1. Find the derivative of each function below.

(a) \( f(x) = \frac{2}{x^a} - \sqrt{x} + \ln(5) \) where \( a \) and \( b \) are constants

(b) \( q(t) = t^2 \sin(5 - 8t) \)
2. If \( f(x) = \ln(2x^2 - 1) \), answer the following questions.

   (a) Find a formula for the derivative \( f'(x) \).

   (b) Based on your answer to (a), find the formula for the tangent line to \( f(x) \) at \( x = 1 \).

   (c) Using your equation for the tangent line at \( x = 1 \) in (b), approximate \( f(2) \).
3. A health organization is committed to curing malaria. The organization must decide how to invest its funds in order to stop the spread of malaria. One way to prevent malaria from spreading is to supply rural villages with mosquito nets. A recent study recorded the number of malaria cases, \( N \), as a function of time \( t \), months since mosquito nets were distributed throughout a specific region. Below is a graph of rate of change of the number of malaria cases, \( N'(t) \).

![Graph of rate of change of malaria cases](Image)

Figure 1: Rate of change of malaria cases

(a) Are the number of malaria cases increasing or decreasing over this time?

(b) What is the concavity of \( N(t) \). Note: I am not asking for the concavity of the graph of \( N'(t) \) given above. I am asking about the concavity of the original function \( N(t) \) whose derivative is graphed above.

(c) Based on the graph of \( N'(t) \) above, give an argument in favor of using malaria nets in order to fight malaria. Use complete sentences.

(d) Based on the graph of \( N'(t) \) above, give an argument against the use of malaria nets in the fight against malaria. Use complete sentences.
4. A company manufactures tires. Let $C(q)$ and $R(q)$ denote the cost and revenue (in dollars) of manufacturing $q$ tires. If $C(120) = 40,000$, $MC(120) = 70$, $R(120) = 55,000$, and $MR(120) = 85$, answer the following questions.

(a) What is the profit/lost if they produce 120 tires?

(b) Explain in practical terms the meaning of the marginal revenue at $q = 120$.

(c) Using the information above, approximate $R(124)$.

(d) Using the information above, approximate $C(115)$.

(e) Should this company produce more or less than 120 tires? Explain how you determined your answer using complete sentences. No credit for yes or no answers without an explanation.
5. The table below gives the total number car accidents, $A$, in a county over the years 1990 to 2010.

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<tbody>
<tr>
<td>$A$</td>
<td>250</td>
<td>310</td>
<td>335</td>
<td>342</td>
<td>315</td>
<td>260</td>
</tr>
</tbody>
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(a) Over what time period (if any) is $\frac{dA}{dt}$ positive?

(b) Over what time period (if any) is $\frac{dA}{dt}$ negative?

(c) Over what time period (if any) is $\frac{d^2A}{dt^2}$ positive?

(d) Over what time period (if any) is $\frac{d^2A}{dt^2}$ negative?

6. If $f(3) = 5$, $f'(3) = -2$, $g(3) = -3$, and $g'(3) = 8$, evaluate

$$\frac{d}{dx} \left( \frac{f(x)}{g(x)} \right) \bigg|_{x=3}.$$


7. The temperature $Y$ in degrees Fahrenheit of a yam in a hot oven $t$ minutes after it has first been placed in the oven is given by

$$Y(t) = 400 \left(1 - 0.85e^{-0.006t}\right)$$

(a) What is initial temperature of the yam when it is first placed in the oven?

(b) Approximately when does the yam reach $200^\circ F$?

(c) Calculate $Y'(10)$, and explain the significance, in terms of temperature and time, of this value. Be sure to include units in your answer.