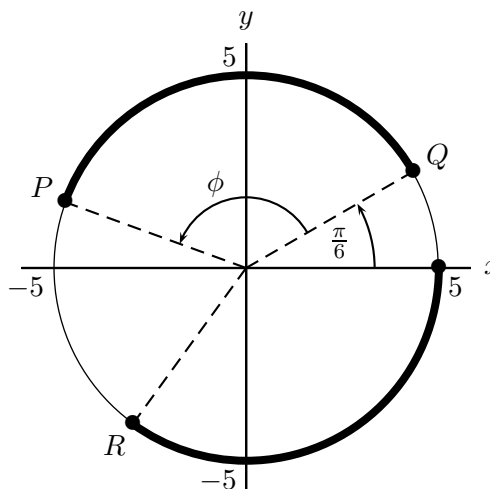


5. [13 points]

The problems on this page refer to the diagram to the right. As shown in the diagram, note the following:

- The points  $P$ ,  $Q$ , and  $R$  are on the circle.
- The angle between the positive  $x$ -axis and the line segment from the origin to  $Q$  is  $\frac{\pi}{6}$  radians.
- The angle between the line segment from the origin to  $Q$  and the line segment from the origin to  $P$  is  $\phi$  radians.



a. [2 points] Find the coordinates of the point  $Q$ .

*For full credit, each coordinate should be exact and simplified as much as possible.*

**Answer:** The coordinates of  $Q$  are ( \_\_\_\_\_ , \_\_\_\_\_ ).

b. [2 points] Find the coordinates of the point  $P$  in terms of  $\phi$ .

**Answer:** The coordinates of  $P$  are ( \_\_\_\_\_ , \_\_\_\_\_ ).

c. [2 points] Find the length of the path from  $Q$  to  $P$  counterclockwise along the circle (the upper path shown in **bold** in the diagram above). Give your answer in terms of  $\phi$ .

**Answer:** \_\_\_\_\_

d. [5 points] The length of the counterclockwise path along the circle from the point  $R$  to the point  $(5,0)$  (the lower path shown in **bold** in the diagram above) is 11 units. Find the coordinates of the point  $R$ . *For full credit, show your work and give decimal approximations rounded to the nearest 0.01 unit rather than exact answers.*

**Answer:** The coordinates of  $R$  are ( \_\_\_\_\_ , \_\_\_\_\_ ).

e. [2 points] Based on the diagram above, which of the following statements are true?

*Circle ALL of the statements that are true.*

*Circle NONE OF THESE if none of the statements are true.*

$\cos\left(\frac{\pi}{6}\right) > \cos\left(\phi + \frac{\pi}{6}\right)$ 
         
   $0 > \cos\left(\phi + \frac{\pi}{2}\right)$ 
         
  NONE OF THESE

$\cos(\phi) > \cos\left(\frac{\pi}{6}\right)$ 
         
   $\sin\left(\phi + \frac{\pi}{6}\right) > 0$