# KENNEDY SECONDARY SCHOOL, KISUBI

Physics S.3 Notes

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Week 10

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**Applications of Newton's third law of motion**

**(a) Rockets and jets**

Rockets and jet engines are designed to burn fuel in oxygen to produce large amounts of exhaust gases. These gases are passed backwards through the exhaust pipes at high velocity (large momentum).

This in turn gives the Rocket or jet a high forward momentum which is equal but opposite to that of the exhaust gases.

$$M_g v_g = -m_R v_R$$

Where $m_g v_g$ is the momentum of the exhaust gases, and $m_R v_R$ is momentum of the Rocket.

**(b) Motion in the lift**

Consider a person of mass **m** standing on the floor of the lift which is moving with an acceleration **a** with respect to the surrounding.

**i) When the lift is stationary or moving with uniform velocity**

The person exerts a weight **mg** on the lift and at the same time the lift exerts a reaction R on the person.

F = mg – R

But F = ma

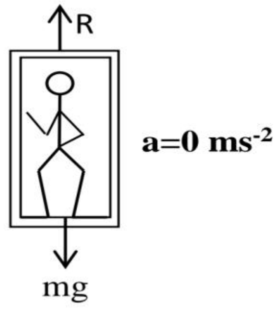
Ma = mg – R

But for uniform velocity a = 0

m x 0 = mg – R

0 = mg – R

R = mg



Thus **R = mg**

**ii) Lift is moving upwards with acceleration, a**

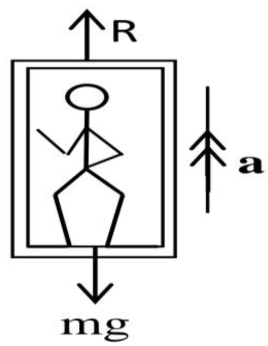
In this case, three forces act on the lift i.e the resultant accelerating force ( **ma** ), the weight( **mg** ) and the normal reaction ( **R** )

Accelerating force = Net force

$ma = R – mg$

$R = mg + ma$

$R = m (g + a)$




Thus $R = m (g + a)$

Thus, the reaction on the person (apparent weight, **R**) is greater than the actual weight of the person, mg. This is why one feels **heavier** when the lift is just beginning its upward journey.

iii) **Lift moving down wards with acceleration, a**

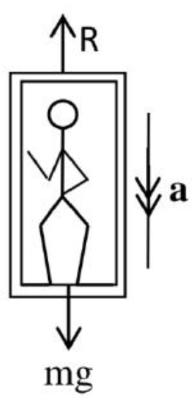
In this case, the resultant accelerating force (**ma**), and the weight, (**mg**) acts down wards. The normal reaction acts upwards.

Accelerating force = Net force

$ma = mg - R$

$R = mg – ma$

$R = m (g - a)$



Thus, the reaction on the person (apparent weight, R) is less than the actual weight of the person, mg. This is why one feels **lighter** when the lift is just beginning its downward journey.

Note: if the cable of the lift breaks, the lift moves downwards with acceleration due to gravity ( g) and an object in the lift has an acceleration equal to acceleration due to gravity i.e

$mg - R = mg$

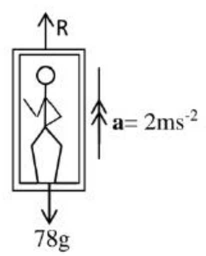
$mg - mg = R$

$R = 0$

Thus when the reaction is zero , **the person feels weightless**

**Examples**

1) A person of mass 78kg is standing inside an electric lift. What is the apparent weight of the person if the;
   a) Lift is moving upwards with an acceleration of $2ms^{-2}$?
   b) Lift is descending with an acceleration of $3ms^{-2}$?
   Solution




$m = 78kg$ , $a = 2ms^{-2}$ ,$R=?$

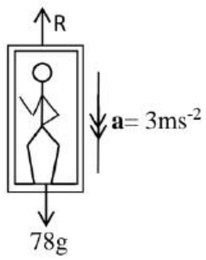
$R = mg + ma$

$R = m ( g + a )$

$R = 78 (10+2)$

**$R = 936N$**

**b) solution**




m = 78kg , a = $3ms^{-2}$ R=?

R = mg - ma

R = 78(10 - 3)

**R = 546N**

**2)** Find the reaction of a woman of mass 70kg standing in a lift if the lift is ;

a) At rest

**Solution**

**At rest there is no acceleration , a = 0**

Using F = ma

M =70kg

F = R – mg

R – mg = m x 0

R = mg

R = 70 x 10

R = 700N

**The Reaction = 700N**

b) Ascending upwards with uniform acceleration of $4ms^{-2}$.

**Solution**

a= $4ms^{-2}$ , m = 70kg , g = 10m/s using F = ma

R – mg = ma

R = m (a + g )

R = 70 ( 4 + 10 )

R = 980 N

**The reaction = 980 N**

c) Moving downwards with uniform acceleration of $4ms^{-2}$ .

**Solution**

a= $4ms^{-2}$ m = 70kg , g = 10m/s using F = ma

mg – R = ma

R = mg – ma

R = m ( g – a )

$R = 70\ (10 - 4)$

$R = 70 \times 6$

$R = 420\ N$

**The reaction is 420 N**

d) Moving downwards with uniform acceleration of $10ms^{-2}$

**Solution**

$a = 10ms^{-2}$ $m = 70kg$ , $g = 10m/s$ using $F = ma$

$mg - R = ma$

$R = mg - ma$

$R = m\ (g - a)$

$R = 70\ (10 - 10)$

$R = 70 \times 0$

$R = 0\ N$

**The reaction is 0 N**

**Revision exercise**

A. A 100kg man is standing in a lift. Find the force acting on him by the floor of the lift when ;
   i) The lift is at rest
   ii) The lift is accelerating upwards at $3ms^{-2}$
   iii) The lift is moving with constant speed of 6m/s ( take $g = 10ms^{-2}$)
   Note; for uniform velocity, acceleration = 0

B. A man 80 kg stands in a stationary lift at earth. Calculate his apparent weight when the man ;
   i) Accelerates upwards at $2ms^{-2}$
   ii) Falls freely under gravity

C. A man of mass 75kg stands in a stationary lift at earth. Calculate his apparent weight when the man ;
   i) Accelerates upwards at a rate of $4ms^{-2}$
   ii) Accelerates downwards at a rate of $4ms^{-2}$
   iii) Fall freely under gravity