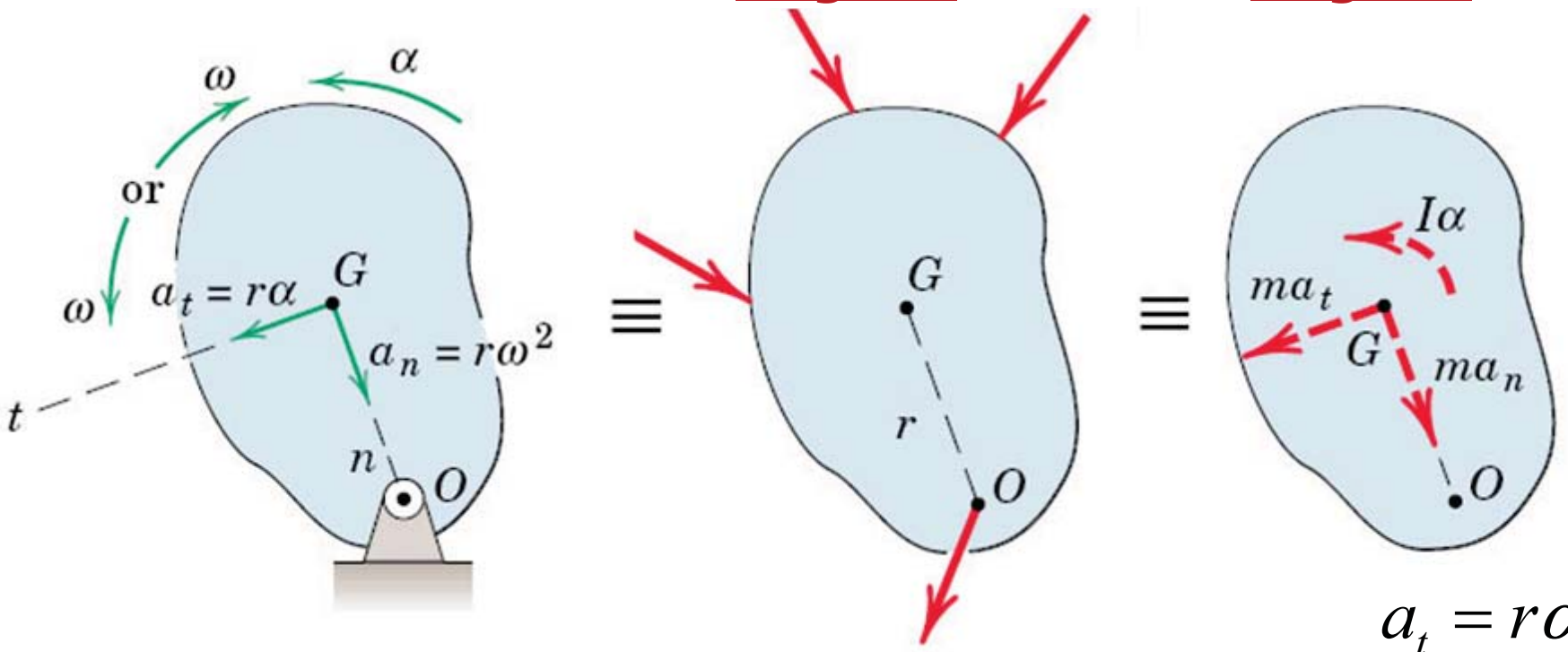
Fixed-Axis Rotation



- Mass center's circular motion easily expressed in n-t coordinates
- Plane-motion equations:

$$\sum \mathbf{F} = m\mathbf{a} \qquad \sum \mathbf{M}_G = I_G\boldsymbol{\alpha} \qquad \sum \mathbf{M}_O = I_O\boldsymbol{\alpha}$$

