Use $\boxed{2}$ and $\boxed{1}$ in ☆ to get:

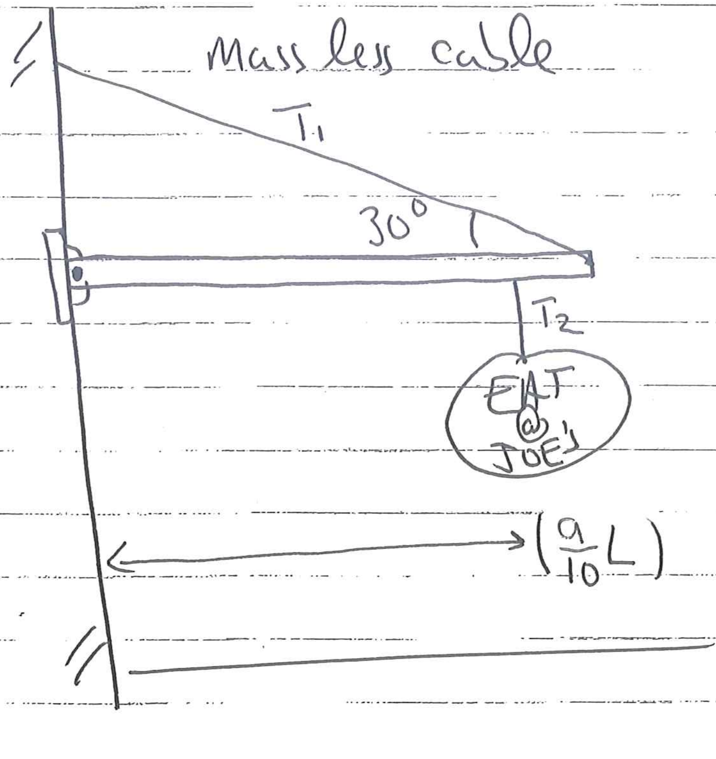
$$M_3 g - M_3 a_x - M_1 a_x = \frac{M_2 a_x}{2}$$

$$M_3 g = a_x \left(\frac{M_2}{2} + M_3 + M_1 \right)$$

$$7.54 \, m/s^2 = \frac{M_3 g}{\left(\frac{M_2}{2} + M_3 + M_1 \right)} = a_x$$

STATIC EQUIL 1

EX.

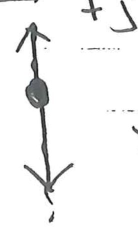


Find tension in the cable.
Find force the bracket exerts on rod.

length 'L'
uniform
Mass 'M'

Let 'M' be Mass of Sign.

