MOJZA

AS Level

Mechanics Notes

9709/04

BY TEAM MOJZA

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CONTENTS

Forces and Equilibrium

- Force:

- ➔ Product of the mass of an object and the acceleration of the object.
- ➔ The SI unit of force is Newton (N).

$$F=ma$$

- **F** is the force acting on the body
- **m** is the mass of the body
- **a** is the acceleration of the body

- Balanced Forces:

- ➔ When the resultant of a number of forces acting on an object is zero.

- Unbalanced Forces:

- ➔ When the resultant of a number of forces acting on an object is not zero.

- Contact Force:

- ➔ Force acting at a right angle when two surfaces are in contact with each other.

- Resistive Force:

- ➔ A force acting in the opposite direction of motion.

- Drag:

- ➔ A force that resists the motion of an object in a fluid.

- Inertia:

- ➔ Measure of how difficult it is to change the speed, velocity or direction of an object.
- ➔ Inertia of a body is directly proportional to its mass.

- Weight:

- ➔ The force of an object caused by the gravitational field strength acting on its mass.
- ➔ The SI unit of weight is Newton (N).

$$W=mg$$

- **W** is the weight of the object
- **m** is the mass of the object
- **g** is the gravitational field strength (9.81m/s on Earth)

- Centre of Gravity:

- ➔ The point at which the whole weight of an object appears to act.

- Equilibrium:

- ➔ When an object is in a constant state of motion or in a state of rest.
- ➔ For an object in equilibrium, the vector sum of the forces acting on the object is zero.

- Friction:

- ➔ A resistive force acting due to contact between two surfaces.
- ➔ The SI unit of friction is Newton (N).

- Limiting Friction:

- ➔ The friction created when two static surfaces come into contact with each other.

- Limiting Equilibrium:

- ➔ The method where limit state conditions are assumed.

- Coefficient of Friction:

- ➔ The measure of the amount of friction existing between two surfaces.

$$F=\mu R$$

- **F** is the frictional force
- **μ** is the coefficient of friction
- **R** is the normal reaction force

Kinematics

- Scalar Quantity:

➔ A quantity consisting of a magnitude only.

- Speed:

➔ Distance travelled by an object per unit time.

➔ The SI unit of speed is metres per second (m/s).

$$v=d/t$$

- **v** is the speed of the object
- **d** is the distance travelled by the object
- **t** is the time taken by the object to travel that distance

- Distance:

➔ Length covered by an object.

➔ The SI unit of distance is metres (m).

$$d=vt$$

- **v** is the speed of the object
- **d** is the distance travelled by the object
- **t** is the time taken by the object to travel that distance

- Vector Quantity:

➔ A quantity having a magnitude and a direction.

- Velocity:

➔ Speed of an object in a particular direction or rate of change of displacement of an object.

➔ The SI unit of velocity is metre per second (m/s).

$$v=s/t$$

- **v** is the velocity of the object
- **s** is the displacement covered by the object
- **t** is the time taken by the object to cover that displacement

- Displacement:

➔ Distance covered by an object in a particular direction.

➔ The SI unit of displacement is metre (m).

$$s=vt$$

- **v** is the velocity of the object
- **s** is the displacement covered by the object
- **t** is the time taken by the object to cover that displacement

- Acceleration:

➔ Rate of change of velocity of an object.

➔ The SI unit of acceleration is metre per second squared (m/s2).

$$a=(v-u)/t$$

- **a** is the acceleration of the object
- **v** is the final velocity of the object
- **u** in the initial velocity of the object
- **t** is the time taken for the velocity change of the object

- Uniform Acceleration:

➔ When the change in velocity of an object is constant.

- Non-Uniform Acceleration:

➔ When the change in velocity of an object is not constant.

- Important:

➔ The gradient of a distance-time graph gives the speed.
➔ The gradient of a displacement-time graph gives the velocity.
➔ Gradient of a speed-time and velocity-time graph gives the acceleration.
➔ Area under the speed-time graph gives the distance.
➔ Area under the velocity-time graph gives the displacement.

