1. The family of orthogonal trajectories of the family $y^4 = Cx^2 + 3$ is:
   (a) $2x^2 + y^2 - 2y^{-3} = C$
   (b) $2x^2 + y^2 + 3y^{-2} = C$
   (c) $x^2 + 2y^2 - 3y^{-2} = C$
   (d) $\frac{1}{2}x^2 + y^2 + 3y^{-2} = C$
   (e) None of the above.

2. The family of orthogonal trajectories for the family of parabolas with axis parallel to the $x$-axis and vertex at the point $(2, -1)$ is:
   (a) $2(x + 2)^2 + (y - 1)^2 = C$
   (b) $4(x - 2)^2 + (y + 1) = C$
   (c) $2(x - 2)^2 - (y + 1)^2 = C$
   (d) $2(x - 2)^2 + (y + 1)^2 = C$
   (e) None of the above.

3. If $1000$ is deposited in a bank that pays $5.5\%$ interest compounded continuously, then the amount in the account at the end of $10$ years is:
   (a) $1803.82$
   (b) $1733.25$
   (c) $1685.42$
   (d) $1758.72$
   (e) None of the above.

4. A laboratory has $75$ grams of a certain radioactive material. Two months ago, it had $100$ grams. How much will the laboratory have $4$ months from now?
   (a) $39.57$ grams
   (b) $51.11$ grams
   (c) $42.19$ grams
   (d) $46.43$ grams
   (e) None of the above.

5. A biologist observed that the population of her bacteria culture obeyed the population growth law. There were $300$ bacteria initially and the population increased by $20\%$ after $2$ hours. Determine the number of bacteria (rounded off to the nearest bacterium) after $24$ hours
   (a) $2675$
   (b) $2486$
   (c) $2917$
   (d) $2249$
   (e) None of the above.
6. What is the half-life of a radioactive material if it takes 5 minutes months for 1/4 of the material to decay?

(a) 2.50 minutes  
(b) 9.47 minutes  
(c) 14.47 minutes  
(d) 12.05 minutes  
(e) None of the above.

7. At 12 noon the count in a bacteria culture was 400; at 3:00 pm the count was 1200. Let \( P(t) \) denote the bacteria count at time \( t \) and assume that the culture obeys the population growth law. What was the bacteria count at 8 am, rounded off to the nearest bacterium?

(a) 92  
(b) 114  
(c) 99  
(d) 77  
(e) None of the above.

8. A thermometer is taken from a room where the temperature is \( 72^\circ F \) to the outside where the temperature is \( 32^\circ F \). After 2 minutes, the thermometer reads \( 48^\circ F \). How many minutes does the thermometer have to be outside for it to read \( 36^\circ F \)?

(a) 6.29 min  
(b) 5.02 min  
(c) 5.62 min  
(d) 4.73 min  
(e) None of the above.

9. A 100-gallon barrel, initially full of oil, develops a leak at the bottom. Let \( A(t) \) be the amount of oil in the barrel at time \( t \). Suppose that the oil is leaking out at a rate proportional to the product of the time elapsed and the square root of amount of oil present in the barrel. The mathematical model is

(a) \( \frac{dA}{dt} = k\sqrt{A}, \quad A(0) = 100 \)  
(b) \( \frac{dA}{dt} = ktA^2, \quad A(0) = 50 \)  
(c) \( \frac{dA}{dt} = kt\sqrt{A}, \quad A(0) = 100 \)  
(d) \( \frac{dA}{dt} = k\sqrt{tA}, \quad A(0) = 100 \)  
(e) None of the above.

10. Using the information in Problem 9, suppose that 36 gallons of oil leak out in the first 2 hours. At what time \( t \) will the barrel be empty?

(a) 4.47 hours  
(b) 6.27 hours  
(c) 5.33 hours  
(d) 3.91 hours  
(e) None of the above.
11. A disease is spreading through a journey of 100 giraffes. Let \( G(t) \) be the number of sick giraffes \( t \) days after the outbreak. The disease is spreading at a rate proportional to the number of giraffes that do not have the disease. Suppose that 5 giraffes had the disease initially. The mathematical model is:

(a) \( \frac{dG}{dt} = k t G, \quad G(0) = 5 \)
(b) \( \frac{dG}{dt} = k G(100 - G), \quad G(0) = 5 \)
(c) \( \frac{dG}{dt} = k t (100 - G), \quad G(0) = 5 \)
(d) \( \frac{dG}{dt} = k (100 - G), \quad G(0) = 5 \)
(e) None of the above.

12. Using the information in Problem 11, suppose that 20 giraffes have the disease after 6 days. Then the number of healthy giraffes (rounded off to the nearest giraffe) after 18 days is

(a) 47
(b) 65
(c) 57
(d) 51
(e) None of the above.

13. A disease is spreading through a parade of 100 elephants. Let \( E(t) \) be the number of sick elephants \( t \) days after the outbreak. The disease is spreading at a rate proportional to the product of number of elephants that have the disease, the number that do not have the disease and the time elapsed. Suppose that 2 elephants had the disease initially. The mathematical model is:

(a) \( \frac{dE}{dt} = k t E, \quad E(0) = 2 \)
(b) \( \frac{dE}{dt} = k t E(100 - E), \quad E(0) = 2 \)
(c) \( \frac{dE}{dt} = k t (100 - E), \quad E(0) = 2 \)
(d) \( \frac{dE}{dt} = k E(100 - E), \quad E(0) = 2 \)