Suppose the position of a cow in a tornado is given by

$$\vec{\mathbf{r}}(t) =< \cos(2t), \sin(3t)^3, \cos(3t) - \sin(3t) + 19 >$$

for $0 \leq t \leq 5$ where t is measured in seconds after 12:00 noon on June 1, and distance is measured in meters.

(Feel free to experiment with using Maple to solve these problems!)

1. Find when the cow is traveling horizontally. What direction is the cow moving at each time?

2. Is there any time when the cow is traveling straight up or straight down?

3. Find the cow's maximum speed?

A cow is launched from a catapult at ground level with an initial speed of 50 meters per second and at an angle of θ from the horizontal. Assume that the only force acting on the cow is gravity.

1. Find a vector-valued function $r(t)$ that describes the path travelled by the cow. Note that your answer will involve θ as a constant.

2. At what time will the cow hit the ground?

3. How far from the launch point will the cow hit the ground?

4. Find the value of θ that will maximize the horizontal distance traveled.