for Sign



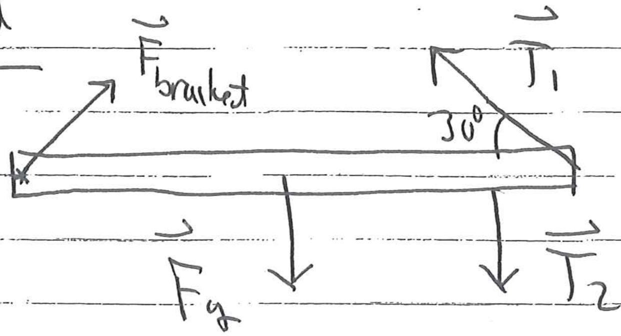
$$\vec{T}_2 = T_2 \hat{j}$$

$$\vec{F}_g = -Mg\hat{j}$$

2nd $\boxed{\hat{j}}$ $\sum F_y = 0$

$$\therefore T_2 = Mg$$

for rod



$\vec{T}_2 = -Mg\,\hat{j}$

$\vec{F}_g = -mg\,\hat{j}$

$\vec{F}_{bracket} = F_x\hat{i} + F_y\hat{j}$

$\vec{T}_1 = -T_1\cos(30)\,\hat{i} + T_1\sin(30)\,\hat{j}$

2nd $\sum\vec{F} = m\vec{a} \to 0$

$(\hat{i})$ $\sum F_x = 0$

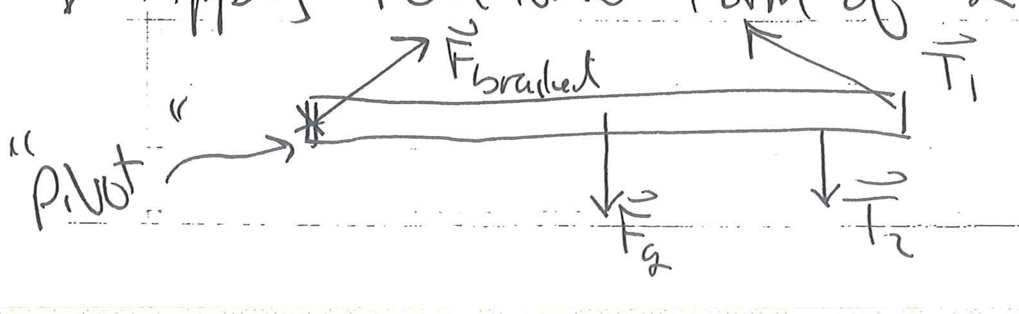
$\boxed{F_x - T_1\cos(30) = 0}$ $\boxed{1}$

$(\hat{j})$ $\sum F_y = 0$

$\boxed{-Mg - mg + F_y + T_1\sin(30) = 0}$ $\boxed{2}$

Hmmm.... $\sum\vec{\tau}_c = I\vec{\alpha} \to 0$

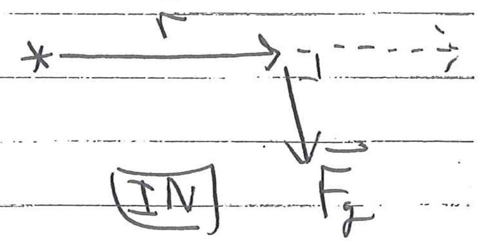
Apply rotational form of 2nd Law



$$\vec{\tau}_{\vec{F}_{bracket}} = 0$$

$$\vec{\tau}_{\vec{F}_g} = \vec{r} \times \vec{F}_g$$

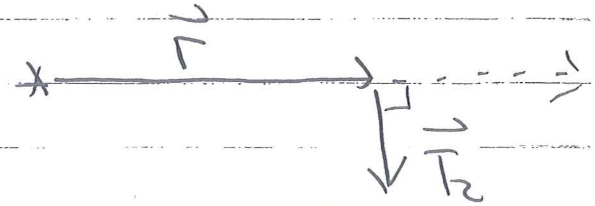
$$= \left(\frac{L}{2}\right)(mg)\sin(90)$$

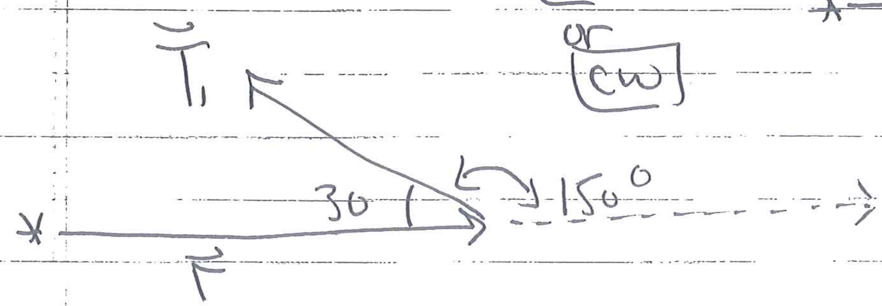


$\boxed{IN}$ or $\boxed{CW}$

$$\vec{\tau}_{\vec{T}_2} = \vec{r} \times \vec{T}_2 = \left(\frac{9L}{10}\right)(Mg)\sin(90)$$

