Course and Section_______ Names ___________________________

Date___________________ ___________________________

LINEAR MOMENTUM SIMULATION

Introduction

In this simulation you will investigate some basic proprieties of the linear momentum and the role it plays for different kinds of collisions.

Input your answers on Blackboard.

1 – Preliminary Questions

A cart of mass *m* rolls along a track at speed *v*, hits a bumper and then it bounces back.

1. The impulse given to a cart is equal to
   (a) the change in the cart's kinetic energy
   (b) the change in the cart's momentum
   (c) the average force exerted on the cart
   (d) the average acceleration of the cart
   (e) all of the above

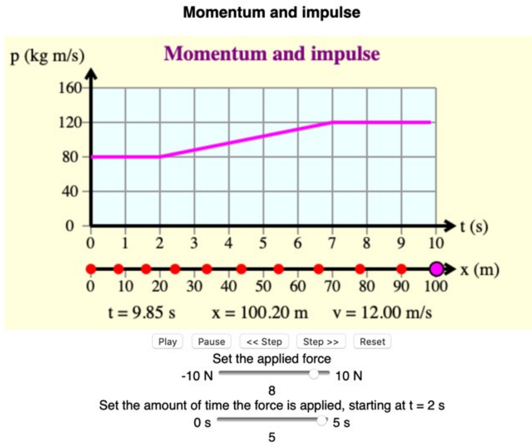
2. What is the maximum possible impulse for this collision?
   (a) mg (b) 2mg (c) mv (d) 2mv (e) impossible to determine from information given.

Consider an isolated system (no external forces)

3. Is the momentum conserved during elastic collision?
4. Is the momentum conserved during inelastic collision?
5. Is the kinetic energy conserved during elastic collision?
6. Is the kinetic energy conserved during inelastic collision?

2 – Momentum- Impulse

Run the following simulation. http://physics.bu.edu/~duffy/HTML5/impulse.html



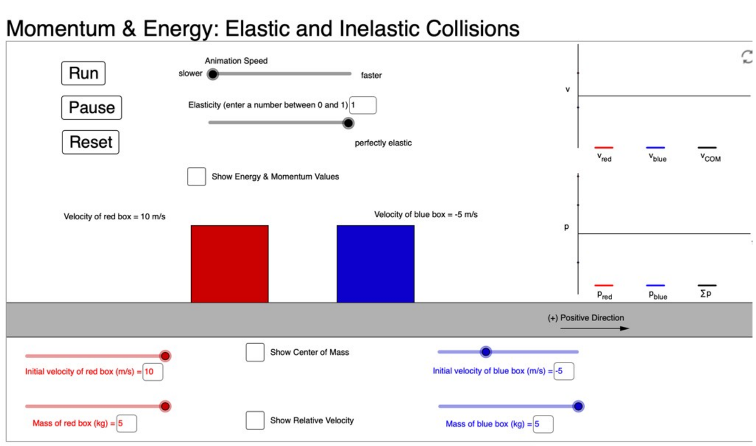
Note: the force is applied starting at t = 2 sec.

7. Run the simulation with applied force zero. Does the momentum change?
8. The initial momentum is 80 kg m/sec. Find the mass of the object.

Now set the force to 8 N and apply the force for 5 sec.
9. What is the final momentum?
10. What is the change in momentum?
11. Is the change of momentum equal to (force applied) × (time the force is applied)?
12. Find the change in the kinetic energy.
13. Find the work done by the applied force. Use work done = (force) × (distance the force is applied).
14. Are your answers to question 12 and 13 equal?

3 – Elastic vs Inelastic Collision

Click the following link and run the simulation. (https://ophysics.com/e2.html)



Uncheck the box s*how relative velocity* and *show center of mass.*
15. Assign a positive velocity to the red box and negative velocity to the blue box. Are they moving in opposite direction?
16. Assign both of them a positive velocity. Are they moving in same direction before the collision?

