

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

Moments, torques, and static equilibrium.

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

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

Result:

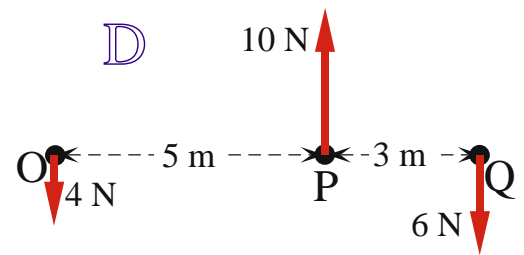
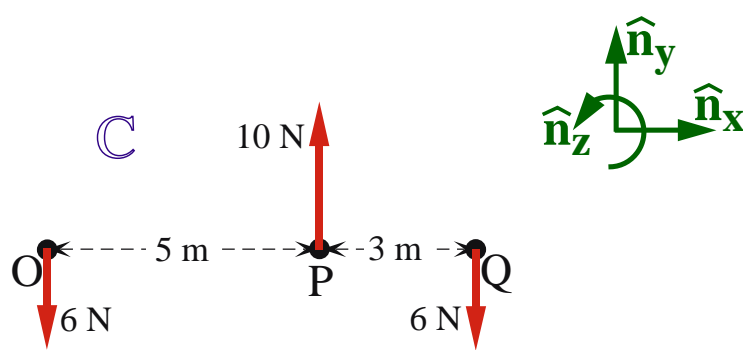
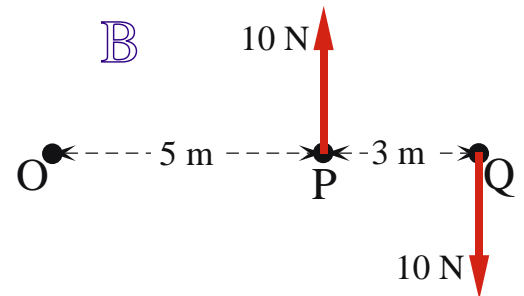
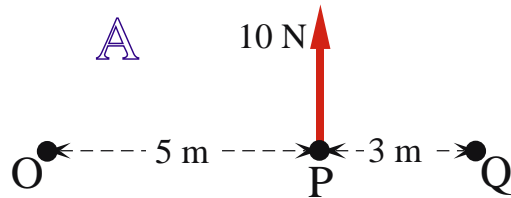
$$\vec{M}^{\vec{F}^Q/O} \triangleq \text{[]} \times \text{[]}$$



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

Consider the various sets S of forces, their resultants \vec{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{F}^S | $\vec{M}^{S/O}$ | $\vec{M}^{S/P}$ | $\vec{M}^{S/Q}$ | $\vec{M}^{S/O} \stackrel{?}{=} \vec{M}^{S/P} \stackrel{?}{=} \vec{M}^{S/Q}$ | Moment is torque? |
|-----|----------------|-----------------|-----------------|-----------------|---|-------------------|
| A | $10 \hat{n}_y$ | $50 \hat{n}_z$ | $\vec{0}$ | [] | 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

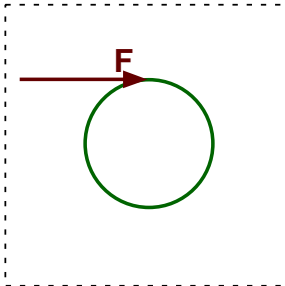
61% The moment of a couple about a point O is equal to the moment of the couple about any other point P True/False

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

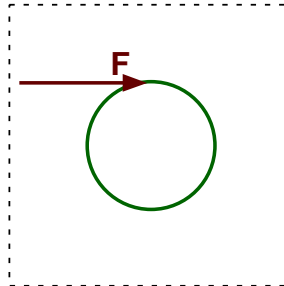
17.4 ♣ Drawing couples

Each figure below shows a single force \vec{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:

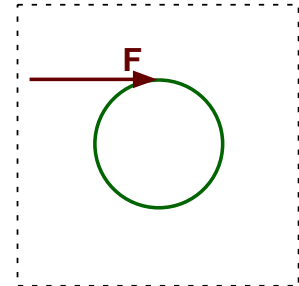
- Each force has magnitude $|\vec{F}|$ and is applied at distinct points on the circle's periphery
- Each force is directed **tangent** to the circle's periphery
- The set of forces create a couple with non-zero torque



Couple with **two** forces



Couple with **three** forces

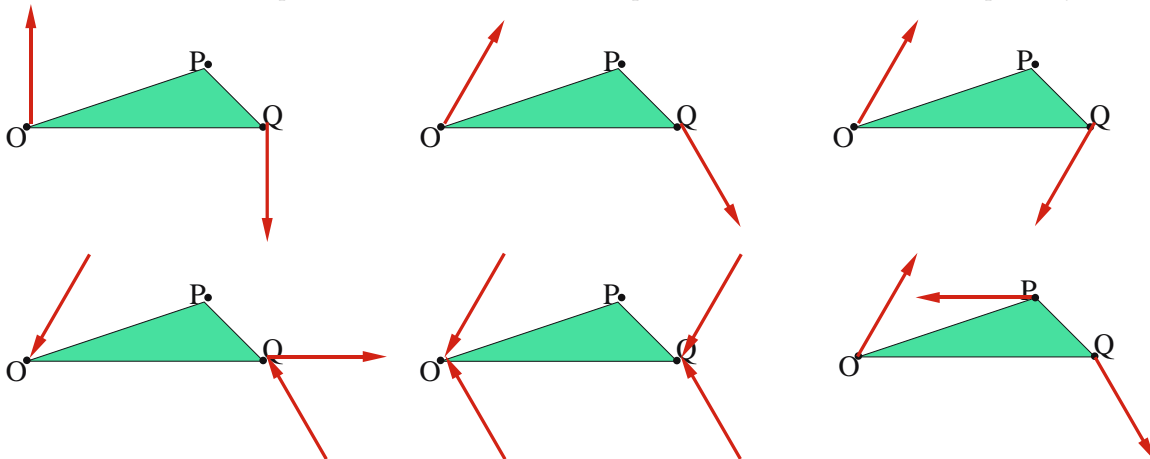


Couple with **four** forces

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.,

$$\text{Moment around point } O = \text{Moment around point } P = \text{Moment around point } Q$$



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