HW1 Problem 4: Orbit Numerical Integration

```matlab
fprintf('\n');
clearvars -except function_list pub_opt
close all

ode_opts = odeset('RelTol', 1e-12, 'AbsTol', 1e-20);
r = [-2436.45; -2436.45; 6891.037]; % km
v = [5.088611; -5.088611; 0.0]; % km/s
state = [r;v];

%Find the period
OE = cart2oe(state);
a = OE(1);
period = 2*pi*sqrt(a*a*a/3.986e5);


times = 0:20:period*2;


[T,X] = ode45(@two_body_state_dot, times, state, ode_opts);

%Get the magnitues for plotting
r_mag = zeros(1,length(times));
v_mag = zeros(1,length(times));
a_mag = zeros(1,length(times));

for i = 1:length(times)
    r_mag(i) = norm(X(i,1:3));
    v_mag(i) = norm(X(i,4:6));
    s_dot = two_body_state_dot(0,X(i,:));
    a_mag(i) = norm(s_dot(4:6));
end

%Plot the result
figHandle = figure;
set(figHandle, 'Position', [100, 100, 600, 800])
subplot(3,1,1);
plot(times, r_mag)
title('Position magnitude over two orbits')
ylabel('r (km)');
xlabel('time (s)');
subplot(3,1,2)
plot(times, v_mag)
title('Velocity magnitude over two orbits')
ylabel('v (km/s)');
xlabel('time (s)');
subplot(3,1,3)
plot(times, a_mag)
title('Acceleration magnitude over two orbits')
ylabel('a (km/s^2)');
xlabel('time (s)');
```

```
Error using two_body_state_dot (line 14)
Not enough input arguments.

Error in odearguments (line 88)
f0 = feval(ode,t0,y0,args{:});    % ODE15I sets args{1} to yp0.

Error in ode45 (line 114)
[neq, tspan, ntspan, next, t0, tfinal, tdir, y0, f0, odeArgs, odeFcn, ...

Error in HW1_P4 (line 18)
[T,X] = ode45(@two_body_state_dot, times, state, ode_opts);
```

HW1 Problem 5: Orbit Numerical Integration Energy

Why is the change in total specific energy not constant?

The computational precision does not allow for exact calculations. The small error that results is built upon as the simulation runs.

```
KE = v_mag.*v_mag/2;
PE = -3.986e5./r_mag;

deltaE = KE + PE - (KE(1)+PE(1));
figure
plot(times, deltaE)

title('Change in energy over two numerically-integrated orbits')
ylabel('\DeltaEnergy');
xlabel('time (s)');
```

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