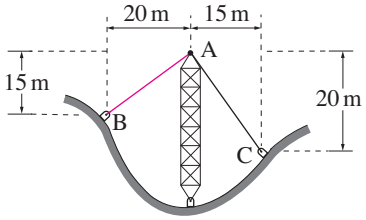
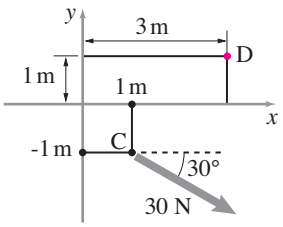
2.1.4 The net force on A from the two cables is a force that points down and has magnitude of 125 N. Find the tension in cable AB.



Problem 2.4

Answer:
$T_{AB} = 75$ N

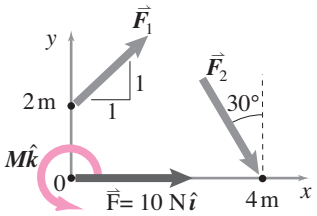
2.1.7 Find a force-couple system at D that is equivalent to the single force at C shown.



Problem 2.7

Answer:
$\vec{F}_D = (15\sqrt{3}\hat{\imath} - 15\hat{\jmath})$ N, $\vec{M}_D = 30(1 + \sqrt{3})\hat{k}$ N·m

2.1.10 The force system $(\vec{F}_1, \vec{F}_2)$ is equivalent to a force $\vec{F} = 10\hat{\imath}$ N at the origin and a couple $M\hat{k}$. Find M.



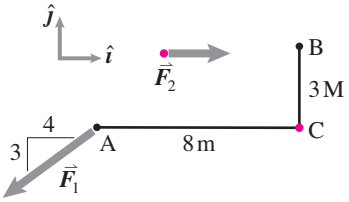
Problem 2.10

Answer:
$M = 30\left(\sqrt{3} - 3\right)$ N·m$\hat{k}$

2.1.12 $\vec{F}_1$ acts at A and $\vec{F}_2 = 7\,\text{N}\hat{\imath}$ acts at an unknown location. Together they are equivalent to a force $\vec{F}_B$ and moment $\vec{M}_B = 48\,\text{N·m}\hat{k}$ at B. Together they are also equivalent to a force $\vec{F}_C$ and moment $\vec{M}_C = 75\,\text{N·m}\hat{k}$ at C.

a) Find $\vec{F}_C$.

b) Find the line of action of $\vec{F}_2$.



Problem 2.12

Answer:
$\vec{F}_C = (-9\hat{\imath} - 12\hat{\jmath})$ N
Through B and also through a point 3 m above A.

2.1.15 2D. Assume a force system is equivalent to a force $\vec{F}_1 \neq \vec{0}$ and couple $\vec{M}_1 = M_1\hat{k}$ acting at point $\vec{r}_1$.

a) Find some point $\vec{r}_2$, and force $\vec{F}_2$ so that $\vec{F}_2$ acting at $\vec{r}_2$ is equivalent to $\vec{F}_1$ and $\vec{M}_1$ acting at $\vec{r}_1$.

b) Find all possible wrenches (combinations of point location, force and moment) equivalent to the system with $\vec{F}_1$ and $\vec{M}_1$ acting at the point with position vector $\vec{r}_1$.

c) Describe the situation in the special case when $\vec{F}_1 = \vec{0}$.

Answer:
(a) $\vec{r}_2 = \vec{r}_1 + \vec{F}_1 \times \hat{k}M_1/|\vec{F}_1|^2$, $\vec{F}_2 = \vec{F}_1$.
(b) $\vec{r}_2 = \vec{r}_1 + \vec{F}_1 \times \hat{k}M_1/|\vec{F}_1|^2 + c\vec{F}_1$ where c is any real number, $\vec{F}_2 = \vec{F}_1$.
(c) $\vec{F}_2 = \vec{0}$ and $\vec{M}_2 = \vec{M}_1$ applied at any point in the plane.

2.1.16 3D. Assume a force system is equivalent to a force $\vec{F}_1$ and couple $\vec{M}_1$ acting at point with position vector $\vec{r}_1$.

a) Find a point P with position vector $\vec{r}_2$, so that an equivalent force system $\vec{F}_2$ and $\vec{M}_2$ acting at P has $\vec{F}_2$ is parallel to $\vec{M}_2$. (Finding such a point, force and moment is called "reducing the force system to a *wrench*").

b) Find all possible wrenches (combinations of point location, force and moment) equivalent to the system with $\vec{F}_1$ and $\vec{M}_1$ acting at $\vec{r}_1$.

Note, one special case with a slightly different result than the other cases is if $\vec{F}_1 = \vec{0}$, so it should be treated separately.

Answer:
(a) $\vec{r}_2 = \vec{r}_1 + \vec{F}_1 \times \vec{M}_1/|\vec{F}_1|^2$, $\vec{F}_2 = \vec{F}_1$, $\vec{M}_2 = \vec{M}_1 \cdot \vec{F}_1\vec{F}_1/|\vec{F}_1|^2$. If $\vec{F}_1 = \vec{0}$ then $\vec{F}_2 = \vec{0}$, $\vec{M}_2 = \vec{M}_1$, and $\vec{r}_2$ is any point at all in space.
(b) $\vec{r}_2 = \vec{r}_1 + \vec{F}_1 \times \vec{M}_1/|\vec{F}_1|^2 + c\vec{F}_1$ where c is any real number, $\vec{F}_2 = \vec{F}_1$, $\vec{M}_2 = \vec{M}_1 \cdot \vec{F}_1\vec{F}_1/|\vec{F}_1|^2$. See above for the special case of $\vec{F}_1 = \vec{0}$.