$\boxed{IN}$ or $\boxed{CW}$





$$\vec{\tau}_{\vec{T}_1} = \vec{r} \times \vec{T}_1 = (L)(T_1)\sin(150)$$

$\boxed{OUT}$

$\boxed{CCW}$ "+"

2nd.

$$\sum \vec{\tau} = I\cancel{\alpha} \to 0$$

$$0 - \frac{L}{2}(mg) - \left(\frac{9L}{10}\right)(Mg) + LT_1\sin(150) = 0$$

$$LT_1\sin(150) = \frac{mgL}{2} + \frac{9MgL}{10}$$

$$T_1\sin(150) = \frac{mg}{2} + \frac{9Mg}{10}$$

$$T_1 = \frac{g(5m + 9M)}{10\sin(150)}$$

So from [1] we have:

$$F_x = T_1 \cos(30) = \frac{g(5m + 9M)}{10 \sin(150)} \cos(30)$$

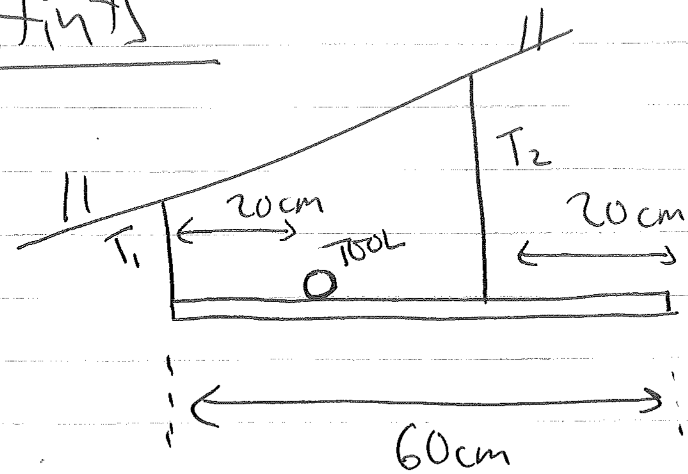
from [2] we have:

$$F_y = Mg + mg - T_1 \sin(30)$$

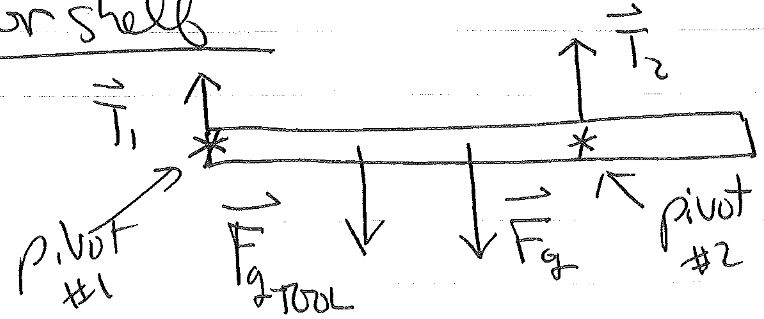
$$\vec{F}_{bracket} = F_x \hat{i} + F_y \hat{j}$$

HW Hints

11.8]



for shelf



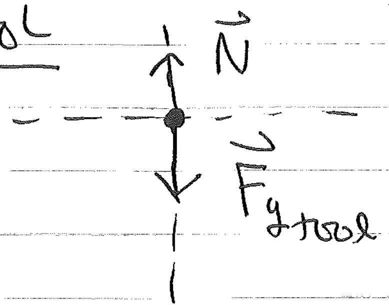
Approach #1

$$\sum \vec{\tau}_{pivot\ \#1} = 0$$

$$\sum \vec{\tau}_{pivot\ \#2} = 0$$

$\boxed{OR}$ $\sum \vec{F} = 0$ and either of torque eqtns.

