

Free Fall LR

Free fall. Objective, to understand free fall motion. During the flight of an aircraft, there are multiple forces in action on the aircraft which moves it forwards, upwards, downwards and sideways.

This can be an analogy for the motion of an object under the action of multiple forces. When a skydiver detaches himself from an aircraft at a very high altitude, he falls towards the ground with increasing speed. In this situation, if we ignore the resistance of air at such a high altitude, the only force acting on the diver is gravity, which is giving him an accelerated motion.

The motion of a body in which the only force acting upon it is the force of gravity is called free fall. When we drop a coin and a feather at the same time and from the same height, we see that the coin reaches the floor faster than the feather. Since the coin is heavier than the feather, it seems that the heavier object falls faster than the lighter one.

But such a conclusion was completely rejected by Galileo Galilei, an Italian scientist. Galileo dropped two stones of different masses from the top of the Leaning Tower of Pisa. Both the stones fell down with the same acceleration and hit the ground together.

Galileo explained that it is the resistance from air which slows down the motion of an object which is less dense and has a larger surface area than the other object. In the case of the free fall of the coin and the feather, we can see that the large surface area of the feather hit by contacting layers of air which tend to sway it away in any possible direction. As a result, the feather remains in the air for a longer time and drops at some distance from the fallen coin.

If the same coin and feather are kept in a big glass jar and the air inside the jar is completely removed using a vacuum pump, then on inverting the jar, we can observe that both the coin and the feather have a similar free fall and reach the other end at the same time. Thus, freely falling bodies fall with the same acceleration which does not depend on how heavy the bodies are. To summarize, the motion of a body in which the only force acting upon it is the force of gravity is called free fall.

The acceleration is the same for all free falling bodies and does not depend on how heavy the bodies are.

Summary of Free Fall

Understanding Free Fall

Free fall is the motion of an object under the influence of **only gravity**, with no other forces acting on it.

✓ Example:

- When a **skydiver jumps** from an airplane, he falls **towards the ground with increasing speed**.
 - If **air resistance is ignored**, the only force acting on the skydiver is **gravity**, making his motion **accelerated**.
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Galileo's Free Fall Experiment

✓ Observation:

- When a **coin and a feather** are dropped together, the **coin reaches the ground faster**.
- This seems to suggest that **heavier objects fall faster** than **lighter ones**.

✓ Galileo's Experiment (Leaning Tower of Pisa):

- Galileo dropped **two stones of different masses** from a tower.
- **Both stones hit the ground at the same time**.
- He concluded that **all objects fall with the same acceleration due to gravity, regardless of mass**.

✓ Effect of Air Resistance:

- A **feather falls slower** than a coin because **air resistance pushes against it**.
 - In **vacuum conditions** (no air), **both fall at the same time**.
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Key Takeaways

- ✓ Free fall occurs when gravity is the only force acting on an object.
 - ✓ All freely falling objects accelerate at the same rate, regardless of their mass.
 - ✓ Air resistance affects lighter objects with larger surface areas (like feathers).
 - ✓ In a vacuum, all objects fall at the same rate.
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Quiz on Free Fall

1. What is free fall?

- ☒ **The motion of an object under the influence of only gravity.**
- ☐ The motion of an object influenced by air and gravity.
- ☐ The motion of an object floating in water.
- ☐ The motion of an object due to multiple forces.

2. Why does a feather fall slower than a coin in the air?

- ☒ **Because air resistance slows it down.**
- ☐ Because it is lighter.
- ☐ Because gravity does not act on it.
- ☐ Because the coin is heavier.

3. What did Galileo's experiment show?

- ☒ **Objects of different masses fall at the same rate in the absence of air resistance.**
- ☐ Heavier objects fall faster than lighter ones.
- ☐ Objects fall because of air resistance.
- ☐ Free fall only happens on the moon.

4. What happens when a coin and a feather are dropped in a vacuum?

- ☒ **Both fall at the same rate and hit the ground at the same time.**
- ☐ The feather still falls slower.
- ☐ The coin falls first, then the feather.
- ☐ Gravity does not affect them in a vacuum.