Parallel Axis Theorem



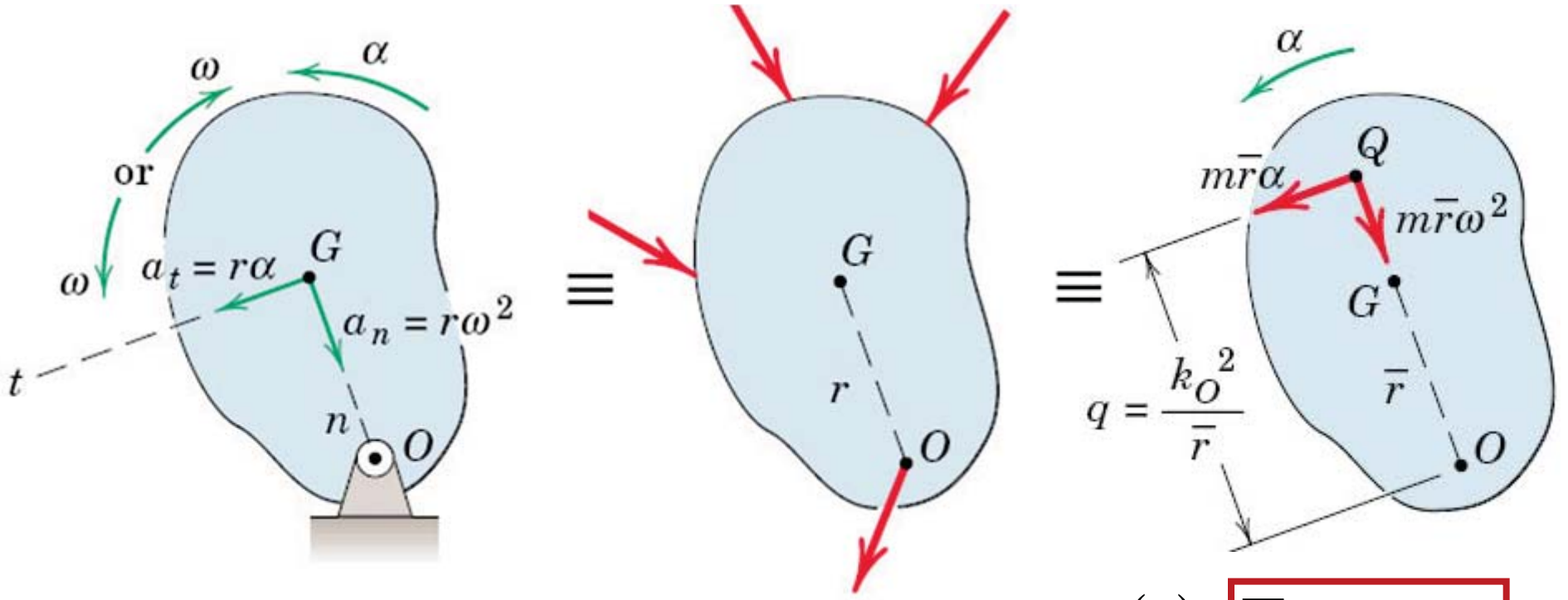
$$\sum M_O = I_G\alpha + ma_t r$$

$$a_t = r\alpha$$

$$I_O = I_G + mr^2$$

$$\sum M_O = \left(I_O - mr^2\right)\alpha + mr^2\alpha = I_O\alpha$$

