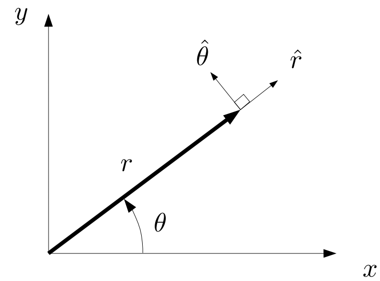
1 plane polar coordinates

The vector position of a particle in plane polar coordinates can be represented as $\vec{r} = r\hat{r}$, where $\hat{r}$ is the unit vector in the direction of increasing r at a given θ.



1.1 velocity in plane polar coordinates

Show that the velocity of a particle in plane polar coordinates can be represented as $\dot{\vec{r}} = \dot{r}\hat{r} + r\dot{\theta}\hat{\theta}$, where $\hat{\theta}$ is the unit vector in the direction of increasing θ. Note: the direction of the $\hat{r}$ and $\hat{\theta}$ change with the value of θ. $\hat{r}$ is written as $\mathbf{e}_r$, and $\hat{\theta}$ is written as $\mathbf{e}_\theta$, in section 1.14 of Thornton and Marion. Your instructor prefers the hat notion because it works on the chalk board, and other reasons.

1.2 acceleration in plane polar coordinates

Find the acceleration, $\ddot{\vec{r}}$, of the particle in plane polar coordinates. Answer in terms of r and θ, and there first and second time derivatives, $\hat{r}$ and $\hat{\theta}$.

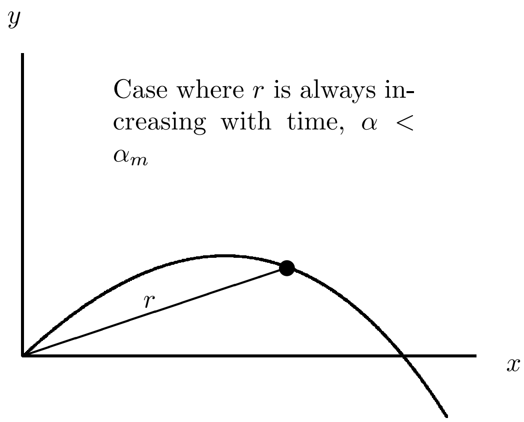
2 review - free fall with no air drag

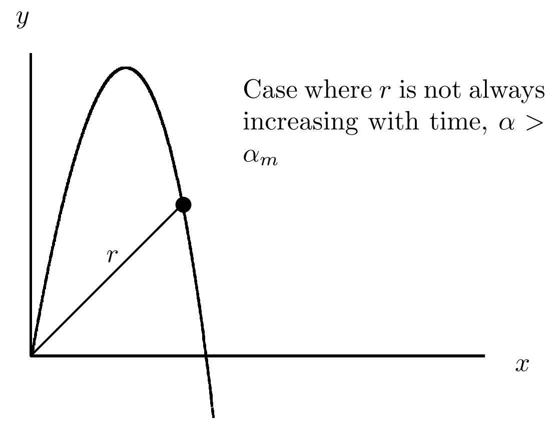
A projectile is fired from the base of an inclined plane up the inclined plane. The initial velocity of the projectile is v_0 at an angle α measured from the horizontal. The angle of slope of the inclined plane is β where, $\beta < \alpha$. Find the time t_1, from when the projectile is fired, for the projectile to impact the inclined plane.

3 more free fall with no air drag

3.1

Find the largest angle, α_m, as measured from the horizontal, with which a particle can be projected such that the distance from the launch point to the particle will always be increasing. See the figure below. Note: If, when solving this problem, you find that the statement of this problem is a little inconsistent (as your instructor did), have a look at the next part of this problem.





3.2

Explain why your instructor feels that the problem in subsection 3.1, which was restated from Thornton & Marion problem 2-19, should be rewritten as: Find the angle, α_m, as measured from the horizontal, below which a particle can be projected such that the distance from the launch point to the particle will always be increasing for all time after the particle is released.

4 how high with v^2 air drag?

A ball traveling through a fluid (kind of like air) has a drag force that is proportional to the square of the speed of the ball. Near the surface of the earth the terminal speed of the free falling ball is v_t. The ball is thrown straight up with an initial speed of v_0.

4.1 how high?

Find h, how high from the point of release that the ball will travel. Answer in terms of v_t, v_0, and g, the acceleration due to gravity.

4.2 limiting case

Show that your result, h, from subsection 4.1 is the same as the case when there is no drag by taking the limit when v_t goes to infinity of the expression that you got for h in subsection 4.1.