

# Elevators Revisited



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**We last looked at elevators in terms of tension and the total force.**

**While studying them, we made a few observations:**

- when accelerating up, we feel heavier**
- when accelerating down, we feel lighter**
- when at uniform motion, we feel normal**

**We will now explain these observations in terms of gravity.**

# Situation 1: **Accelerating Up**



- Disregard tension in the elevator.

**Q - What forces are acting on the rider?**

$\vec{F}_g$  acting down

$\vec{F}_N$  acting up

$\vec{F}_{Tot}$  acting up

In this type of question, we have two weights:

1. **True Weight:** the force of gravity acting downwards.

2. **Apparent Weight:** the opposite of the normal force, which makes the rider "feel" lighter or heavier.

- Our rider has a true weight,  $F_g$ , acting downwards. This weight stays the same throughout the problem.
- Our rider is on a scale which will measure the rider's apparent weight, which varies depending on the direction the elevator moves in.



## Finding Apparent Weight (Acceleration Up)

Step 1: Write total force statement.

$$\vec{F}_{\text{Tot}} = \vec{F}_g + \vec{F}_N$$

$$\vec{F}_N = \vec{F}_{\text{Tot}} - \vec{F}_g$$

where:  $\vec{F}_{\text{Tot}} = m\vec{a}$   
 $\vec{F}_g = mg$

acceleration of  
elevator

**ex) An elevator has an upwards acceleration of  $3.5 \text{ m/s}^2$ .  
What is the true and apparent weight of a rider with mass  
of  $75 \text{ kg}$ ?**

**Note: You will need to reverse the sign on the normal force  
for the apparent weight to make sense.**

**Hint: Be careful of your  
signs on the accelerations!**

## **What about accelerating downwards?**

**ex) An elevator has a downwards acceleration of  $-8.5 \text{ m/s}^2$ . What is the true and apparent weight of a rider with mass of  $75 \text{ kg}$ ?**

# Free Fall

**Free fall occurs when there is no balancing normal force present.**



**Without a normal force, there is no apparent weight, and the rider experiences "weightlessness".**

**This is what happens to astronauts in orbit and was also simulated for movies.**



## **NASA's Vomit Comet or the Weightless Wonder.**

