Two-Body Problem

My Solutions >

By solving a system of differential equations, determine the orbit of two masses using Newton's law and the universal law of gravitation. Display an animation of the orbit.

To obtain full credit, you will need to assign the position vectors of the two masses into the variables x1, y1 and x2, y2 over one full orbital period. The eccentricity of the orbit, masses, tspan times, and RelTol of the ode solver are pre-specified in the Learner's template.

To view an animation of the orbit itself, you will need to uncomment the graphics code and run in MATLAB online or desktop. At this time, MATLAB Grader does not support animation.

Script

Save Reset MATLAB Documentation (https://www.mathworks.com/help/)

```
e=0.7; m1=1; m2=4;
T=2*pi./(1-e).^1.5; tspan=linspace(0,T,1000);
options=odeset('RelTol',1.e-6);
%%%%% Solve differential equations for x and y using ode45 with arguments tspan and options.

x0 = -1; y0 = 0; u0 = 0; v0 = sqrt(1+e);
[t,x_y_u_v]=ode45(@(t,x_y_u_v) twobody(x_y_u_v),tspan,[x0, y0, u0, v0],options);
x=x_y_u_v(:,1); y=x_y_u_v(:,2); u=x_y_u_v(:,3); v=x_y_u_v(:,4);

%%%%% Determine x1, y1 and x2, y2
x1 = x * m2 / (m1 + m2);
y1 = y * m2 / (m1 + m2);
x2 = -x * m1 / (m1 + m2);
y2 = -y * m1 / (m1 + m2);

%%%%% graphics: UNCOMMENT TO RUN ON MATLAB ONLINE OR DESKTOP %%%%%%%%%%%%%%
k=0.1;
R1=k*(m1)^(1/3); R2=k*(m2)^(1/3); %radius of masses
theta = linspace(0,2*pi);
figure; axis equal; hold on; set(gcf,'color','w');
axis off;
xlim([-2,5]); ylim([-2.5,2.5]);
planet=fill(R1*cos(theta)+x1(1), R1*sin(theta)+y1(1),'b');
sun=fill(R2*cos(theta)+x2(1), R2*sin(theta)+y2(1),'r');
pause(1);
nperiods=5; %number of periods to plot
for j=1:nperiods
    for i=1:length(t)
        planet.XData=R1*cos(theta)+x1(i); planet.YData=R1*sin(theta)+y1(i);
        sun.XData=R2*cos(theta)+x2(i); sun.YData=R2*sin(theta)+y2(i);
        drawnow;
    end
end
%%%%% Write local function for differential equations %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
function d_x_y_u_v_dt = twobody(x_y_u_v)
    % define the differential equation here
    x=x_y_u_v(1); y=x_y_u_v(2); u=x_y_u_v(3); v=x_y_u_v(4);
    r = sqrt(x^2+y^2);
    d_x_y_u_v_dt=[u;v;-x/r^3;-y/r^3];
end
```

Run Script

Assessment: All Tests Passed

Submit

- x coordinate of mass one
- y coordinate of mass one
- x coordinate of mass two
- y coordinate of mass two

Output

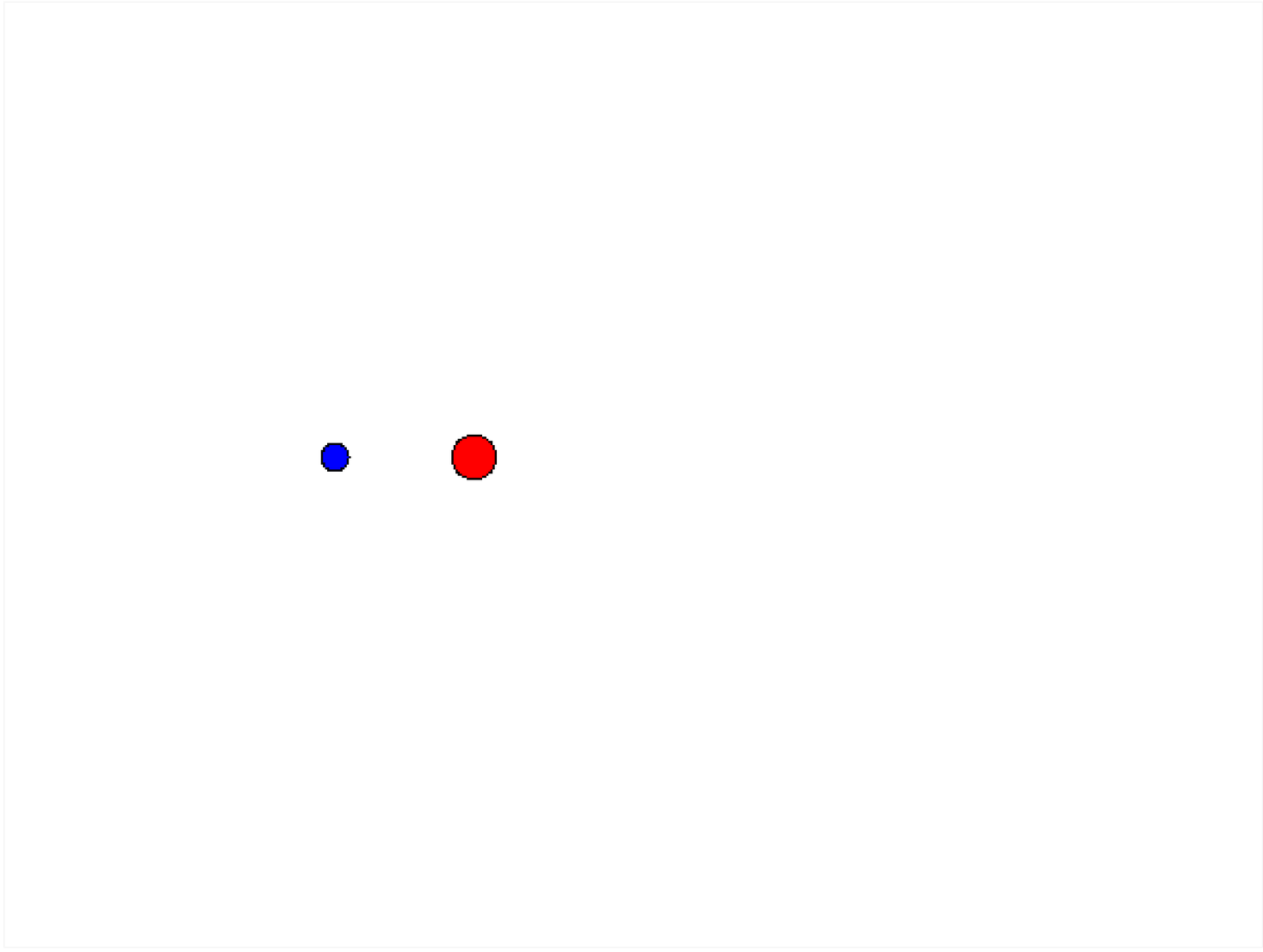

Figure 1 of 1

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