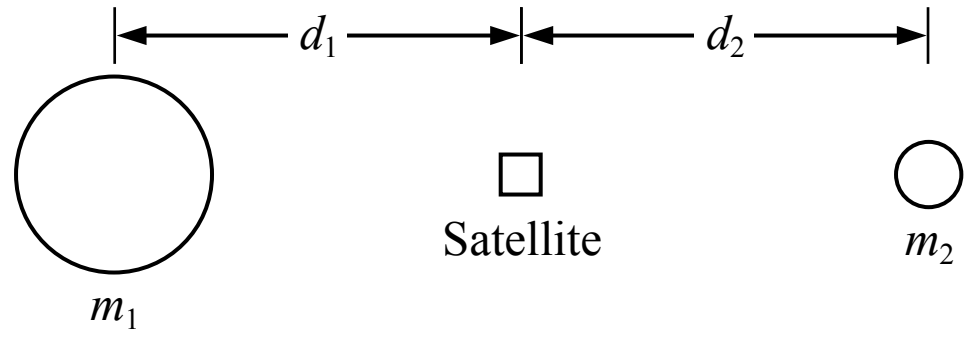
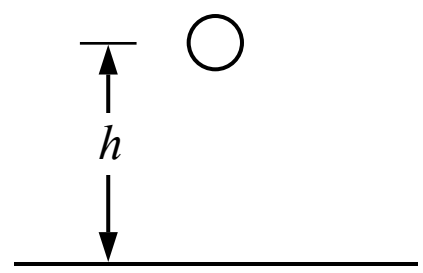
GRAVITY & WEIGHT



Note: Figure not drawn to scale.

1. A satellite is in line with a planet of mass m_1 and a moon with a mass of m_2 as shown in the figure above, and m_1 is greater than m_2. The net force on the satellite is zero at this position. How does the distance between the satellite and the center of the planet, d_1, compare to the distance between the satellite and the center of the moon, d_2?

   (A) $d_1 > d_2$
   (B) $d_1 < d_2$
   (C) $d_1 = d_2$
   (D) Cannot be determined



2. A ball with a mass of m is at a height of h above the ground on a planet with a mass of M and a radius of R. Which of the following is a correct expression for the acceleration of the ball the moment it is released from that height?

   (A) $\dfrac{GM}{R^2}$

   (B) $\dfrac{GMm}{(R+h)^2}$

   (C) $\dfrac{GM}{(R+h)^2}$

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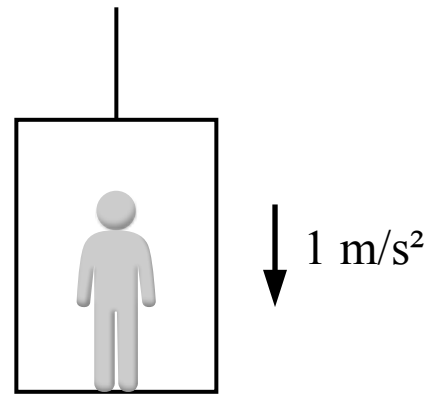


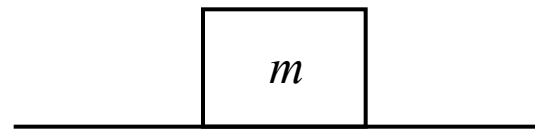
3. A person is standing in an elevator which is accelerating downwards at 1 m/s². Which of the following is true of the net force acting on the person?

   (A) The net force on the person is downwards

   (B) The net force on the person is upwards

   (C) There is no net force acting on the person

   (D) The direction of the net force cannot be determined



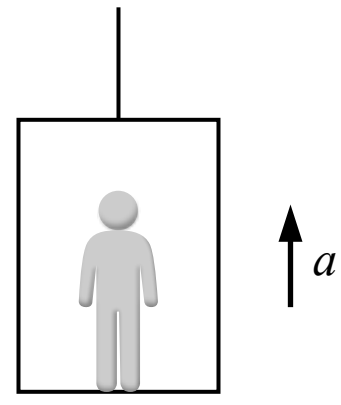
4. A block with a mass of m is sitting on the surface of a planet where the gravitational field strength is 20% of the gravitational field strength near the surface of earth. If the weight of the block on this planet is 100 N the mass of the block is most nearly

   (A) 10 kg

   (B) 50 kg

   (C) 2 kg

   (D) 13 kg



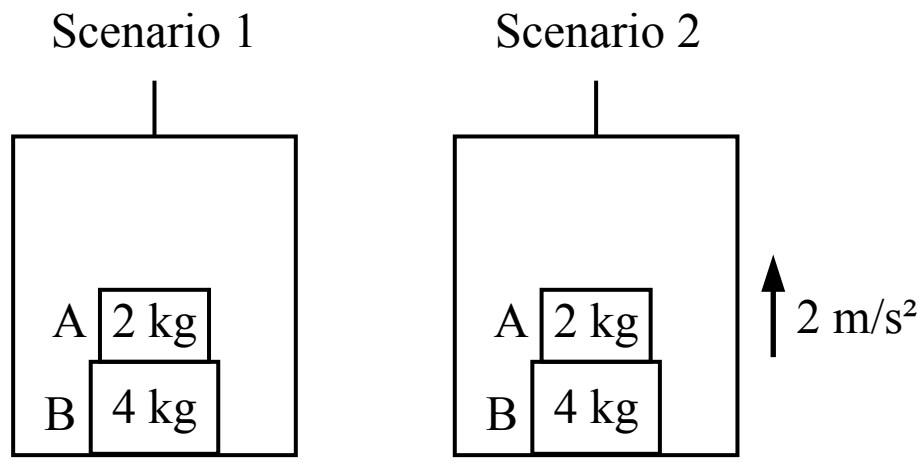
5. A person is standing in an elevator which is accelerating upwards. Which of the following is true of the person's apparent weight?

