

1 Lagrange multipliers

Solve *one* of the following problems using the method of Lagrange multipliers.

- (a) Find the maximum and minimum values of $x^2 + y^2 - 2x - 2y$ on the circle of radius $\sqrt{8}$ centered at the origin, that is, on the circle $\{x^2 + y^2 = 8\}$
- (b) Find the points on the curve $x^2 + xy + y^2 = 3$ which are closest to and furthest from the origin.

2 Velocity I

An object moving with constant velocity passes through the point $(1, 1, 1)$, then through the point $(2, -1, 3)$ five seconds later. What is its velocity vector? What is its speed? What is its acceleration vector? (Assume the coordinates are given in meters.)

3 Velocity II

Suppose $\vec{r}(t) = 3 \cos(\omega t) \hat{x} + 3 \sin(\omega t) \hat{y} + 4\omega t \hat{z}$ represents the position of a particle on a curve after t seconds (with distance measured in meters and $\omega > 0$).

- (a) Is the particle ever moving downward? If so, when?
- (b) When does the particle reach a point 12 meters above the ground?
- (c) What is the velocity of the particle when it is 12 meters above the ground? What is its speed?
- (d) When it is 12 meters above the ground, the particle leaves the curve and moves along the tangent line to the curve. Find an equation for this tangent line.