YIKES!! $\vec{F}_{g\text{-TOOL}}$?? Really NOPE. Short cut for Tool

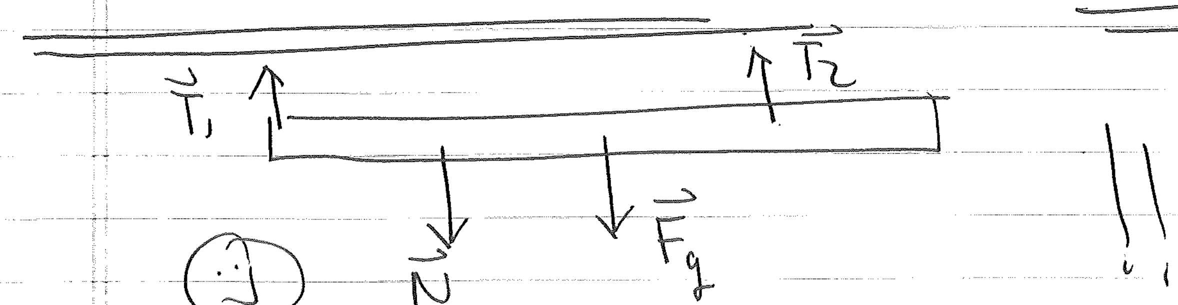


2nd

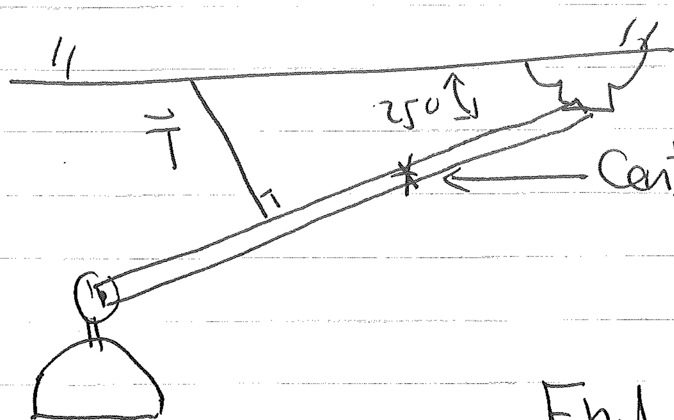
$\boxed{\hat{j}}$ $\sum F_y = 0$

$+N - F_{g\,tool} = 0$

$N = F_{g\,tool}$



$\boxed{11.20}$



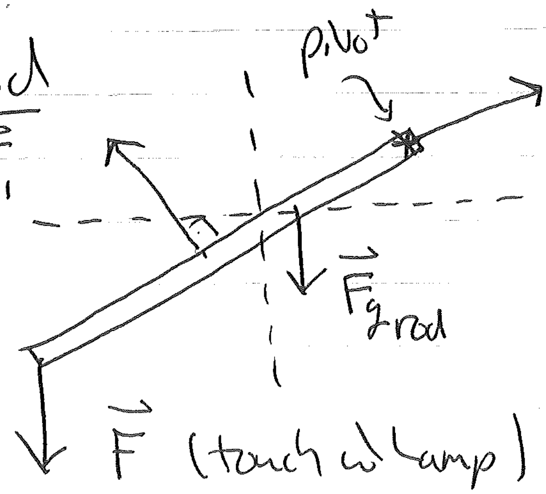
Center of mass (given) not in middle of rod

