

EFFECTS OF FORCE



A force is a push or pull. It can change the **state of rest or motion** of an object. It can also change the **speed**, **direction** or **shape** of an object.

1 CHANGE IN STATE OF REST OR MOTION

A force can change a stationary object to motion or a moving object to rest.

From Rest to Motion



From Motion to Rest



EXAMPLE

Applying force starts a cycle from rest. Brakes apply force to stop a moving car.



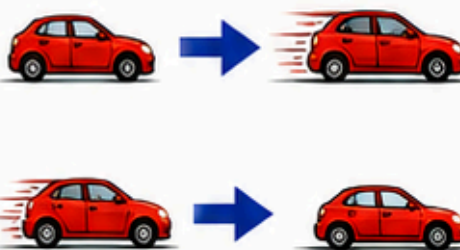
2 CHANGE IN SPEED

A force can increase or decrease the speed of an object.

Increase in Speed



Decrease in Speed



EXAMPLE

When we pedal a bicycle, its speed increases. Brakes apply force to slow it down.



3 CHANGE IN DIRECTION

A force can change the direction in which an object is moving.



EXAMPLES

- A kicked ball changes its direction.
- A car takes a turn due to the force applied on it.
- A rower changes the direction of the boat.

EXAMPLE

When a bat hits a moving ball, its direction changes.



4 CHANGE IN SHAPE OR SIZE

A force can change the shape or size of an object.



EXAMPLES

- Stretching a rubber band.
- Compressing a spring.
- Moulding clay or dough.

EXAMPLE

Pressing clay with hands changes its shape.



KEY POINTS

- ✓ A force can bring change in an object.
- ✓ It can change the state of rest or motion.
- ✓ It can change the speed of an object.
- ✓ It can change the direction of motion.
- ✓ It can change the shape or size of an object.



EVERYDAY EXAMPLES



Pushing a door to open it.



Hitting a ball with a racket.



Kicking a ball.



Stretching a rubber band.



Pressing a spring.

DID YOU KNOW?



Force is invisible, but we can see its effects!



MEMORY TIP
Force is the reason for every change in our world!

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MEASURING FORCE

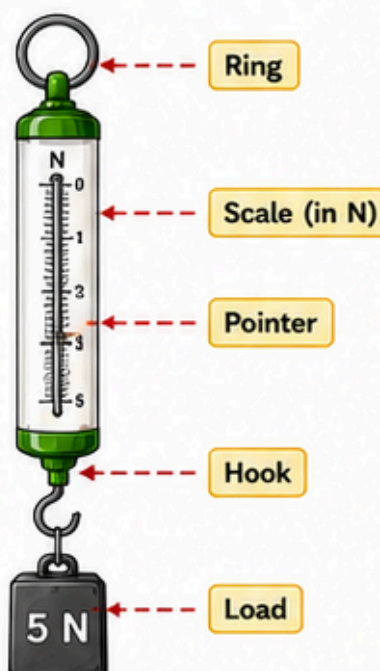
Force is measured using a spring balance.
The SI unit of force is newton (N).
Forces have both **magnitude** and **direction**.



1 SPRING BALANCE

A spring balance is an instrument used to measure force.

It works on the principle that the extension in a spring is proportional to the force applied.



2 SI UNIT OF FORCE

The SI unit of force is newton (N).

1 newton is the force which produces an acceleration of 1 m/s^2 in a mass of 1 kg.

$$1 \text{ N} = 1 \text{ kg} \cdot \text{m/s}^2$$

EXAMPLES

- Weight of an apple $\approx 1 \text{ N}$
- Weight of a water bottle (1 litre) $\approx 10 \text{ N}$
- Weight of a school bag $\approx 20 - 40 \text{ N}$

3 HOW TO MEASURE FORCE USING A SPRING BALANCE

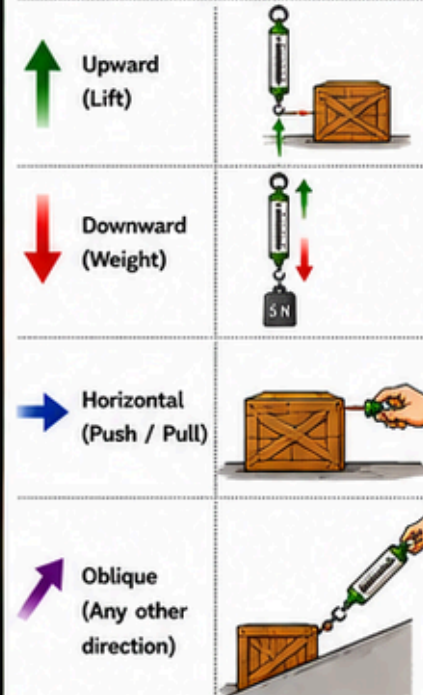
- Hold the spring balance vertically.
- Make sure the pointer is at zero (0).
- Attach the object to the hook.
- Let the object hang freely without touching anything.
- Read the value shown by the pointer on the scale.



The reading gives the magnitude of the force.

4 DIRECTION OF FORCE

Force has direction. It acts along a line. It can be upwards, downwards, horizontal (left or right) or in any other direction.



5 MEASURING DIFFERENT FORCES

WEIGHT OF AN OBJECT



Weight is the force with which the Earth attracts an object towards it.

Weight acts vertically downwards.

PULLING FORCE



The spring balance measures the force required to pull an object. The force acts in the direction of pull.

PUSHING FORCE



The spring balance measures the force required to push an object. The force acts in the direction of push.

TENSION IN A STRING



Tension is the pulling force transmitted through a string or rope when it is stretched.

