Optional: Homework 17. Chapters 18, 19, 21.
Moments, torques, and static equilibrium.

Show work – except for ♣ fill-in-blanks.

17.1 ♣ Concepts: Define and draw the moment of a force.

Write the ***definition*** for the moment of force $\vec{\mathbf{F}}^{Q}$ applied to point Q about point O. **Draw** a sketch with *each* part of your definition clearly labeled.

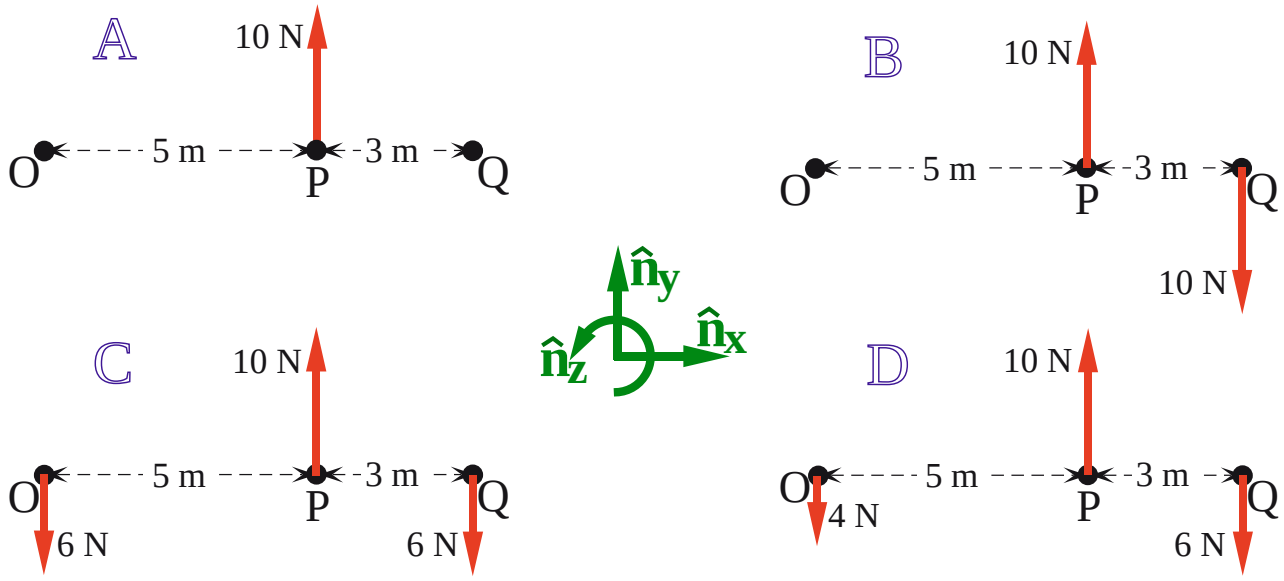
Result:

$$\vec{\mathbf{M}}^{\vec{\mathbf{F}}^{Q}/O} \triangleq \square \times \square$$

17.2 ♣ Moment vs. torque (refer to Section 19.5).

Consider the various sets S of forces, their resultants $\vec{\mathbf{F}}^{S}$, and moments about points O, P, and Q. This example shows how to easily determine whether a moment is a torque.[1]

S	$\vec{\mathbf{F}}^{S}$	$\vec{\mathbf{M}}^{S/O}$	$\vec{\mathbf{M}}^{S/P}$	$\vec{\mathbf{M}}^{S/Q}$	$\vec{\mathbf{M}}^{S/O} \stackrel{?}{=} \vec{\mathbf{M}}^{S/P} \stackrel{?}{=} \vec{\mathbf{M}}^{S/Q}$	Moment is torque?
A	$10\,\hat{\mathbf{n}}_y$	$50\,\hat{\mathbf{n}}_z$	$\vec{\mathbf{0}}$		**Yes/No**	**Yes/No**
B					**Yes/No**	**Yes/No**
C					**Yes/No**	**Yes/No**
D					**Yes/No**	**Yes/No**



17.3 ♣ Moment and torque concepts.

75% All torques are moments. **True/False**

61% All moments are torques. **True/False**

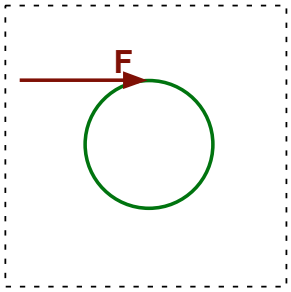
61% The moment of a couple about a point O is equal to the moment of the couple about any other point P **True/False**

[1] Since $\vec{\mathbf{T}}^{S} \triangleq \vec{\mathbf{M}}^{S/O}$ if $\vec{\mathbf{F}}^{S} = \vec{\mathbf{0}}$ (point O is ***any*** point), the ***moment*** is a ***torque*** if $\vec{\mathbf{F}}^{S} = \vec{\mathbf{0}}$ (it is that simple).

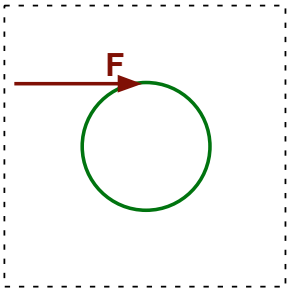
17.4 ♣ Drawing couples (a couple is a set of forces whose resultant is zero).

