

13.1 ♣ 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:

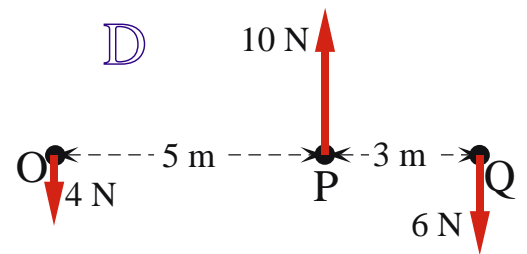
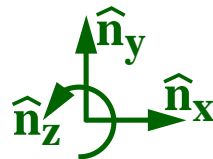
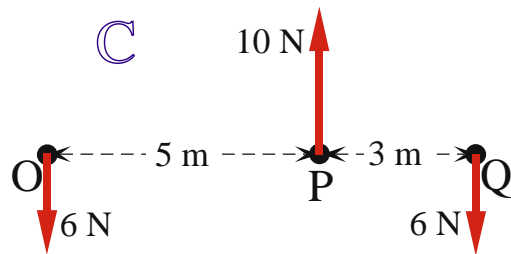
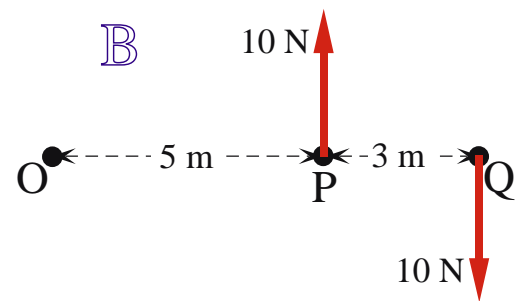
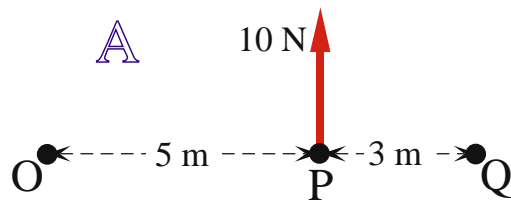
$$\vec{M}^{\vec{F}^Q/O} \triangleq \text{[]} \times \text{[]}$$



13.2 ♣ Moment vs. torque (refer to Section 17.5)

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



13.3 ♣ Moment and torque concepts

75% All torques are moments.

True/False

61% All moments are torques.

True/False

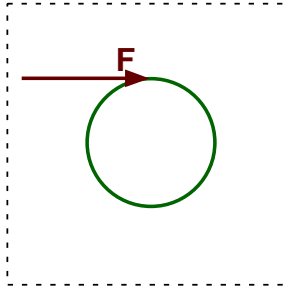
61% The moment of a couple about a point O is equal to the moment of the couple about any other point P True/False

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).

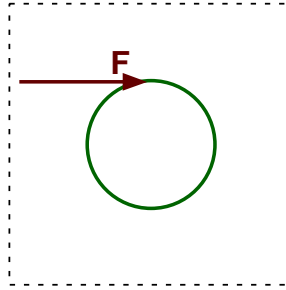
13.4 ♣ Drawing couples

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:

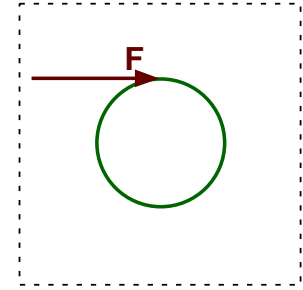
- Each force has magnitude $|\vec{F}|$ and is applied at distinct points on the circle's periphery
- Each force is directed **tangent** to the circle's periphery
- The set of forces create a couple with non-zero torque



Couple with **2** forces



Couple with **3** forces

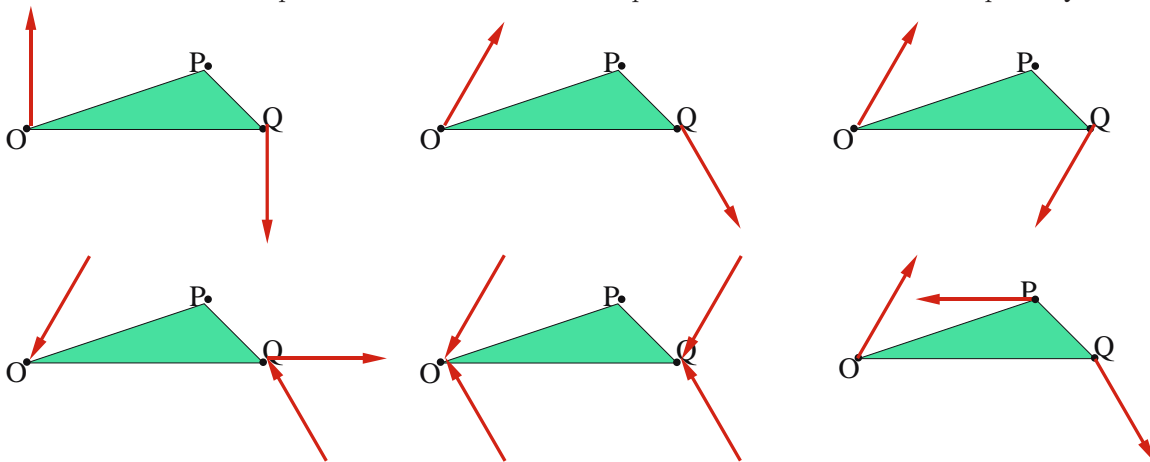


Couple with **4** forces

13.5 ♣ 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.

13.6 ♣ Forces, moments, and lines of action

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

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

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

<p>$\vec{F}^P = \vec{F}^Q$ $\vec{M}^{\vec{F}^P/O} = \vec{M}^{\vec{F}^Q/O}$</p> <div style="border: 1px dashed black; padding: 10px; text-align: center;"> </div> <p>\vec{F}^P has the same line of action as \vec{F}^Q.</p>	<p>$\vec{F}^P = \vec{F}^Q$ $\vec{M}^{\vec{F}^P/O} \neq \vec{M}^{\vec{F}^Q/O}$</p> <div style="border: 1px dashed black; padding: 10px; text-align: center;"> </div> <p>\vec{F}^P has a different line of action than \vec{F}^Q.</p>
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