AP Calculus Homework Seven – Applications of Differential Calculus

3.7 Motion along a Curve: Velocity and Acceleration; 3.8 Related Rates; 3.9 Slope of a Polar Curve

1. If the position of a particle moving along a straight line is given by $s = t^3 - 6t^2 + 12t + 8$.
   a) Find the values of *t* for which *s* is increasing.
   b) What is the minimum value of the speed?
   c) Find the values of *t* for which the acceleration is positive.
   d) Find the values of *t* for which the speed is decreasing.

2. The displacement from the origin of a particle moving on a line is given by $s = t^4 - 4t^3$. Find the maximum displacement during the time interval $-2 \le t \le 4$.

3. If $\vec{R} = 3\cos\frac{\pi}{3}t\ \vec{i} + 2\sin\frac{\pi}{3}t\ \vec{j}$ is the (position) vector from the origin to a moving point P(*x*, *y*) at time *t*.
   a) What is the equation in x and *y* for the path of the point?
   b) Find the speed of the point at $t = 3$.
   c) Find the magnitude of the acceleration at $t = 3$.
   d) At the point where $t = 0.5$, what is the slope of the curve along which the point moves?

4. A balloon is being filled with helium at the rate of 4 ft^3/min. Find the rate, in square feet per minute, at which the surface area is increasing when the volume is $32\pi/3$ ft^3.

5. The height of a rectangular box is 10 cm. Its length increases at the rate of 2 cm/sec; its width decreases at the rate of 4 cm/sec. When the length is 8 cm and the width is 6 cm, what is the rate, in cubic cm per second, at which the volume of the box is changing?

6. The table shows the velocity at time t of an object moving along a line. Estimate the acceleration (in cm/sec^2) at $t = 6$ sec.

t (sec)	0	4	8	10
velocity	18	16	10	0

7. Two cars are traveling along perpendicular roads, car A at 40 mph, car B at 60 mph. At noon, when car A reaches the intersection, car B is 90 miles away, and moving toward it. What is the rate, in miles per hour, at which the distance between the cars is changing at 1:00 P.M.?

8. Find the points at which the curve given by $r = 1 + \cos\theta$ has a vertical or horizontal tangent line for $0 < \theta \leq 2\pi$.