HW7 Problem 1

```
fprintf('\n');
clearvars -except function_list hw_pub toolsPath
close all
CelestialConstants; % import useful constants

X0 = [5492.000;%km
 3984.001 ;%km
 2.955 ;%km
 -3.931 ;%km/sec
 5.498 ;%km/sec
 3.665 ];%km/sec

% Anon fcn to calculate specific energy. It shouldn't change!
spec_energy = @(X) norm(X(4:6))^2/2 - Earth.mu/norm(X(1:3));

% Classical orbit elements
[a,e,i,RAAN,w,f] = cart2OE(X0(1:3),X0(4:6),Earth.mu);

% Get the stuff that's propagated
n = sqrt(Earth.mu/a/a/a);
M0 = E2M(f2E(f,e),e);

for t = [100 1e6]; %s
    % Final mean anom is easy...
    Mf = M0 + n*t;
    % Unwinde the mean anom
    while Mf > 2*pi
        Mf = Mf - 2*pi;
    end
    % Final true anom
    ff = E2f(M2E(Mf,e),e);
    % Back to ECI!
    [r_f, v_f] = OE2cart(a,e,i,RAAN,w,ff,Earth.mu);
    fprintf('r_f(t=%d):\n',t)
    disp(r_f);
    fprintf('delta Energy(t=%d):\n',t)
    disp(spec_energy([r_f;v_f]) - spec_energy(X0));
end

% Anonymous function to calculate 2-body accel
two_body = @(t,X) [X(4);X(5);X(6);...
    -Earth.mu*X(1)/norm(X(1:3))^3;...
    -Earth.mu*X(2)/norm(X(1:3))^3;...
    -Earth.mu*X(3)/norm(X(1:3))^3];

% Anon fcn to calculateposition difference.
calc_dr = @(X_exp, r_f) sqrt((X_exp(1)-r_f(1))^2 ...
        +(X_exp(2)-r_f(2))^2 ...
        +(X_exp(3)-r_f(3))^2);
```

```
tol=1e-12;
options=odeset('RelTol',tol,'AbsTol',[tol tol tol tol tol tol]);
for t = [100 1e6]
    [t_array,X_array]=ode45(two_body,[0 t],X0,options);
    fprintf('r_f(t=%d)(integrated):\n',t_array(end))
    disp(X_array(end,1:3)');
    fprintf('delta Energy(t=%d)(integrated):\n',t)
    disp(spec_energy(X_array(end,1:6)) - spec_energy(X0));
end

for tol = [1e-12 1e-10 1e-8 1e-6 1e-4]
    options=odeset('RelTol',tol,'AbsTol',[tol tol tol tol tol tol]);
    [t_array,X_array]=ode45(two_body,[0 1e6],X0,options);
    fprintf('Position Diff @ tol = %e:\n',tol)
    disp(calc_dr(X_array(end,1:3)',r_f));
    fprintf('delta Energy @ tol = %f:\n',tol)
    disp(spec_energy(X_array(end,1:6)) - spec_energy(X0));
end
```

```
r_f(t=100):
   1.0e+03 *

   5.064753117135560
   4.507257422053243
   0.368658029818315

delta Energy(t=100):
     3.552713678800501e-15

r_f(t=1000000):
   1.0e+03 *

   1.407037337984632
   6.270084686694161
   2.306266072702379

delta Energy(t=1000000):
     1.421085471520200e-14

r_f(t=100)(integrated):
   1.0e+03 *

   5.064753168465420
   4.507257366803862
   0.368657989226936

delta Energy(t=100)(integrated):
     4.973799150320701e-14

r_f(t=1000000)(integrated):
   1.0e+03 *

   1.407037859051284
```

```
   6.270084634401733
   2.306265884003925

delta Energy(t=1000000)(integrated):
     2.198543569420508e-09

Position Diff @ tol = 1.000000e-12:
     5.566435667007229e-04

delta Energy @ tol = 0.000000:
     2.198543569420508e-09

Position Diff @ tol = 1.000000e-10:
   0.043311061412548

delta Energy @ tol = 0.000000:
     2.203521596300107e-07

Position Diff @ tol = 1.000000e-08:
   3.948961410452488

delta Energy @ tol = 0.000000:
     2.020949409953232e-05

Position Diff @ tol = 1.000000e-06:
  31.540622301006042

delta Energy @ tol = 0.000001:
    -1.331167062197380e-04

Position Diff @ tol = 1.000000e-04:
     1.204741406084945e+04

delta Energy @ tol = 0.000100:
  -2.587559250330802
```

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