KEY POINTS

- Force is measured using a spring balance.
- The SI unit of force is newton (N).
- $1 \text{ N} = 1 \text{ kg} \cdot \text{m/s}^2$
- Force has both magnitude and direction.
- It can act in different directions.



IMPORTANT NOTES

- Always keep the spring balance vertical while measuring.
- Do not jerk the spring balance.
- Do not let the object touch any surface.
- Read the scale at eye level.



EXAMPLES IN DAILY LIFE

- Pushing a door
- Pulling a suitcase
- Lifting a bucket of water
- Hanging a picture on the wall

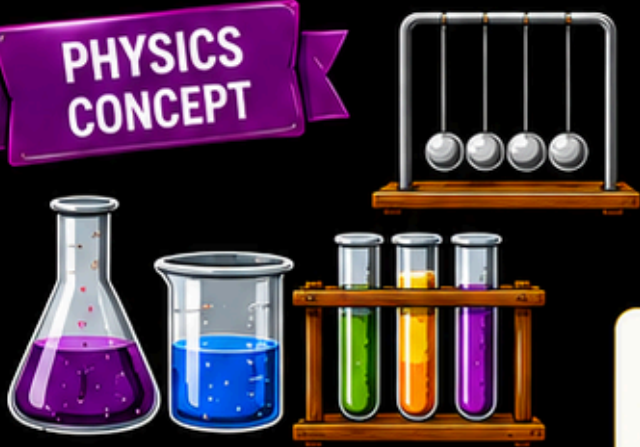


MEMORY TIP



Measure with care, Read at eye level, Force has magnitude and direction as well!





FORCE AND FRICTION



A force can **start** or **stop** a moving object.
Friction is a force that **opposes motion** between two surfaces in contact.

1 FORCE CAN START OR STOP A MOVING OBJECT

Start a Moving Object

When a force is applied, a stationary object starts moving.



Force applied → Object starts moving

Stop a Moving Object

When a force opposite to the motion is applied, the object stops.



Force applied opposite to motion
→ Object stops

2 FRICTION OPPOSES MOTION

Friction acts between two surfaces in contact and always acts opposite to the direction of motion.



Friction slows down or stops the motion of an object.

Without friction, objects would keep moving and we would not be able to walk or hold things.

3 FRICTION CAN BE USEFUL OR HARMFUL

USEFUL FRICTION

Friction is helpful in our daily life.



Helps us to walk without slipping.



Allows us to write with a pencil.



Helps vehicles to move without skidding.



Helps to light a matchstick.



Brakes stop a moving vehicle.

HARMFUL FRICTION

Friction causes wear and tear and wastes energy.



Causes wear and tear of machine parts.



Soles of shoes and tyres wear out.



Produces heat and reduces efficiency.



Makes it difficult to move heavy objects.



Extra energy is needed to overcome friction.

4 MEASURING FRICTION

Friction can be measured using a spring balance.



When the object just begins to move, the reading on the spring balance gives the magnitude of friction.

More Rough Surface
→ **More Friction**



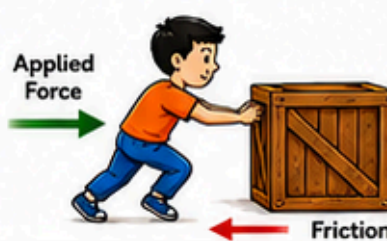
Smooth Surface
→ **Less Friction**



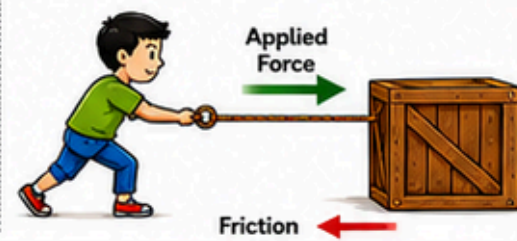
5 DIRECTION OF FRICTION

Friction always acts opposite to the direction of motion or the applied force.

Object Being Pushed



Object Being Pulled



KEY POINTS

- ✓ A force can start or stop a moving object.
- ✓ Friction opposes motion between two surfaces.
- ✓ Friction can be useful or harmful.
- ✓ Friction depends on the nature of surfaces.
- ✓ More roughness → More friction.
- ✓ Friction acts in the direction opposite to motion.



EVERYDAY EXAMPLES



Friction between tyres and road helps the bicycle to move.



Friction between hand and lid helps to open a jar.



Friction between shoes and ground helps the player to stop quickly.



Friction in fan bearings causes heat and wear, so oil is used.



Less friction on smooth surface makes sliding easy.

DID YOU KNOW?

Ice has very less friction, which is why we can slide on ice easily!



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NEWTON'S FIRST LAW OF MOTION

Newton's First Law of Motion is also called the **Law of Inertia**. It states that an object remains **at rest** or continues to move with **uniform velocity** in a straight line unless it is acted upon by an external unbalanced force.

WHAT DOES THIS LAW MEAN?

1 OBJECT AT REST

An object at rest will remain at rest unless an external unbalanced force acts on it.



EXAMPLE

A book kept on a table remains at rest. It will not move unless you push it.

2 OBJECT IN MOTION

An object in motion will continue to move with the same speed in the same direction in a straight line unless an external unbalanced force acts on it.



EXAMPLE

A car moving on a straight road will continue to move with the same speed and in the same direction unless brakes are applied.

3 UNBALANCED FORCE

It is only when an unbalanced external force acts on the object that its state of rest or uniform motion changes.



EXAMPLE

When the boy pushes the box with enough force, the box starts moving.

EVERYDAY EXAMPLES

TABLECLOTH TRICK



When the tablecloth is pulled quickly, the dishes remain at rest.