Find $\vec{T}$ and $\vec{F}_{pivot}$

for Rod

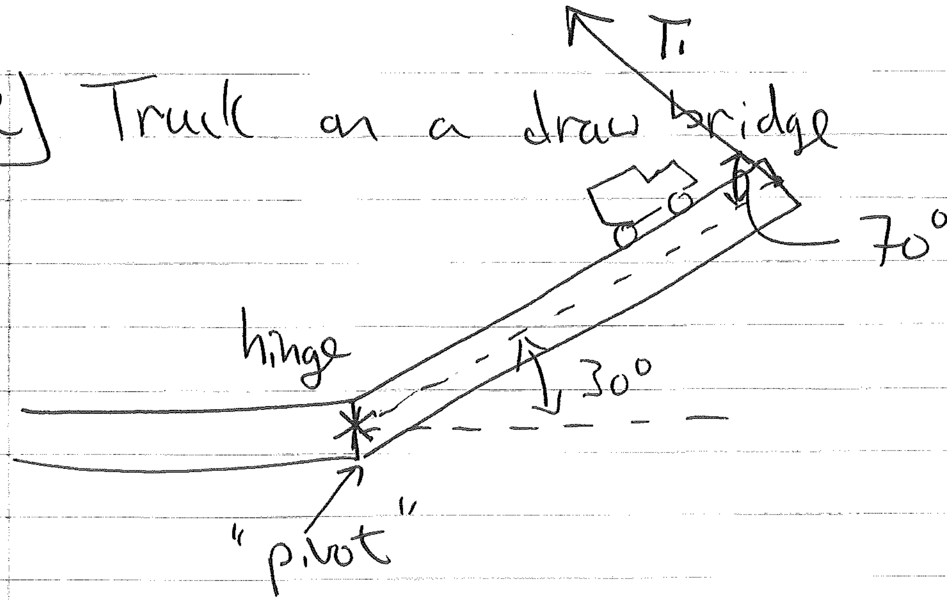
$\sum \vec{F} = 0$

$\sum \vec{\tau} = 0$

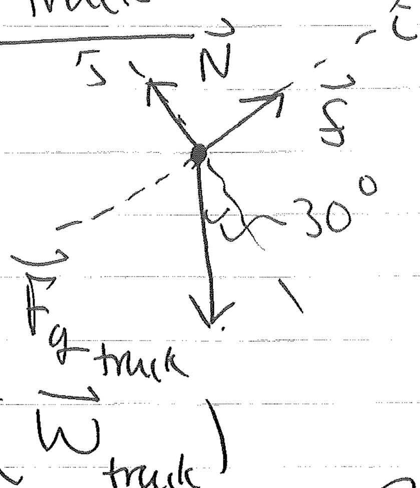


$\vec{F}_{bracket} = F_x \hat{i} + F_y \hat{j}$

11.52) Truck on a draw bridge



for truck



"@ REST"

$\vec{N} = N\hat{j}$
$\vec{f} = f\hat{i}$
$\vec{F}_{g_{truck}} = -mg\sin(30)\,\hat{i} - mg\cos(30)\,\hat{j}$

