Calculations on motion of objects in a lift

1) A man of mass **65kg** is accelerated upwards from the ground floor to the fifth floor in a lift at a rate of **$2ms^{-2}$**.

a) Draw a diagram to show the forces acting in the motion system.

b) Indicate the direction of motion, with acceleration of the lift.

c) Calculate:

i. The resultant force producing the acceleration in (b) above.

ii. The value of reaction force, **R** on the man in the lift.

d) Compare:

i. The value of reaction force, **R** that the man feels as his weight to the value of his actual (normal) weight, **W**.

ii. What do you conclude from your comparison above in terms of his weight?

2) A girl of mass **80kg** stands on a weighing scale on the floor of the lift. Calculate:

a. The resultant force on the girl

b. The reaction in Newtons on the weighing scale if the lift moves:

i.Upwards with an acceleration of **$2ms^{-2}$.**

ii. Down wards with an acceleration of **$2ms^{-2}$**

iii. Upwards with a constant velocity of **$6ms^{-1}$**.

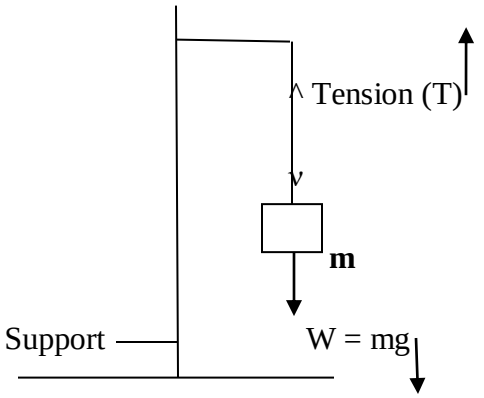
c. Compare your answers in **(b)** above and make a conclusion about what happens to the weight of a person in each case of motion in a lift.

TENSION IN A STRING

Tension is the force which pulls the ends of an object apart when it is applied. It's a stretching force.

Tension acts towards a fixed point of support when the body is at rest or moving at a constant velocity.

Illustration: consider a mass, **m** suspended on a support using inextensible string.



The mass, **m** is suspended on a support using an inextensible string. The force of gravity acts on the mass downwards. The tension force results in the string since it is tied to a rigid support. Two forces act on the mass. i.e. its weight, **W = mg** and the tension force, **T** (in the string). When the mass is at rest, its acceleration **a** = **0 ms$^{-2.}$** .

Now, using Newton's second law of motion,

T- mg = ma

T = m x a + mg

T = m (a + g), but a=0

T = m (0 + g) = mg

T = mg

If the tension force causes the object to accelerate upwards with a ms-2, then;

T – mg = ma (resultant force)

T = ma + mg

OR T = m(a + g)

So, in this case the tension in the string is greater than when the mass is at rest.

If the object accelerates downwards with acceleration, **a ms^{-2}** but still attached to the string, then;

mg – T = ma (Newton's 2nd law of motion)

T = mg – ma (reduction in Tension force)

Or T = m (g - a)

If the mass moves with a steady/constant speed, i.e. **a = 0 ms^{-2}**, then,

T- mg = ma (Newton's 2nd law of motion)

T- mg = 0

T = mg

Calculations involving Tension force (T)

1) A bail of cotton of mass **100g** is pulled upwards by a **5N** force.
   Calculate;

   a) Weight of the bail
   b) Resultant force on the bail
   c) The upward acceleration

2) A crane lifter raises a container of mass **400kg** suspended on inextensible string.
   a) Draw a diagram and indicate the forces acting on the mass of the container.
   b) If the force in the string is 4800. Find the acceleration of the mass as it rises.
   c) Calculate the value of force in the string which makes the mass of the container to move with a constant speed.

3) Aspiring balance carrying a mass of 4kg is suspended from a ceiling of a lift. Calculate the reading on the spring balance when the;
   i. Lift is ascending with an acceleration of 0.4ms-2
   ii. Lift is descending with an acceleration of 0.4ms-2
   iii. Lift is ascending with uniform velocity.

END