43. **WORLD POPULATION** The world population is projected to grow according to the model

$$P(t) = \frac{12}{1 + 3e^{-0.2747t}} \qquad (0 \leq t \leq 8)$$

where $P(t)$ is measured in billions and t in decades, with $t = 0$ corresponding to 1960.

a. What was the world population in 1960?

b. What is the world population expected to be in 2040?

Source: U.S. Census Bureau.

44. **ABSORPTION OF DRUGS** The concentration of a drug in an organ at any time t (in seconds) is given by

$$x(t) = 0.08(1 - e^{-0.02t})$$

where $x(t)$ is measured in grams/cubic centimeter (g/cm^3).

a. What is the initial concentration of the drug in the organ?

b. What is the concentration of the drug in the organ after 30 sec?

The problem-solving skills that you learn in each chapter are building blocks for the rest of the course. Therefore, it is a good idea to make sure that you have mastered these skills before moving on to the next chapter. The Before Moving On exercises that follow are designed for that purpose. After completing these exercises, you can identify the skills that you should review before starting the next chapter.

CHAPTER 3 Before Moving On . . .

1. Solve $e^{2x} - e^x - 6 = 0$ for x.
   Hint: Let $u = e^x$.

2. Solve $\log_2(x^2 - 8x + 1) = 0$.

3. Solve the equation $\dfrac{100}{1 + 2e^{0.3t}} = 40$ for t.

4. The temperature of a cup of coffee at time t (in minutes) is

$$T(t) = 70 + ce^{-kt}$$

Initially, the temperature of the coffee was 200°F. Three minutes later, it was 180°. When will the temperature of the coffee be 150°F?

Name:

Date 10/22/2018

MATHEMATICS 129, Section 06 EXAM #2 (TAKE HOME) Instr Artis C. Street

(10 Points)

1) The oxygen consumption (in milliliters per pound per minute) for a person walking at x mph is approximated by the function

$$f(x) = \frac{5}{3}x^2 + \frac{5}{3}x + 10 \quad (0 \le x \le 9)$$

Where the oxygen consumption for a runner at x mph is approximated by the function

$$g(x) = 11x + 10 \quad (4 \le x \le 9)$$

(a) Sketch the graphs of f and g.

(b) At what speed is the oxygen consumption the same for a walker was it is for a runner? What is the level of oxygen consumption at that speed?

(c) What happens to the oxygen consumption of the walker and the runner at speeds beyond that found in part (b)?

4. a. If $x > 0$, then $e^{\ln x} =$ ______.
   b. If x is any real number, then $\ln e^x =$ ______.

5. a. In the unrestricted exponential growth model $Q = Q_0e^{kt}$, Q_0 represents the quantity present ______, and k is called the ______ constant.
   b. In the exponential decay model $Q = Q_0e^{-kt}$, k is called the ______ constant.
   c. The half-life of a radioactive substance is the ______ required for a substance to decay to ______ ______ of its original amount.

6. a. The model $Q(t) = C - Ae^{-kt}$ is called ______ ______. The value of $Q(t)$ never exceeds ______.
   b. The model $Q(t) = \dfrac{A}{1 + Be^{-kt}}$ is called ______ ______. If the quantity $Q(t)$ is initially smaller than A, then $Q(t)$ will eventually approach ______ as t increases; the number A represents the life-support capacity of the environment and is called the ______ of the environment.

CHAPTER 3 Review Exercises

In Exercises 1–4, sketch the graph of the function.

1. $f(x) = 5^x$
2. $y = \left(\dfrac{1}{5}\right)^x$
3. $f(x) = \log_4 x$
4. $y = \log_{1/4} x$

In Exercises 5–8, express each equation in logarithmic form.

5. $3^4 = 81$
6. $9^{1/2} = 3$
7. $\left(\dfrac{2}{3}\right)^{-3} = \dfrac{27}{8}$
8. $16^{-3/4} = 0.125$

In Exercises 9–12, given that $\ln 2 \approx 0.6931$, $\ln 3 \approx 1.0986$, and $\ln 5 \approx 1.6094$, find the value of the expression using the laws of logarithms.

9. $\ln 30$
10. $\ln 9$
11. $\ln 3.6$
12. $\ln 75$

In Exercises 13–15, given that $\ln 2 = x$, $\ln 3 = y$, and $\ln 5 = z$, express each of the given logarithmic values in terms of x, y, and z.

13. $\ln 30$
14. $\ln 3.6$
15. $\ln 75$

In Exercises 16–21, solve for x without using a calculator.

16. $2^{2x-3} = 8$
17. $e^{x^2+x} = e^2$
18. $3^{x-1} = 9^{x+2}$
19. $2^{x^2+x} = 4^{x^2-3}$
20. $\log_4(2x + 1) = 2$
21. $\ln(x - 1) + \ln 4 = \ln(2x + 4) - \ln 2$

34. $\dfrac{20}{1 + 2e^{0.2x}} = 4$
35. $\dfrac{30}{1 + 2e^{-0.1x}} = 5$

36. Sketch the graph of the function $y = \log_2(x + 3)$.

37. Sketch the graph of the function $y = \log_3(x + 1)$.

38. **Growth of Bacteria** A culture of bacteria that initially contained 2000 bacteria has a count of 18,000 bacteria after 2 hr.
   a. Determine the function $Q(t)$ that expresses the exponential growth of the number of cells of this bacterium as a function of time t (in minutes).
   b. Find the number of bacteria present after 4 hr.

39. **Radioactive Decay** The radioactive element radium has a half-life of 1600 years. What is its decay constant?

40. **Demand for DVD Players** VCA Television found that the monthly demand for its new line of DVD players t months after placing the players on the market is given by:

$$D(t) = 4000 - 3000e^{-0.06t} \qquad (t \geq 0)$$

Graph this function and answer the following questions:
   a. What was the demand after 1 month? After 1 year? After 2 years?
   b. At what level is the demand expected to stabilize?

41. **Flu Epidemic** During a flu epidemic, the number of students at a certain university who contracted influenza after t days could be approximated by the exponential model

$$Q(t) = \frac{3000}{1 + 499e^{-kt}}$$

(10 Points)

2) A Norman window has the shape of a rectangle surmounted by a semicircle (see the accompanying figure). Suppose a Norman window is to have a perimeter of 32 feet. Find a function in the variable x giving the area of the window.