2^{nd} $\sum \vec{F} = m\vec{a} \to 0$

$\vec{F}_{TRUCK} = f\hat{i} + N\hat{j}$

TOUCH by SINGLE FORCE

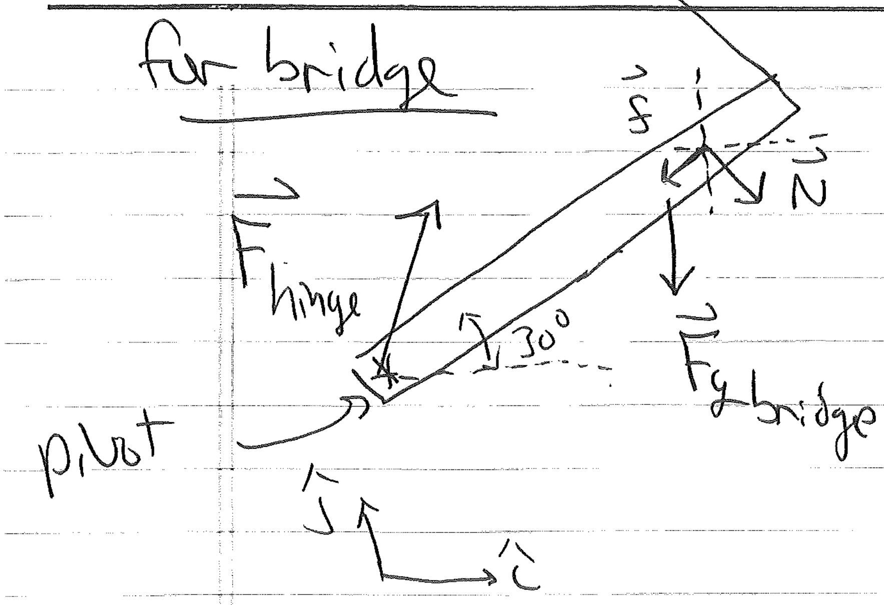
$\boxed{\hat{i}}$ $\sum F_x = 0$

$\therefore f = mg\sin(30)$

$\boxed{\hat{j}}$ $\sum F_y = 0$

$\therefore N = mg\cos(30)$

for bridge



$\sum \vec{F} = 0$

$\sum \vec{\tau} = 0$

pivot

$\vdots$

T_1 ✓

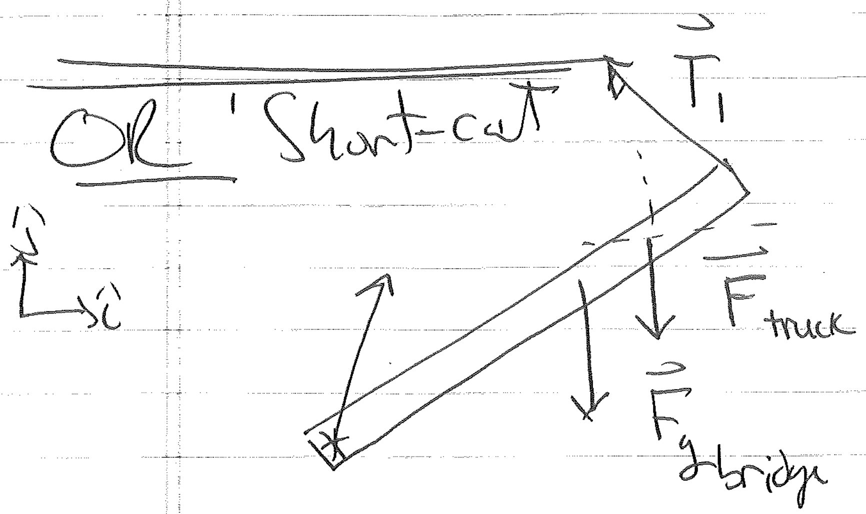
$\tau_{\vec{f}} = 0 \; (\sin(180))$

$\tau_{\vec{N}} = |\vec{r}||\vec{N}| \sin(90)$

$= rN$

$= r\,mg\cos(30)$

OR 'Short-cut'



(combination of $\vec{f}$ and $\vec{N}$)