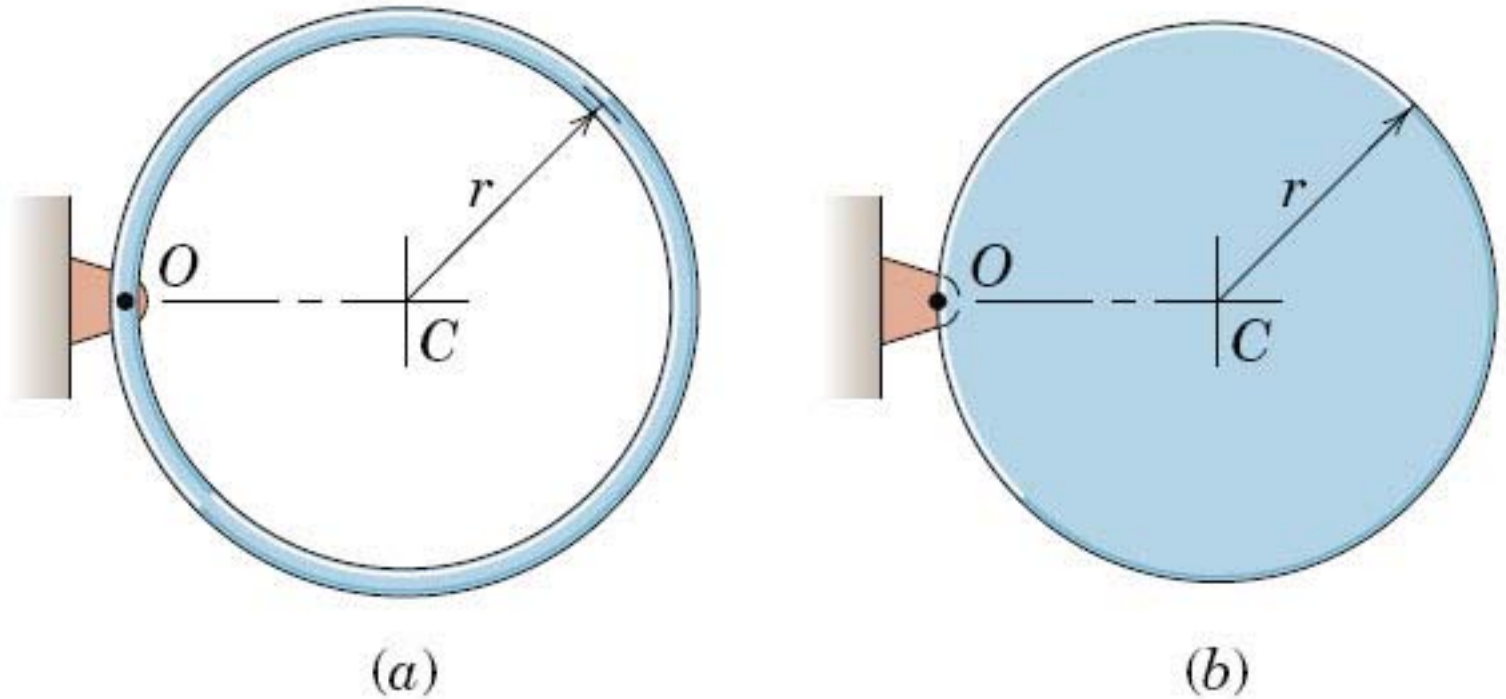
Center of Percussion



$$mr\alpha q = I_G\alpha + mr\alpha(r) \qquad \boxed{\sum M_Q = 0}$$

combine ma_t, $I_G\alpha$ ***by moving*** ma_t ***to point Q (center of percussion)***

