Problem 2.116

We need to find the magnitude of the total acceleration at Point B. Because the car is on a circular path at that point we can use the following equation to find the acceleration vector:

\[ \dot{a} = a_t \hat{e}_t + a_n \hat{e}_n \]

where \( a_t = 0.4t \) and \( a_n = \frac{v^2}{R} \)

Well, in order to solve the problem, we need to still find the time, \( t \), it takes the car to reach Point B and we need to find an expression for \( v \).

We can find \( v \) by integrating the given expression for \( a_t \). Note that we do not need \( a_n \) to find the velocity, because the velocity only has a component in the tangential direction.

Thus, \( v = \int a_t dt = \int 0.4t dt = 0.2t^2 + \text{constant} \)

To find the value of the constant, we plug in the initial conditions, \( V_0 = 0 = 0.2(0)^2 + \text{constant} \) \( \Rightarrow \) \( : \) constant = 0.

This gives us \( \boxed{v = 0.2t^2} \)

We can integrate this to find an expression for \( s \):

\[ s = \int v dt = \int 0.2t^2 dt = \frac{0.2}{3} t^3 + \text{constant} \]

The initial conditions show that the constant equals zero. Therefore, \( \boxed{s = 0.067 t^3} \)
Prob 2.116 (continued)

From the expression for \( s \) we can calculate the time it takes for the car to reach Point B.

The total distance the car travels from A to B is

\[
200 \, \text{m} + R \frac{\pi}{2} = 200 \, \text{m} + 50 \, \text{m} \left( \frac{\pi}{2} \right) = 278.54 \, \text{m}
\]

Thus,

\[
s = 278.54 = 0.067 \, t^3 \implies t^2 = \frac{278.54}{0.067} = 4157.3 \, \text{sec}^2
\]

\[
\therefore \, t = 16.1 \, \text{sec}
\]

Now that we have \( t \) we can find the velocity of the car at Point B:

\[
V_{B} = 0.2 \, t^2 = 0.2 \, (16.1)^2 = 51.88 \, \text{m/sec}
\]

Now we can plug our \( t \) and \( V \) values into the expression for the acceleration vector at Point B:

\[
a_t = 0.4 \, t = 0.4 \, (16.1) = 6.44 \, \text{m/sec}^2
\]

\[
a_n = \frac{V^2}{R} = \frac{(51.88)^2}{50} = 53.83 \, \text{m/sec}^2
\]

Therefore, the total magnitude is:

\[
|\vec{a}| = \sqrt{(6.44)^2 + (53.83)^2} = 54.21 \, \frac{\text{m}}{\text{sec}^2}
\]