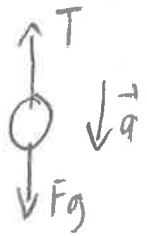
# Elevators and Apparent Weight

Consider a lamp hanging vertically from a cord in an elevator, which is descending with a downward acceleration of 2.00 m/s$^2$. The tension in the cord is 10.0 N. What is the mass of this lamp?




$F_{NET} = ma$

$F_g - T = ma$

$mg - T = ma$

$mg - ma = T$

$m(g-a) = T$

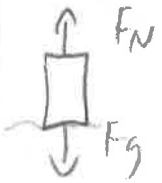
$\therefore m = \frac{T}{(g-a)} = \frac{10.0N}{9.80 m/s^2 - 2.0 m/s^2}$

$= 1.2820 = \boxed{1.3 kg}$

When a person is accelerating upwards or downwards they can sometimes *feel* heavier or lighter than they actually are. Although their actual weight (force of gravity) is the same, their apparent weight differs. Apparent weight (how heavy we *feel*) is equal to the normal force supporting us.

## Consider a student jumping off of a desk

a) What is their apparent weight while standing on the desk?




$F_N = F_g$

So feel their normal WEIGHT

b) What is their apparent weight while in the air?


$F_N = 0$

So you feel weightless

c) What is their apparent weight when they hit the ground?


$\vec{a}$ → stopping so net force

$F_N > F_g$ so heavier

Ex 1: A 65 kg person in an elevator is traveling upwards at 5.0 m/s. What is their apparent weight?


$\vec{a} = 0$

so

$F_g = F_N$

$F_N = mg$

$= (65kg)(9.80 m/s^2)$

$= 637 = \boxed{640N}$

Ex 2: The same 65 kg person is in an elevator that accelerates upwards at 4.9 m/s$^2$. What is their apparent weight?


$F_{NET} = ma$

$F_N - F_g = ma$

$F_N = ma + F_g$

$= ma + mg$

$= m(a+g)$

$F_N = (65kg)(4.9 m/s^2 + 9.8 m/s^2)$

$= 955.5 = \boxed{960N}$

Ex 3: The elevator reaches the top floor and slows down at 4.9 m/s$^2$. What is their apparent weight?


$F_{NET} = ma$

$F_g - F_N = ma$

$F_N = F_g - ma$

$= mg - ma$

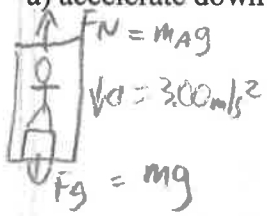
$= m(g-a)$

$F_N = (65kg)(9.80 m/s^2 - 4.9 m/s^2)$

$= 318.5 = \boxed{320N}$

An 85.0 kg person in an elevator goes from the top to the bottom floor. Find their apparent mass when they:

a) accelerate downwards at 3.00 m/s$^2$?




$m = 75 kg$

$m_A = ?$

$F_{NET} = ma$

$F_g - F_N = ma$

$F_N = F_g - ma$

$m_A g = mg - ma$

$\therefore m_A = \frac{m(g-a)}{g}$

$= (85 kg)\left(\frac{9.80 m/s^2 - 3.0 m/s^2}{9.80 m/s^2}\right)$

$= 58.9 = \boxed{59 N}$

b) accelerate upwards at 3.00 m/s$^2$?


$m = 75 kg$

$m_A = ?$

$F_{NET} = ma$

$F_N - F_g = ma$

$F_N = ma + F_g$

$m_A g = ma + mg$

$\therefore m_A = \frac{m(a+g)}{g} = \frac{(85 kg)(9.80 m/s^2 + 3.00 m/s^2)}{9.80 m/s^2}$

$= 111.02 = \boxed{110 kg}$

## Elevator Problems and Apparent Weight

1. If you normally weigh 706 N, what is your apparent weight if you are in an elevator going up that is slowing down at the rate of 1.65 m/s$^2$ ?

2. You are standing on a scale in an elevator. You have a mass of 75 kg. Determine what a scale would show as your "apparent" mass (in kilograms) if…
   a. the elevator starts to accelerate upwards at 3.0 m/s$^2$.
   b. the elevator starts to accelerate downwards at 4.0 m/s$^2$

3. A 2.00 kg pendulum hangs in an elevator. Calculate the tension in the string supporting the pendulum if the elevator moves:
   a. with zero velocity
   b. downward at a constant velocity of 2.5 m/s
   c. upward at a constant velocity of 2.5 m/s
   d. downward at a constant acceleration of 2.00 m/s$^2$
   e. upward at a constant acceleration of 2.00 m/s$^2$

4. A man measures the acceleration of an elevator by using a spring balance. He fastens the scale to the roof, and suspends a mass from it. The scale reads 98 N when the elevator is at rest, and 93 N when the elevator is moving.
   a. In which direction is the elevator accelerating?
   b. What is the acceleration of the elevator?

5. A 17 kg fish hangs from a spring scale supported from the roof of an elevator.
   a. If the elevator has an upward acceleration of 1.2 m/s$^2$ and the scale reads 200.0 N, what is the true force of gravity on the fish?
   b. Under what circumstances will the scale read 150 N and what would be the acceleration of the elevator?
   c. What will the scale read if the elevator cable breaks?

1) 587 N 2) a. 98 kg, b. 44 kg 3) a. 19.6 N, b. 19.6 N, c. 19.6 N, d. 15.6 N, e. 23.6 N
4) a. down, b. 0.50 m/s$^2$ 5) a. 180 N, b. either going up and slowing down or going down and speeding up, 1.7 m/s$^2$ down, c. 0 N