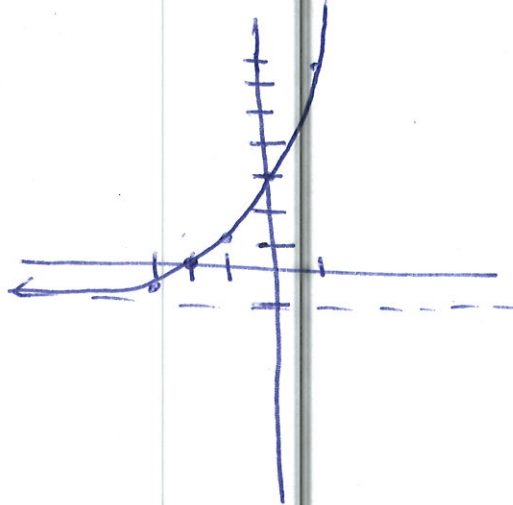


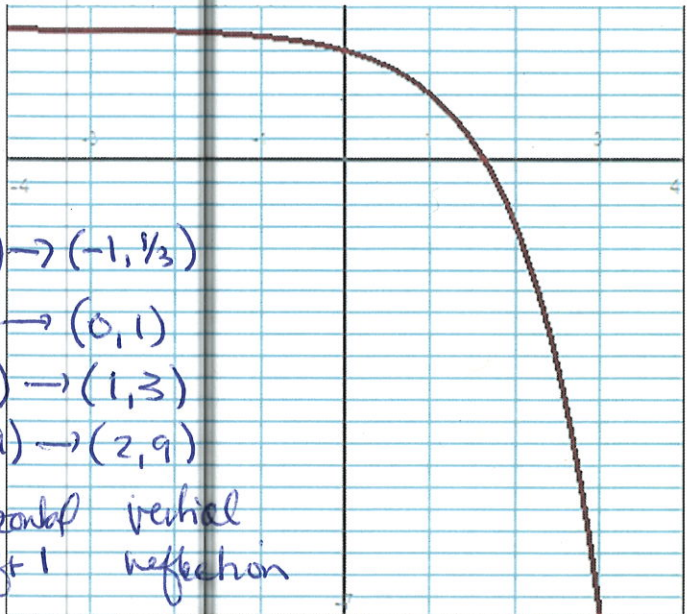
Instructions: Show all work. Give exact answers unless specifically asked to round. All complex numbers should be stated in standard form, and all complex fractions should be simplified. If you do not show work, problems will be graded as "all or nothing"; partial credit will not be possible.

1. Sketch the graph of the curve $f(x) = 2^{x+2} - 1$. State the domain and range. (7 points)



D: $(-\infty, \infty)$
 R: $(-1, \infty)$

2. For the graph shown below, write the equation of the function. Each horizontal line represents $\frac{1}{3}$ unit. Each vertical line represents one unit. The base of the exponential is an integer. The graph window is $[-4, 4] \times [-7, \frac{7}{3}]$. (6 points)



$(0, \frac{5}{3}) \rightarrow (0, -\frac{1}{3}) \rightarrow (-1, -\frac{1}{3}) \rightarrow (-1, \frac{1}{3})$
 $(1, 1) \rightarrow (1, -1) \rightarrow (0, -1) \rightarrow (0, 1)$
 $(2, -1) \rightarrow (2, -3) \rightarrow (1, -3) \rightarrow (1, 3)$
 $(3, -7) \rightarrow (3, -9) \rightarrow (2, -9) \rightarrow (2, 9)$

vert. shift up 2 horizontal shift -1 vertical reflection

$$f(x) = -3^{x-1} + 2$$

3. Suppose that you have \$6000 to invest. How much would you have after 6 years earning 5.4% compounded semi-monthly? (8 points)

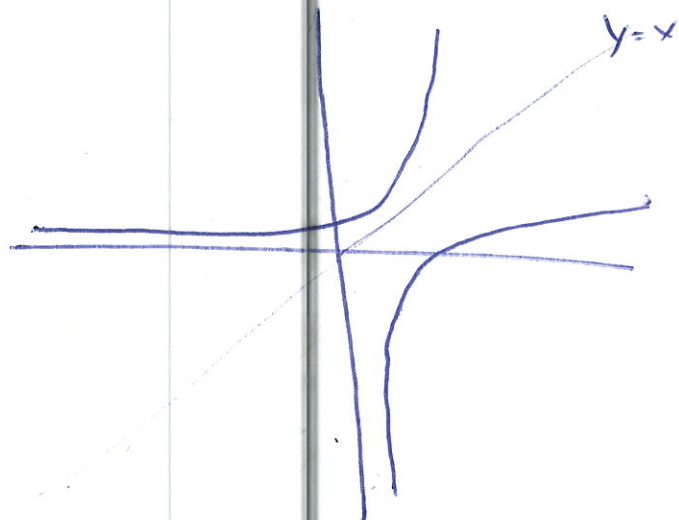
$$A = 6000 \left(1 + \frac{.054}{24}\right)^{24 \cdot 6} = \$8292.87$$

