

2025Q3**MASS & MASS BALANCES**

Hello students! Today, we're going to explore mass and how it moves from one place to another, both within a system and in and out of a system. A system can be anything we study, like a fishtank, a river, a wind turbine, a pipeline, or just your kitchen sink.

Mass is the amount of matter in an object. Everything has mass: the air we breathe, the water we drink, the food on our plate, and even our own bodies. Mass is typically measured in kilograms, and it doesn't just change on its own. The only way to change mass is by adding or removing matter. But why is that?

One of the most important scientific rules is the **Principle of Conservation of Mass**, which states:
Mass cannot be created or destroyed in a system – it can only move from one place to another.

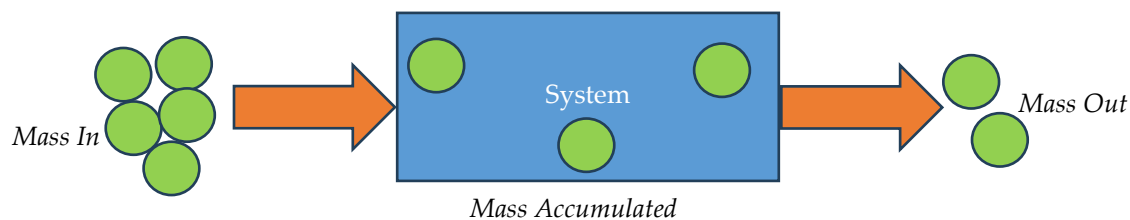
The Principle of Conservation of Mass says that mass doesn't just appear or disappear inside a system—it either moves in, moves out, or stays inside (this is called accumulation). For example, when you blow air into a balloon, the air doesn't vanish. It either stays inside the balloon or escapes when you let go. If you keep blowing without letting any air escape, the balloon gets bigger because more air is being added. The total amount of air stays the same; it just moves in, moves out, or remains inside the balloon.

Scientists and engineers track how much mass moves in and out of a system using a concept called mass balance. A mass balance is simply this equation:

$$\text{Mass In} = \text{Mass Out} + \text{Mass Accumulated}$$

Where:

- **Mass In** → The amount of mass entering (like air blowing into the balloon).
- **Mass Out** → The amount of mass leaving (like air escaping if you let go).
- **Mass Accumulated** → The mass that stays inside (like the air still in the balloon).



But what happens if no mass is accumulating? That brings us to **steady state**. A system is at steady state when the amount of mass entering is exactly equal to the amount of mass leaving. That means:

$$\text{Mass In} = \text{Mass Out}$$

Imagine you have a bucket that is partially filled with water and has a small hole at the bottom. If you pour water in at the same speed that it leaks out, the water level doesn't rise or fall, it stays the same! That's called steady state.

Understanding mass balance and steady state helps us understand how air moves through ventilation systems, how rivers flow, and even how wind passes through a wind turbine!

LEVEL 1 QUESTION (GRADES 5 – 8)

A dump truck is dropping sand onto a pile at a construction site. Every minute, 500 kg of gravel is added to the pile, and 500 kg is removed by trucks. If this continues for 30 minutes, how much gravel has accumulated in the pile? *Hint: If the amount of sand coming in is the same as the amount leaving, does the pile get bigger, smaller, or stay the same?*

LEVEL 2 QUESTION (GRADES 8 – 11)

A cement mixer on a construction site initially contains 2500 kg of cement. Every hour, 1000 kg of cement is added, but only 750 kg is used. However, for the first 2 hours, no cement is removed from the mixer. How much cement is in the mixer after 6 hours? *Hint: Think about breaking the duration in the two intervals, the first 2 hours separately and the next 4 hours after.*