Show all work!

1. Find $\mathbf{f}'(t)$ and $\mathbf{f}''(t)$ if $\mathbf{f}(t) = \cosh(2t)\mathbf{i} + \sinh(2t)\mathbf{j}$.
2. If $\mathbf{g}(0) = 2\mathbf{i} - 3\mathbf{j}$, $\mathbf{f}(0) = 3\mathbf{i} + 4\mathbf{j}$, $\mathbf{g}'(0) = -2\mathbf{i}$, and $\mathbf{f}'(0) = 3\mathbf{j}$, find
   (a) The derivative of $\mathbf{f}(t) \cdot \mathbf{g}(t)$ at $t = 0$.
   (b) The derivative of $\mathbf{f}(t) \times \mathbf{g}(t)$ at $t = 0$.
3. Find the tangent vector $\mathbf{r}'(t)$ at the indicated point and parameterize the tangent line:
$$\mathbf{r}(t) = 3\cosh(t)\mathbf{i} + 4\sinh(t)\mathbf{j}, \quad t = \ln(2). \tag{1}$$
4. Find the curvature of the curve: $y = e^{2x}$.
5. Find the radius of curvature of the curve $y = x^2$ at the point $(1, 1)$.
6. Express the curvature of the curve $\mathbf{r}(t) = e^t\mathbf{i} + e^{-t}\mathbf{j}$ as a function of t.
7. Interpret $\mathbf{r}(t)$ as the position of a moving object at time t.
$$\mathbf{r}(t) = \cos(5t)\mathbf{i} + \sin(5t)\mathbf{j} + 12t\mathbf{k} \tag{2}$$
   (a) Find the curvature of the path using $\mathbf{v} = \mathbf{r}'(t)$ and $\mathbf{a} = \mathbf{r}''(t)$.
   (b) Find the tangential and normal components of acceleration.
   (c) Find the principal (unit) normal vector from $\mathbf{r}''(t)$ and the results of 8b.
   (d) Find $s(t)$, the arc length of this curve as a function of t, starting at $t = 0$.