Topic 3 Notes

Newton's 3rd Law

When body A exerts a force on body B, force on body A is equal in magnitude to force on body B from A. Both forces are in opposite directions and of same kind.

Action reaction forces:

- act on different bodies
- be of the same type
- equal magnitude
- act in opposite direction

Newton's 1st Law

An object continues to be in a state of rest or in motion with constant velocity, unless acted upon by a resultant force.

Mass: Property of a body which resists change in motion

Weight: Force acting on it due to gravitational field.

Linear momentum

The product of a body's mass and velocity

Linear Momentum	$p = mv$	p is the linear momentum (kg m s^{-1}) m is the mass of the object (m) v is the velocity of the object (m s^{-1})

Newton's 2nd Law

The rate of change of momentum of a body is directly proportional to the resultant force acting on it, and it takes place in the direction of the resultant force.

Newton's 2nd Law	$F_{net} = \frac{dp}{dt} = ma$	F_{net} is the resultant force (N) p is the linear momentum (kg m s^{-1}) t is the time taken for the object to change momentum (s) m is the mass of the object (m) a is the acceleration of the object (m s^{-2})

Weightlessness = no contact force but there is weight. Weighing scales do not always measure true weight but the contact force acting on the weighing scale.

Free Fall

As an object falls, its vertical acceleration decreases over time. Initially, its acceleration is 9.81 m s^{-2}. As it increases in velocity, the air resistance will increase with it, but the acceleration decreases. When it reaches terminal velocity, it will fall at constant speed where $W=F_{drag}$. No acceleration.

Flowing Mass and Newton's 2nd Law

e.g. water leaving a hose

Newton's 2nd Law involving Flowing Mass	$F_{net} = \frac{m}{t}\Delta v$	F_{net} is the resultant force (N) m is the mass of the object (kg) t is the time taken for the amount of mass to flow out (s) v is the velocity (m s^{-1})

<u>Impulse</u>

The product of the force and the time duration of the impact. = change in momentum

Impulse	$\Delta p = \int F\,dt$	F_{net} is the resultant force (N) p is the linear momentum (kg m s^{-1}) t is the time taken for the object to change momentum (s)

Shown by the area under the force-time curve.

<u>Principle of Conservation of Linear Momentum</u>

The total linear momentum of a system remains constant provided that no external resultant force acts on the system.

Principle of Conservation of Linear Momentum	$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$	m_1 and m_2 are the masses of the 2 colliding objects u_1 and u_2 are the velocities of the objects before collision v_1 and v_2 are the velocities of the objects after collision
Principle of Conservation of Kinetic Energy	$\frac{1}{2}m_1{u_1}^2 + \frac{1}{2}m_2{u_2}^2 = \frac{1}{2}m_1{v_1}^2 + \frac{1}{2}m_2{v_2}^2$	m_1 and m_2 are the masses of the 2 colliding objects u_1 and u_2 are the velocities of the objects before collision v_1 and v_2 are the velocities of the objects after collision
Relative speed of approach = relative speed of separation	$u_1 - u_2 = v_2 - v_1$	u_1 and u_2 are the velocities of the objects before collision v_1 and v_2 are the velocities of the objects after collision

Elastic collision: Total kinetic energy of the colliding bodies is conserved. All 3 equations are applicable.

Inelastic collision: Collision where kinetic energy is not conserved. A perfectly inelastic collision is a collision where the colliding bodies will stick with one another and move off with the same velocity. Only the principle of conservation of linear momentum is applicable.