

1. Find a parametrization of the tangent line to the curve $y = x^3 - 4x + 2$ at the point $(1, -1)$,
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2. Find a parametrization of the line passing through $(4, 1, 5)$ and normal to the plane $3x - 2y + 5z = 12$.
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3. A particle moves in the xy -plane in such a way that its position at time t is

$$\mathbf{r}(t) = \begin{pmatrix} t - \sin(t) \\ 1 - \cos(t) \end{pmatrix}$$

- (a) Find the domain and range of $\mathbf{r}(t)$.
(b) Graph $\mathbf{r}(t)$.
(c) Find $\mathbf{v}(t)$. Graph the velocity vector for $t = \pi$ and $t = 3\pi/2$.
(d) Find the maximum and minimum values of $|\mathbf{v}(t)|$. (Hint: Maximize instead $|\mathbf{v}(t)|^2$.)
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4. Given the velocity functions below, find the particle's position subject to the given initial conditions.

- (a) $\mathbf{v}(t) = (180t)\mathbf{i} + (180t - 16t^2)\mathbf{j}$ with $\mathbf{r}(0) = 100\mathbf{j}$.
(b) $\mathbf{v}(t) = (t^3 + 4t)\mathbf{i} + t\mathbf{j} + 2t^2\mathbf{k}$ with $\mathbf{r}(0) = \mathbf{i} + \mathbf{j}$.
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