Newton's 2nd Law – GCSE Physics

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1. Introduction:

- **Newton's Second Law of Motion states,**

  Non-Zero Resultant Force acts on an object, then it will cause the object to **Accelerate.**

- Where Acceleration is,

$$\text{Acceleration} = \frac{\text{Change in Velocity}}{\text{Change in time}}$$

Example: Pushing a Shopping Cart:

- If we push an empty shopping cart with certain force, then it Accelerates quickly.
- If we push a loaded shopping cart with same force, then it Accelerates slowly.

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2. What is Newton's 2nd Law of Motion?

- It states that, **Acceleration** of an object is directly proportional to the net **Force** acting on it and inversely proportional to its **Mass.**
- Mathematically,

$$a = \frac{F}{m} \quad \text{or} \quad F = ma$$

Where,

- **F =** Net Force applied
- **m =** Mass of an Object
- **a =** Acceleration

Example:

If you push a **10 kg** box with a **20 N** force, what is the **Acceleration** of the Box?

Solution:

Given:
- **F =** 20N
- **M =** 10kg

Using the value,

$$a = \frac{F}{m}$$

Putting the Values,

$$a = \frac{20}{10} = 2 \text{ m/ s}^2$$

Acceleration of the Box is 2 m/ s^2

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3. How Newton’s 2nd Law works?

Newton's Second Law explains how an object's motion changes when a force is applied.

Relationship between Force, Mass and Acceleration:

- **Force** is directly proportional to **Acceleration** when **Mass** is constant.

$$F \propto a$$

where Mass is constant

- **Force** is directly proportional to **Mass** when **Acceleration** is constant.

$$F \propto m$$

where Acceleration is constant

- **Acceleration** is inversely proportional to **Mass** when **Force** is constant.

$$a \propto \frac{1}{m}$$

where Force is constant

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4. What is Inertial Mass?

- **Inertial mass** is a measure of an object's **Resistance to Acceleration** when a Force is applied.
- If there is more Inertial Mass then, it's harder to Accelerate.
- If there is less Inertial Mass then, it's easy to Accelerate.

Examples:

- **Bicycles** are lightweight, stops quickly when brakes are applied while **Trucks** are Massive, takes much longer to stop even with strong brakes.

- **Soccer Ball** are low mass, small kick makes it fly fast (**large acceleration**) while **Bowling Ball** are high mass, Same kick barely moves it (**small acceleration**).

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5. FAQs

1. What is Newton's Second Law in simple terms?

Newton's Second Law says that the more force you apply to an object, the faster it will Accelerate. But if the object is heavier, it won't speed up as quickly with the same force.

2. How do you calculate force using Newton's Second Law?

Use the formula:

Force = Mass × Acceleration (F = m x a).

For example, if a car has a mass of **1000 kg** and accelerates at 2 m/s^2, the force is **2000 N.**

3. What is the difference between mass and inertial mass?

Mass is how much matter something has. Inertial mass tells us how much an object resists being pushed or sped up. It's calculated by dividing force by acceleration.

4. Can you give a real-life example of Newton's 2nd law?

Yes. A light bicycle accelerates faster than a heavy car when the same force is applied. This is because the bike has less mass, so it speeds up more.

5. What are newton seconds, and how are they used in physics?

A Newton Second is a unit of Impulse **(force x time)**. It's not directly part of Newton's Second Law, but it comes up when studying how momentum changes over time.