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Find the unit tangent and principal unit normal vectors at the given points.

5. $\vec{r}(t) = \langle t, t^2 \rangle$ at $t = 0,\ t = 1$

7. $\vec{r}(t) = \langle \cos 2t, \sin 2t \rangle$ at $t = 0,\ t = \frac{\pi}{4}$

9. $\vec{r}(t) = \langle \cos 2t, t, \sin 2t \rangle$ at $t = 0,\ t = \frac{\pi}{2}$

Find the osculating circle at the given points.

13. $\vec{r}(t) = \langle t, t^2 \rangle$ at $t = 0$

16. $\vec{r}(t) = \langle 2\cos t, 3\sin t \rangle$ at $t = \frac{\pi}{4}$

Find the tangential and normal components of acceleration for the given position functions at the given points.

17. $\vec{r}(t) = \langle 8t, 16t - 16t^2 \rangle$ at $t = 0,\ t = 1$

23. For the circular helix traced out by $\vec{r}(t) = \langle a\cos t, a\sin t, bt \rangle$, find the tangential and normal components of acceleration.

Find the binormal vector $\vec{B}(t) = \vec{T}(t) \times \vec{N}(t)$ at $t = 0$ and $t = 1.$ Also, sketch the curve traced out by $\vec{r}(t)$ and the vectors $\vec{T},\ \vec{N}$ and $\vec{B}$ at these points.

25. $\vec{r}(t) = \langle t, 2t, t^2 \rangle$

27. $\vec{r}(t) = \langle 4\cos \pi t, 4\sin \pi t, t \rangle$

Label the statement at true (i.e., always true) or false and explain your answer.

29. $\vec{T} \cdot \frac{d\vec{T}}{ds} = 0$

30. $\vec{T} \cdot \vec{B} = 0$

31. $\frac{d}{ds}(\vec{T} \cdot \vec{T}) = 0$

32. $\vec{T} \cdot (\vec{N} \times \vec{B}) = 1$