Part 6: Kinematic equations (motion with constant acceleration):

The kinematic equations describe the motion of objects under constant acceleration. They are particularly useful in solving problems involving linear motion, such as calculating the position, velocity, or time of an object in motion. The four primary kinematic equations relate displacement, initial velocity, final velocity, acceleration, and time.

Kinematic equations	Quantities	Symbol	SI unit
$v_f = v_i + a.\Delta t$		Δt	
$v_f^2 = v_i^2 + 2a.\Delta x$		v_i	
$\Delta x = v_i.t + \frac{1}{2}\,a.\Delta t^2$		v_f	
$\Delta x = \frac{1}{2}\,(v_i + v_f).\Delta t$		a	
		Δx	

Test yourself

1- A car accelerates from 5 m/s to 25 m/s, over a distance of 60 m. Find the car's acceleration.

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.....

2- A train traveling at 20 m/s decelerates uniformly to a stop over a distance of 400 m. Find the deceleration.

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.....

3- A car accelerates from the rest uniformly at 3 m/s for 15 s. How far does it travel during this time?

.....

.....

Part 7: Freefall motion

Test yourself

1- An object is dropped from a height of 80 m

- How long will it take for the object to reach the ground?
- What will its velocity be just before it hits the ground?(Assume g=9.8 m/s)

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2- A ball is dropped from the top of a building. How far has it fallen after 3 s?

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Part 8: Projectile motion

Projectile motion refers to the motion of an object that is launched into the air and moves under the influence of gravity, following a curved path called a **parabola**. This type of motion occurs when an object is given an initial velocity and is then subjected only to the force of gravity

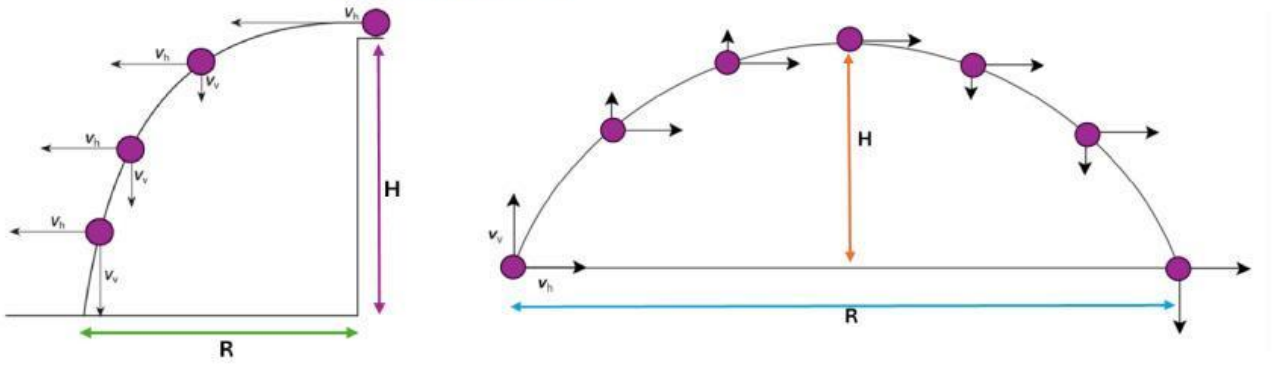
Key Characteristics of Projectile Motion

1. **Two-Dimensional Motion:**
   - Projectile motion takes place in two dimensions: horizontal (x-direction) and vertical (y-direction).
   - The two motions are independent of each other but occur simultaneously.
2. **Horizontal Motion:**
   - There is no acceleration in the horizontal direction (assuming no air resistance), so the horizontal velocity remains constant.

Equations needed	
Range	Maximum height
$R = \frac{v_i^2 . \sin(2\theta)}{g}$	$H_{max} = \frac{v_i^2 . (sin\theta)^2}{2\,g}$

Test yourself

1- Illustrate how the direction and magnitude of the vertical and horizontal components of projectile velocity change over time. (it is already solved)



2- A cannon launches a shell at an angle of 65° with an initial speed of 10 m/s. Neglecting air resistance, calculate the maximum height of the shell.

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3- A cannon launches a shell at an angle of 35° with an initial speed of 12 m/s. Neglecting air resistance, calculate the range of the shell.

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4- What is the angle at which a projectile should be launched to achieve the maximum possible horizontal range?

