Problem 1

```
%%%%%%
clear all; clc; close all

mu = 3.9860044189e5;
Re = 6378; %radius of earth
mo = 1800; %kg
rp_1 = 520 + Re;
ra_1 = 900 + Re;
e1 = (ra_1-rp_1)/(ra_1+rp_1);
h1 = sqrt(rp_1*mu*(1+e1));
vp_1 = h1/rp_1;
va_1 = h1/ra_1;

rp_2 = 520+Re;
ra_2 = 14000+Re;
e2 = (ra_2-rp_2)/(ra_2+rp_2);
h2 = sqrt(rp_2*mu*(1+e2));
vp_2 = h2/rp_1;
T = 12; % thrust in kN
Isp = 291;
g=9.81;
options = odeset('RelTol',1e-6);
dv = vp_2 - vp_1;
dt = 150;
i = 0;
while 1
    [T,Z] = ode45('OrbEq_thrust',[0 dt],[ra_1 0 0 0 va_1 0 mo],
 options);
    deltaV = -Isp*g*log(Z(end,7)/mo)/1000;
    dm = mo*(1-exp(-deltaV*1000/(Isp*g)));
    if dv-deltaV>0
        dt = dt + 0.1;
    else
        dt = dt - 0.1;
    end
    if abs(dv-deltaV)<.001
        break
    end
    i = i+1;
end

fprintf('Burn time: %0.1f s \n',dt)
fprintf('Total mass expended: %0.0f kg \n',dm)
fprintf('New eccentricity %0.2f \n',e2)
```

```
Burn time: 182.9 s
Total mass expended: 768 kg
New eccentricity 0.49
```

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function [vecDeriv] = OrbEq(t,z)

mu = 3.9860044189e5;
r = sqrt(z(1)^2+z(2)^2+z(3)^2);
v = sqrt(z(4)^2+z(5)^2+z(6)^2);
T = 12;
Isp = 291;
go = 9.81;
vecDeriv(1) = z(4);
vecDeriv(2) = z(5);
vecDeriv(3) = z(6);
vecDeriv(4) = -mu/r^3*z(1) + T*z(4)/(v*z(7));
vecDeriv(5) = -mu/r^3*z(2) + T*z(5)/(v*z(7));
vecDeriv(6) = -mu/r^3*z(3) + T*z(6)/(v*z(7));
vecDeriv(7) = -T/(Isp*go)*1000;
vecDeriv = vecDeriv.';

end
```

```
function [RX,VX,r,v,QXx] = OrbElem2StateVec(h,e,i,w,W,true_ano)
%This function will take orbital elements and compute two state vectors r
and v
% r and v must be 3-D vectors
mu = 3.9860044189e5;
r = (h^2/mu)/(1+e*cos(true_ano))*[cos(true_ano) sin(true_ano) 0]';
v = mu/h*[-sin(true_ano) (e+cos(true_ano)) 0]';
R3_W = [cos(W)  sin(W) 0;
      -sin(W) cos(W) 0;
      0       0      1;];
R1_i = [1 0 0;
        0 cos(i) sin(i);
        0 -sin(i) cos(i);];
R3_w = [ cos(w) sin(w) 0;
        -sin(w) cos(w) 0
        0 0 1;];
QXx = (R3_w) *(R1_i) *(R3_W);

RX = QXx.'*r;
VX = QXx.'*v;

end
```