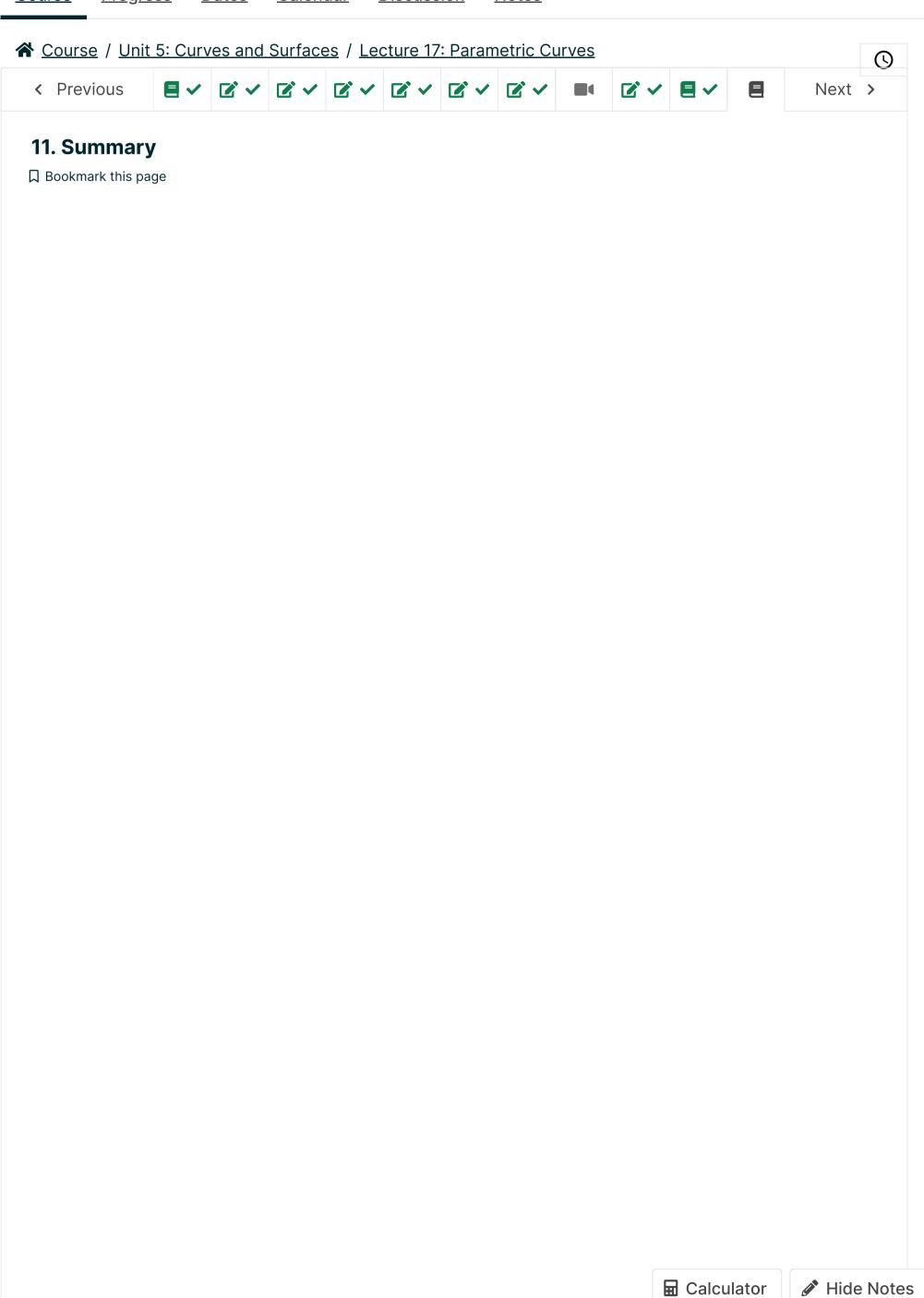
<u>Help</u>

sandipan\_dey ~

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### **Summarize**

#### **Big Picture**

Motion in the plane or in three-dimensional space can be described by a vector-valued function  $\vec{r}(t)$ . We can do calculus with  $\vec{r}(t)$  to get insight into the motion's speed and velocity.

