Calculators are not allowed
Answer the following questions.

1. Let $y = 5x^2 - 3$ and Δx be an increment of x.

   (a) Find general formulas for Δy and dy.   (3 points)
   (b) If x changes from 3 to 3.1, then find dy (3 points)

2. (a) Find an equation of the normal line to the graph of the following equation

$$x \sin y + xy + y - x = 0.$$

   at the point whose $x - coordinate$ is 0.   (5 points)

   (b) Find the extrema of

$$f(x) = 2\sin x - x \qquad \text{on } [0, \pi]$$

   $(\sqrt{3} \simeq 1.73 \text{ and } \pi \simeq 3.141)$ (5 points)

3. (a) A point P moves on the circle $x^2 + (y - 2)^2 = 5$, in such a way that its $y -$ coordinate increases at a rate of 4 units per second. How fast is its $x - coordinate$ changing when $x = 1$?   (5 points)

   (b) State Rolle's theorem. Does this theorem apply to $f(x) = \sqrt{9 - x^2}$ on $[-3, 3]$? If yes, find c which satisfies the conclusion of the theorem and if not explain why not.   (2+3 points)

4. Let

$$f(x) = \frac{x}{\sqrt[3]{x^2 - 1}}.$$

   (a) Show that $f'(x) = \dfrac{x^2 - 3}{3\sqrt[3]{(x^2 - 1)^4}}$ (3 points)

   (b) Find the vertical and horizontal asymptotes for the graph of f (if any). (3 points)

   (c) Find the intervals on which f is increasing or decreasing, and find the local extrema of f (if any).   (3 points)

   (d) Given that $f''(x) = \dfrac{2x(9 - x^2)}{9\sqrt[3]{(x^2 - 1)^7}}$, find the intervals on which the graph of f is concave upward or concave downward, and find the points of inflection (if any)
   (3 points)

   (e) Sketch the graph of f.   (3 points)

(Good Luck)