8.8  The force is a constant force so the work can be found using $W = \vec{F} \cdot \Delta \vec{r}$. The change in the position vector is

$$\Delta \vec{r} = \vec{r}_f - \vec{r}_i = (5.0 \text{ m}) \hat{i} - (10.0 \text{ m}) \hat{i} = -(5.0 \text{ m}) \hat{i}.$$  

The work done is

$$W = \left( (-30.0 \text{ N}) \hat{i} + (20.0 \text{ N}) \hat{j} \right) \cdot \left( -(5.0 \text{ m}) \hat{i} \right) = 1.5 \times 10^2 \text{ J}.$$  

8.9  The work done by a force component such as $F_x$ is equal to the area under the graph of $F_x$ versus $x$, between the initial and final positions. Here, the area is that of a semicircle. When evaluating the square of the radius of the circle, take one radius as the distance and the other as the force component.

$$W = \frac{\pi}{2} (30.0 \text{ N})(5.0 \text{ m}) = 2.4 \times 10^2 \text{ J}.$$  

8.10  The force is a constant force so the work can be found using $W = \vec{F} \cdot \Delta \vec{r}$. Take $\hat{i}$ to be in the direction that the file cabinet is moved. Then $\Delta \vec{r} = (6.5 \text{ m}) \hat{i}$ and $\vec{F} = (280 \text{ N}) \hat{i}$, so the work done is

$$W = \left( (280 \text{ N}) \hat{i} \right) \cdot \left( (6.5 \text{ m}) \hat{i} \right) = 1.8 \times 10^3 \text{ J}.$$  

8.11  

a)  Here’s the picture.

![Diagram of vectors and forces](image)

The vectors $\hat{i}$, $\hat{j}$, and $\vec{F}$ all have their tails at the origin. We’ve chosen the scale so that a unit length is 1.00 m.

b)  The force is a constant force so the work can be found using $W = \vec{F} \cdot \Delta \vec{r}$. To do zero work, we want the scalar product of $\vec{F}$ with $\Delta \vec{r}$ to be zero, that is, we want $\vec{F}$ and $\Delta \vec{r}$ to be perpendicular. Therefore, choose a path such as $P_0$ in the picture. The work done will be zero for any movement along this path — either towards or away from the origin.

c)  To do the maximum amount of positive work for the given length of 2.00 m, we want $\vec{F}$ to be parallel to $\Delta \vec{r}$. Path $P_{\text{max}}$ is a two meter path that does the trick when moving away from the origin. The work done by $\vec{F}$ along this path is

$$W = \vec{F} \cdot \Delta \vec{r} = F \Delta r \cos 0^\circ = \sqrt{(1.00 \text{ N})^2 + (1.00 \text{ N})^2}(2.00 \text{ m}) = 2.83 \text{ J}.$$  

If the system returns to the origin along this path, the work done is $-2.83 \text{ J}$ because the direction of $\Delta \vec{r}$ is reversed and therefore the cosine of the angle between $\vec{F}$ and $\Delta \vec{r}$ is $-1$ instead of 1.

d)  To do the most negative work for the given length of 2.00 m, we want $\vec{F}$ to be antiparallel to $\Delta \vec{r}$. Path $P_{\text{min}}$ is a two meter path that does the trick when moving away from the origin. The work done by $\vec{F}$ along this path is

$$W = \vec{F} \cdot \Delta \vec{r} = F \Delta r \cos 180^\circ = \sqrt{(1.00 \text{ N})^2 + (1.00 \text{ N})^2}(2.00 \text{ m})(-1) = -2.83 \text{ J}.$$  

If the system returns to the origin along this path, the work done is 2.83 J because the direction of $\Delta \vec{r}$ is reversed and therefore the cosine of the angle between $\vec{F}$ and $\Delta \vec{r}$ is 1 instead of $-1$. 