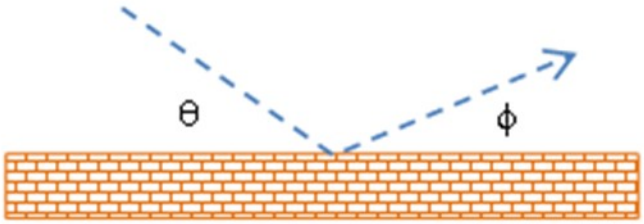
THE COPPERBELT UNIVERSITY
SCHOOL OF MATHEMATICS AND NATURAL SCIENCES
DEPARTMENT OF PHYSICS

PH 110 INTRODUCTORY PHYSICS

TUTORIAL SHEET 6_2024: LINEAR MOMENTUM

1. A baseball has a mass of 0.2 kg and a velocity of 30 m/s eastwards. After the baseball is struck by the batter, its velocity changed to 50 m/s, in the opposite direction. What impulse acted on the ball while it was in contact with the bat?

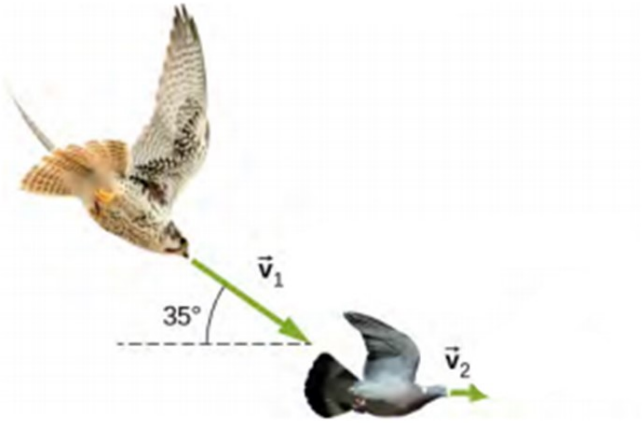
2. A ball of mass 200 g glances of a wall as shown in the diagram below. The ball approaches at 15 m/s at θ = 30° and leaves at 12 m/s at Φ = 20°. The collision lasts for 15 milliseconds.
   (a) What is the magnitude of the impulse experienced by the ball?
   (b) What is the magnitude of the average force experienced by the ball?



3. A 70 kg man skating with a speed of 12 m/s collides with a 50 kg skater at rest and they cling to each other after collision. Find the kinetic energy lost during the collision.

4. Two balls of equal mass undergo perfectly elastic head-on collision. The initial velocity of the ball travelling north is 0.5 m/s while the initial velocity for the ball travelling south is 0.2 m/s. Find the final velocities for each ball.

5. A 1-kg falcon is diving at 25 m/s at a downward angle of 35° as shown in the figure below. It catches a 0.5-kg pigeon from behind in midair. What is their combined velocity after impact if the pigeon's initial velocity was 7 m/s directed horizontally?



6. A billiard ball moving at 5 m/s strikes a stationary ball of the same mass. After the collision, the first ball moves at 4.33 m/s at an angle of 30° with respect to the original line of motion. Assuming an elastic collision (and ignoring friction and rotational motion), find the struck ball's velocity. Also show that the collision is elastic.

7. A body of mass 10 kg initially at rest, explodes and breaks into three fragments of mass in the ratio, 1:1:3. The two pieces of equal masses fly perpendicular to each, each making an angle of 45° with the horizontal at a speed of 30 m/s each. What is the velocity of the heavier fragment?

8. A 0.5-kg ball is thrown with a speed of 15 m/s. A stationary receiver catches the ball and brings to rest in 0.02 s. (a) what is the impulse delivered to the ball? (b) What is the average force exerted on the receiver?

9. A ball of mass 500 g is dropped from a height 1.5 m. It rebounds from the floor to reach a height 1.2 m. Calculate the impulse that was given to the ball by the floor.

