Physics 12 Momentum Problem SET

5.8
A 750g red ball traveling at 0.30m/s East hits a 550g blue ball traveling at 0.50m/s West. After the collision, the red ball moves away at 0.15m/s [30.0˚S of E]. What is the final velocity of the blue ball? *Answer: 0.287m/s @20.9˚N of W*

5.5 A 4.0kg object is travelling south at a velocity of 2.8m/s when it collides with a 6.0kg object travelling East at a velocity of 3.0m/s. If these two objects stick together upon collision, at what velocity do the combined masses move immediately after they collide?
Answer: 2.12m/s @ 31.9 S of E

5.6

A 4.0kg object is moving East at an unknown velocity when it collides with a 6.1kg stationary object. After the collision, the 4.0kg object us travelling at a velocity of 2.8m/s 32˚N of E and the 6.1kg object us travelling at a velocity of 1.5m/s 41˚S of E. What was the velocity of the 4.0kg object before the collision? *Answer: 4.1 m/s East*

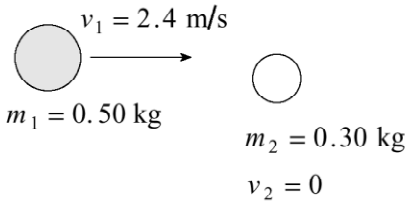
5.7

An object at rest explodes into 3 equal masses. One mass moves East at a velocity of 15.0m/s. If a second mass moves at a velocity of 10.0m/s 45˚ S of E, what is the velocity of the third bit of mass? *Answer: 23.2m/s @ 17.8˚N of W*

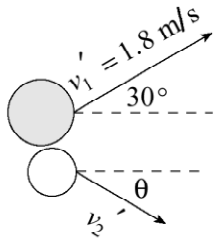
14.

Two steel pucks collide as shown in the diagram below.

BEFORE COLLISION



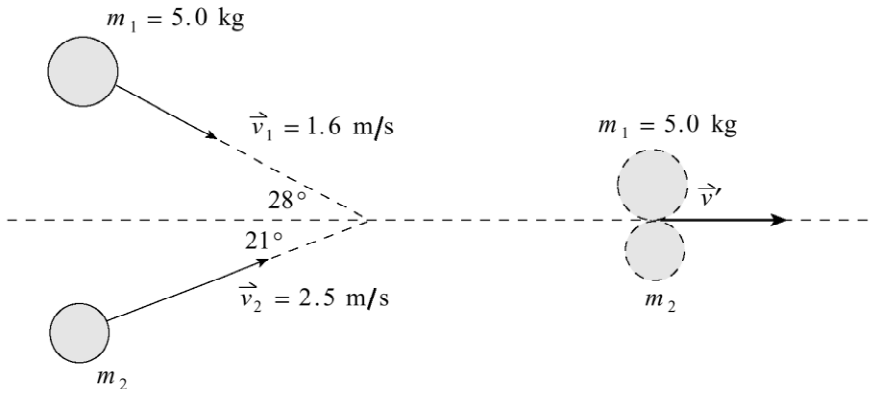
AFTER COLLISION



Determine the speed and direction (angle θ) of the 0.30 kg puck after the collision. **(7 marks)**

16.

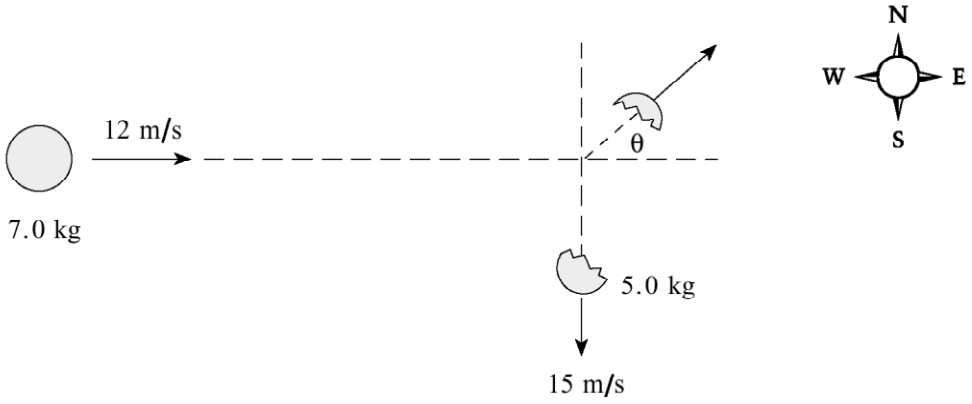
A 5.0 kg object travelling at 1.6 m/s collides with an object of unknown mass m_2 travelling at 2.5 m/s. The two objects stick together and move towards the right as shown in the diagram.



