1.) The following problem is a combination of problems 41 and 42 on page 859
Given two curves in space one can ask the two questions.
1. Do the curves intersect?
2. Do the curves intersect at the same time?

The difference between the two is often important when the curves model the movement of objects in space. Even if the curves intersect that doesn't necessarily mean the objects collide.
a.) Given the two curves $\overrightarrow{r}_1(t) = \langle t^2, 7t-12, t^2\rangle$ and $\overrightarrow{r}_2(t) = \langle 4t-3, t^2, 5t-6\rangle$ answer questions 1. and 2.
b.) Given the two curves $\overrightarrow{r}_1(t) = \langle t, t^2, t^3\rangle$ and $\overrightarrow{r}_2(t) = \langle 1+2t, 1+6t, 1+14t\rangle$ answer questions 1. and 2.
Be careful, the curves could intersect in more than one point.

2.) Consider a vector valued function $\mathbf{r}(t) = (f(t), g(t))$. Note that the range of $\mathbf{r}$ is $\mathbb{R}^2$. For a given point on the curve, say $\mathbf{r}(t_0) = (f(t_0), g(t_0))$, consider the circle which passes through $(f(t_0), g(t_0))$, is tangent to $\mathbf{r}$ at $(f(t_0), g(t_0))$, which lies on the concave side of $\mathbf{r}$, and which has radius $1/\kappa$ where κ is the curvature of $\mathbf{r}$ at $(f(t_0), g(t_0))$. This is called the *osculating circle* of $\mathbf{r}$ at $(f(t_0), g(t_0))$.
a.) Consider the vector valued function $\mathbf{r}(t) = (2\cos(t), 3\sin(t))$ where the domain of $\mathbf{r}$ is $[0, 2\pi]$. Draw a sketch of $\mathbf{r}$.

b.) Describe and sketch the osculating cirlces for $\mathbf{r}$ at the points $\mathbf{r}(0)$, $\mathbf{r}(\pi/2)$, and $\mathbf{r}(\pi)$.

c.) What does the word "osculating" mean? Feel free to use any resources you like, although please cite them.

d.) Why do you think we call this thing the *osculating circle*?