1. On which intervals is the function \( f(x) = -2x^3 + 3x^2 + 12x \) increasing? Where is it decreasing? Here is a picture from maple to help, but you must show your work.

Answer: Increasing over ________________, decreasing over ___________________.

2. Over what interval(s) is the above function concave up (leaning to the left) and concave down?

Answer: concave up over ________________, concave down over ________________.

3. Locate the maximum and minimum values of the function \( f(x) = x^2 + \frac{2}{x} \) on the interval \([\frac{1}{2}, 2]\). Don’t forget to check the endpoints as well as the critical points.

Answer: Minimum is ________, maximum is ________.
4. Approximate the cube root of 9 by using Newton’s method to find the root of 
\( y = x^3 - 9 \). Start with the first guess of 2 and fill in the table.

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
<th>y'</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>-1</td>
<td>?</td>
</tr>
<tr>
<td>?</td>
<td>?</td>
<td>?</td>
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</tbody>
</table>

5. What does the mean value theorem say about the function \( f(x) = x^3 - 9 \) on the interval \([0, 3]\)?

6. For question above, find the number in the interval \((0, 3)\) guaranteed by the mean value theorem to exist.

Use L’Hôpital’s rule if applicable to find the following limits:

7. \( \lim_{{x \to 0}} \frac{\cos(x) - 1}{x} \)
8. \( \lim_{x \to 0} \frac{x}{e^x} \)

9. \( \lim_{x \to 4} \frac{\sqrt{x} - 2}{x - 4} \)

10. Definition: If \( f \) is continuous on \([a, b]\), the **definite integral of \( f \) from \( a \) to \( b \) is**

\[
\int_a^b f(x) \, dx = \int_a^b f(x) \, dx
\]

11. Define each symbol on the right hand side of the equal sign above.

12. Suppose \( \int_a^b f(x) \, dx = -5 \), \( \int_a^c f(x) \, dx = 2 \). What is \( \int_c^b f(x) \, dx \)?
13. For the function above, what is $\int_{b}^{a} f(x)dx$

14. Let $F(x) = \int_{a}^{x} f(t)dt$. $F$ is a function of what variable? __________

15. For the function defined above, what is $F'(x)$?

16. Evaluate $\int_{1}^{4} \frac{1}{\sqrt{t}} dt$

17. What are $\int_{1}^{4} \frac{1}{\sqrt{x}} dx$ and $\int_{1}^{4} \frac{1}{\sqrt{z}} dz$? Answer: ___________ and ___________

18. Let $F(x) = x \ln x - x$ show that $F'(x) = \ln x$ (Don’t forget the product rule!)

19. Evaluate $\int_{1}^{e} \ln x dx$