How many times to the following pairs of curves intersect? Find all points of intersection, and the angles at which they intersect.

1. $\mathbf{r_1}(t) = \langle t^2, t+1, 5\rangle$
   $\mathbf{r_2}(s) = \langle 9, s^2, s+7\rangle$
2. $\mathbf{r_1}(t) = \langle t^2, 6, -t\rangle$
   $\mathbf{r_2}(s) = \langle s, \cos(2\pi s), \sqrt{s}\rangle$
3. $\mathbf{r_1}(t) = \langle t, t^3+1, 0\rangle$
   $\mathbf{r_2}(s) = \langle s-1, s, \sin(\pi s)\rangle$

Find the arclength of the following curves

4. $\mathbf{f}(t) = \langle -\frac{1}{2}t^2, \frac{1}{15}(10t)^{3/2}, 5t\rangle$, $-2 \leq t \leq 2$
5. $\mathbf{f}(t) = \langle \ln(t), -\sqrt{2}\cdot t, \frac{1}{2}t^2\rangle$, $1 \leq t \leq e$
6. $\mathbf{f}(t) = \langle -e^{2t}, \frac{1}{2}e^{2t}, -e^{2t}\rangle$, $0 \leq t \leq 1$

7. We have seen that there are multiple ways to parameterize a function. For example, two sets of equations can describe coinciding lines even though they look different. Does the arclength of a function depend on the parameterization we use to describe it?
   (a) Reparameterize the funtion in problem 6 using $u = e^{2t}$
   (b) What are the corresponding bounds?
   (c) Find the arclength of this new curve.
   (d) Is your answer the same as in problem 6?

8. A bird is flying in the air following the curve
   $\mathbf{f}(t) = \langle 4\cos t, 4\sin t, 20-3t\rangle$ from $t = 0$ to $t = 2\pi$
   (a) Describe this curve in words
   (b) The sun is directly overhead, so the bird's shadow is directly beneath him. What shape does the shadow trace?
   (c) Using geometry, calculate the distance the shadow travels.
   (d) How far above the ground is the bird at the start and end? How much does his height change?
   (e) Use parts (c) and (d) to calculate the distance flown by the bird.
   (f) Use calculus to calculate the distance flown by the bird.