1. Which of the following is a particular solution of $y'' - 4y = 6x - 4x^3$?
   A, $x^2 - x^4$
   B. $x^3 + x$
   C. x^3
   D. $x^4 - x^3$
   E. none of the above

2. Which equilibrium points of $N' = N(N-1)(2-N)$ are stable considering only non-negative solutions?
   A. 0
   B. 1
   C. 0 and 2
   D. 2
   E. none of the above

3. Starting at 9am, oil is pumped into a storage tank at a rate of $150t^{\frac{1}{2}} + 25$ (in gal/hr), for time t in hours after 9am. How many gallons will have been pumped into the tank at 1pm?
   A. 800
   B. 500
   C. 400
   D. 900
   E. none of the above

4. A boat moves away from a dock along a straight line, with an acceleration at time t (in seconds) given by $a(t) = 12t - 4$ (in ft/sec^2). If at time $t = 0$, the boat had a velocity of 8 ft/sec and was 15 feet from the dock, find its distance in feet from the dock at time $t = 2$ seconds.
   A. 24
   B. 39
   C. 32
   D. 27
   E. none of the above

5. Find $y(0)$ if y solves $y'' + y = 4x + 10\sin(x)$ with $y(\pi) = 0$, $y'(\pi) = 2$.
   A: π
   B: 14π
   C: 1
   D: 9π
   E: none of the above

6. An 8-pound weight stretches a spring 2 feet beyond its natural length. The weight is then pulled down another .5 feet and released with an initial upward velocity of 6 ft/sec. Find a formula for the position of the mass at any time t, given $y(0) = -1/2$.
   A. $-.5\cos 4t - \sin 4t$
   B. $-.5\cos 4t + 2\sin 4t$
   C. $-.5\cos t$
   D. $2\cos t - 4\sin t$
   E. none of the above

7. Using the general solution of
$$\frac{dy}{dt} + \tan(t)y = \cos(t)$$
   on the interval $(-\pi/2, \pi/2)$, calcluate the limit of $y(t)$ as t goes to $\pi/2$ from the left
   A: 0
   B: 1
   C: 2
   D: 3
   E: none of the above

8. For the solution of $y' - 2xy = x$ with $y(0) = 0$, find $y(1)$.
   A: $-1 + e$
   B: $\frac{1-e}{2}$
   C: $\frac{e-1}{2}$
   D: $1 + e$
   E: none of the above

9. Find an implicit solution of
$$\frac{dy}{dx} = \frac{y\cos x}{1 + 2y^2},\ y(0) = 1.$$
   A: $5/3 - y\sin x = y + \frac{2y^3}{3}$
   B: $\ln|y| + y^3 = \cos x$
   C: $-y\sin x = y^3 - 1$
   D: $\ln|y| + y^2 = 1 + \sin x$
   E: none of the above

10. Find $y(0)$, if y solves $y'' + 4y' + 4y = 0$ with $y(1) = 0, y(2) = e^{-4}$.
    A: 1
    B: -2
    C: e
    D: $1 + e^{-4}$
    E: none of the above

11. Which of the following implicitly defines a solution of this equation? $(1 + 3x \sin y)dx = x^2 \cos y \, dy$.
    A: $\frac{4}{x} \cos y = cx^3 - 1$
    B: $3x \sin y = Cx^2 - \ln |x|$
    C: $4x \sin y = C - x^3$
    D: $4x \sin y = Cx^4 - 1$
    E: none of the above

12. A ball is thrust up vertically from the ground into the air and hits the ground 2.5 seconds later. What is the maximum height of the ball in feet? Assume that air resistance is negligible. (Use acceleration due to gravity -32ft/sec^2)
    A: 50
    B: 25
    C: 100
    D: 75
    E: none of the above

13. Solve for y, such that $y' = \frac{2xy}{1+x^2}$ and $y(2) = 5$.
    A: $y = \frac{25x}{2(1+x^2)}$
    B: $y = \frac{125}{(1+x^2)^2}$
    C: $y = \frac{10x}{x+2}$
    D: $y = \frac{25}{1+x^2}$
    E: none of the above

14. At time $t = 0$, a tank contains 10 pounds of salt dissolved in 100 gallons of water. Assume that water containing 0.25 pounds of salt per gallon is entering the tank at a rate of 3 gallons per minute and that a well-stirred solution is leaving the tank at the same rate. Find an expression for the amount of salt in the tank at time t.
A. $25(1 - e^{-0.3t} + 10e^{-3t})$
B. $25 - 10e^{-0.3t}$
C. $100 - e^{-0.3t}$
D. $100 - 0.3e^{-t}$
E. none of the above

15. In a book, you read the following text:
"The initial value problem

$$y^{\blacksquare} + y' + 5y = \frac{\cos^2 t}{e^t + e^{-t}}\,,\ y(0) = 1,\ y'(0) = 2,\ y''(0) = 3,\ y'''(0) = -1$$

has exactly one solution."

Alas a smudge has made the derivative in the first term ("$y^{\blacksquare}$") unreadable. Reconstruct the correct reading.