Each figure below shows a single force $\vec{\mathbf{F}}$ applied tangentially to a point on the periphery of a circle. Complete each figure by drawing couples consisting of **2**, **3**, and **4** forces, respectively, so:

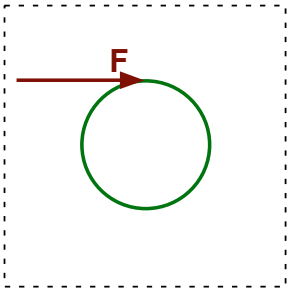
- Each force has magnitude $\left|\vec{\mathbf{F}}\right|$ and is applied at distinct points on the circle's periphery
- Each force is directed **tangent** to the circle's periphery
- The set of forces create a couple with non-zero torque



Couple with 2 forces



Couple with 3 forces

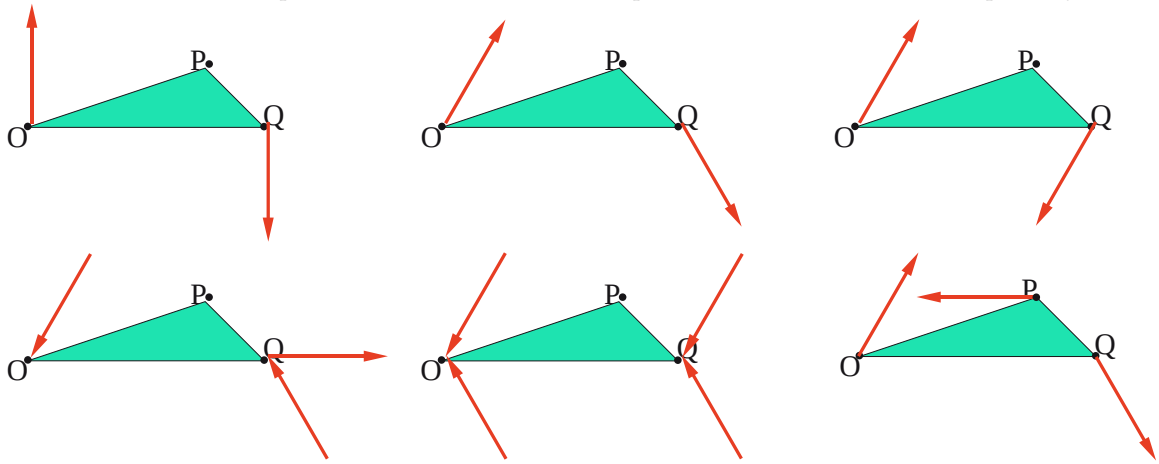


Couple with 4 forces

17.5 ♣ Moments of forces about various points.

Consider the six figures below, each which contain a set of forces. Circle the figure(s) in which the moment of its set of forces about points O, P, and Q all are equal, i.e.,

Moment around point O = Moment around point P = Moment around point Q



Note: All forces have the same magnitude. Forces that are not horizontal or vertical are 30° from vertical.

17.6 ♣ Forces, moments, and lines of action.

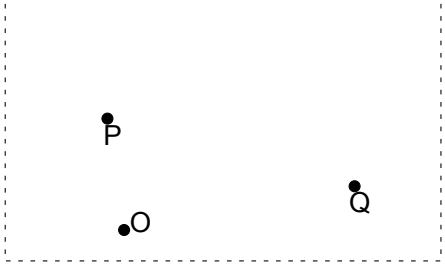
Draw a non-zero force $\vec{\mathbf{F}}^{P}$ on point P and a non-zero force $\vec{\mathbf{F}}^{Q}$ on point Q so:

- $\vec{\mathbf{F}}^{P} = \vec{\mathbf{F}}^{Q}$ (force on P has the same magnitude and direction as the force on Q)
- $\vec{\mathbf{M}}^{\vec{\mathbf{F}}^{P}/O}$ (moment of $\vec{\mathbf{F}}^{P}$ about point O) is **equal** to $\vec{\mathbf{M}}^{\vec{\mathbf{F}}^{Q}/O}$ (moment of $\vec{\mathbf{F}}^{Q}$ about O).

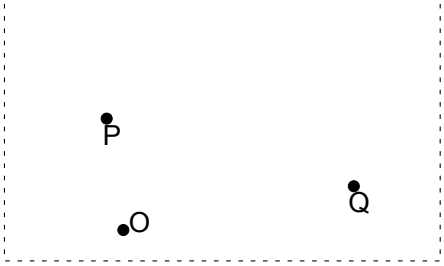
Repeat on the right-figure below, except ensure $\vec{\mathbf{F}}^{P}$ and $\vec{\mathbf{F}}^{Q}$ produce **unequal** moments about O.

$\vec{\mathbf{F}}^{P} = \vec{\mathbf{F}}^{Q}$ $\quad \vec{\mathbf{M}}^{\vec{\mathbf{F}}^{P}/O} = \vec{\mathbf{M}}^{\vec{\mathbf{F}}^{Q}/O}$

$\vec{\mathbf{F}}^{P}$ has the same line of action as $\vec{\mathbf{F}}^{Q}$.



$\vec{\mathbf{F}}^{P} = \vec{\mathbf{F}}^{Q}$ $\quad \vec{\mathbf{M}}^{\vec{\mathbf{F}}^{P}/O} \neq \vec{\mathbf{M}}^{\vec{\mathbf{F}}^{Q}/O}$



$\vec{\mathbf{F}}^{P}$ has a different line of action than $\vec{\mathbf{F}}^{Q}$.