

## Maple Questions

Here are some sample Maple assessment questions for this chapter.

1. Illustrate analytically and graphically that if  $\mathbf{w}$  is a unit vector and

$$\mathbf{v} = \mathbf{k} \times \mathbf{u}$$

then  $\mathbf{v}$  is a  $90^\circ$  rotation of  $\mathbf{u}$  about an axis parallel to  $\mathbf{k}$ .

2. Have user input a unit vector  $\mathbf{u} = \langle u_1, u_2, u_3 \rangle$  in which all 3 components are non-zero, and then calculate

$$\mathbf{v} = \mathbf{k} \times \mathbf{u} \quad \text{and} \quad \mathbf{w} = \mathbf{u} \times \mathbf{v}$$

Show that if a user inputs another vector  $\mathbf{p}$ , then

$$\mathbf{p} = \text{proj}_{\mathbf{u}}(\mathbf{p}) + \text{proj}_{\mathbf{v}}(\mathbf{p}) + \text{proj}_{\mathbf{w}}(\mathbf{p})$$

3. On the earth's surface, the acceleration due to gravity is 32 feet per second per second. On the surface of Mars, the acceleration due to gravity is 12.2 feet per second per second. Construct a worksheet which compares projectile motion on the earth to projectile motion on Mars by drawing both parabolic paths simultaneously (but with different colors) for a given set of inputs
4. For any smooth curve  $\mathbf{r}(t)$ ,  $t$  in  $[a, b]$ , input by the user, demonstrate that the arclength  $L$  of the curve is also given by

$$L = \int_a^b \sqrt{\frac{\mathbf{a} \cdot \mathbf{N}}{\kappa}} dt$$

Illustrate by showing the relationship of the integrand to the osculating circle at time  $t$ .

5. Let a user input a smooth curve  $\mathbf{r}(t) = \langle x(t), y(t), 1 \rangle$ ,  $t$  in  $[a, b]$ , which is in the  $z = 1$  plane. Construct the curve

$$\mathbf{q}(t) = \frac{\mathbf{r}(t)}{\|\mathbf{r}(t)\|}$$

and show both  $\mathbf{r}(t)$  in the  $z = 1$  plane and  $\mathbf{q}(t)$  on the upper unit hemisphere. In addition, calculate and include in the graphic the unit tangent and unit normal vectors to each curve at a given point. **Extra:** Animate the unit tangent and unit normal vectors. Calculate and include in the animation the unit binormals of each curve. What is significant about each of the binormals?