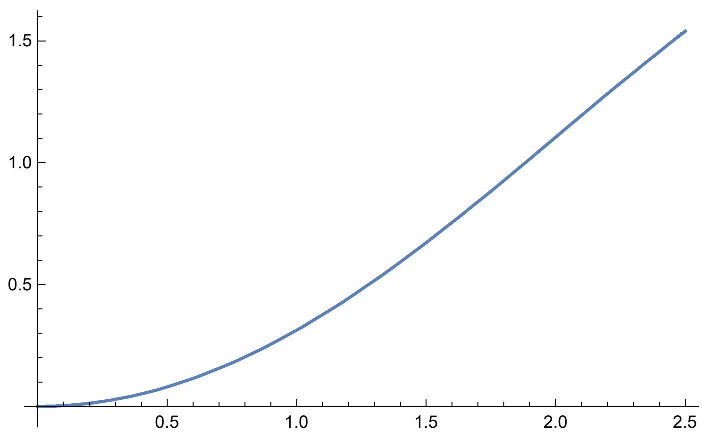
In[•]:=
```
Clear["Global`*"]
ycrit = 70 * Degree;
yfinal = 90 * Degree;
g = 9.81;
r = 14;
M = 5216;
u = .05;
eqns = {y''[t] == g * Sin[ycrit - y[t]] / r - u * y'[t] * y'[t] - u * g * Cos[ycrit - y[t]] / r,
   y[0] == 0, y'[0] == 0};
solution = NDSolve[eqns , {y, x}, {t, 0, 2.5}]
Plot[y[t] /. solution, {t, 0, 2.5}]
Plot[y'[t] /. solution, {t, 0, 2.5}]
Plot[y''[t] /. solution, {t, 0, 2.5}]
Plot[Evaluate[{y[t], y'[t], y''[t]} /. solution], {t, 0, 2.5}]
Plot[Evaluate[(y'[t] * y'[t] + g * Cos[ycrit - y[t]] / r) * M * r /. solution], {t, 0, 2.1}]
```

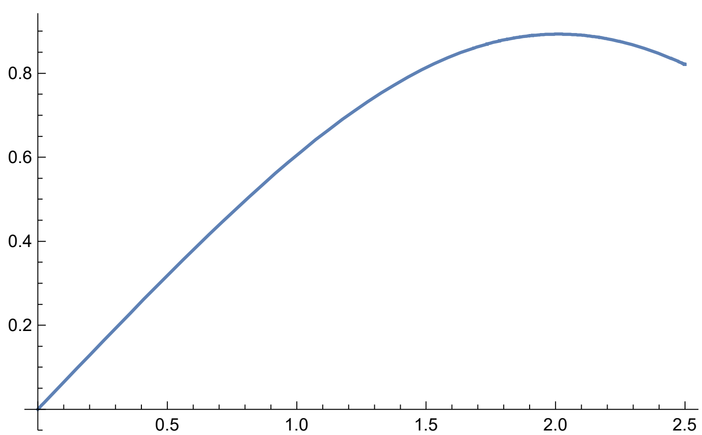
Out[•]= {{y → InterpolatingFunction[Domain: {{0., 2.5}} Output: scalar], x → x}}

Out[•]=



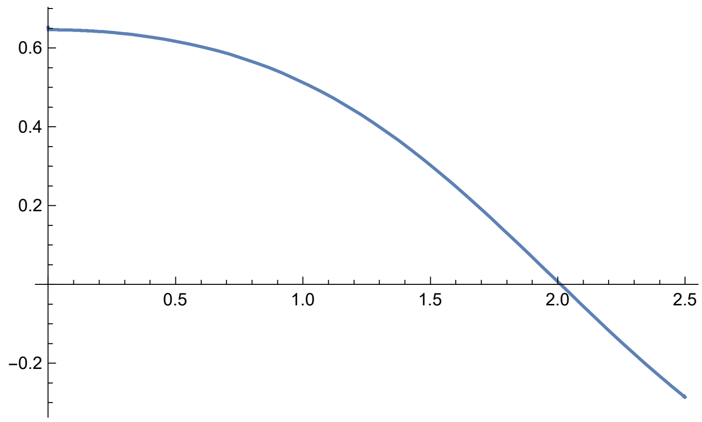
1st plot = This is a plot of angle vs time all in SI units so radians and seconds

Out[•]=



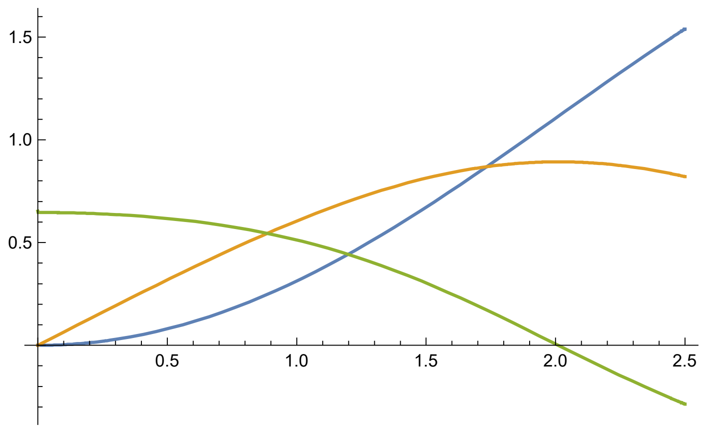
2nd plot = This is a plot of angular velocity vs time all in SI units so radians/s and seconds

Out[ ]=



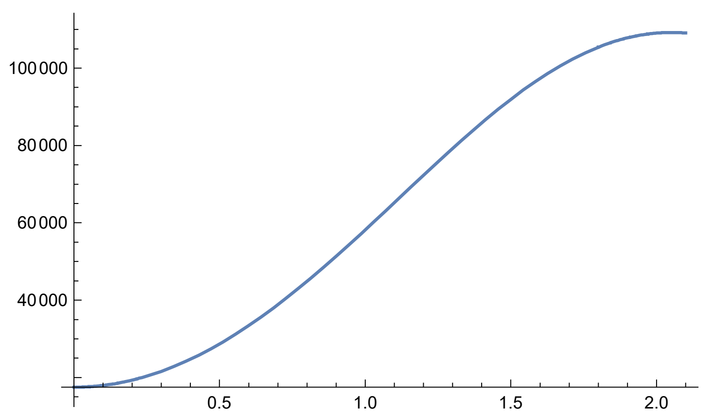
3rd plot =This is a plot of angular acceleration vs time all in SI units so radians/s/s and seconds

Out[ ]=



4th plot = all previous ones on top of each other

Out[ ]=



5th plot = Plot of normal force vs time. It can be seen that the maximum is around 21,500 Newtons total. N wheels will each experience an average force that is (21,500/N) Newtons. However, it is possible for individual wheels to experience more or less depending on the final weight distribution of the cart and passengers. This force is a function of time and is expressed in this 5th plot for the train going through this part of the track.

NOTE: u, the coefficient of rolling friction between the wheels and the roller coaster track was chosen to be .05 based on online information. Further prototyping could be used to dial in this value and therefore alter the numbers ubtained by this analysis.