Announcements:

- **Final Exam**: December 14 at 12:00 pm  
  Location: MATH 100  
  Duration: 2.5 hours

- **Office Hours during the exam period**:
  - Thursday, Dec 6, 11 am - 12 pm in MATx 1118  
  - Thursday, Dec 13, 11 am - 1 pm & 2 - 3 pm in LSK 300  
  - Friday, Dec 14, 10 - 11 am

  Change of location in my earlier email.

- **Exam topics**: Everything week 1 - Week 13  
  - Heavier on Integral Calculus.

- **Check everything posted and solve all the examples & problems** in:
  -> Lecture Notes
  -> Labs
  -> Quizzes
  -> HW
  -> Sample exam & review practice
  -> Textbook problems

  You should be able to do them without checking the solution.

- **TEACHING EVALUATION** -> Please complete the survey 😊
3. Find the equation of the tangent line to
\[ f(x) = \frac{\cos(2x)}{x} \]
at the point \( x = \pi \).

General Equation of a line:
\[ y - y_0 = m(x - x_0) \]

Tangent line:
\[ m = f'(\pi) \]
\[ y_0 = f(\pi) \]

\[ f(x) = \frac{\cos(2x)}{x} \Rightarrow f'(x) = \frac{(\cos(2x))' \cdot x - (\cos(2x)) \cdot (x)'}{x^2} \]

- \( (\cos(2x))' = 2 \cdot -\sin(2x) \)
\[ \Rightarrow f'(x) = \frac{-2 \sin(2x) \cdot x - \cos(2x)}{x^2} \]
\[ \Rightarrow f'(\pi) = \frac{-2 \sin(2\pi) \cdot \pi - \cos(2\pi)}{\pi^2} = \frac{-1}{\pi^2} = m \]

- \( y_0 = \frac{\cos(2\pi)}{\pi} = \frac{1}{\pi} \)
\[ x_0 = \pi \]
\[ \Rightarrow y_0 - \frac{1}{\pi} = -\frac{1}{\pi^2} (x - \pi) \]
\[ \Rightarrow y = -\frac{1}{\pi^2} x + \frac{1}{\pi} + \frac{1}{\pi} \]
\[ \Rightarrow y = -\frac{1}{\pi^2} x + \frac{2}{\pi} \]
4. Find the derivative of

\[ f(x) = xe^{2x} \sin(x^2). \]

\[
(fgh)' = f'gh + g'fh + h'fg.
\]

\[ (x)' = 1 \]

\[ (e^{\frac{2x}{\sin(x^2)}})' = 2 \cdot e^{2x} \]

\[ \underbrace{(e^{\frac{2x}{\sin(x^2)}})}_{\text{outside}}' = 2 \cdot \frac{2x}{\sin(x^2)} \cdot \cos(x^2) \]

\[ \underbrace{(\sin(x^2))}_{\text{in}}' = 2x \cdot \cos(x^2) \]

\[ f'(x) = 1 \cdot e^{2x} \sin(x^2) + 2 e^{2x} \cdot x \sin(x^2) + 2x \cos(x^2) \cdot x e^{2x} \]
6. A spherical snow ball is melting such that its surface area is decreasing at a rate of 0.5cm$^2$/min. How fast is the volume decreasing when the radius is 6cm? The Volume and Surface Area of a sphere are given by

$$V = \frac{4}{3}\pi r^3 \quad \text{and} \quad A = 4\pi r^2$$

respectively.

**Steps:**

1) Diagram and label the picture.

2) Read the question carefully & summarize the info.
   - changing quantities
   - constant
   - given & unknown rate of change.

3) Relate the variables:
   1) Pythagorean
   2) $\sin$, $\cos$, $\tan$
   3) Use the given equations in the problem.

4) Differentiate

5) Substitute the info.
Changing quantities:

\[ A = \text{Surface area} \]
\[ V = \text{Volume} \]
\[ r = \text{radius} \]

Given/unknown info:

\[ \frac{dA}{dt} = -0.5 \text{ cm}^2/\text{min} \]
\[ \frac{dV}{dt} = ? \rightarrow \text{must be negative} \]
when \( r = 6 \text{ cm} \)

\[ V(t) = \frac{4}{3} \pi r^3(t), \quad A(t) = 4\pi r(t)^2 \]

\[ \frac{dV}{dt} = \frac{4}{3} \pi \cdot 3r^2\cdot \frac{dr}{dt} \]

\[ \frac{1}{3} \cdot (-0.5) = 3 \cdot (-0.5) \]
\[ = -1.5 \text{ cm}^3/\text{min} \]

\( \frac{dA}{dt} = 4\pi \cdot 2r \cdot \frac{dr}{dt} \)

\[ -0.5 = 4\pi \cdot 2 \cdot 6 \cdot \frac{dr}{dt} \]

\[ \frac{-0.5}{48\pi} = \frac{dr}{dt} \]