Resultant Force – GCSE Physics

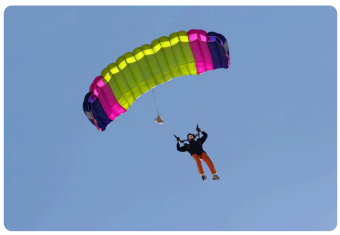
CONTENTS:

1. Introduction:

- **Force** is a push or pull acting on a body.
- A body needs **Force** to change its state of motion.
- There are number of Forces acting on a body at a same time, so instead of analyzing multiple forces individually, we use the **Resultant Force** to predict **Motion**.
- The **Resultant Force** is the single Force that replaces multiple forces acting on an object, producing the same effect.

Real-life Scenario:

Tug of War



A Falling Parachute

Pushing a Shopping Cart

Boat Crossing a River

Airplane in Crosswinds

Driving up a Hills

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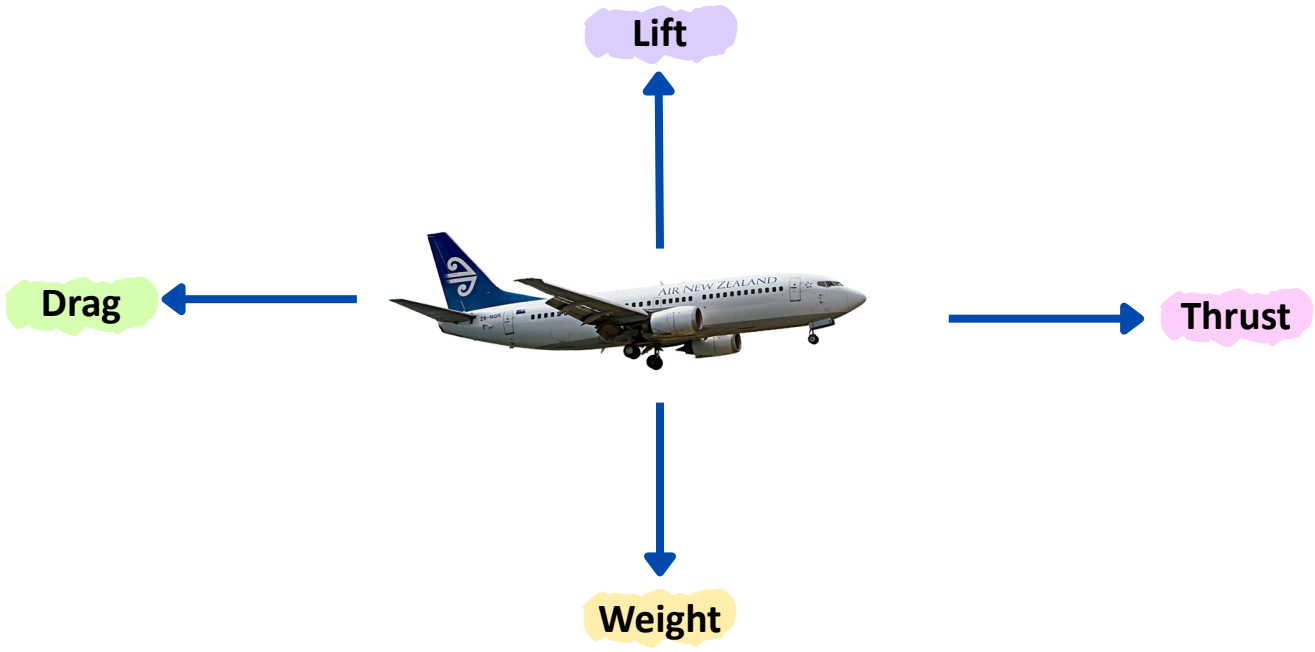
2. What is Free Body Diagram?

- A **Free Body Diagram** is a simplified visual representation of an object to visualize the forces acting on a single object (or body).
- It helps analyze the effects of External Forces.

