1. A solution of \( \frac{dy}{dt} = \frac{2y}{t+1} \) with \( y(1) = 8 \) is
   
   A. \( y = (t + 1)^2 + 4 \)
   B. \( y = 32(t + 1)^{-2} \)
   C. \( y = 2(t + 1)^2 \)
   D. \( y = 4\sqrt{2(t + 1)} \)
   E. \( y = \sqrt{(t + 1)^2 + 60} \)

2. An implicit solution of \( y' = \frac{2x}{y + x^2 y} \) is
   
   A. \( y^2 = 2 \ln(1 + x^2) + C \)
   B. \( y^2 = C \ln(1 + x^2) \)
   C. \( \frac{1}{2}y^2 = \ln x^2 + C \)
   D. \( y^2 = \ln(1 + x^2) + C \)
   E. \( \frac{1}{2}y^2 = \ln |1 + x| + C \)

3. The substitution \( v = \frac{y}{x} \) transforms the equation \( \frac{dy}{dx} = \sin \left( \frac{y}{x} \right) \) into
   
   A. \( v' = \sin(v) \)
   B. \( v' = x \sin(v) \)
   C. \( v' + v = \sin(v) \)
   D. \( xv' + v = \sin(v) \)
   E. \( v' + xv = \sin(v) \)

4. The solution in implicit form of
   \[
   \frac{dy}{dx} = \frac{x^2 + 3y^2}{2xy}
   \]
   is:
   
   A. \( x^2 + y^2 = x^3 + C \)
   B. \( x^2 + y^2 = Cx^3 \)
   C. \( x^2 + x^3 = y^2 + C \)
   D. \( Cx^2 = x^3 + y^2 \)
   E. \( x^2 + y^3 + xy^2 = C \)
5. Which of the following best describes the stability of equilibrium solutions for the autonomous differential equation \( y' = y(4 - y^2) \)?

A. \( y = 0 \) unstable; \( y = 2 \) and \( y = -2 \) both stable
B. \( y = 0 \) unstable; \( y = 2 \) stable
C. \( y = 0 \) and \( y = 2 \) both stable
D. \( y = 0 \) stable; \( y = 2 \) unstable; \( y = -2 \) stable
E. \( y = 0 \) stable; \( y = -2 \) and \( y = 2 \) both unstable

6. Solve the initial value problem \( y' - 2y = e^{-2t} \) with \( y(0) = a \). For what value of \( a \) is the solution bounded (i.e., not tending to infinity as \( t \to +\infty \)) on the interval \( t > 0 \)?

A. \( a = 0 \)
B. \( a = 1 \)
C. \( a = -1 \)
D. \( a = -\frac{1}{4} \)
E. \( a = \frac{1}{4} \)

7. Solve the differential equation

\[
(2xy + x^3)dx + (x^2 + y^3 + 2)dy = 0, \quad y(0) = 2.
\]

A. \( x^2y + 2y = 4 \)
B. \( x^4 + 2y = 8 \)
C. \( x^2y + \frac{1}{2}x^4 + \frac{1}{4}y^4 + 2y = 8 \)
D. \( x^2y + \frac{1}{2}x^4 + \frac{1}{4}y^4 = 0 \)
E. \( \frac{1}{4}x^4 + \frac{1}{4}y^4 = 8 \)

8. The function \( y_1 = t^2 \) is a solution of the differential equation

\[
t^2 \frac{d^2y}{dt^2} - 2t \frac{dy}{dt} + 2y = 0.
\]

A. \( y_2 = \sin t \)
B. \( y_2 = e^t \)
C. \( y_2 = t \cos t \)
D. \( y_2 = t \)
E. \( y_2 = 2t^2 \)

9. A ball of mass 5 kg. is thrown upward with an initial velocity of 10 (m/sec). If we neglect the air resistance, the maximum height that the ball can reach is: \( (g = 9.8 \text{ m/sec}^2) \)
10. The largest open interval on which the solution to the initial value problem
\[
\cos ty' + \frac{t}{t-3}y = \ln(4-t), \quad y(2) = 0
\]
is guaranteed by the Existence and Uniqueness Theorem to exist is

A. \((-\frac{x}{2}, \frac{x}{2})\)
B. \((0, \pi)\)
C. \((\frac{x}{2}, 3)\)
D. \((2, 4)\)
E. \((4, \infty)\)

11. The function \(y_1 = t\) is a solution of the differential equation
\[
t^2\frac{d^2y}{dt^2} + 2t\frac{dy}{dt} - 2y = 0, \quad t > 0.
\]
Find another solution \(y_2(t)\) such that \(y_1, y_2\) form a set of fundamental solutions.

A. \(y_2 = t^2\)
B. \(y_2 = t^{-2}\)
C. \(y_2 = t^3\)
D. \(y_2 = t \ln t\)
E. \(y_2 = t^2 \ln t\)

12. The solution of
\[
y'' + 4y' - 5y = 0, \quad y(0) = 2, y'(0) = -4
\]
is

A. \(y = e^t\)
B. \(y = e^{-5t}\)
C. \(y = e^{-t} + e^{5t}\)
D. \(y = 2e^{-2t}\)
E. \(y = e^t + e^{-5t}\)