Fixed-Axis Rotation: Exercise

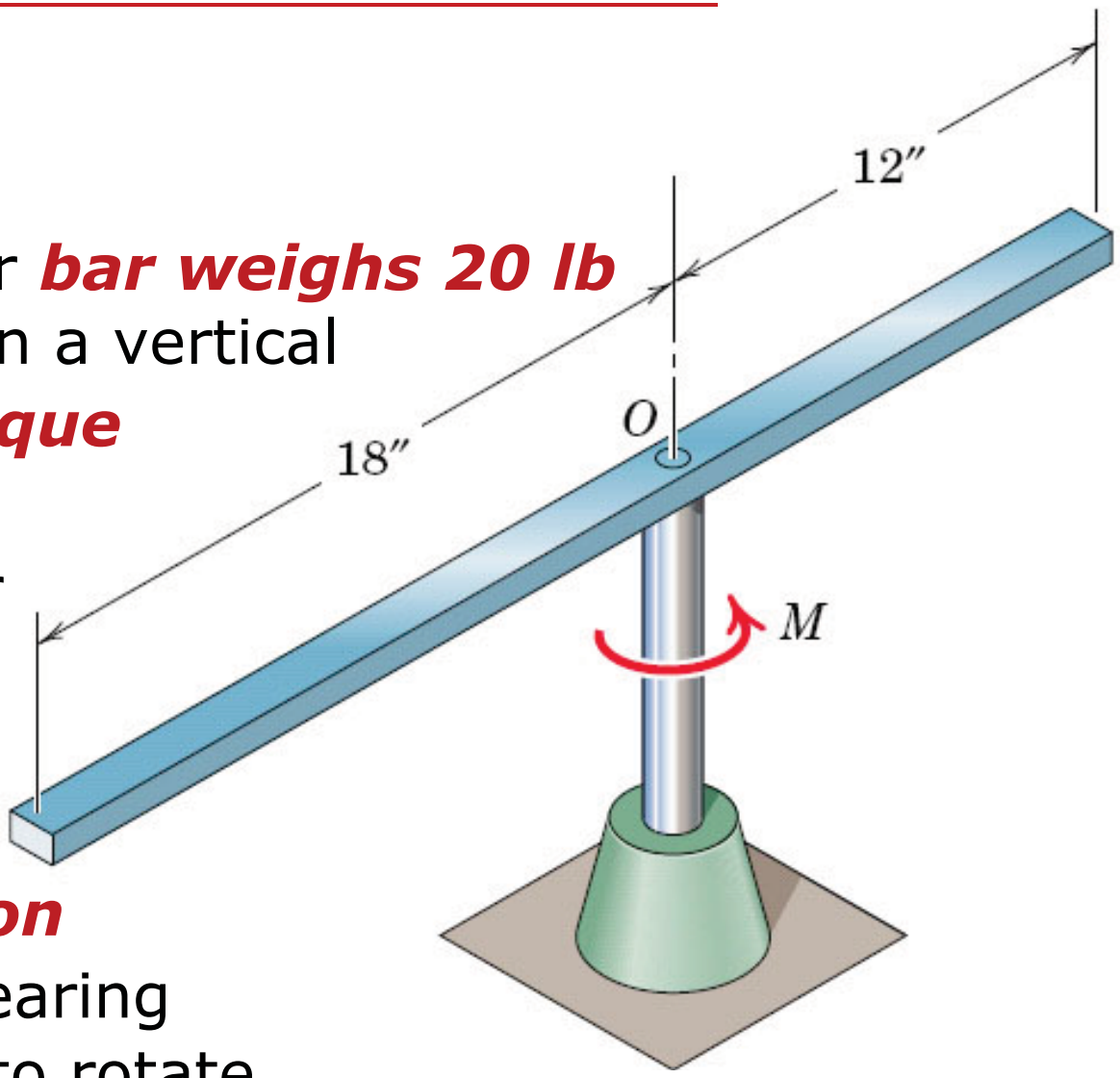


Determine the ***angular acceleration*** and the ***force*** on the ***bearing*** at O for (a) the narrow ***ring*** of ***mass*** m and (b) the flat circular ***disk*** of ***mass*** m immediately after each is released from rest with OC horizontal.

