

I prefer that you submit your answers on a printed copy of this document, like it's a quiz or exam. However, you may instead rewrite the questions by hand before solving them. Staple sheets together, in order. **Be neat. Always give enough work and clear explanation so that fellow students could follow what you did (from start to finish) just by reading your paper.** Numbers in [] give point values for each question.

1. Suppose the position of a particle (as a function of time) is given by $\mathbf{r}(t) = \langle \sin(2t), \cos(2t), t^2/\pi \rangle$.

[4] (a) Find the velocity, speed and acceleration functions for this particle.

[4] (b) Find equation(s) which describe the line that's tangent to the graph of \mathbf{r} at the point $(0, 1, \pi)$.

[4] (c) Using only your brain, graph the curve \mathbf{r} for $0 \leq t \leq \pi$.

2. Suppose the position of an object (as a function of time) is given by $\mathbf{r}(t) = \langle t^2, 2 - t^2, t^3 \rangle$.

[4] (a) Find simplified expressions for the tangential acceleration a_T , normal acceleration a_N , and curvature $\kappa(t)$.

[4] (b) By hand, find the distance this object travels from $t = 0$ to $t = 2$.