PASSENGERS IN A BUS



When the bus stops suddenly, passengers tend to move forward.

HOCKEY PUCK



A hockey puck keeps sliding on ice until friction or another force stops it.

FOOTBALL



A football moves on the ground until friction brings it to rest.

SPACE EXAMPLE



In space, an astronaut keeps moving unless another force acts on him.

KEY POINTS

- ✓ An object has a natural tendency to remain in its current state.
- ✓ Rest or uniform motion in a straight line is called equilibrium.
- ✓ It is the property of matter due to which it resists any change in its state of rest or uniform motion. This property is called **inertia**.
- ✓ Inertia depends on mass. More the mass, more is the inertia.



INERTIA

Inertia is the tendency of an object to resist any change in its state of rest or uniform motion.



Less Mass
Less Inertia

More Mass
More Inertia

REMEMBER

No unbalanced force,
No change in motion.

Rest stays at rest.
Motion stays in motion.



REAL LIFE



Seat belts in cars are used because of inertia. When a car stops suddenly, our body tends to keep moving forward.



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MEMORY TIP

First Law says –
Objects are lazy!
They resist change.



NEWTON'S SECOND LAW OF MOTION

Newton's Second Law of Motion states that the **acceleration** of an object is **directly proportional** to the **net force** applied and **inversely proportional** to its mass.

STATEMENT

When a net force acts on an object, it produces an acceleration in the direction of the force. The acceleration is directly proportional to the force and inversely proportional to the mass.

MATHEMATICAL FORMULA

$$F = ma$$

Where,

F = Net force (newton, N)

m = Mass of the object (kilogram, kg)

a = Acceleration produced (m/s^2)

SI UNIT

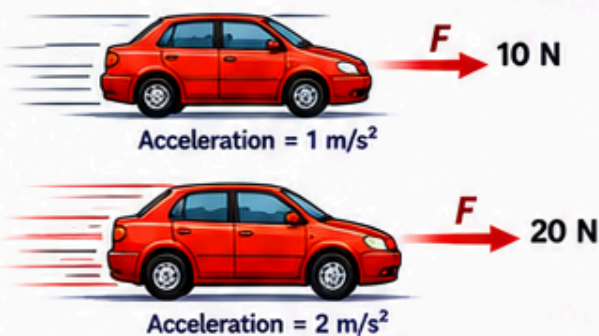
- ✓ Force → newton (N)
- ✓ Mass → kilogram (kg)
- ✓ Acceleration → metre per second squared (m/s^2)

$$1 \text{ N} = 1 \text{ kg} \cdot \text{m/s}^2$$

WHAT DOES THIS LAW TELL US?

1 Direct Relation with Force

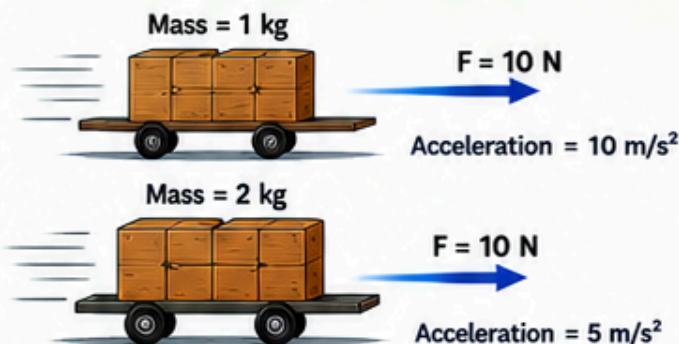
For a given mass, if the force is increased, the acceleration also increases.



More force → More acceleration

2 Inverse Relation with Mass

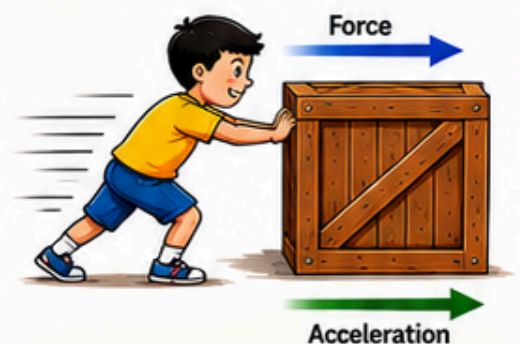
For a given force, if the mass is increased, the acceleration decreases.



More mass → Less acceleration

3 Direction of Acceleration

The acceleration produced is always in the direction of the net force applied.



EVERYDAY EXAMPLES

Kicking a Football



A harder kick (greater force) gives the ball a larger acceleration.

Bat Hitting a Ball



A heavier bat (more mass) accelerates less for the same force.

Pushing a Shopping Cart



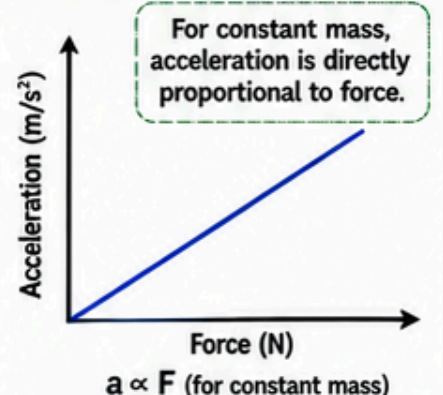
An empty cart (smaller mass) speeds up more than a full cart (same force).

Rocket Launch



Powerful thrust (large force) gives the rocket a very high acceleration.

GRAPHICAL REPRESENTATION



KEY POINTS

- ✓ Force produces acceleration.
- ✓ $a \propto F$ (for constant mass)
- ✓ $a \propto \frac{1}{m}$ (for constant force)
- ✓ $F = ma$
- ✓ The SI unit of force is newton (N).
- ✓ Direction of acceleration is the same as the direction of net force.