Find the mass of object m_2. **(7 marks)**

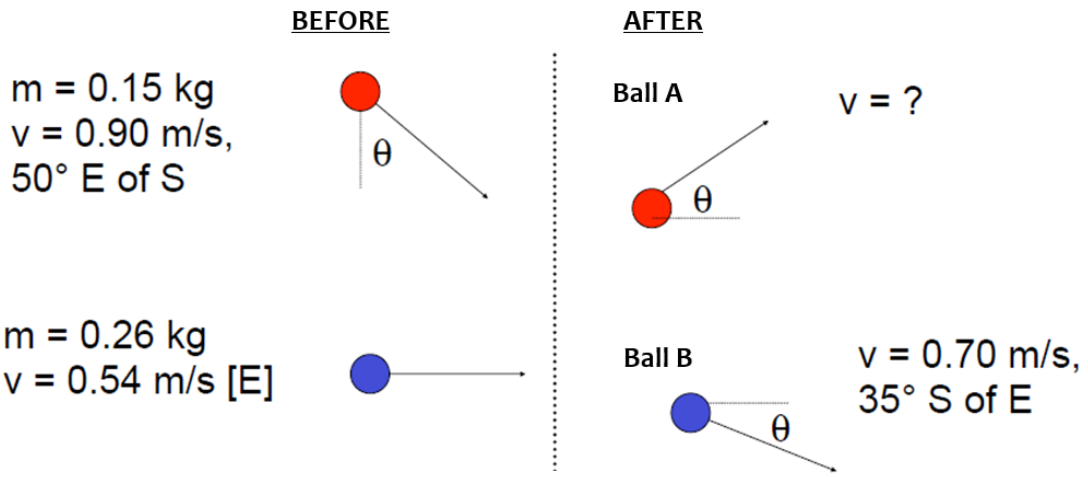
22.

A 7.0 kg object moving at 12 m/s to the east explodes into two unequal fragments. The larger 5.0 kg fragment moves at 15 m/s south.



What is the velocity (speed and direction) of the smaller 2.0 kg fragment? **(7 marks)**

5. **Two Balls collide as shown below:**

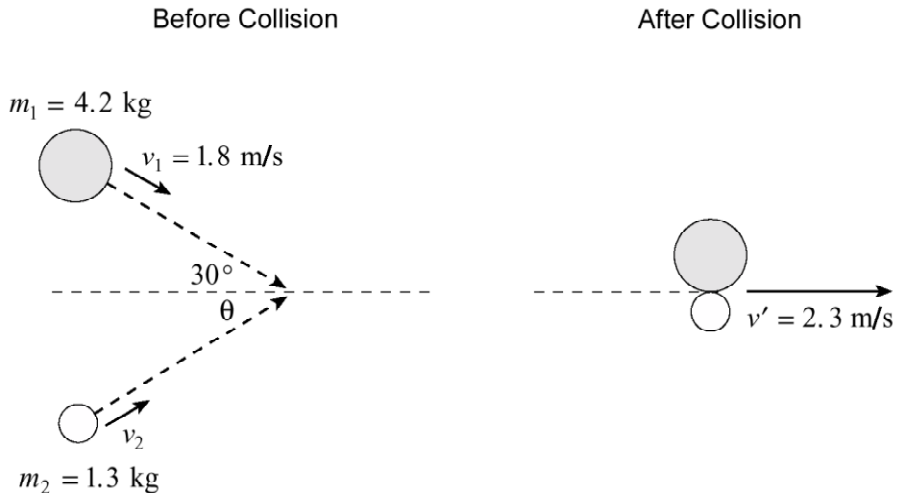


Determine the velocity of **ball "A"** after the collision.

Bonus Problems

34.

Two steel pucks are moving as shown in the diagram. They collide inelastically.



