AL MUSTAQBAL UNIVERSITY

ENGINEERING TECHNICAL COLLEGE

DEPARTMENT OF BUILDING & CONSTRUCTION ENGINEERING TECHNOLOGIES

ENGINEERING PHYSICS

FIRST CLASS

LECTURE NO. 7

ASST. LECTURER

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Momentum, Impulse and Collisions

Linear momentum is defined as the product of a system's mass multiplied by its velocity.

$$\boldsymbol{p = mv}$$

Impulse: is the change in momentum of an object.

$$\boldsymbol{J = \Delta p = p_f - p_i}$$

Collisions

when two bodies collide, they exert large forces on one another (during the time of the collision) called impulsive forces. These forces are very large such that any other forces (e.g., friction or gravity) present during the short time of the collision can be neglected.

In general, for any type of collision, the total linear momentum is conserved during the time of the collision. That is, $p_i = p_f$, where p_i and p_f are the momenta immediately before and after the collision.

a) **Elastic Collisions:** An elastic collision is one in which the total kinetic energy, as well as momentum, of the two-colliding-body system is conserved.
b) **Inelastic Collisions:** An inelastic collision is one in which the total kinetic energy of the two-colliding-body system is not conserved, although momentum is conserved.

Example 1: A $50\ g$ golf ball initially at rest is struck by a golf club. The golf club exerts a force on the ball that varies during a very short time interval from zero before impact, to a maximum value and back to zero when the ball is no longer in contact with the club. If the ball is given a speed of $25\ m/s$, and if the club is in contact with the ball for $7 \times 10^{-4} s$, find the average force exerted by the club on the ball.

Solution:

$$m = \frac{50}{1000} = 0.05\ kg$$

$$F\Delta t = mv_f - mv_i$$

$$F \times 7 \times 10^{-4} = (0.05)(25)$$

$$F = 1785.7\ N$$

Example 2: A canon placed on a carriage fires a $250\ kg$ ball to the horizontal with a speed of $50\ m/s$. If the mass of the canon and the carriage is $4000\ kg$, find the recoil speed of the canon.

Solution:

$$p_{fx} = p_{ix}$$

$$m_1 v_{1f} + m_2 v_{2f} = 0$$

$$v_{2f} = \frac{-m_1 v_{1f}}{m_2}$$

$$v_{2f} = \frac{-250 \times 50}{4000} = -3.1\ m/s$$

Example 3: A hockey puck of mass $0.16\ kg$ traveling on a smooth ice surface collides with the court's edge. If its initial and final velocities are $v_i = -2\ m/s$ and $v_f = 1\ m/s$ and if the hockey puck is in contact with the wall for $2\ ms$, find the impulse delivered to the puck and the average force exerted on it by the wall.

Solution:

$$J = \Delta p$$

$$J = p_f - p_i$$

$$J = mv_f - mv_i$$

$$J = (0.16)(1) - (0.16)(-2)$$

$$J = 0.48\ kg.m/s$$

$$t = \frac{2}{1000} = 0.002\ s$$

$$J = F\Delta t$$

$$F = \frac{0.48}{0.002} = 240\ N$$