Example:



Characteristics:

- The arrow points in the direction that the force is acting.
- The length of the arrow shows how strong the force is:

A Longer arrow = Greater Force

A Shorter arrow = Smaller Force

Common Forces in Free Body Diagrams

- Weight
- Tension
- Friction
- Air Resistance/Drag

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3. What is Resultant Force Equation?

- Resultant Force is the **Vector sum** of all the individual forces acting on an object.
- It is also called a net force which represent the combined effect of all other forces.
- SI Unit of Force: **Newton(N)**

Equation1:

If F1, F2, F3,….are the forces acting on a body, the Resultant Force FR is calculated using the formula with positive and negative signs used for pair of opposite forces,

$$F_R = F_1 + F_2 + F_3 \ldots\ldots$$

Where F_1, F_2, F_3, . . . are the Linear Forces acting of the body.

Equation2:

If F_1 and F_2 are the forces perpendicular to each other then their Resultant Force is,

$$F_R = \sqrt{(F_1^2 + F_2^2)}$$

This consequence can also be calculated geometrically using other methods.

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4. How to Calculate Resultant Force?

Method1:

If force acts on a same direction, then the **Resultant force** is,

$$F_R = F_1 + F_2 + F_3 .....$$

Example: If Person **A** pushes a car in the East direction with a Force of **200 N**, and Person **B** also pushes the car in the same direction with a Force of **300 N**, what will be the Resultant Force?

Solution:

Given:

- **Person A applies Force F_1 :** 200N
- **Person B applies Force F_2 :** 300N

Then the Resultant Force will be,

$$F_R = F_1 + F_2$$

$$F_R = 200N + 300N$$

$$F_R = 500N$$

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Method2:

If force acts on a opposite direction, then the **Resultant force** is,

$$F_R = F_L \text{ (Larger Force)} - F_S \text{(Smaller Force)}$$

Example: If Person **A** pushes a box to the Left with a Force of **200 N**, and Person **B** pushes the same box to the Right with a Force of **300 N**, what is the Resultant Force on the box?

Solution:

Given:

- **Person A applies Force F_1 :** 200N
- **Person B applies Force F_2 :** 300N

Then the Resultant Force will be,

$$F_R = F_L \text{ (Larger Force)} - F_S \text{ (Smaller Force)}$$

$$F_R = 300N - 200N$$

$$F_R = 100N$$

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5. What are Balanced and Unbalanced Force?

Balanced Force:

- Forces acting on an object are equal in **Magnitude** but opposite in **Direction**.
- They cancel each other out, so the Resultant Force is **Zero.**

$$F_R = 0$$

Characteristics:

- No change in Motion.
- Object or Body remains at rest or continues at Constant Velocity.

Examples:

Book on a Table

Car moving with Constant Velocity

Hanging Picture frame

Floating Boat

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Unbalanced Force:

- Forces acting on an object are not equal in **Unbalanced Force.**
- They do not cancel each other out, so the Resultant Force is **non-zero.**

$$F_R \neq 0$$

Characteristics:

- Change in Motion.
- Object or Body accelerates (speed up, speed down or change direction).

Examples:

Falling Ball

Pushing a Car

Braking a Bicycle

Kicking a Football

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6. FAQs

1. What is a Resultant Force?

A Resultant Force is the overall force acting on an object after all individual Forces are combined.

2. How do you calculate Resultant Force?

- Add Forces in the same direction
- Subtract it they act in opposite directions. This gives the net force.

3. What is the Equation of Resultant Force?

- Resultant force = Larger Force - Smaller Force (if opposite)
- Resultant force = Sum of Forces fil same direction

4. What is a Resultant Force Diagram?

A drawing that shows the size and direction of each force using arrows.

5. What happens if the Resultant Force is zero?

The object is Balanced. It either stays still or keeps moving at Constant Speed.

6. When is a force Unbalanced?

When the Resultant Force is not zero this causes movement or change.

7. Can you give a Real-life Example of Resultant Forces?

A Rocket producing 13,000 N thrust and 5,000 N weight then,

Resultant Force is,

$F_R = F_L$ (Larger Force) - F_S (Smaller Force)

F_R = 13,000 - 5000 = 8,000 N upwards