Note: use of differentiation and integration with respect to time (P1 knowledge only)

- Equations of Motion (SUVAT):

$$v=u+at$$
$$s=ut+\frac{1}{2}at^2$$
$$s=\frac{1}{2}(u+v)t$$
$$v^2=u^2+2as$$
$$s=vt-\frac{1}{2}at^2$$

- **s** is the displacement or distance
- **u** is the initial velocity
- **v** is the final velocity
- **a** is the acceleration
- **t** is the time taken

Momentum

- Momentum:

- ➔ A quantity of motion of a moving body measured by the product of its mass and velocity.
- ➔ Its SI unit is kilogram metre per second (kgm/s).

$$p=mv$$

- **p** is the momentum
- **m** is the mass
- **v** is the velocity

- Law of Conservation of Momentum:

- ➔ The total momentum of two bodies in a closed system is constant provided no external force is acting.

- Impulse:

- ➔ The change in momentum.

$$I=mv-mu$$

- **I** is the impulse
- **m** is the mass
- **v** is the final velocity
- **u** is the initial velocity

- ➔ Area under the graph of a force-time graph gives the impulse.

- Elastic Collision:

- ➔ Collisions in which the kinetic energy remains constant before and after the collision.
- ➔ Momentum in elastic collisions is also conserved.
- ➔ In real life situations there are energy losses such as sound and heat, thus perfectly elastic collisions are not possible.

- Inelastic Collisions:

- ➔ Collision in which all the kinetic energy is converted into other forms of energies.
- ➔ Momentum in inelastic collisions is conserved.

- Relative Speed of Approach:

- ➔ The net speed with which two objects are coming close to each other.

- Relative Speed of Separation:

- ➔ The net speed with which two objects are going away from each other.

Note: For one-dimensional elastic collisions the relative speed of approach is equal to the relative speed of separation.

Newton’s Law of Motion

- Newton’s First Law:

➔ An object will not change its state of motion or state of rest until acted upon by an external force.

- Newton’s Second Law:

➔ The resultant force on an object is the product of its mass and its acceleration.

- Newton’s Third Law:

➔ For an object in equilibrium, when it interacts with another body, the force they exert on each other is equal in magnitude and opposite in direction.

- Conditions for Forces in Newton’s Third Law:

➔ They act on different objects.
➔ They are equal in magnitude.
➔ They are opposite in direction.
➔ They are of the same type.

Work, Energy & Power

- Work:

➔ Product of the force applied on an object and the distance it travels in the direction of the force applied.

➔ Its SI unit is Joules (J) or Newton metre (Nm).

$$W=Fs$$

- **W** is the work
- **F** is the force applied
- **s** is the distance travelled

- Gravitational Potential Energy:

➔ Energy possessed by an object due to its position in a gravitational field.

$$G.P.E=mgh$$

- **G.P.E** is the gravitational potential energy
- **m** is the mass of the body
- **g** is the gravitational field strength (9.81 on earth)
- **h** is the height

- Kinetic Energy:

➔ Energy possessed by an object due to its motion.

$$K.E=\frac{1}{2}mv^2$$

- **K.E** is the kinetic energy
- **m** is the mass
- **v** is the velocity

- Principle of Conservation of Energy:

➔ Energy can not be created nor destroyed. It can only be transformed from one form to another.

- Power:

➔ Rate of doing work or rate at which energy is being transferred.

$$P=\frac{W}{t}=\frac{F.d}{t}=Fv$$

- **P** is the power
- **W** is the work
- **F** is the force
- **t** is the time
- **d** is the distance
- **v** is the velocity

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A Note from Mojza

These notes for AS Mathematics (9709) have been prepared by Team Mojza, covering the content for AS Level 2022-24 syllabus. The content of this resource has been prepared with utmost care. We apologise for any issues overlooked; factual, grammatical or otherwise. We hope that you benefit from these and find them useful towards achieving your goals for your Cambridge examinations.

If you find any issues within these notes or have any feedback, please contact us at support@mojza.org.

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Authors:
Muhammad Aadil Khan
Musbah Moid

Proofreaders:
Aroosham Mujahid
Miraal Omer

Designers:
Fasiha Raza