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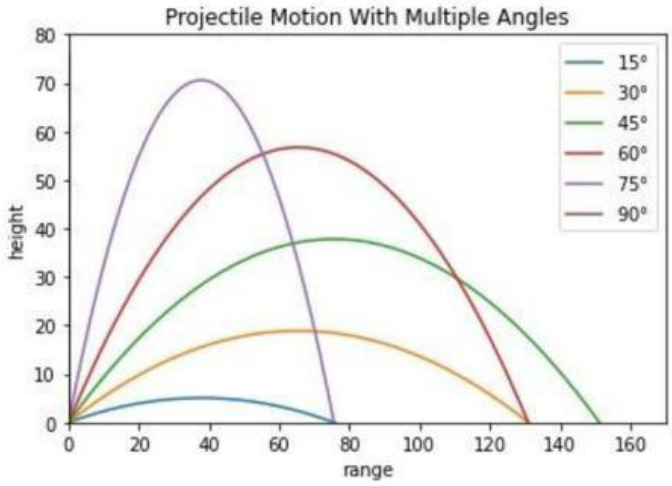

Part 9: Mass And Weight

Property	Mass	Weight
Definition		
Nature		
Unit		
Formula		
Constant?		
Measured With		

1- If the mass of an object is 10 kg and the gravitational force is 9.8 m/s², calculate its weight.

.....

.....

2- Imagine you are on the Moon where gravity is about 1/6th that of Earth's gravity. If your mass on Earth is 60 kg, what will your weight be on the Moon?

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Part 10: Force

Force is a physical quantity that represents a push or pull acting on an object. It can cause an object to accelerate, decelerate, remain stationary, or change its shape. Forces are vector quantities, meaning they have both magnitude and direction.

Some types of forces	The definition
	It is the force that pulls objects toward the earth center, it gives objects weight
	Normal force is (Ctrl) endicular (upward) force exerted by a surface to support the weight of an object resting on it.
	Friction force is the force that opposes the relative motion or the tendency of motion between two surfaces in contact.

Part 11: Free body diagram

A Free Body Diagram is a graphical representation used in physics to visualize all the forces acting on a single object. It isolates the object from its environment and represents the object as a simple shape (usually a dot or a box) with arrows showing all the forces acting on it

Features of a Free Body Diagram:

Force Arrows:

- Arrows are drawn starting from the object to show forces.
- The length of each arrow represents the magnitude of the force.
- The direction of each arrow shows the direction of the force.

Labels:

Each arrow is labeled to identify the type of force

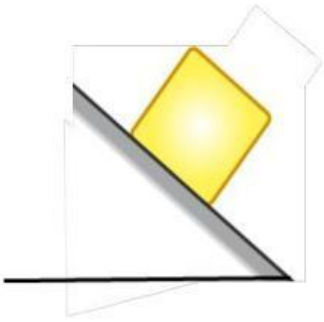
Common Forces Represented in an free body diagram

- Gravitational Force (F_g): Acts downward due to the object's weight.
- Normal Force (F_n): Acts perpendicular to a surface supporting the object.
- Friction Force (F_f): Acts parallel to the surface and opposes motion.
- Tension Force (F_T): Force transmitted through a string, rope, or cable

Test yourself

1- Draw a free body diagram for a book lying stationary on a flat table. Identify all the forces acting on it.

2- Draw an free body diagram for a block sliding down a frictionless incline



3- Draw the free body diagram for a box moving on a rough horizontal surface under the influence of a pulling force

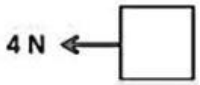
↓	↑	F_g	F_N
→	←	F_{app}	F_f

Part 12: Net force

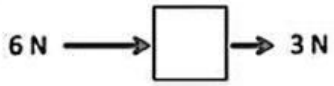
The net force is the overall force acting on an object when all the individual forces acting on it are combined.

Test yourself

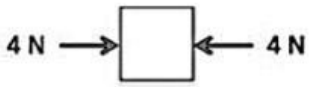
Determine the net force on the object in the following cases.



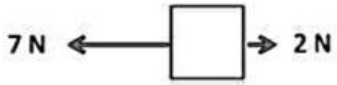
Net Force:



Net Force:



Net Force:



Net Force:

Part 13: Newton's Laws of motion

Test yourself

"An object at rest will stay at rest , and an object in motion will stay in motion at a constant speed and in a straight line, unless an external force acts on it."

"states that the acceleration of an object is directly proportional to the net force acting upon it, inversely proportional to its mass, and occurs in the direction of the net force"

"For every action, there is an equal and opposite reaction."