1. The set of orthogonal trajectories for the family indicated by

\[(x - c)^2 + y^2 = c^2\]

is the family indicated by

(a) \((x - c)^2 + y^2 = c^2\)
(b) \((x - c)^2 - y^2 = c^2\)
(c) \(x^2 + (y - c)^2 = c^2\)
(d) \(x^2 - (y - c)^2 = c^2\)
(e) None of the above.

2. If 25 grams of a 100 gram radioactive sample decay in 2 hours, how much will remain at the end of 10 hours?

(a) \(\frac{25}{256}\) g
(b) \(\frac{6075}{256}\) g
(c) 0.10 g
(d) 24 g
(e) None of the above.

3. Suppose that the temperature of a cup of coffee obeys Newton’s law of cooling. If the coffee has a temperature of 200°F when freshly pored, and one minute later has cooled to 190°F in a room at 70°F, determine approximately the time that it takes for the coffee to reach a temperature of 150°F.

(a) 6.07 minutes
(b) 7.06 minutes
(c) 13.3 minutes
(d) 15.2 minutes
(e) None of the above.

4. An object with mass 10kg is dropped from a height of 200m. Given that the constant \(k\) in the equation

\[mv'(t) = -mg - kv(t)\]

is 2.5Nsm\(^{-1}\), after approximately how many seconds does the object hit the ground?
(a) 6.39
(b) 8.64
(c) 5.10
(d) 7.36
(e) None of the above.

Suggestion: Find \( v(t) \) using \( v(0) = 0 \), then find the height \( s(t) \) using \( s(t) - s(0) = \int_0^t v(\tau)d\tau \). Finally, use Newton’s method or a graphing calculator to find the number \( c \) such that \( s(c) = 0 \).

5. Water is pumped into a cylindrical tank with cross section area \( A \) at a constant rate \( k \), and leaks out through a hole of area \( a \) in the bottom of the tank at the rate

\[
\alpha a \sqrt{2gh(t)}
\]

where \( g \) is the acceleration due to gravity, \( h(t) \) is the depth of water in the tank at time \( t \), and \( \alpha \) is a constant with \( 0.5 \leq \alpha \leq 1.0 \). It follows that

\[
\lim_{t\to\infty} h(t) =
\]

(a) \( \frac{k^2}{2g(\alpha a)^2} \)
(b) \( \frac{k}{4g^2\alpha a} \)
(c) \( \frac{k^2}{2g\alpha a^2} \)
(d) \( \frac{k^2}{2g\alpha^2 a} \)
(e) None of the above.

Suggestion: The volume of water in the tank at time \( t \) is \( Ah(t) \). Its rate of change is the rate at which water enters the tank minus the rate at which it leaves. If you cannot solve the differential equation, try assigning specific values to \( A \), \( \alpha \), \( a \), and \( k \) and drawing the direction field. Focus on the points where the slope is zero and on near by points.