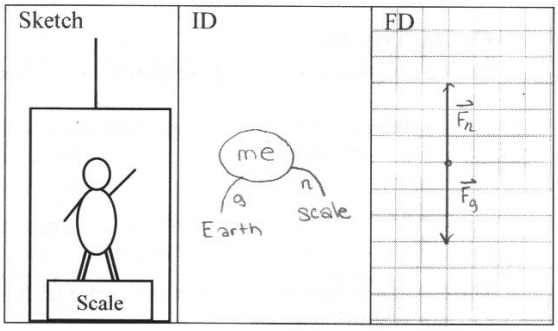
SPH4U: Weight and Acceleration

Recorder: _____
Manager: _____
Speaker: _____
0 1 2 3 4 5

A:The Elevator

You may have noticed a curious sensation while travelling in an elevator. At certain times, it feels like your weight is changing. Since you are such a curious student, you decide to investigate this. You step into an elevator at the ground floor of a tall building and stand on top of a bathroom scale that gives readings in newtons. You haven't pushed any buttons yet and you look down at the scale.



1. **Represent.** Draw an ID andFD for the system of you in the elevatorwhile it is at rest on the ground floor.

2. **Reason.** Marie suggests, "There should be another force on the FD showing the upward effect of the cable." Do you agree with Marie? Explain.
   I disagree with Marie because you are at rest and the elevator is not exerting a force on you

In the world of physics, weight is a synonym for the force of gravity: $F_g = mg$, where the gravitational field strength $g = 9.8$ N/kg. Our physical sensation of weight corresponds not to the force of gravity, but to the force supporting us (often a normal force). The reading of a bathroom scale measures this supporting force which we call our **apparent weight**.

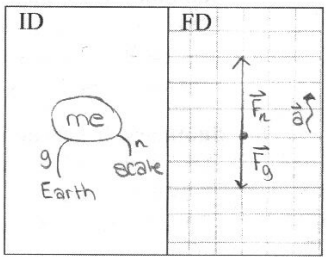
3. **Solve.** Use Newton's 2nd law ($F_{net} = ma$) to determine your apparent weight in this situation. (If you like, assume your mass is 65 kg).

   $F_{net_y} = ma_y$ $\quad F_g = mg$ $\quad \therefore$ our apparent weight is 637N
   $F_n - F_g = 0$ $\quad = 65kg\,(9.8\,N/kg)$
   $F_n = F_g$ $\quad = 637\,N$

4. **Evaluate.** Is your weight different from your apparent weight in this situation?
   In this situation my weight is the same as the apparent weight. $\vec{F}_g$ corresponds to weight & F_n corresponds to apparent weight. I am at rest, so they should be the same

B:Going Up!

Now you press the button in the elevator and go for a ride! The elevator starts speeding up as it begins your trip to the 20th floor.



1. **Reason.** Isaac says, "In this situation we need to add another upwards force to the force diagram since youare now accelerating upwards." Do you agree or disagree with Isaac? Explain and draw a revised ID and FD for this situation.
   I disagree because there are no additional forces being introduced to the system

2. **Predict.**Will the reading of the scale increase or decrease compared to the when you were at rest? Explain without using any math.
   The reading of the scale will increase compared to when I was at rest because the normal force is greater.

3. **Test.** Hang a heavy mass from a spring scale and gently accelerate it upwards. Compare the scale's reading (apparent weight) with the weight of the object (force of gravity). Does this agree with your prediction?
   Before accelerating, the scale reading was 5N. When it accelerated, the scale reading became greater. This agrees with our prediction

4. **Solve.** The elevator is accelerating at a rate of 1.5 m/s^2. Use Newton's 2nd law to determine your apparent weight. How does this compare with your weight?

$F_g = mg$
$= 65kg\ (9.8N/kg)$
$= 637\ N$

$F_{net_y} = ma_y$
$F_n - F_g = ma_y$
$F_n = ma_y + F_g$

$F_n = 65kg(1.5m/s^2) + 637N$
$= 734.5$

∴ the apparent weight is 734.5N

C: The Trip Up

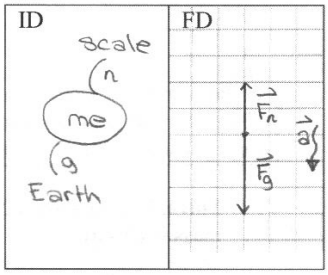
It is larger than my weight

As you are going up, somewhere around the 2nd floor you notice the scale reading returns to normal.

1. **Explain.** How has the motion of the elevator changed? Use your spring scale and mass to help explain.
The elevator is now travelling with a constant velocity. If we held our spring scale with the weight at rest then had it accelerate upwards, we would notice that the reading was greater. Then, when it stopped accelerating the reading would return to what it was at the beginning

The elevator is near the 19th floor and continues to move upwards, but you notice another change to the scale reading as the elevator is slowing down.

2. **Reason.** Emmy comments, "I think the upwards force must still be larger than the downwards, or else the elevator would not be moving upwards." Respond to Emmy and draw a new ID and FD.
I disagree with Emmy. Since the elevator is slowing down, the acceleration is in the downwards direction, meaning the upwards force should be smaller.



3. **Predict and Test.** How will the reading of the scale will change as the elevator slows down? Test this with your mass and spring scale. Describe your observations.
The reading of the scale will decrease as the elevator slows down since the normal force is smaller than the force of gravity. We pulled the mass and spring scale up with constant velocity. Then we slowed it down and noticed the the reading was smaller.

4. **Solve.** The elevator slows at a rate of 3.4 m/s^2. Determine your apparent weight.

$F_g = mg$
$= 65kg(9.8N/kg)$
$= 637N$

$F_{net_y} = ma_y$
$F_n - F_g = ma_y$
$F_n = ma_y + F_g$

$F_n = 65kg(-3.4m/s^2) + 637N$
$= 416N$

∴ the apparent weight 416N

5. **Summary**. How did the interaction and forces change in the different situations you have explored?
The interactions did not change, as there were no additional forces introduced. The normal in these situations changed. This is reasonable because normal can change.

6. **Summary.** In general, how is apparent weight related to the acceleration of an object?
If the acceleration is in the positive direction, the apparent weight will be greater. If the acceleration is in the negative direction, the apparent weight will be smaller

D: A Strange Elevator

You wake up to find yourself in a very strange elevator with no buttons, lights or windows. You are floating just above the scaleand have lost the sensation of weight. The scale itself reads zero. Offer two possible explanations for this very curious situation.

1) You are at rest in outer space and there is no gravity, so no normal force.

2) You may be in free fall, where the normal force is 0 and you were accelerating downwards at 9.8 m/s2