4. Find the inverse function of $f(x) = 2e^x + 1$. Sketch the graph and its inverse on the same axis. (8 points)

$$x = 2e^y + 1$$

$$\frac{x-1}{2} = e^y$$

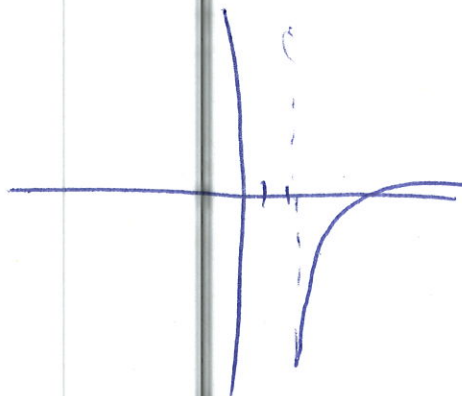
$$\ln\left(\frac{x-1}{2}\right) = y = f^{-1}(x)$$



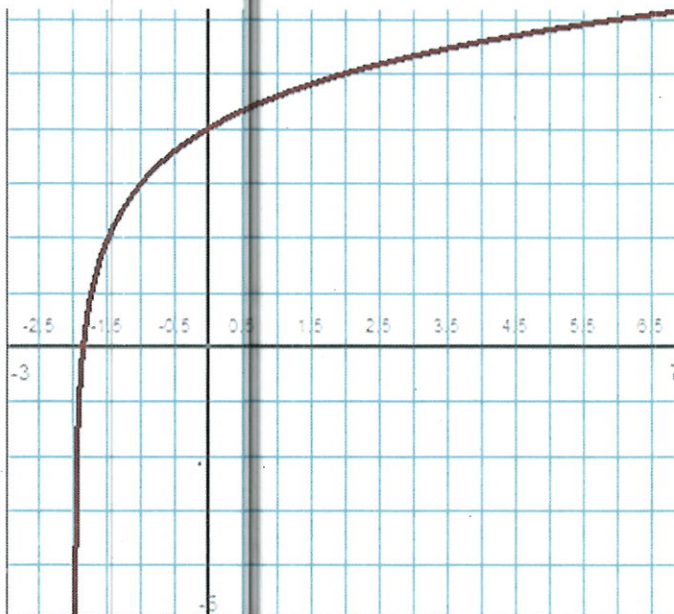
5. Find the domain and range of the graph $f(x) = \log(x - 2) - 1$. Sketch the graph. (6 points)

$$D: (2, \infty)$$

$$R: (-\infty, \infty)$$



6. The graph of a logarithmic function is shown below. The window dimensions are $[-3, 7] \times [-5, 6]$. Each horizontal line represents one unit. Each vertical line represents a $\frac{1}{2}$ unit. Find the equation of the function if the base of the log is an integer. (6 points)



$$D: (-2, \infty)$$

$$(-1, 3) \rightarrow (1, 3) \rightarrow (1, 0)$$

$$(0, 4) \rightarrow (2, 4) \rightarrow (2, 1)$$

$$(2, 5) \rightarrow (4, 5) \rightarrow (4, 2)$$

$$(-\frac{3}{2}, 2) \rightarrow (\frac{1}{2}, 2) \rightarrow (\frac{1}{2}, -1)$$

horizontal
shift 2

vertical shift
3

$$f(x) = \log_2(x + 2) + 3$$

7. Expand the logarithmic function $\log \left[\frac{10x^2 \sqrt[3]{1-x}}{7(x+1)^2} \right]$ into simpler logs and simplify expressions where possible. (5 points)

$$\log 10 + \log x^2 + \log \sqrt[3]{1-x} - \log 7 - \log (x+1)^2$$

$$1 + 2\log x + \frac{1}{3}\log(1-x) - \log 7 - 2\log(x+1)$$

8. Write the expanded logarithm $\frac{2}{3}[2\ln(x+5) - \ln x - \ln(x^2-4)]$ as a single logarithmic expression. (5 points)

$$\frac{2}{3} \left[\ln \left(\frac{(x+5)^2}{x(x^2-4)} \right) \right] = \log \sqrt[3]{\left(\frac{(x+5)^2}{x(x^2-4)} \right)^2}$$

