Dynamics Notes

Elevator Problems and Apparent Weight

When a person stands on a scale, the reading (kilograms) on the scale is actually the Normal Force that the scale exerts back towards the person to support the person's weight.

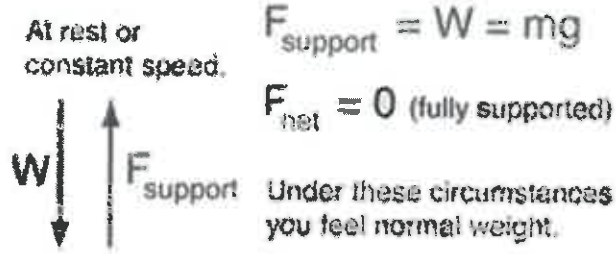
There are times when a person who is accelerating upwards or downwards can feel heavier or lighter than they actually are. Although their actual weight (force of gravity) is the same, their apparent weight differs. Apparent weight (how heavy we feel) is equal to the normal force supporting us.

Situation A: No acceleration of the Elevator

Describe 3 times when the actual and apparent weights are *equal*:

(1) rest
(2) upwards @ constant $\vec{v}$
(3) downwards @ constant $\vec{v}$

In other words, when there is zero acceleration, $F_N = F_g$.

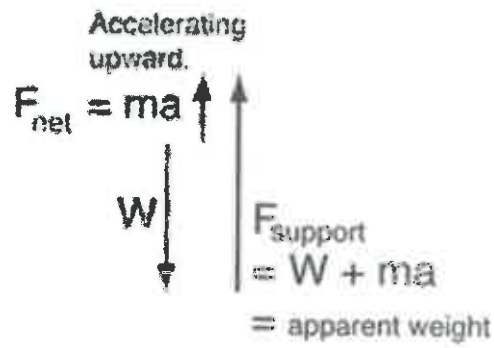


Situation B: Upwards acceleration of the Elevator

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

(1) go ↑ from rest
(2) go ↓ and stop

In other words, when there is upwards acceleration, $F_N = ma + F_g$.

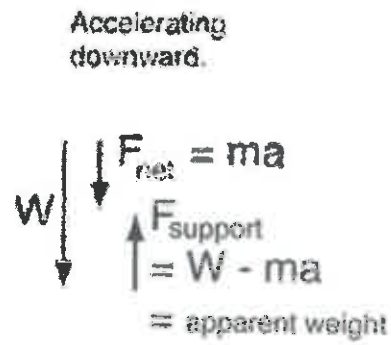


Situation C: Downwards acceleration

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

(1) go ↓ from rest
(2) go ↑ and stop

In other words, when there is downwards acceleration, $F_N = F_g - ma$.



Situation D: Freefall

$a_{elevator} = a_{occupant} \cong g \cong 9.8\ m/s^2$ Both elevator and occupant are in free fall.

$W = mg$ ↓ ↓ $F_{net} = mg$

$F_{support} = 0 =$ apparent weight

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

constant $\vec{v}$

$\Sigma F_{net\,y} = ma = 0$

$F_N - F_g = 0$

$F_N = F_g$

$F_g = mg$

$= 65\,kg\left(9.8\,\frac{m}{s^2}\right)$

$= 640\,N$

Ex 2: The same 65 kg person is in an elevator that accelerates upwards at 4.9 m/s². What is their apparent weight?

$\Sigma F_{net\,y} = ma$

$F_N - F_g = ma$

$F_N = ma + F_g$

$= 65 \cdot 4.9 + 637\,N$

$= 960\,N$

Ex 3: The elevator reaches the top floor and accelerates negatively at 4.9 m/s². What is their apparent weight?

$\Sigma F_{net\,y} = ma$

$F_g - F_N = ma$

$F_N = F_g - ma$

$= 637 - 65(4.9)$

$= 320\,N$

In Summary: