Show all your work.

1. (25 pts.) Find $\frac{dy}{dx}$ for each of the following:
   
   (a) $y = 10x^3 - 3\sqrt{x} + x - 12 + 1/x^2$
   (b) $y = \sin(3x)$
   (c) $y = \cos x^2$
   (d) $y = \tan^2 x$

2. (15 pts.) Find $dy/dx$ for each of the following:
   
   (a) $y = \ln(x^2 \sec x)$
   (b) $y = \frac{xe^x}{\csc x + 1}$
   (c) $y = e^{kx} \sin wx$, where $k$ and $\omega$ are constants.

3. (15 pts.) Find $dy/dx$ at the point $(\pi/2, \pi)$ on the curve

   $$\sin x \cos y + \frac{y}{2x} = 0$$

4. (15 pts.) If $y = ax^3 + bx$ has a horizontal tangent at the point $(2, 4)$, find $a$ and $b$.

5. (15 pts.) An object moves along a straight path so that its position (in meters) after $t$ seconds is

   $$s(t) = \frac{\pi t}{2} + \cos(\pi t)$$

   Find the acceleration of the object at each instant in the interval $0 \leq t \leq 2$ when it changes direction.

6. (15 pts.) A car travels at 61 miles per hour on a straight highway towards point $A$ (as shown at right.) A highway patrolman stationed at point $B$ aims a radar gun towards the car. When the car is 500 feet from point $A$, what is the rate of change of the distance between the car and the patrolman?
7. **Bonus:** Assume that the radar gun measures the absolute value of the speed you calculated in Problem 6.

   (a) (1 pt.) If the speed limit on this highway is 60 miles per hour, will the patrolman think the car is over the speed limit?

   (b) (5 pts.) At what distance (car from point $A$) will the radar gun read exactly 60 miles per hour?