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1 % Sounak (Shaun) Ghosh
2 % 11/05/19
3 % ECE 202 - Fall 2019 - MATLAB Exercise M6
4 % Equation source: http://www.convertalot.com/elastic\_collision\_calculator.html
5 % MATLAB script to determine the number of collisions in a system of cart
6 % using User-Defined Functions
7
8 clear      % clears all variables in the workspace; avoids common errors
9 clc        % clears all previous outputs in the command window
10
11 M = [240 120 360]; % mass of the carts in g
12 Vi = [30 15 -45]; % initial velocity of carts in cm/s
13
14 Momentum_i = sum(M.*Vi); % Initial Momentum of the total system.
15 Energy_i = sum(0.5*M.*Vi.^2); % Initial Energy of the total system.
16
17 % From the diagram M2 & M3 are going to collide first.
18 % After Collision a
19
20 [Va(2), Va(3)] = final_velocity(M(2), M(3), Vi(2), Vi(3));
21
22 Va(1) = Vi(1) % velocity of carts after collision a
23
24 CheckMomentum_a = sum(M.*Va) - Momentum_i % The change in total energy
25 % momentum of the system
before
26 CheckEnergy_a = sum(0.5*M.*Va.^2) - Energy_i % & after the collision
should
27 % be zero.
28 % The velocities after collision A indicate carts #1 & #2 are going to collide.
29 % After Collision b.
30
31 [Vb(1), Vb(2)] = final_velocity(M(1), M(2), Va(1), Va(2));
32
33 Vb(3) = Va(3) % velocity of carts after
collision a
34
35 CheckMomentum_b = sum(M.*Vb) - Momentum_i % The change in total
energy
36 % momentum of the system
before
37 CheckEnergy_b = sum(0.5*M.*Vb.^2) - Energy_i % & after the collision should
38 % be zero.
39
40 % The velocities after collision B indicate carts #2 & #3 are going to collide.
41 % After Collision c.
42
43 [Vc(2), Vc(3)] = final_velocity(M(2), M(3), Vb(2), Vb(3));
44
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45 Vc(1) = Vb(1) % velocity of carts after collision a
46
47 CheckMomentum_c = sum(M.*Vc) - Momentum_i % The change in total energy
48 % momentum of the system before
49 CheckEnergy_c = sum(0.5*M.*Vc.^2) - Energy_i % & after the collision should
50 % be zero.
51 % After Collision c
52
53 % The velocities after collision C indicate carts #1 & #2 are going to collide.
54 % After Collision D.
55
56 [Vd(1), Vd(2)] = final_velocity(M(1), M(2), Vc(1), Vc(2));
57
58 Vd(3) = Vc(3) % velocity of carts after collision a
59
60 CheckMomentum_d = sum(M.*Vd) - Momentum_i % The change in total energy
61 % momentum of the system before
62 CheckEnergy_d = sum(0.5*M.*Vd.^2) - Energy_i % & after the collision should
63 % be zero.
64
65
66
67 function [v1f, v2f] = final_velocity(m1, m2, v1i, v2i)
68     M = m1 + m2;
69     v1f = (m1*v1i - m2*(v1i - 2*v2i))/M; % final velocity of left cart
70     v2f = (m1*(2*v1i - v2i) + m2*v2i)/M; % final velocity of right cart
71 end
72
73 % The final velocities of the carts 1, 2 and 3 after collision D are -50
74 % cm/s, -35 cm/s and 25 cm/s respectively, which indicate that cart#1 and
75 % cart#2 are moving in the same direction with cart#1 moving faster than
76 % cart 2, hence carts #1 and #2 will never collide, and cart#3 is moving in
77 % the opposite direction of cart#1 and cart#2, therefore cart#3 won't have
78 % a collision with either of the other carts. In conclusion,
79 % we can determine that the carts will not have any further collisions.
80
81
82
83

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```
1
2 Va =
3
4     30    -75    -15
5
6
7 CheckMomentum_a =
8
9     0
10
11
12 CheckEnergy_a =
13
14     0
15
16
17 Vb =
18
19    -40     65    -15
20
21
22 CheckMomentum_b =
23
24     0
25
26
27 CheckEnergy_b =
28
29     0
30
31
32 Vc =
33
34    -40    -55     25
35
36
37 CheckMomentum_c =
38
39     0
40
41
42 CheckEnergy_c =
43
44     0
45
46
```

```
47 vd =  
48  
49     -50    -35     25  
50  
51  
52 CheckMomentum_d =  
53  
54         0  
55  
56  
57 CheckEnergy_d =  
58  
59         0  
60  
61 >>
```