

1. **(17 points)** Answer the following two questions.
- (a) **(7 points)** A colony of 100 mythrax bacteria grows so that after  $t$  hours, its population is given by the function  $f(t) = 100e^{0.2t}$ . How many hours will it take the colony to reach a size of 350 bacteria? You may leave unreduced exponents, natural logarithms, or base-10 logarithms in your answer.
- (b) **(10 points)** A zorkmid is a coin weighing 3 grams and worth 5 dollars; a quatloo is a coin weighing 4 grams worth 4 dollars. You have a pile of these two coins which weighs a total of 50 grams and which is worth 62 dollars. Construct and solve a system of two equations to find out how many there are of each coin.

	FOR GRADER USE ONLY
1	/17
2	/22
3	/17
4	/19
$\Sigma$	/75

2. **(22 points)** Answer the following questions about exponential and logarithmic functions and equations:
- (a) **(5 points)** Evaluate each of the following exponential expressions; write your answer without exponents.
- $3^0$
  - $27^{-2/3}$
  - $4^{-2}$
  - $\left(\frac{2}{7}\right)^2$
- (b) **(5 points)** Evaluate each of the following logarithmic expressions; write your answer without logarithms.
- $\log_9 3$
  - $\log_2 \frac{1}{8}$
  - $\log_2 16$
  - $\log_7 1$
  - $\log_{100} 1000$
- (c) **(5 points)** Condense the expression  $2 \ln x + \frac{1}{2} \ln(x^2 - 1) - 4 \ln 2$  into a single logarithm.
- (d) **(7 points)** Find a numeric solution to the equation  $\log_{10}(15x + 3) - \log_{10}(x + 1) = 1$ . Do not leave unsimplified exponents or logarithms in your answer.

3. **(17 points)** Answer the following questions about polynomial and rational functions.

(a) **(4 points)** Find the possible rational roots of the polynomial  $f(x) = 2x^3 - x^2 - 12x - 9$ ; you do not need to test to find which ones are actual zeroes.

(b) **(5 points)** Find the quotient and remainder when  $4x^3 - 4x^2 + 3$  is divided by  $2x^2 - x - 5$ . Label which is which.

(c) **(8 points)** Find the  $y$ -intercept,  $x$ -intercepts (a.k.a. zeroes), vertical asymptotes, and horizontal/oblique asymptotes (a.k.a. long-term behavior) of the function  $f(x) = \frac{(2x-1)(x+3)}{x^2-4}$ . Label which is which, and if any of these features are completely absent, say so.

4. **(19 points)** Find the solutions to the following systems of equations. Show your work.

(a) **(6 points)** 
$$\begin{cases} 2x + 3y = 3 \\ 3x - y = 10 \end{cases}$$

(b) **(5 points)** 
$$\begin{cases} 4x + 5y + 2z = -3 \\ 3y - z = 14 \\ -3z = 15 \end{cases}$$

(c) **(8 points)** 
$$\begin{cases} x - 3y + 2z = 9 \\ 2x + 4y - 3z = -9 \\ 3x - 2y + 6z = 13 \end{cases}$$