COMPARE

Condition	Force (N)	Mass (kg)	Acceleration (m/s^2)
A	10	1	10
B	20	1	20
C	10	2	5

Shows : More force → more acceleration
More mass → less acceleration

MEMORY TIP

$F = ma$

F → Force gives the push

m → Mass resists the change

a → Acceleration is the result!

DID YOU KNOW?

Sir Isaac Newton discovered the three laws of motion in the 17th century!



NEWTON'S THIRD LAW OF MOTION

Newton's Third Law of Motion states that for every **action**, there is an **equal and opposite reaction**. The two forces are **equal in magnitude**, **opposite in direction** and act on **two different objects**.

1 WHAT DOES THIS LAW MEAN?

When object A exerts a force on object B (action), object B exerts an equal force on object A (reaction).



Both forces are **equal in size**, **opposite in direction** and act on **two different objects**.

2 KEY FEATURES



EQUAL IN MAGNITUDE

The action and reaction forces are equal in size.



OPPOSITE IN DIRECTION

They act in exactly opposite directions.



ACT ON DIFFERENT OBJECTS

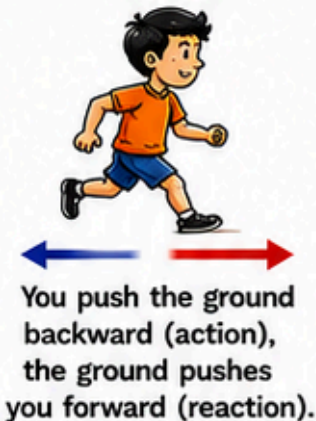
Action and reaction forces never act on the same object.

★ IMPORTANT!

These forces do not cancel each other because they act on two different objects.

3 EVERYDAY EXAMPLES

WALKING



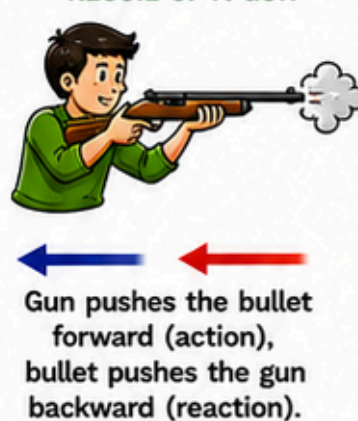
SWIMMING



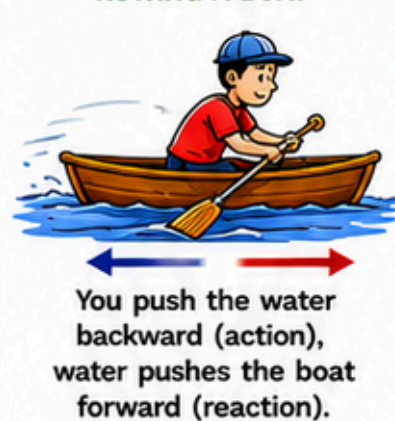
ROCKET LAUNCH



RECOIL OF A GUN



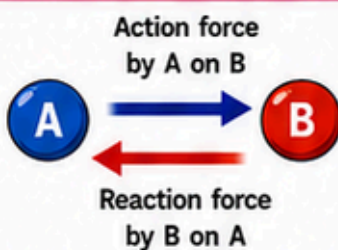
ROWING A BOAT



4 ACTION - REACTION PAIR

ACTION

Force exerted by object A on object B



REACTION

Force exerted by object B on object A

Both forces are equal in magnitude and opposite in direction, acting on two different objects.

5 SAILOR JUMPING FROM A BOAT

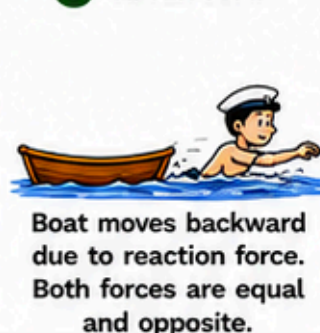
1 BEFORE JUMP



2 DURING JUMP



3 AFTER JUMP



6 KEY POINTS

- For every action, there is an equal and opposite reaction.
- Forces are equal in magnitude and opposite in direction.
- They act on two different objects.
- These forces are of the same type (both contact or both non-contact forces).



7 COMMON MISCONCEPTION



Action and reaction forces do NOT cancel each other. They act on different objects so they do not balance out.

8 REAL LIFE CONNECTION



From walking to flying rockets, Newton's Third Law of Motion is at work everywhere!

9 MEMORY TIP

Action - Reaction Always in Pair, Equal in Size, Opposite in Direction, Act on Different Objects!



GRAPHICAL REPRESENTATION

Graphs help us understand the motion of an object easily.

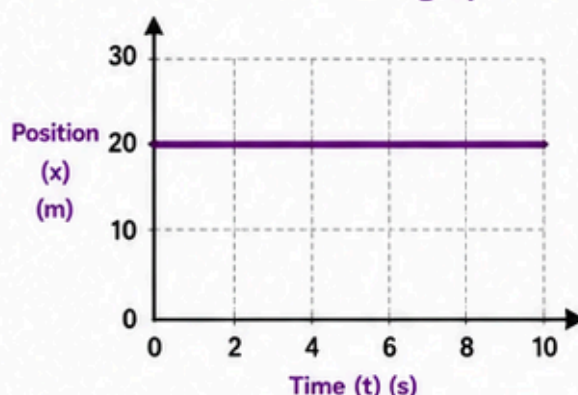
1 OBJECT AT REST

An object is said to be at rest if its position does not change with time.

