

**Question 1 [10 points]:** An inverted cone full of water has top diameter and height both equal to 10 cm. The water drains from the cone at a rate of  $32 \text{ cm}^3/\text{min}$ . At what rate is the water level dropping when the water level in the cone is 4 cm?

(Recall: The volume of a cone of height  $h$  and base radius  $r$  is  $V = \pi r^2 h/3$  .)

**Question 2:**

(a)[5] Use a linear approximation to estimate the value of  $\ln(0.99)$ . (Recall that  $\ln(1)$  is a “nice” number.)

(b)[5] Determine the linearization  $L(x)$  of  $f(x) = \frac{\tan(x) - x}{x}$  at  $a = \pi$ .

**Question 3:** Determine the derivative of each of the following functions (it is not necessary to simplify final answers):

(a)[3]  $y = 2^{\sec x} - \frac{e^{-x^3}}{x}$

(b)[3]  $f(x) = \ln(x \sin^2 x)$

(c)[4]  $y = (\sqrt{x})^{x+1}$  (logarithmic differentiation may be helpful here.)

**Question 4:** For this question use the function  $f(x) = (x^2 - 8)e^x$ .

**(a)[7]** Determine the intervals of increase and decrease of  $f(x)$ . State a clear conclusion.

**(b)[3]** State the relative (or local) extreme values of  $f(x)$ .

**Question 5:** Suppose  $f(x)$  has domain all real numbers and first derivative  $f'(x) = \frac{x}{x^2 + 36}$ .

**(a)[7]** Determine the intervals of concavity of the graph of  $y = f(x)$ . State a clear conclusion.

**(b)[3]** State the  $x$ -coordinates of the inflection points, if any. (note: you do not have enough information to give the  $y$ -coordinates.)