

**Show all work.**

1. Verify exact, then solve:

$$\left(y + \frac{e^y}{x}\right)dx + (x + e^y \ln x + \sqrt{y})dy = 0.$$

2. Verify homogeneous, then solve:

$$(x^3 - y^3)dx + (y^2x)dy = 0.$$

3. Solve the 1st order linear differential equation:

$$\frac{dy}{dx} + \frac{y}{x+1} = \frac{2x}{x+1}.$$

4. Mechanics problem: A 32 pound object is launched straight upwards from ground level at 1000 feet per second. Assuming that acceleration due to gravity is 32 feet per second per second towards the earth, and assuming that the force of wind resistance is numerically equal to one half the velocity of the object in units of pounds, calculate how many seconds it takes for the object to achieve zero velocity.