A. y''
B. y'''
C. $y^{(4)}$
D, $y^{(5)}$
E. none of the above

16. For the solution of the IVP

$$\frac{y'}{2 + \cos x} - e^{-y} = 0\,,\ y(0) = 0$$

find $y(\pi/2)$.

A. $\ln \pi$
B. $\ln(2 + \pi)$
C. $\ln(1 + \pi)$
D. does not exist
E. none of the above

17. In 1980, the population of the kingdom of Edenia was 1 million. The 2000 census then found a population of 1.44 million. Assuming Malthusian growth, i.e., the growth rate is proportional to the population size, how many people should have lived in Edenia in 1990?

    A. 1.18 million
    B. 1.20 million
    C. 1.22 million
    D. 1.24 million
    E. none of the above

18. Which of the following is an integrating factor for the ODE $yy'y'' = 1$?

    A. y
    B. y'
    C. yy'
    D. y'/y
    E. none of the above

19. For which choices of a real number a do all solutions to $y'' + 2ay' + (1-a)y = 0$ satisfy $\lim_{x\to\infty} y(x) = 0$?

    A. all real a
    B. all positive a
    C. all negative a
    D. $0 < a < 1$
    E. none of the above

20. Solve the IVP

$$y' = \frac{4y^2 + 4xy + x^2}{4x^2} \quad y(1) = 0.$$

    A. $y = \frac{x}{2}\tan(\frac{\ln x}{2})$
    B. $y = x\tan(\frac{\ln x}{2})$
    C. $y = \frac{x}{2}\tan(2\ln x)$
    D. $y = 2x\tan(\ln x)$
    E..none of the above

21. The parabolas $y = Cx^2$ are solutions of which ODE?

    A. $\frac{dy}{dx} = \frac{2y}{x}$

    B. $\frac{dy}{dx} = 2xy$

    C. $\frac{dy}{dx} = \frac{2x}{y}$

    D. $\frac{dy}{dx} = \frac{y}{x}$

    E.. none of the above

22. Which is the general solution to the ODE $y'' + 2y' - 3y = 0$?

    A. $y = C_1e^x + C_2e^{3x}$
    B. $y = C_1e^x + C_2e^{-2x}$
    C. $y = C_1e^{-x}x + C_2e^{2x}$
    D. $y = C_1(e^x + e^{-3x})$
    E. none of the above

23. Use Euler's method with a single step for the ODE IVP $y' = (x + y)/(x^2 + y^2)$, $y(1) = 2$, to find an approximation for $y(1.1)$.

    A. $y(1.1) \approx 2.6$
    B. $y(1.1) \approx 0.1$
    C. $y(1.1) \approx 2.1$
    D. $y(1.1) \approx 2.2$
    E.. none of the above

24. For which choice of $g(x, y)$ is the ODE $(2x - 3y^2)\,dx + g(x, y)\,dy = 0$ exact?

    A. $g(x, y) = x^2 - 3xy^2 + y^4$
    B. $g(x, y) = -y^3$
    C. $g(x, y) = 1$
    D. $g(x, y) = -6xy + 4y^2$
    E. none of the above

25. Solve the IVP $y' + xy = x$, $y(0) = 2$ and find $y(2)$.

    A. $y(2) = e^{-2}$
    B. $y(2) = 1 + e^{-2}$
    C. $y(2) = 1$
    D. $y(2) = e^2 + 1$
    E.. none of the above

26. Solve the IVP $xy' + y = 1$, $y(1) = 2$ and find $y(2)$.

    A. $y(2) = 1 + e^{-1}$
    B. $y(2) = 1$
    C. $y(2) = \frac{3}{2}$
    D. $y(2) = 1 + \frac{1}{2}e^{-2}$
    E. none of the above

27. If y is continuous and $y' = |1 - x|$ and $y(0) = 0$, what is $y(3)$?

    A. $-3/2$
    B. $3/2$
    C. $5/2$
    D. 2
    E. none of the above

28. If y is a solution to

$$\frac{dy}{dx} = \frac{3x^2 + 4x + 2}{2(y - 1)}.$$

    with $y(0) = -1$, find $y(1)$.

    A. 4
    B. $1 + \sqrt{10}$
    C. 1
    D. $1 - \sqrt{10}$
    E. none of the above

29. If x and y solve

$$x' = x + y$$
$$y' = 4x + y$$

    and $x(0) = 1$ and $y(0) = 1$, find $x(1)$.
    A. e
    B. $e^3 - e^{-1}$
    C. e^3
    D. $\frac{e^3}{4}$
    E. none of the above

30. Johnny Appleseed Pike and John Hancock Highway are straight roads that intersect at a right angle. An SUV is heading, on Appleseed Pike, towards the intersection with speed 50mi/hr. A convertible is heading away from this intersection on Hancock Hwy at a speed of 60 mi/hr. At the moment when the SUV car is 1 mile before the intersection and the convertible is 1/2 mile past the intersection, at what rate is the distance between the cars changing? (Distance measured as the crow flies).

    A. decreasing at $8\sqrt{5}$ mi/hr
    B. increasing at $8\sqrt{5}$ mi/hr
    C. decreasing at $6\sqrt{5}$ mi/hr
    D. increasing at $2\sqrt{5}$ mi/hr
    E. none of the above.