SECTION 11.3 (Motion in Space)
NAME:__________________________________________________________________________

1. Find the force acting on an object of mass 10 kg with the given position function (in units of meters and seconds): \( \mathbf{r}(t) = \langle 3 \cos 4t, \ 2 \sin 5t \rangle \).

2. A projectile is fired with initial speed \( v_0 = 100 \) feet per second from a height of \( h = 0 \) feet at an angle of \( \theta = \pi/6 \) above the horizontal. Assuming that the only force acting on the object is gravity, find the maximum altitude, horizontal range and speed at impact.

3. Beginning with Newton’s second law of motion, derive the equations of motion for a projectile fired from altitude \( h \) above the ground at an angle \( \theta \) to the horizontal and with initial speed equal to \( v_0 \).
4. For the general projectile of exercise 3, with \( h = 0 \), (a) show that the horizontal range is 
\[
\frac{v_0 \sin 2\theta}{g}
\]
and (b) find the angle that produces the maximum horizontal range.

5. A baseball pitcher throws a pitch horizontally from a height of 6 feet with an initial speed of 130 feet per second. Find a vector-valued function describing the position of the ball \( t \) seconds after release. If home plate is 60 feet away, how high is the ball when it crosses home plate?

6. A tennis serve is struck horizontally from a height of 8 feet with initial speed 120 feet per second. For the serve to count (be “in”), it must clear a net that is 39 feet away and 3 feet high and must land before the service line 60 feet away. Find a vector function for the position of the ball and determine whether this serve is in or out.