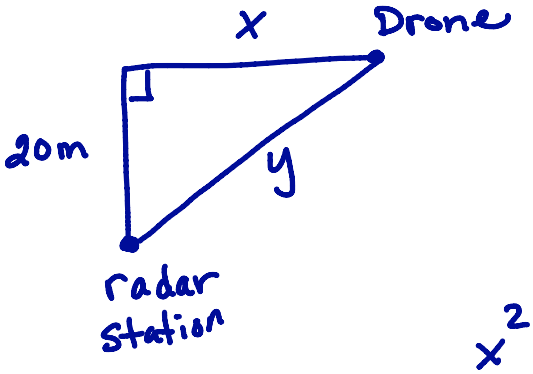
25 points possible. No aids (book, calculator, etc.) are permitted. You need not simplify, but show all work and use proper notation for full credit.

1. **[8 points]** A drone flying horizontally at an altitude of 20 meters and speed of 30 m/s passes directly over a radar station. Find the rate at which the distance from the drone to the station is changing 2 seconds after the drone passes above the station.

[To earn full credit you need to: Draw and label a picture. Write your solution in an orderly, easy to follow manner. Clearly identify your answer. Include units.]



Know: $\frac{dx}{dt} = 30\ m/s$

want: $\frac{dy}{dt}$ when $t=2$ or $x=60$

$$x^2 + 20^2 = y^2$$

$$2x\frac{dx}{dt} + 0 = 2y\frac{dy}{dt} \quad \text{or} \quad \frac{dy}{dt} = \frac{x}{y}\cdot\frac{dx}{dt} \ *$$

We need y.

$$60^2 + 20^2 = y^2$$

$$y^2 = 4000$$

$$y = 20\sqrt{10}$$

$$\begin{array}{r} 3600 \\ 400 \\ \hline 4000 \end{array}$$

Plug into $*$

$$\frac{dy}{dt} = \frac{60}{20\sqrt{10}}\cdot 30 = \frac{90}{\sqrt{10}} = 9\sqrt{10}\ m/s$$

2. [8 points] Let $y = \sqrt[3]{x} = x^{\frac{1}{3}}$

a. Find the linearization, $L(x)$, of $y = \sqrt[3]{x}$ at $x = 1000$.

$y(1000) = 3(1000)^{1/3} = 3 \cdot 10 = 30$

$y'(x) = x^{-2/3}$

$y'(1000) = \frac{1}{(1000)^{2/3}} = \frac{1}{100}$

So $y - 30 = \frac{1}{100}(x - 1000)$

$L(x) = 30 + \frac{1}{100}(x - 1000)$

typo above ← typo here.

b. Use the linearization from part (a) to estimate $\sqrt[3]{999}$. Give your answer as a decimal.

$L(998) = 30 + \frac{1}{100}(999 - 1000) = 30 - \frac{1}{100} = 29.99 \approx \sqrt[3]{999}$

3. [9 points] The half-life of Strontium-90 is 28 days.

a. Suppose a sample has an initial mass of 30 mg. Find a formula for the mass remaining after t days.

$P(t) = Ce^{kt}$

$\frac{1}{2} = e^{k \cdot 28}$

$\frac{\ln(1/2)}{28} = k$

Answer: $P(t) = 30e^{\frac{\ln(1/2)}{28}t}$

b. How long would it take for the sample to decay to a mass of 2 mg? ← include units

Find t when $P = 2$.

$2 = 30e^{\frac{\ln(1/2)}{28}t}$

$\frac{1}{15} = e^{\ln(1/2)t/28}$

$t = \frac{28\ln(1/15)}{\ln(1/2)}$ days

c. Sketch the graph of the mass function.