```
% Title: Newton-Raphson Algorithm to calculate values of gamma_2 and L2
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% Characteristic length [km]
a_Earth = 149597898;
a_Moon = 384400; % around Earth
a_Titan = 1221865; % about Saturn
a_Phobos = 9376; % about Mars

% Gravitational Parameters [km^3/s^2]
mu_Sun = 132712440017.99;
mu_Earth = 398600.4415;
mu_Moon = 4902.8005821478;
mu_Mars = 42828.314258067;
mu_Saturn = 37940626.061137;
mu_Phobos = 0.0007112;
mu_Titan = 8978.1382;

% Mass ratio of minor primary
mu_Earth_Moon = mu_Moon/(mu_Earth+mu_Moon);
mu_Sun_Earth = mu_Earth/(mu_Sun+mu_Earth);
mu_Saturn_Titan = mu_Titan/(mu_Saturn+mu_Titan);
mu_Mars_Phobos = mu_Phobos/(mu_Mars+mu_Phobos);

% Create a table
System = ["Earth-Moon";"Sun-Earth";"Saturn-Titan";"Mars-Phobos"];
mu_system = [mu_Earth_Moon;mu_Sun_Earth;mu_Saturn_Titan;mu_Mars_Phobos];
a_system = [a_Moon;a_Earth;a_Titan;a_Phobos];
system_data = table(System,mu_system,a_system)

% Newton-Raphson Algorithm

% Step 1: Pick a gamma
% Step 2: Plug into function
% Step 3: Check if result = abs(10^-12)
% Step 4: If not, update gamma using update equation and repeat
% Step 5: If it is, break and print gamma result.

all_results = zeros(0,8);
tolerance = 1e-12;
counter = 0;
rows = height(system_data);
for row = 1:rows
    name = System(row,:);
    mu = system_data{row,2};
    a = system_data{row,3};
    % Step 1
    gamma = 0.000001; % initial guess
    while 1
        counter = counter + 1;
        % Step 2
```

```
        f = -(((1-mu)/(1+gamma)^2)+(mu/gamma^2)-1+mu-gamma);
        f_prime = ((2*(1-mu))/(1+gamma)^3)+((2*mu)/(gamma^3))+1;
        % Step 3
        if abs(f) > tolerance
            % Step 4
            gamma = gamma - f/f_prime;
            continue
        else
            % Step 5
            x = 1 - mu + gamma;
            all_results(end+1,:) = [name mu gamma gamma*a gamma*100 x x*a
counter];
            counter = 0;
            break
        end
    end
end
t = array2table(all_results,'VariableNames',{'System', 'mu of system',
'gamma', 'gamma_dim', 'percentage of a', 'x', 'x_dim', 'Iterations'});
format long
disp(t)
```

```
system_data =

  4×3 table

        System             mu_system          a_system
    _______________    ____________________    _________

    "Earth-Moon"         0.0121505853505625       384400
    "Sun-Earth"        3.00348064022678e-06    149597898
    "Saturn-Titan"     0.000236580549110361      1221865
    "Mars-Phobos"      1.66058365945601e-08         9376

    System    mu of system     gamma       gamma_dim      percentage of
a       x           x_dim         Iterations
    ______    _____________    ________    _____________    _____________
______    _____________    __________

     NaN          0.012151       0.16783       64514.909        16.7833
1.1557        444244.224         35
     NaN         3.0035e-06      0.010037     1501532.0471
1.0037           1.01     151098980.7327         28
     NaN         0.00023658      0.043489       53138.1882         4.3489
1.0433       1274714.1187         32
     NaN         1.6606e-08      0.00177          16.5954           0.177
1.0018          9392.5952         24
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