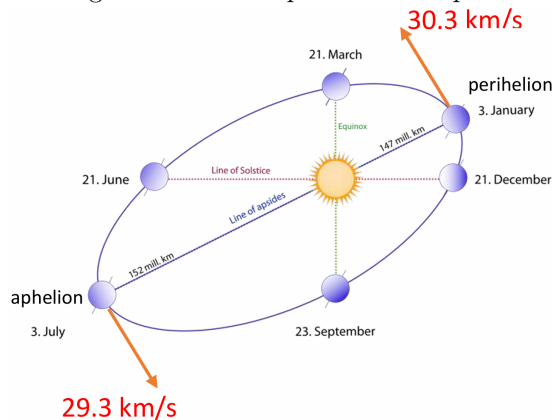


Homework 4

1. Calculate the numeric derivative of $f(x) = 1/x$ (evaluated at $x = 2$), using the central difference formula over a range of values for h (10^{-15} to 10^{-1}).
 - (a) Create a log-log plot of the error $|f'_{calc}(2) - f'_{exact}(2)|$ as a function of h .
 - (b) For what order of magnitude of h is the error minimized?
 - (c) Repeat parts (a) and (b) for a value of $x = 200$
2. A ball falls from a height of 1000 m. The force acting on the ball due to wind resistance is directly proportional to the velocity squared, $f_R = .005v^2$.
 - (a) Plot $y(t)$ over the duration of the fall.
 - (b) Plot $v(t)$ over the duration of the fall.
 - (c) Approximately how long does it take the ball to hit the ground?
 - (d) Approximately how long does it take the ball to reach 99% of terminal velocity?
3. Using a root finder, solve for x when
 - (a) $\cos(x) = x^2$
 - (b) $e^{-x} = \ln(x)$
4. Starting with either the perihelion or aphelion initial conditions given, [h!]



- (a) Assuming the position of the sun is fixed, plot the trajectory of the earth around the sun (x vs. y). Note, make sure the aspect ratio of the plot is 1.
- (b) From $x(t)$ or $y(t)$, determine the period of oscillation (hint? : it should be close to a year).
- (c) If the sun is allowed to move, how does that change the period of oscillation?