Examples

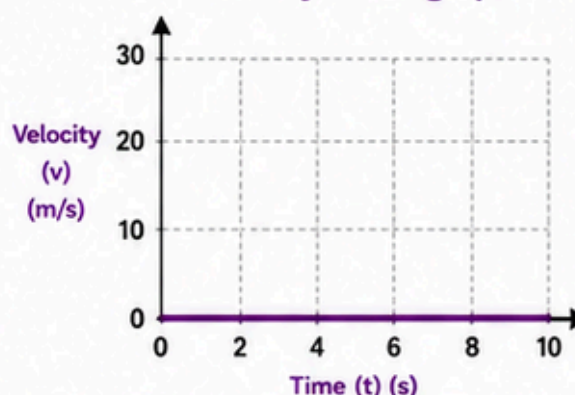
- A book kept on a table.
- A wall clock fixed on the wall.
- A parked car.

Position–time graph



The position–time graph is a horizontal straight line parallel to the time axis.

Velocity–time graph



The velocity–time graph is a straight line along the time axis (velocity = 0).

Key Point

At rest,
velocity = 0
at all times.

0

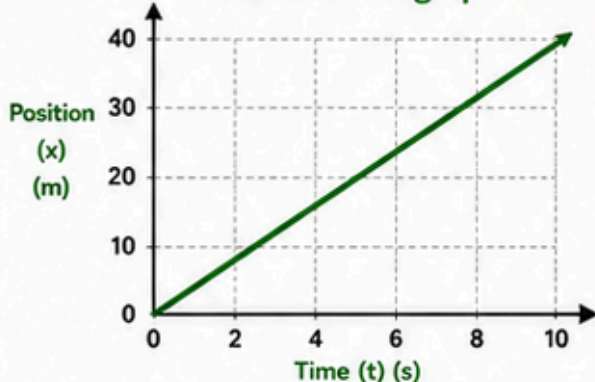
2 OBJECT MOVING WITH CONSTANT VELOCITY

An object is said to be moving with constant velocity if it covers equal distances in equal intervals of time in a straight line.

Examples

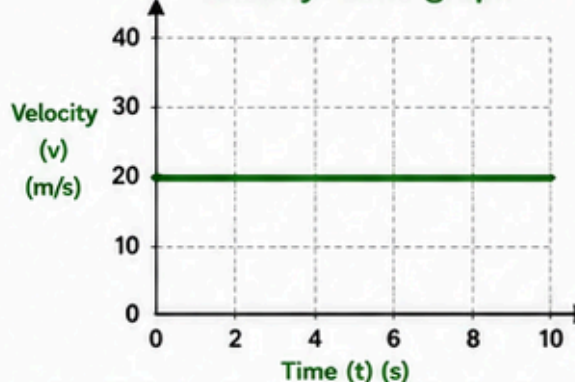
- A train moving on a straight track with constant speed.
- A car moving on a highway with constant speed.

Position–time graph



The position–time graph is a straight line with a constant slope.

Velocity–time graph



The velocity–time graph is a horizontal line parallel to the time axis.

Key Point

Velocity is
constant
with time.



3 VELOCITY–TIME REPRESENTATION

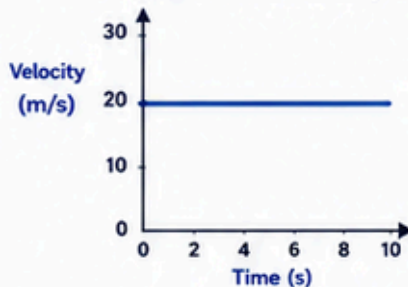
Different Types of Velocity–Time Graphs

The velocity–time graph shows how the velocity of an object changes with time.

Key Understandings

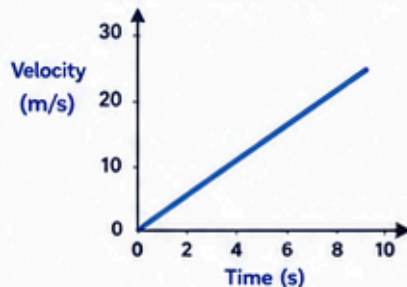
- The slope of the v–t graph represents acceleration.
- Area under the v–t graph represents displacement.
- Positive slope → Acceleration
- Negative slope → Retardation
- Zero slope → Constant velocity

(i) Constant Velocity



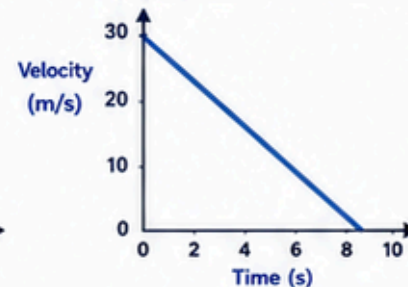
Object moves with
constant velocity.
(Zero acceleration)

(ii) Uniform Acceleration



Velocity increases
uniformly with time.
(Positive acceleration)

(iii) Uniform Retardation



Velocity decreases
uniformly with time.
(Negative acceleration)

Key Point

The shape of the
v–t graph tells
us the type of
motion.



QUICK SUMMARY

1 Object at Rest	Position–time: Horizontal line	Velocity–time: On time axis ($v = 0$)
2 Constant Velocity	Position–time: Straight line	Velocity–time: Horizontal line
3 v–t Representation	Describes how velocity changes with time Slope = Acceleration	

REMEMBER!

- Graphs make complex ideas simple.
- Always label the axes and use proper scale.
- Understand the graph, understand the motion!



FORCE, FRICTION, INERTIA & NEWTON'S THREE LAWS

The basic concepts that explain the motion of objects in our everyday life.

