ODE 45 non-linearized pendulum

$$\theta'' + \omega^2 * \sin(\theta) = 0$$

$$let\ \theta\ be\ represented\ as\ \theta = \begin{bmatrix}\theta \\ \theta'\end{bmatrix} = \begin{bmatrix}\theta_1 \\ \theta_2\end{bmatrix}$$

$$then\ let\ \dot{\theta}\ be\ represented\ as\ \dot{\theta} = \begin{bmatrix}\theta_1 \\ \theta_2\end{bmatrix}' = \begin{bmatrix}\theta' \\ \theta''\end{bmatrix} = \begin{bmatrix}\theta_2 \\ -\omega^2 * \sin(\theta_1)\end{bmatrix}$$

$$the\ initial\ conditions\ are\ defined\ as: \quad \begin{matrix}\theta(0) = \pi/2 \\ \theta'(0) = 0\end{matrix} \quad \ldots \quad \theta = \begin{bmatrix}\pi/2 \\ 0\end{bmatrix}$$

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% note: theta referred to above is represented by v_theta, indicating
virtual

[t,theta] = ode45(@(t,theta) odePendulum(t,theta,w2),span,initial);

function thetaDot = odePendulum(t,v_theta)
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$$let\ \theta = \begin{bmatrix}\theta_1 \\ \theta_2\end{bmatrix}$$

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    thetaDot = zeros(2,1);
    thetaDot(1) = v_theta(2);
   thetaDot(2) = -9.81*sin(v_theta(1));
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$$\dot{\theta} = \begin{bmatrix}\theta_2 \\ -\omega^2 * \sin(\theta_1)\end{bmatrix}$$

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end
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function inherits a virtual variable/parameter in matrix form (in this case: ***v_theta****)*
it then returns the differential as ***thetaDot*** *with respect to the members of* ***v_theta***

ode45 takes that thetaDot parameter, and a span, and integrates each row with respect to the span,
the function then returns the array of numerically calculated values,
ode45 returns the values in a column in the n^{th} *position of* ***theta_soln*** *that correspond,*
to the m^{th} *position of* ***thetaDot***

$$v\_theta = \begin{bmatrix}\theta \\ \theta'\end{bmatrix} = \begin{bmatrix}\theta_1 \\ \theta_2\end{bmatrix}$$

$$thetaDot = \begin{bmatrix}\theta_2 \\ -\omega^2 * \sin(\theta_1)\end{bmatrix}$$

$$theta\_soln = \begin{bmatrix}\theta & \theta' \\ \vdots & \vdots\end{bmatrix}$$

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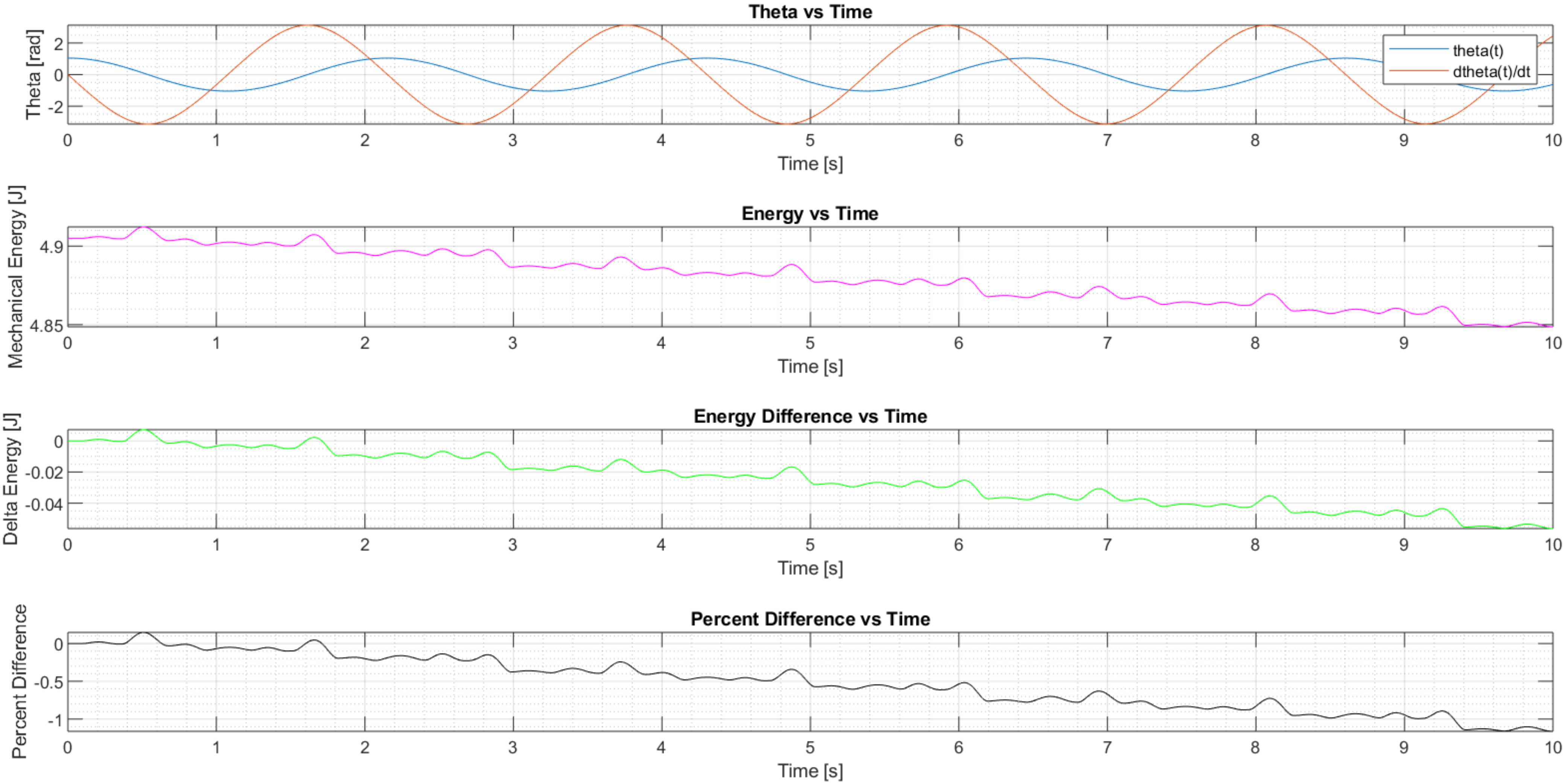

$$t(0): \theta = \frac{\pi}{3}, \omega = 0$$

ODE45 solver is accurate to approximately $\leq 1\ \%$ *error with a timestep of* 0.000001 *until approximately* 10 *seconds*