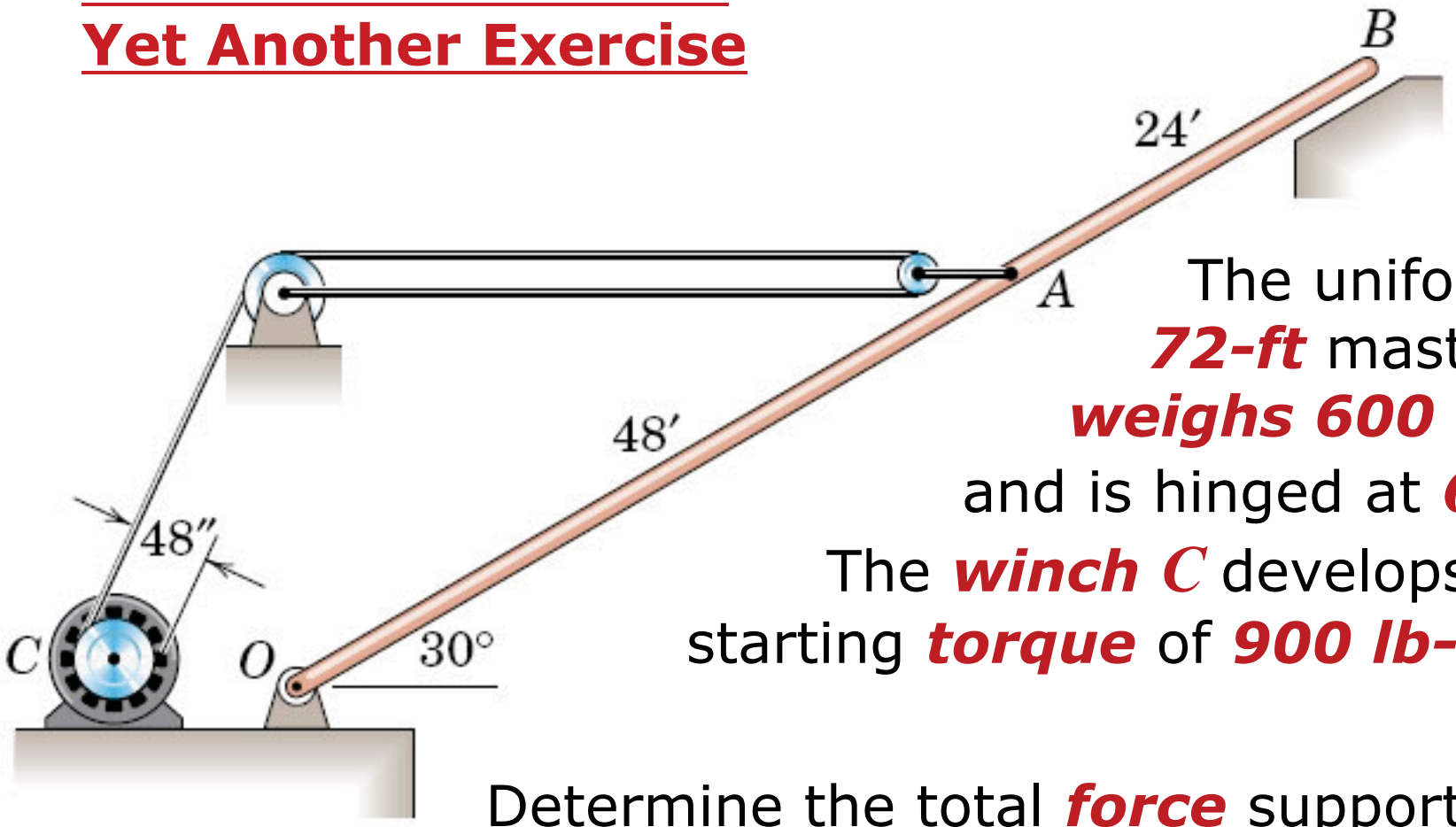
Fixed-Axis Rotation: Another Exercise

The ***30-in*** slender ***bar weighs 20 lb*** and is mounted on a vertical shaft at ***O***. A ***torque M = 100 lb-in*** is applied to the bar through its shaft.

Determine the horizontal ***reaction force R*** on the bearing as the bar starts to rotate.



Fixed-Axis Rotation: Yet Another Exercise



The uniform ***72-ft*** mast ***weighs 600 lb*** and is hinged at O. The ***winch*** C develops a starting ***torque*** of ***900 lb-ft***.

Determine the total ***force*** supported by the ***pin*** at O as the mast begins to lift off its support at B. Also find the corresponding ***angular acceleration*** α of the mast.

For Next Time…

- Complete Homework #8 due on ***Thursday (10/25)***
- Read Chapter 7, Section 7.4