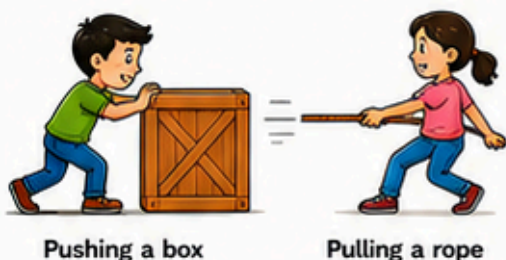
1 FORCE

A **push or pull** that can change the **state of rest or motion**, change **speed**, or change the **shape or direction** of an object.

Characteristics of Force

- It has both magnitude and direction.
- SI unit: newton (N)
- It is a vector quantity.

Examples



Types of Friction

- Static Friction** – Acts when there is no motion.
- Kinetic (Sliding) Friction** – Acts when surfaces slide.
- Rolling Friction** – Acts when a body rolls.
- Fluid Friction** – Acts in liquids and gases.

2 FRICTION

A force that **opposes** the motion between two surfaces in contact.

Key Points

- It acts **opposite** to the direction of motion.
- It depends on the nature of surfaces and the force pressing them together.
- It produces heat and causes wear and tear.

Examples



3 INERTIA

The property of a body by which it **resists any change** in its **state of rest or uniform motion**.

Key Points

- More the mass, more the inertia.
- It depends on mass, not on speed.
- Inertia is present in both rest and motion.

Examples



4 NEWTON'S THREE LAWS OF MOTION

The fundamental laws that govern the motion of objects.

1 Newton's First Law (Law of Inertia)

A body remains at rest or in uniform motion in a straight line unless acted upon by an external unbalanced force.



2 Newton's Second Law (Law of Acceleration)

The acceleration of a body is directly proportional to the net force acting on it and inversely proportional to its mass.

$$F = ma$$

F = Force (N)
m = Mass (kg)
a = Acceleration (m/s²)

3 Newton's Third Law (Law of Action and Reaction)

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



QUICK SUMMARY

Concept	What it is	Key Points	Example
Force	A push or pull that can change motion or shape.	- Has magnitude and direction. - Unit: newton (N).	Pushing a door, throwing a ball.
Friction	A force that opposes motion between surfaces.	- Acts opposite to motion. - Causes heat and wear.	Brakes stopping a car.
Inertia	Resistance to change in state of rest or motion.	- Depends on mass. - Present in rest and motion.	Passengers lurch forward in a bus.
Newton's Laws	Rules that describe motion of objects.	Three laws explain rest, motion, and interaction of forces.	Ball stays still, car accelerates, rockets fly.

REAL LIFE EXAMPLES

- Seat belts keep us safe due to inertia.
- Tyre treads increase friction and prevent slipping.
- Players apply force to kick a ball and change its motion.
- Rockets move upward by applying force to gases downward (action-reaction).



REMEMBER!

- Force can change motion.
- Friction always opposes motion.
- Inertia resists change.
- Newton's laws explain everything around us!

Units to Know

Force → newton (N)
Mass → kilogram (kg)
Acceleration → m/s²
Velocity → m/s

THINK & APPLY

Observe your surroundings and identify examples of force, friction, inertia, and Newton's laws in your daily life.



FORCE, FRICTION, INERTIA & NEWTON'S THREE LAWS

THE BASIC CONCEPTS THAT EXPLAIN THE MOTION OF OBJECTS IN OUR EVERYDAY LIFE.

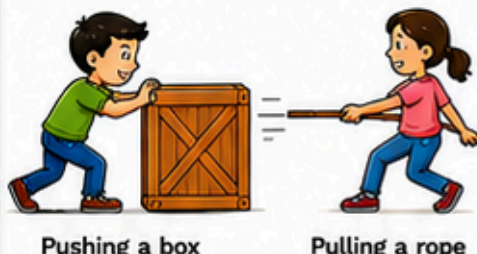
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Characteristics of Force

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Examples



Pushing a box

Pulling a rope

Types of Friction

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A force that **opposes** the motion between two surfaces in contact.

Key Points

- It acts opposite to the direction of motion.
- It depends on the nature of surfaces and the force pressing them together.
- It produces heat and causes wear and tear.

Examples



Friction slows down a moving object.

Brakes use friction to stop a vehicle.

3 INERTIA

The property of a body by which it **resists any change** in its **state of rest or uniform motion**.

Key Points

- More the mass, more the inertia.
- It depends on mass, not on speed.
- Inertia is present in both rest and motion.

Examples



When a bus stops suddenly, passengers tend to move forward due to inertia.



When a cloth is pulled quickly, the book remains in place due to inertia.

4 NEWTON'S THREE LAWS OF MOTION

The fundamental laws that govern the motion of objects.

1 Newton's First Law (Law of Inertia)

A body remains at rest or in uniform motion in a straight line unless acted upon by an external unbalanced force.



2 Newton's Second Law (Law of Acceleration)

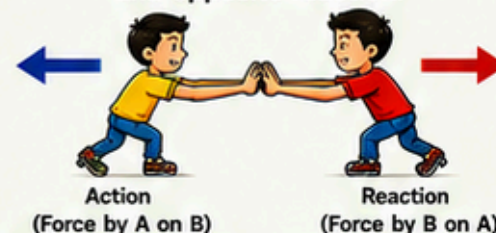
The acceleration of a body is directly proportional to the net force acting on it and inversely proportional to its mass.

$$F = ma$$

F = Force (N)
m = Mass (kg)
a = Acceleration (m/s²)

3 Newton's Third Law (Law of Action and Reaction)

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



Action
(Force by A on B)

Reaction
(Force by B on A)

QUICK SUMMARY

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Newton's Laws ↗	Rules that describe motion of objects.	Three laws explain rest, motion, and interaction of forces.	Ball stays still, car accelerates, rockets fly.