10. A cannon of mass 1.5 tons shoots a projectile of mass 100 kg with a horizontal speed 30 m/s. If the cannon can recoil freely on a horizontal ground, what is its recoil speed just after shooting the projectile?

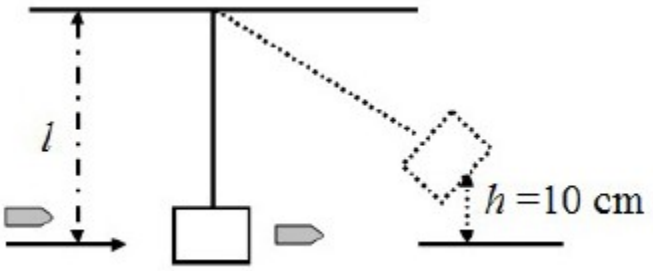
11. A bullet of mass 12 g and horizontal speed 70 m/s strikes a block of wood of mass 400 g and instantly comes to rest with respect to the block. The block is suspended from the ceiling by means of thin wires Calculate the height to which the block rises. Also estimate the amount of kinetic energy lost

12. A 2-ton truck is traveling east through an intersection at 25 m/s when it is hit simultaneously from the side and the rear. One car is a 1-ton compact traveling north at 50 m/s. The other car is a 1.5-ton midsize traveling east at 30 m/s. The three vehicles become entangled and slide as one body. What is their speed and direction just after the collision?

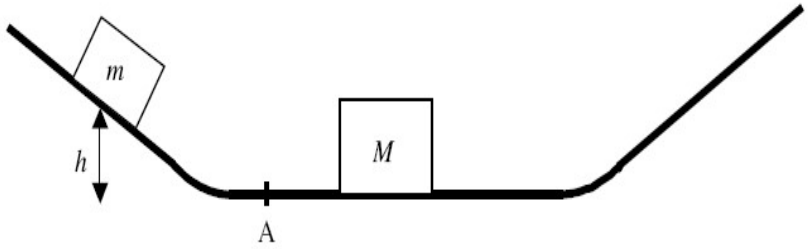
13. A gas molecule having a speed of 300 m/s horizontally collides elastically with another molecule of the same mass which is initially at rest. After collision the first molecule moves at an angle of 30° to its initial direction. Find the speed of each molecule after collision and the direction of the second molecule.

14. A billiard ball moving at 5.00 m/s strikes a stationary ball of the same mass. After the collision, the first ball moves at 4.33 m/s at an angle of 30˚ with respect to the original line of motion. Assuming an elastic collision (and ignoring friction and rotational motion), find the struck ball's velocity.

15. A bullet of mass 15 g and travelling at a speed of 600 m/s strikes a block of mass 3 kg which is suspended by a string of length 4 m. The bullet goes through the block in a very short time and the center of mass of the block is found to rise a vertical distance of 10 cm as shown in the figure below. What was the speed of the bullet just after it emerged from the block?



16. A block of mass m is released from rest and slides down a slope and onto a flat surface, changing its vertical height by h.



a) What is the velocity of the block as it slides past point A on the flat surface? (Assume throughout that there is no friction.)
b) As the block slides across the surface, it collides with another object of mass M. In the collision, the two objects stick together. What is the velocity of the combined objects after the collision

17. A projectile of mass m moving along the x axis with speed $10\sqrt{3}m/s$ collides elastically with a stationary target of mass $2m$. After collision, the projectile is deflected at an angle 90^o

a) What are the speed and the angle of the target after the collision?

b) What is the final speed of the projectile?

18. A 3.00-kg steel ball strikes a wall with a speed of 10.0 m/s at an angle of 60° with the surface. It bounces off with the same speed, mass and angle as shown below. If the ball is in contact with the wall for 0.20 s and the wall is undamaged,

(a) What is the average force exerted by the wall on the ball?

(b) What is the impulse?

(c) What was the total brief deformation on the ball and wall?

(d) What type of collision is depicted by the scenario?

(e) Define the different types of collisions