ELEVATOR SYSTEMS

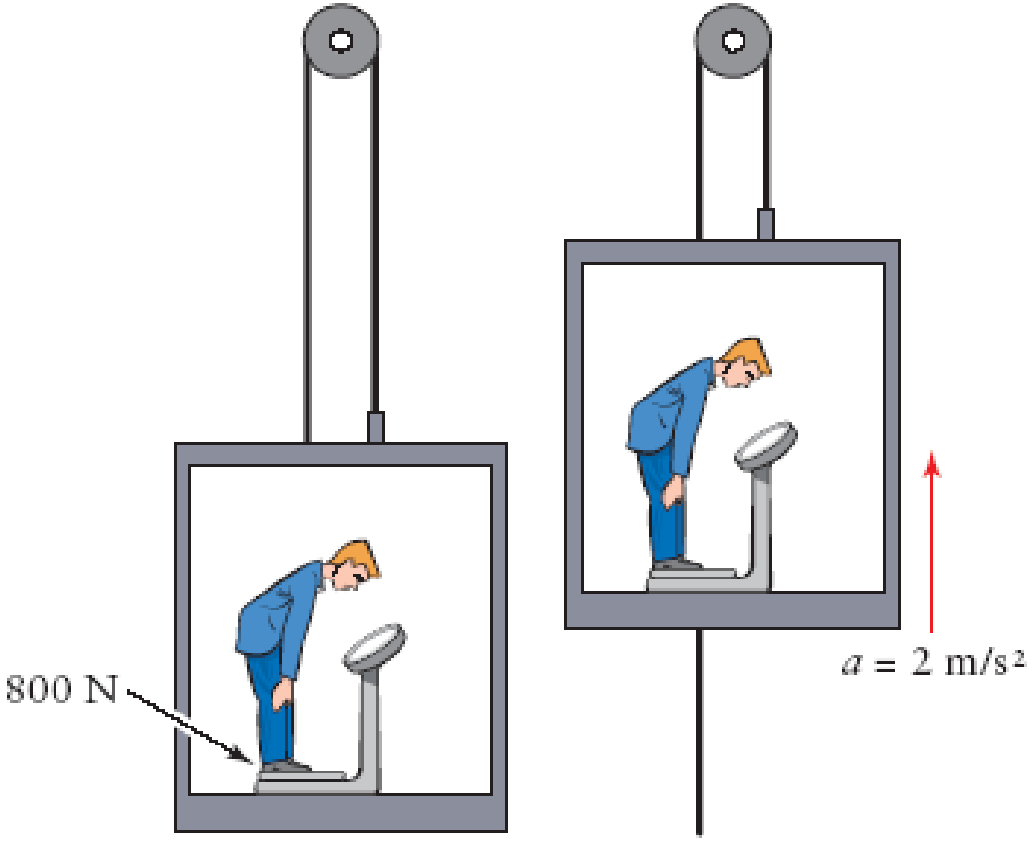
APPLYING NEWTON'S LAWS OF MOTION

PowerPoint Presentation By: Jay Gregorio, AHS

Objectives

- identify the forces acting on the elevator systems;
- use vector arrows to represent magnitude and direction of the forces acting on the system;
- differentiate true weight from apparent weight;
- find the magnitude of the net force and acceleration in elevator systems;

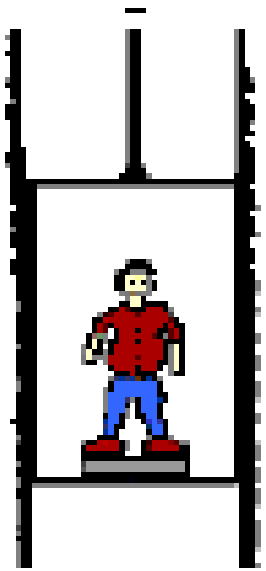
A person stands on a bathroom scale inside the elevator. The scale reads 800 N if the elevator is at rest. What is the scale reading when the elevator accelerates at 2.0 m/s^2 upward?



SOLUTION

1) Describe the motion of the body. Is the body speeding up or slowing down? Upward or downward?
2) Decide whether the acceleration is + or -.
3) Find the mass using $F_g = mg$. That is, $m = F_g/g$
4) Use the equation for apparent weight, $F_N = m(g + a)$ considering that the object is speeding up upwards.
5) Answer is $\mathbf{F_N = 963.27\ N}$.

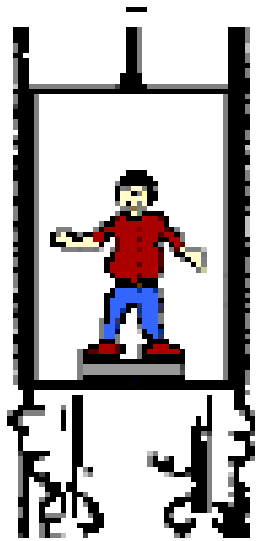
If the person's weight is 500 N, which of the following situations will give a scale reading of 400 N? Briefly explain why the other 3 choices will not result to 400 N.



Constant Speed

$a = 0\ m/s/s$

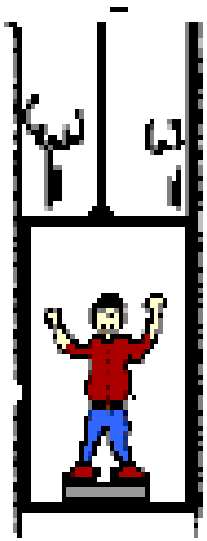
A



Upward Accel'n

$a = 5.0\ m/s/s$, up

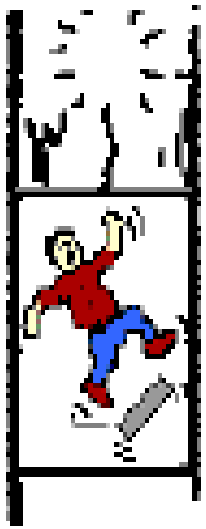
B



Downward Accel'n

$a = 5.0\ m/s/s$, down

C



Downward Accel'n

$a = 9.8\ m/s/s$, down

D

SOLUTION

1) True weight is 500 N and apparent weight is 400 N. If $F_N < F_g$, what happens on the object?
2) Acceleration up is + and acceleration down is -.
3) Option A is at rest and $F_N = F_g$.