MEMORY TIP

FIRST LAW → INERTIA



An object will stay as it is – at rest or in uniform motion unless a force acts on it.

SECOND LAW → $F = ma$

$$\begin{array}{ccc} \mathbf{F} & = & \mathbf{m} \quad \mathbf{a} \\ \downarrow & & \downarrow \quad \downarrow \\ \text{Force} & & \text{Mass} \quad \text{Acceleration} \\ \text{(Newton)} & & \text{(kg)} \quad \text{(m/s}^2\text{)} \end{array}$$

More force or less mass → more acceleration.

THIRD LAW → ACTION = REACTION



Every action has an equal and opposite reaction.



GRAPHICAL REPRESENTATION

Graphs help us understand the motion of an object easily.

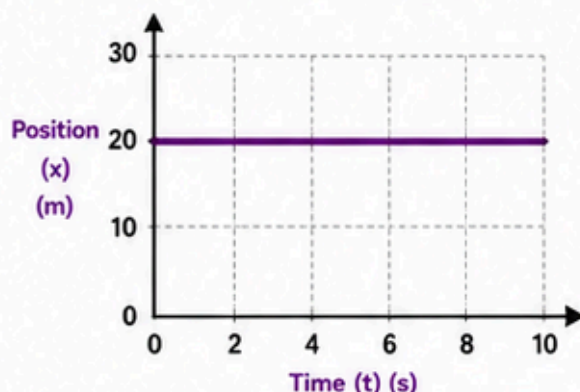
1 OBJECT AT REST

An object is said to be at rest if its position does not change with time.

Examples

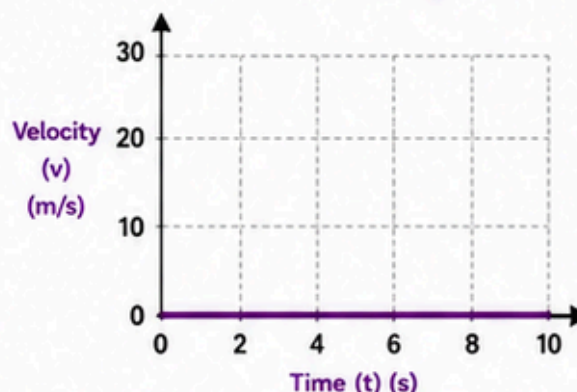
- A book kept on a table.
- A wall clock fixed on the wall.
- A parked car.

Position–time graph



The position–time graph is a horizontal straight line parallel to the time axis.

Velocity–time graph



The velocity–time graph is a straight line along the time axis (velocity = 0).

Key Point

At rest,
velocity = 0
at all times.

0

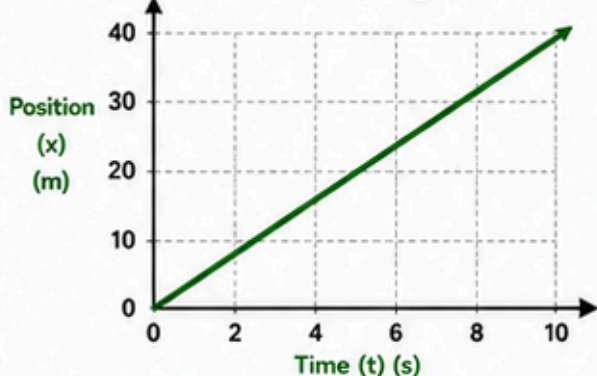
2 OBJECT MOVING WITH CONSTANT VELOCITY

An object is said to be moving with constant velocity if it covers equal distances in equal intervals of time in a straight line.

Examples

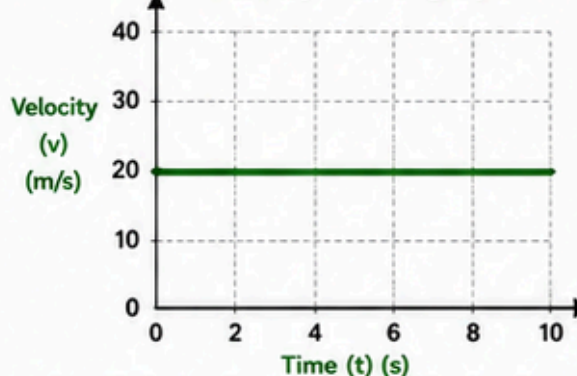
- A train moving on a straight track with constant speed.
- A car moving on a highway with constant speed.

Position–time graph



The position–time graph is a straight line with a constant slope.

Velocity–time graph



The velocity–time graph is a horizontal line parallel to the time axis.

Key Point

Velocity is
constant
with time.



3 VELOCITY–TIME REPRESENTATION

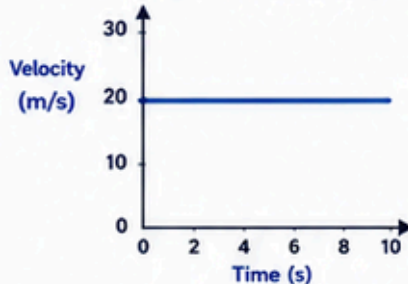
Different Types of Velocity–Time Graphs

The velocity–time graph shows how the velocity of an object changes with time.

