1. Find the derivative of vector function $\mathbf{r}(t)$. Compute definite integrals of vector functions using the Fundamental Theorem of Calculus for vector functions. How would you find the arc length along the curve given by $\mathbf{r}(t)$ from $t = a$ to $t = b$?

2. If $\mathbf{r}(t)$ represents position at time t, how would you calculate the distance travelled from $t = a$ to $t = b$? What is the difference between distance and displacement?

3. If you are given the acceleration of an object $\mathbf{a}(t)$, as well as its initial velocity $\mathbf{v}(0) = \mathbf{v}_0$ and position $\mathbf{r}(0) = \mathbf{r}_0$, how would you find the equations for the velocity and position at time t?

4. Suppose a curve is given by a vector function $\mathbf{r}(t)$ for $a \leq t \leq b$. How would you find an arc length parameterisation for the curve?

5. Suppose a curve C is parameterised by $\mathbf{r}(t)$ for $a \leq t \leq b$. How would you find a tangent vector to C at the point $\mathbf{r}(t_0)$ (pointing in the forwards direction) along C? How would you find a unit tangent vector?

6. How is the curvature at a point on a curve C defined (in terms of arc length and the unit tangent vector)? If you are given $\mathbf{r}'(t)$ and $\mathbf{r}''(t)$, how would you are calculate the curvature? What is an osculating circle, and how does its radius relate to the curvature?

7. Suppose an object is moving along a curve C, and you are given the velocity $\mathbf{v}$ and the acceleration $\mathbf{a}$ at a point P on the curve. Find the tangential and normal components of $\mathbf{a}$ along C at P. How do these relate to the curvature and the rate of change of speed along the curve at P?

8. What point does the polar co-ordinate (r, θ) represent in the plane? What are all the possible polar co-ordinates that represent the same point? Sketch the graphs of curves defined by simple polar equation.

9. Find the area of a region enclosed by curves defined using polar co-ordinates.

10. Given a simple quadratic equation in x and y, determine whether it describes a parabola, ellipse, or hyperbola in the plane. Graph the curve of a conic section given its equation, labelling the x and y–intercepts. Find the co-ordinates for the foci of a parabolia, ellipse, or hyperbola. Find the equations for the asymptotes of a hyperbola. Find equations of tangent lines to a point on a conic section in the plane.

11. Suppose a quadric surface S is given by a simple quadratic equation in x, y, and z. Draw the cross-sections of the surface with planes parallel to the co-ordinate planes. Use these to identify the type of quadric surface.

12. Prove basic formulae involving vector functions (such as differentiation rules) by doing calculations for component function.