   *Option B is moving up so $F_N > Fg$.

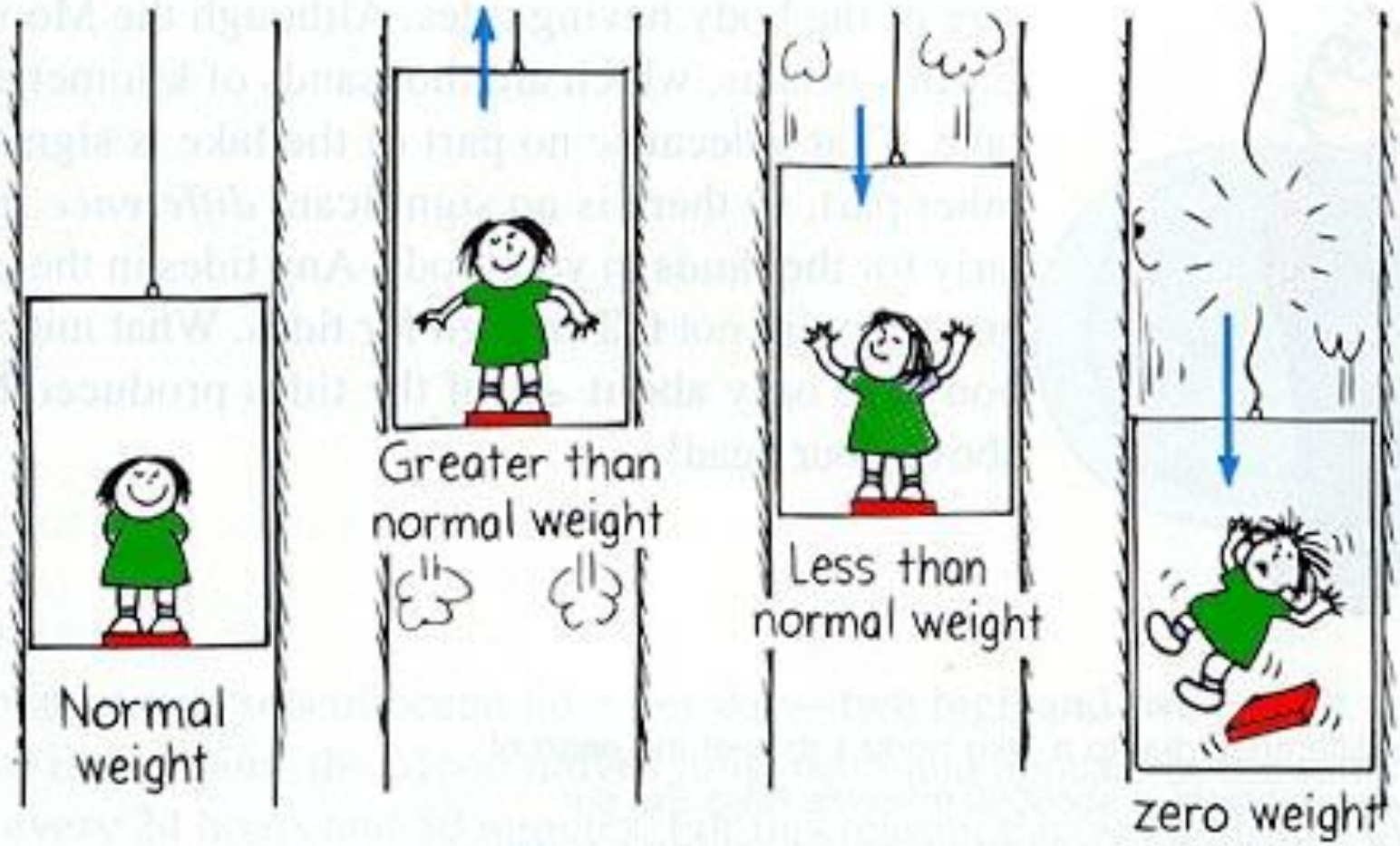
   **Option C is moving down so $F_N < F_g$.

   Option D is freefall so $F_N = 0$.

*Assuming +a

**Assuming -a

Write the mathematical expressions for the apparent weight in each of the following situations.



A **B** **C** **D**

SOLUTION

Option A: $\mathbf{F_{net} = 0}$ (reading on scale is true weight)

Option B: $\mathbf{F_N = m(g + a)}$

Option C: $\mathbf{F_N = m(g - a)}$

Option D: $\mathbf{F_N = 0}$ (body experiences freefall)

- A person of mass 80.00 kg is in an elevator. Determine what the scale they are standing on would read in each of the circumstances:

  a) elevator is moving up at a constant speed

  b) elevator is moving down at a constant speed

  c) elevator is accelerating up at 3.20 m/s^2

  d) elevator is accelerating down at 3.20 m/s^2

SOLUTION

1) At a constant speed (either down or up), the net force is zero. The reading on the scale is the true weight.
2) If the body accelerates up, use $F_N = m(g + a)$

   $F_N = 1040.00$ N
3) If the body accelerates down, use $F_N = m(g - a)$

   $F_N = 528.00$ N

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