Key Understandings

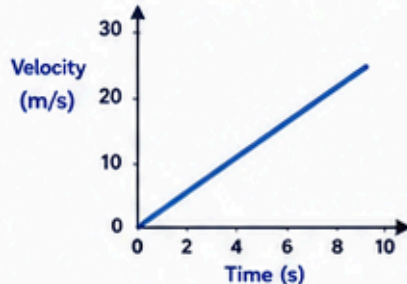
- The slope of the v–t graph represents acceleration.
- Area under the v–t graph represents displacement.
- Positive slope → Acceleration
- Negative slope → Retardation
- Zero slope → Constant velocity

(i) Constant Velocity



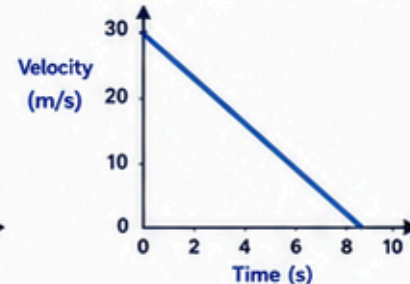
Object moves with
constant velocity.
(Zero acceleration)

(ii) Uniform Acceleration



Velocity increases
uniformly with time.
(Positive acceleration)

(iii) Uniform Retardation



Velocity decreases
uniformly with time.
(Negative acceleration)

Key Point

The shape of the
v–t graph tells
us the type of
motion.



QUICK SUMMARY

1 Object at Rest	Position–time: Horizontal line	Velocity–time: On time axis ($v = 0$)
2 Constant Velocity	Position–time: Straight line	Velocity–time: Horizontal line
3 v–t Representation	Describes how velocity changes with time Slope = Acceleration	

REMEMBER!

- Graphs make complex ideas simple.
- Always label the axes and use proper scale.
- Understand the graph, understand the motion!



FORCE, FRICTION, INERTIA & NEWTON'S THREE LAWS

THE BASIC CONCEPTS THAT EXPLAIN THE MOTION OF OBJECTS IN OUR EVERYDAY LIFE.

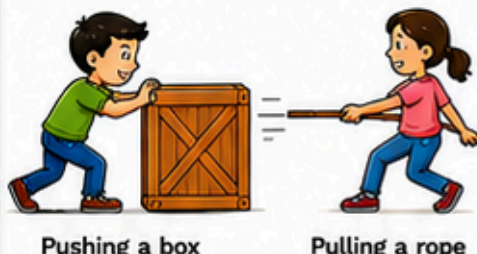
1 FORCE

A **push or pull** that can change the **state of rest or motion**, change **speed**, or change the **shape or direction** of an object.

Characteristics of Force

- Has both magnitude and direction.
- SI unit: newton (N)
- It is a vector quantity.

Examples



Pushing a box

Pulling a rope

Types of Friction

- Static Friction** – Acts when there is no motion.
- Kinetic (Sliding) Friction** – Acts when surfaces slide.
- Rolling Friction** – Acts when a body rolls.
- Fluid Friction** – Acts in liquids and gases.

2 FRICTION

A force that **opposes** the motion between two surfaces in contact.

Key Points

- It acts opposite to the direction of motion.
- It depends on the nature of surfaces and the force pressing them together.
- It produces heat and causes wear and tear.

Examples



Friction slows down a moving object.

Brakes use friction to stop a vehicle.

3 INERTIA

The property of a body by which it **resists any change** in its **state of rest or uniform motion**.

Key Points

- More the mass, more the inertia.
- It depends on mass, not on speed.
- Inertia is present in both rest and motion.

Examples



When a bus stops suddenly, passengers tend to move forward due to inertia.



When a cloth is pulled quickly, the book remains in place due to inertia.

4 NEWTON'S THREE LAWS OF MOTION

The fundamental laws that govern the motion of objects.

1 Newton's First Law (Law of Inertia)

A body remains at rest or in uniform motion in a straight line unless acted upon by an external unbalanced force.



2 Newton's Second Law (Law of Acceleration)

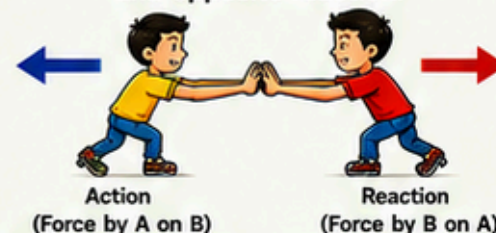
The acceleration of a body is directly proportional to the net force acting on it and inversely proportional to its mass.

$$F = ma$$

F = Force (N)
m = Mass (kg)
a = Acceleration (m/s²)

3 Newton's Third Law (Law of Action and Reaction)

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



Action
(Force by A on B)

Reaction
(Force by B on A)

QUICK SUMMARY

Concept	What it is	Key Points	Example
Force →	A push or pull that can change motion or shape.	- Has magnitude and direction. - Unit: newton (N).	Pushing a door, throwing a ball.
Friction →	A force that opposes motion between surfaces.	- Acts opposite to motion. - Causes heat and wear.	Brakes stopping a car.
Inertia →	Resistance to change in state of rest or motion.	- Depends on mass. - Present in rest and motion.	Passengers lurch forward in a bus.
Newton's Laws ↗	Rules that describe motion of objects.	Three laws explain rest, motion, and interaction of forces.	Ball stays still, car accelerates, rockets fly.

MEMORY TIP

FIRST LAW → INERTIA



An object will stay as it is – at rest or in uniform motion unless a force acts on it.

SECOND LAW → $F = ma$

$$\begin{matrix} \mathbf{F} & = & \mathbf{m} & \mathbf{a} \\ \downarrow & & \downarrow & \downarrow \\ \text{Force} & & \text{Mass} & \text{Acceleration} \\ \text{(Newton)} & & \text{(kg)} & \text{(m/s}^2\text{)} \end{matrix}$$

More force or less mass → more acceleration.

THIRD LAW → ACTION = REACTION



Every action has an equal and opposite reaction.