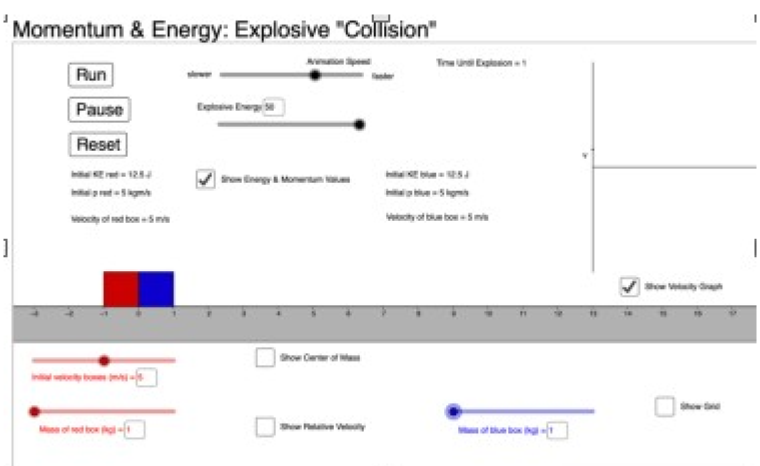
Set both masses to 5 kg, velocity of red box 10 m/s, velocity of blue box -5 m/s. Set the elasticity to zero (i.e totally inelastic collision).
17. What is the total linear momentum before collision?
18. What is the total linear momentum after collision?
19. Is the momentum conserved?
20. What is the total kinetic energy before the collision?
21. What is the total kinetic energy after the collision?
22. Is the kinetic energy conserved?
23. How much kinetic energy is lost during the collision?

Change the elasticity to 1 (i.e. perfectly elastic collision). Keep the same initial values.
24. Is the total linear momentum conserved?
25. Is the kinetic energy conserved?
26. How much energy is lost during the collision?
27. Is the direction of motion of the blue box is same as the direction of motion before collision?

Set mass of red box = 1 kg, blue box = 5 kg. Velocity of red box 10 m/s, blue box at rest.
Set the elasticity to 1. (pay attention to the signs for the following questions)
28. Calculate the final velocity of the red box.
29. Calculate the final velocity of the blue box.
Set the elasticity to 0 and repeat
30. Is the direction of velocity of the red box the same as in 28?
31. Is the direction of velocity of the blue box the same as in 29?

4 – Explosive Collision

An explosion is described as a collision in which the final KE energy is greater than the initial KE. The source of energy can be for example the chemical energy within the dynamite before its explosion. Open the following simulation. (https://ophysics.com/e2a.html)



This simulation shows a very simple case of explosion where the initial object, made of both boxes together, explodes into the two separated boxes. The explosion takes place in one dimension. Uncheck the box ‘*show relative velocity*’ and ‘*show center of mass*’. Mass of the blue box 2 kg, red box is 2 kg. Change the explosive energy to zero (i.e totally inelastic). Initial velocity of the boxes 3 m/sec.
Click *Run* to start the simulation.
32. Does the explosion occur?

Now change the explosive energy to 30. Run the simulation.
33. After explosion, do the red and blue boxes move in same direction?
34. Are the magnitude of velocities of blue and red boxes the same?
35. Is the total linear momentum conserved?
36. Is the total kinetic energy conserved?
Show the center of mass and repeat the explosion
37 How does the velocity of the center of mass before the explosion compare to its velocity after the explosion?

5 – Data- Momentum vs time plot

A physicist applies a constant force for about ten seconds on a cart which moves on a track. The data below displays the measurements of the momentum taken at different times.

Momentum (Kgm/sec)	3.98	6.02	8	9.95	12.05	14	16.03	18.02
Time (s)	2	3	4	5	6	7	8	9

Plot the momentum vs time. Fit it linearly.
38. To which physical quantity does the slope correspond to?
39. What is the value of the slope?