$|\vec{F}_{truck}| = M_{truck}\, g$

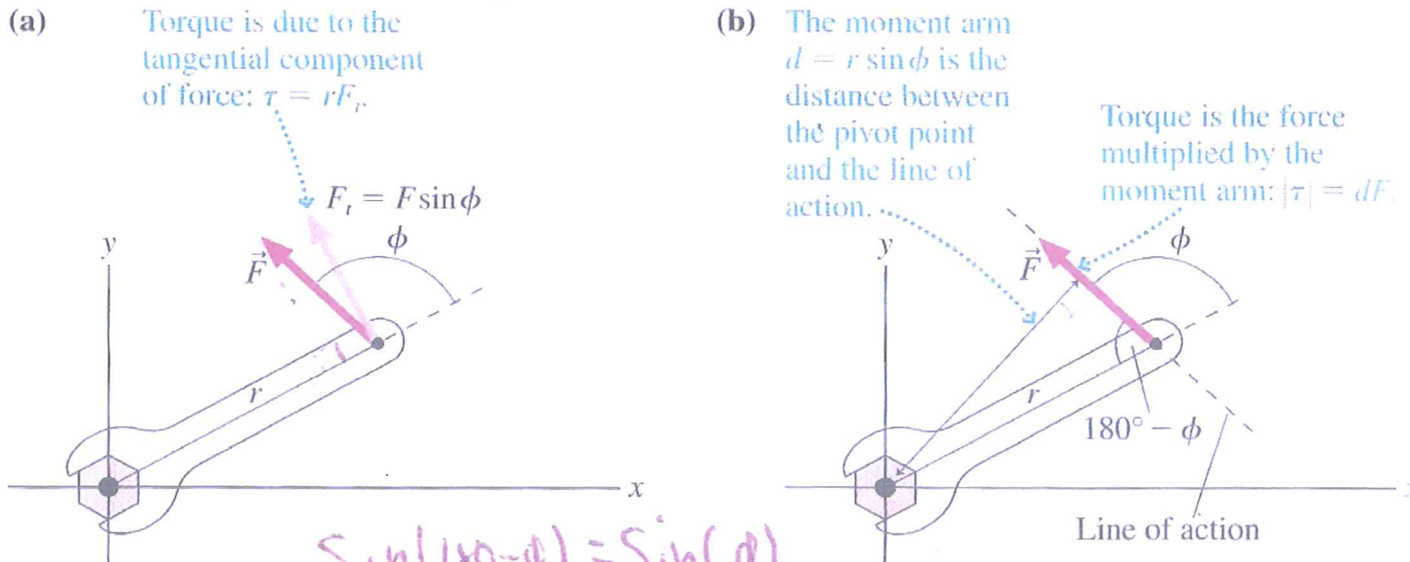
Interpreting Torque

Torque can be interpreted from two perspectives. First, FIGURE 12.21a shows that the quantity $F\sin\phi$ is the tangential force component F_t. Consequently, the torque is

$$\tau = rF_t \tag{12.21}$$

In other words, torque is the product of r with the force component F_t that is *perpendicular* to the radial line. This interpretation makes sense because the radial component of $\vec{F}$ points straight at the pivot point and cannot exert a torque.

FIGURE 12.21 Two useful interpretations of the torque.



$\sin(180-\phi) = \sin(\phi)$

Alternatively, FIGURE 12.21b shows that $d = r\sin\phi$ is the distance from the pivot to the **line of action,** the line along which force $\vec{F}$ acts. Thus the torque can also be written

$$|\tau| = dF = (r\sin\phi)F = rF\sin\phi \tag{12.22}$$

$(\vec{r} \times \vec{F})$

The distance d from the pivot to the line of action is called the **moment arm** (or the *lever arm*), so we can say that the torque is the product of the force and the moment arm. This second perspective on torque is widely used in applications.

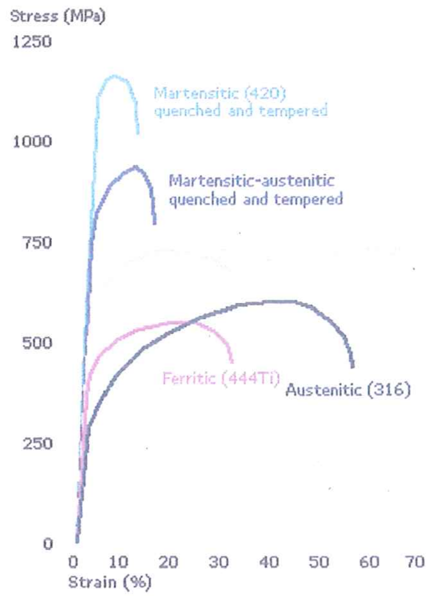
NOTE ▶ Equation 12.22 gives only $|\tau|$, the magnitude of the torque; the sign has to be supplied by observing the direction in which the torque acts. ◀

1-d $\quad \frac{F_\perp}{A} = Y \frac{\Delta l}{l_0}$

pg 347

Chapter 11

①



Stress = [Elastic Modulus] strain

"Hooke's Law"

"Elastic behavior"

Young's

Shear

Bulk