

Physics 215
First Order Differential Equations

1. Generate a finite difference equation for the following equations using the right derivative method and the centered derivative method. State the order of the error for each result.

a. $\frac{dy}{dx} = y + e^{-y} + 2x$

b. $\frac{dy}{dx} = xy^3 - y$

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

2. When an object falls through a resistive medium (like air) its acceleration is retarded by a force related to its speed,

$$F_{retarding} = \frac{1}{2}\rho C A v^2 \quad .$$

Consider an object falling through the air accelerated by the force of gravity and retarded by air friction.

- (a) What is the total force on the object?
 - (b) Express your result from part (a) as a first-order, linear, ordinary differential equation where the speed v is a function of the time t .
 - (c) Generate an algorithm to solve the equation from part (b) using the two-point formula. What is the order of the error term?
 - (d) Generate an algorithm to solve the equation from part (b) using the three-point formula. What is the order of the error term?
3. Consider now a baseball struck by Adrian Gonzalez of the Boston Red Sox and subject to a friction force like the falling object above.
 - (a) What are the components of the total vector force on the object?
 - (b) Express your result from part a. as a set of first-order, linear, ordinary differential equations where the velocity is a function of the time t .
 - (c) Generate an algorithm to solve the equations from part (b) using the Euler method (*i.e.*, the two-point formula). What is the order of the error term for each equation?
 - (d) Generate an algorithm to solve the equations from part (b) using the Taylor series method (*i.e.*, the three-point formula). What is the order of the error term for each equation?