

Please show all work and **box your final answers**. Calculators are not allowed and cellphones should be put away. Good luck!

1. (8 points) Evaluate the following expressions.

(a) $\log_9(3)$

(b) $\log_{10}(0.01)$

(c) $\ln(1)$

(d) $\ln(e)$

2. (8 points) Solve the logarithmic equation for x.

$$\log_{20}(2x - 1) + \log_{20}(x + 1) = 1$$

3. (8 points) Use the laws of logarithms to expand the logarithmic expression.

$$\ln \left(\frac{(xy)^{1/3}}{2(x^2 + y^2)} \right)$$

4. (8 points) A culture starts with 8,600 bacteria. After 1 hour the count is 10,000.

(a) Find a function $P(t)$ that models the number of bacteria after t hours.

(b) After how many hours will the number of bacteria double?

5. (8 points) In the xy -plane below, sketch the graph $y = 1 + \log_2(x + 4)$. Include any horizontal/vertical asymptotes.