9. Solve the following equations without using a calculator. (5 points each)

a. $9^x = \frac{1}{\sqrt[3]{3}}$

$$3^{2x} = 3^{-1/3}$$

$$2x = -1/3$$

$$\boxed{x = -1/6}$$

b. $\log(x+4) - \log 2 = \log(5x+1)$

$$\log \left(\frac{x+4}{2} \right) = \log(5x+1)$$

$$\frac{x+4}{2} = 5x+1$$

$$x+4 = 10x+2$$

$$2 = 9x$$

$$\boxed{x = \frac{2}{9}}$$

$$c. e^{4x} - 3e^{2x} - 18 = 0$$

$$u^2 - 3u - 18 = 0$$

$$(u - 6)(u + 3) = 0$$

$$u = 6, u = -3$$

$$u = e^{2x}$$

$$e^{2x} = 6$$

~~$$e^{2x} = -3$$~~

$$2x = \ln 6$$

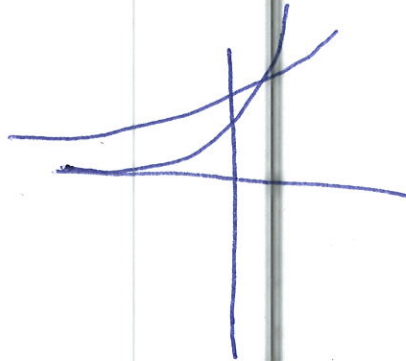
$$x = \frac{\ln 6}{2}$$

10. Solve the following equations. You may use a calculator (show any graphs used). Round answers to 4 decimal places. (5 points)

a. $7^{2x+1} = 3^{x+2}$

$$X = .0899734$$

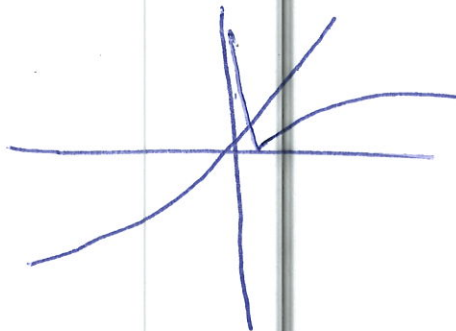
$$\Rightarrow x = .0900$$



b. $2|\ln x| = 2^{x-1} + x$

$$X = .53338082$$

$$\Rightarrow x = .5334$$



11. A bird species is in danger of extinction, with a population that is decreasing exponentially. Five years ago, the population was 14,000 and today only 1000 of the birds are alive. When the population drops below 100, the situation will be irreversible. Find the equation that models the birds' population, and determine when it reaches the point of no return. You may let "five years ago" be $t = 0$. How many years from now will it reach the point of no return? (10 points)

$$1000 = A = 14,000 e^{5k}$$

$$\frac{\ln\left(\frac{1000}{14,000}\right)}{5} = k$$

$$-.5278 = k$$

$$A = 14,000 e^{-.5278t}$$

$$100 = 14,000 e^{-.5278t}$$

$$\frac{\ln\left(\frac{100}{14,000}\right)}{-.5278} = t = 9.36$$

it will reach no return will be in about 4 years from now

12. Solve the systems below by the method of your choice, and characterize each as consistent or inconsistent, and if applicable, dependent or independent. (7 points each)

a. $\begin{cases} 3x - 2y = -5 \\ 4x + y = 8 \end{cases} \rightarrow \begin{cases} 3x - 2y = -5 \\ 8x + 2y = 16 \end{cases}$

$$\frac{11x = 11}{x = 1}$$

$$4(1) + y = 8$$

$$y = 4$$

$$(1, 4)$$

consistent
independent

b. $\begin{cases} x + 3y + 5z = 20 \\ y - 4z = -16 \\ 3x - 2y + 9z = 36 \end{cases} \rightarrow \begin{cases} -3x - 9y - 15z = -60 \\ 3x - 2y + 9z = 36 \end{cases}$

$$\frac{3x - 2y + 9z = 36}{-11y - 6z = -24}$$

$$-11y - 6z = -24$$

$$\rightarrow -11y - 6z = -24$$

$$y - 4z = -16$$

$$\rightarrow 11y - 44z = -176$$

$$\frac{-50z = -200}{z = 4}$$

$$y - 4(4) = -16$$

$$y = 0$$

$$(0, 0, 4)$$

$$z = 4$$

$$x + 3(0) + 5(4) = 20 \rightarrow x = 0$$

consistent
independent

13. A new restaurant is to contain two-seat tables and four-seat tables. Fire codes limit the number of customers to 56. If the owners have enough servers to handle 17 tables, how many of each type of table should the owners purchase? (10 points)

$x = 2$ -seat tables

$y = 4$ -seat tables

$$x + y = 17 \rightarrow -2x - 2y = -34$$

$$2x + 4y = 56$$

$$2x + 4y = 56$$

$$\frac{2y = 22}{y = 11}$$

$$y = 11$$

$$x = 6$$

$$(6, 11)$$