Unit 4: Newton's Laws

Elevators and Apparent Weight

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.

Mass + Spring Scale = Elevator

Describe **2 times** when the mass appears *heavier* than normal.

1) go ↑ from rest
2) go ↓ and stop

What can you summarize about the acceleration of the mass?

upwards

Describe **2 times** when the mass appears *lighter* than normal.

1) go ↓ from rest
2) go ↑ and stop

What can you summarize about the acceleration of the mass?

downwards

Describe **3 times** when the mass' apparent and actual weights are equal.

1) rest
2) up @ const $\vec{v}$
3) down @ const $\vec{v}$

What can you summarize about the acceleration of the mass?

ZERO!

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

$a = 0$

$F_{net} = 0$

$\therefore F_N = F_g$

$F_g = mg = (65\,kg)(9.8\,m/s^2)$

$= \boxed{640\,N}$

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?

$F_{net} = F_N - F_g = ma$

$F_N = ma + F_g$

$= (65\,kg)(4.9\,m/s^2) + 637\,N$

$= \boxed{960\,N}$

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

$F_{net} = F_g - F_N = ma$

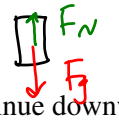
$F_N = F_g - ma$

$= 637 - (65)(4.9)$

$= \boxed{320\,N}$

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

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



$F_{net} = F_g - F_N = ma$ $F_N = F_g - ma = mg - ma$

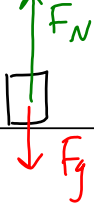
$= (85\,kg)(9.8\,m/s^2) - (85\,kg)(4.9\,m/s^2)$

$= \boxed{578\,N}$

b) continue downward at a velocity of 12.0 m/s?

$F_N = F_g = mg = \boxed{833\,N}$

c) accelerate upwards at 3.00 m/s^2?

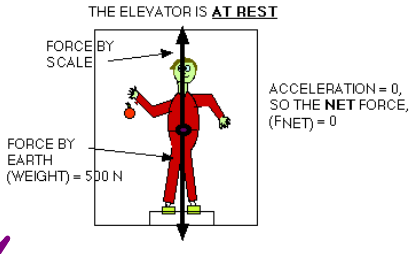


$F_{net} = F_N - F_g = ma$ $F_N = F_g + ma = 833\,N + (85\,kg)(3.00\,m/s^2)$

$= \boxed{1090\,N}$

The Elevator Problem

Imagine that you are standing on a bathroom scale in an elevator. You are holding an apple. (Yes, people *are* staring at you...). You weigh **500 N**, so your mass is about 50 kg.

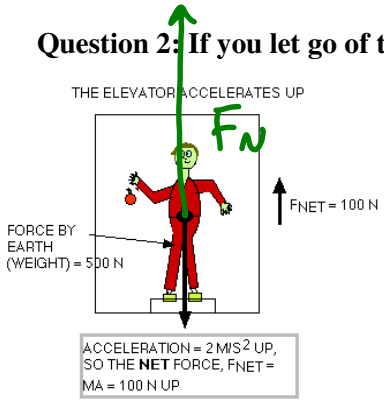


Part A: Elevator Is At Rest.

You have just boarded the elevator, so it (with you inside) is at rest...

Question 1: What does the scale read? 500N

Question 2: If you let go of the apple, what does it do? Falls normally



Part B: The Elevator Accelerates Upward.

The elevator, (with you inside) begins to accelerate upward from rest at 2 m/s^2.

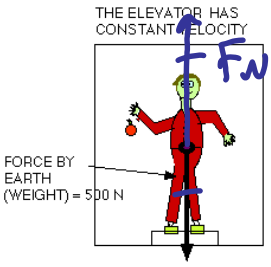
Complete the FBD!

Question 3: What will the scale read now? 600N

Question 4: If you let go of the apple now, what does it do? Falls fast

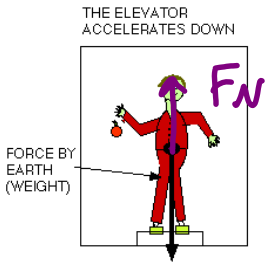
Part C: The Elevator Moves Up With Constant Velocity

The elevator (and you) accelerated for 5 seconds, so it is moving upward with a velocity of 10 m/s. It now moves with this constant upward velocity of 10 m/s.



Question 5: What does the scale read now? 500N

Question 6: If you let go of the apple, what does it do? falls normally



Part D: The Elevator Slows Down (While Going Up)

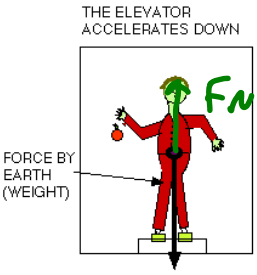
The elevator, (with you inside) begins to slow down as it approaches its destination. Its acceleration (or deceleration) is 2 m/s^2 downward.

Question 7: What does the scale read now? 400N

Question #8: If you let go of the apple now, what does it do? falls slowly

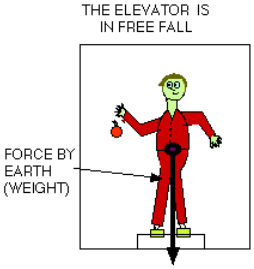
Part E: The Elevator Speeds Up (While Going Down)

The elevator, (with you inside) reaches its floor, stops for a while, and then begins to accelerate downward. Its acceleration is 2 m/s^2 downward.



Question 9: What does the scale read now? 400N

Question #10: If you let go of the apple now, what does it do? falls slowly



Part F: Oh, No!

The elevator cable snaps, and the elevator (with you inside!) begins to fall! Perhaps you have time for one last Physics observation!

Question 11: What does the scale read as the elevator falls? ZERO!

Question 12: If you let go of the apple now, what does it do?

... hangs in the air...