Mechanics of a Rocket

Calculating Max Q

James Saslow - 2/1/2023

```
(*Everything is in SI units*)
(*Falcon 9 Specs/Estimates*)
A = π (3.7 / 2)^2;
Cd = 0.25;
m0 = 25 600;
μ = (395 700 / m0);
τ = 205;
ve = 5630;

(*Fundamental Constants*)
α = 9.8 / 1000;
M = 0.028;
R = 8.314;
ρ0 = 1.225;
T0 = 293;
g = 9.81;
```

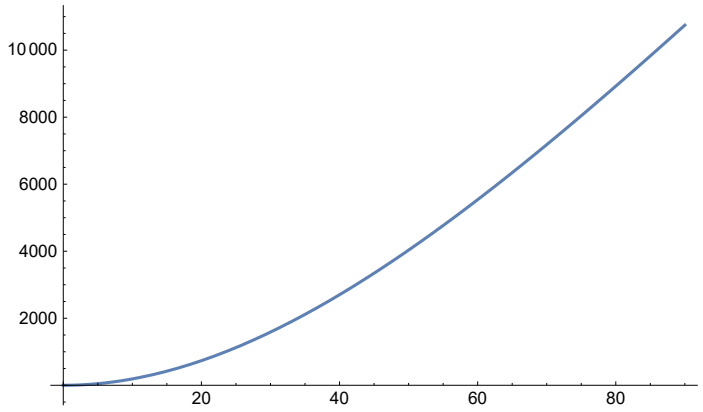
In[•]:=
```
(*s=NDSolve[{x''[t]+x[t]==0,x[0]==0,x'[0]==1},x[t],{t,0,10}]
  Plot[x[t]/.s,{t,0,10}]*)

tmax = 90;
s =
 NDSolve[{m0 ve/τ Exp[-t/τ] - m0 g (1 + Exp[-t/τ]) - 1/2 ρ0 (1 - α x[t]/T0)^(Mg/(α R) - 1) (x'[t])^2 Cd A ==
     m0 (1 + Exp[-t/τ]) x''[t], x[0] == 0, x'[0] == 0}, x, {t, 0, tmax}]

Plot[Evaluate[x[t] /. s], {t, 0, tmax}, PlotRange → All]
Plot[Evaluate[1/2 Cd A ρ0 (1 - α x[t]/T0)^(Mg/(α R) - 1) (x'[t])^2/101 325 /. s],
 {t, 0, tmax}, PlotRange → All]
```

Out[•]=
```
{{x → InterpolatingFunction[ ⊞ Domain: {{0., 90.}}
                             Output: scalar ]}}
```

Out[•]=



Out[•]=