#### **Mechanics**

Motion given by functions  $x\left(t\right),y\left(t\right),z\left(t\right)$  can be packaged into a vector:

$$\vec{r} = \begin{pmatrix} x(t) \\ y(t) \end{pmatrix}$$
 or  $\vec{r} = \begin{pmatrix} x(t) \\ y(t) \\ z(t) \end{pmatrix}$  (6.93)

Sometimes, it's helpful to use vector arithmetic to analyze  $ec{r}$ . One can also compute speed and velocity using calculus:

- $ec{v}=rac{dec{r}}{dt}$  is the **velocity** vector at a given time t. Its components are the derivatives of the components of  $ec{r}$ .
- The  $\mathbf{speed} = |\vec{v}|$  is the magnitude of the velocity vector.
- $\widehat{T} = rac{ ext{velocity}}{ ext{speed}}$  is the unit tangent vector.

#### **Ask Yourself**

#### **▶** Do we have to use vectors to understand parametric curves?

No, the notation of  $\vec{r}(t)$  can be replaced by the individual functions x(t), y(t), z(t). But there are some advantages to thinking with vectors instead of individual functions. For one, it might be possible to use vector arithmetic to understand the motion described by  $\vec{r}$ . Furthermore, using three functions x(t), y(t), z(t) can become cumbersome when there are many other variables in the problem already. Using a single letter  $\vec{r}$  often makes it easier to stay organized and clarify your thinking.

<u>Hide</u>

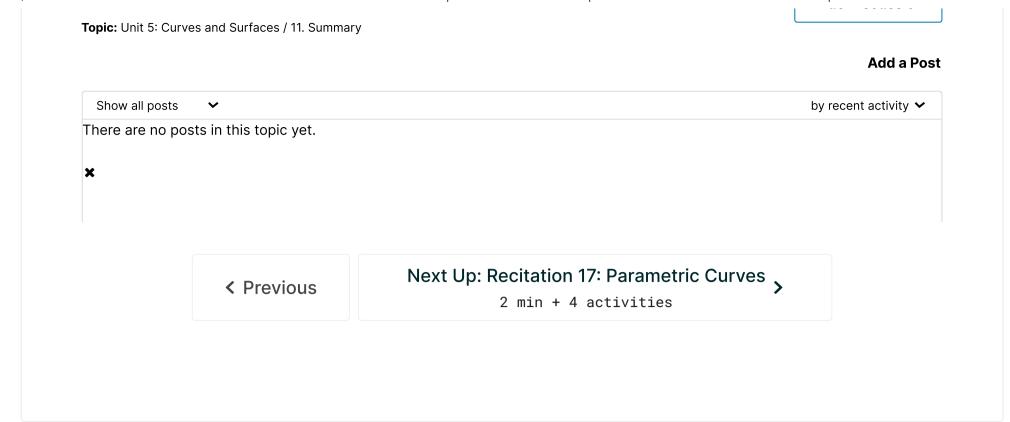
#### ✓ Is it possible for velocity to be zero?

Some care must be taken to interpret "zero" correctly. "Zero" could refer to the number  $\mathbf{0}$  or to the vector of all-zeros  $\vec{\mathbf{0}}$  (the "zero-vector"). But in the context of velocity, we always mean the zero-vector. With this in mind, yes, velocity can be zero.

Intuitively, the velocity is zero means the particle isn't moving. When a car stops at a traffic light, the car's velocity has become zero.

It's not enough for one component of the velocity to be zero. At the peak of its trajectory, a baseball may have y'=0, but the velocity wouldn't be  $\vec{0}$  unless x' is also 0.

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