Determine the speed and direction (angle θ) of the 1.3 kg puck before the collision. **(7 marks)**

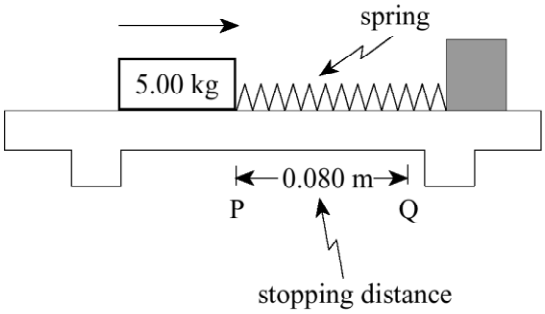
37.

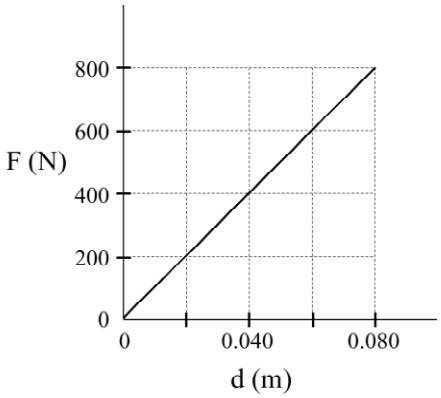
A 12.0 kg shopping cart rolls due south at 1.50 m/s. After striking the bumper of a car, it travels at 0.80 m/s, $30°$ E of S. What is the magnitude of the change in momentum sustained by the shopping cart?

A. $8.4\ \text{kg} \cdot \text{m/s}$
B. $9.7\ \text{kg} \cdot \text{m/s}$
C. $11\ \text{kg} \cdot \text{m/s}$
D. $27\ \text{kg} \cdot \text{m/s}$

43.

A 5.00 kg block, travelling along a horizontal, frictionless surface, collides head on with a spring. The block comes to a stop in 0.080 m. The stopping force exerted by the spring on the block increases from zero to 800 N as shown on the graph below. (Assume no energy loss due to heat.)





a) What was the speed of the block when it first touched the spring at point P? **(7 marks)**

b) What is the magnitude of the impulse exerted by the spring in stopping the block? **(3 marks)**

Answers:

1. a
2. $\Delta KE = 24.1$ J
3. Conservation of momentum is a vector concept. Both gliders have same mass and same speed, so the magnitude of their momentum is the same, but their direction is opposite. One glider has a momentum of +p, one glider has a momentum of –p, so the total momentum before impact is zero. After the collision, the momentum is still zero, so momentum has been conserved, and no momentum has been lost.
4. b
5. = 0.64 m/s, 11° N of E
6. d
7. a
8. d
9. a
10. d
11. d
12. d
13. b
14. $v = 2.1 m/s, \theta = 47^\circ$
15. a
16. m_2=4.19 kg
17. d
18. d

19. a) h=1.3 m
    b) The same height
    c) Energy is a scalar, so the steepness of the slope is irrelevant. All of the kinetic energy will be transferred to potential energy in both cases, and since both cases have the same initial kinetic energy, the final potential energy will also be the same, and so will the final height.
20. c
21. b
22. $v = 56 m/s @ 42^\circ$ N of E
23. b
24. b

25. $\Delta KE = F\Delta d$ and as d increases, F decreases.
    $\Delta p = F\Delta t$, and as Δt increases, F decreases.
    Both the increase in time of impact and increase in distance of impact lower the force transferred to the occupants.
26. b
27. b
28. d
29. b
30. h=0.11 m
31. b
32. b
33. c
34. $v = 5.5 m/s, \theta = 32^\circ$
35. a) 3.8 x 10^5 kg m/s
    b) $\Delta p = 2.3 \times 10^4 N \cdot s$
    c)i) in an explosion, momentum is conserved, so no change
    ii) the explosion adds kinetic energy to the system, so the system will gain kinetic energy

36. c
37. c
38. h= 6.0 m
39. $v = 10 m/s @ 67^\circ$ S of E
40. F = 246 N
41. b
42. d
43. a) v=3.6 m/s b) 18 kg m/s
44. $\Delta p = 5.20$ kg m/s
45. d= 3.25 x 10^4 m
46. $v = 2.4 m/s @ 51^\circ$ S of W
47. v= 3.8 x 10^2 m/s
48. 44.8%