   (A) The person's apparent weight is zero

   (B) The person's apparent weight is equal to the person's weight

   (C) The person's apparent weight is less than the person's weight, but is not zero

   (D) The person's apparent weight is greater than the person's weight



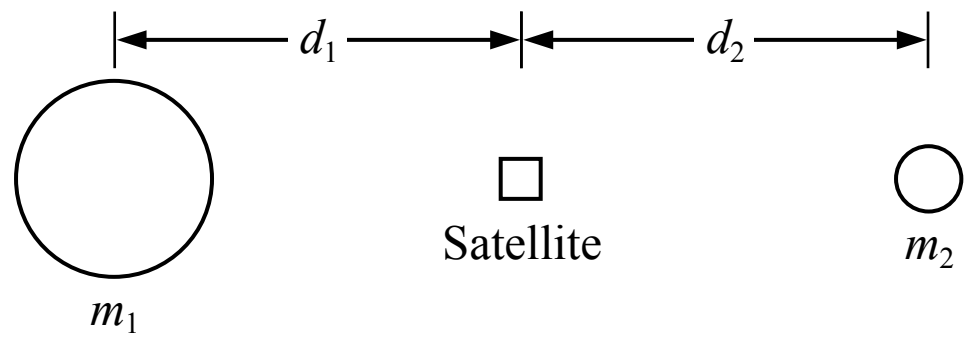
6. Two blocks with different masses are stacked on the floor of an elevator as shown in the figure above. In scenario 1 the elevator is at rest and in scenario 2 the elevator is accelerating upwards. Which of the following statements is true?

   (A) The weight of block A in scenario 1 is greater than the weight of block B in scenario 2

   (B) The weight of block B in scenario 1 is greater than the weight of block A in scenario 2

   (C) The weight of block B in scenario 1 is equal to the weight of block A in scenario 2

   (D) The weight of block A in scenario 1 is equal to the weight of block B in scenario 1



Note: Figure not drawn to scale.

1. A satellite is in line with a planet of mass m_1 and a moon with a mass of m_2 as shown in the figure above, and m_1 is greater than m_2. The net force on the satellite is zero at this position. How does the distance between the satellite and the center of the planet, d_1, compare to the distance between the satellite and the center of the moon, d_2?

(A) $d_1 > d_2$

(B) $d_1 < d_2$

(C) $d_1 = d_2$

(D) Cannot be determined

A **Correct**

The only forces acting on the satellite are the two gravitational forces exerted by the planet and the moon. The forces act in opposite directions and the net force on the satellite is zero, so the gravitational forces from the planet and the moon are equal in magnitude.

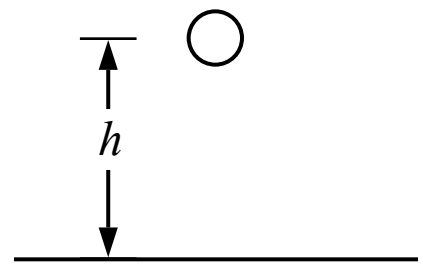
$$\Sigma F = F_{g2} - F_{g1} = 0 \qquad F_{g1} = F_{g2} \qquad \frac{G m_1 m_s}{d_1^2} = \frac{G m_2 m_s}{d_2^2}$$

If m_1 is greater than m_2 then d_1 must be greater than d_2 for the forces to be equal in magnitude.

B Incorrect

C Incorrect

D Incorrect



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(A) $\dfrac{GM}{R^2}$

(B) $\dfrac{GMm}{(R+h)^2}$

(C) $\dfrac{GM}{(R+h)^2}$

(D) $\dfrac{GMm}{R^2}$

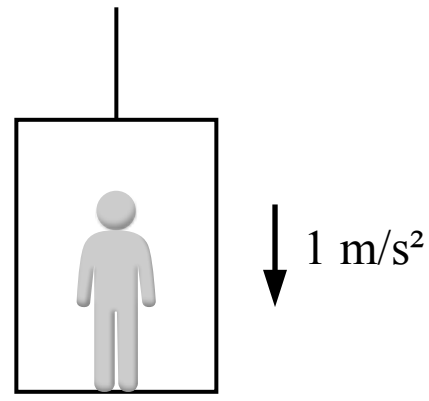
A Incorrect
This answer incorrectly uses the radius of the planet R as the distance between the center of the ball and the center of the planet.

B Incorrect
This answer is the expression for the gravitational force acting on the ball from the planet.

C Correct
The ball is in projectile motion or free fall and its downwards acceleration is the acceleration due to gravity at that point, which is the same as the gravitational field stength at that point. The distance between the center of the ball and the center of the planet is the radius of the planet plus the height above the surface (ground).

$$a = g = \frac{GM}{r^2} = \frac{GM}{(R+h)^2}$$

D Incorrect
This answer would be the expression for the gravitational force acting on the ball, and it also incorrectly uses the radius of the planet R as the distance between the center of the ball and the center of the planet.



3. A person is standing in an elevator which is accelerating downwards at 1 m/s². Which of the following is true of the net force acting on the person?

(A) The net force on the person is downwards

(B) The net force on the person is upwards

(C) There is no net force acting on the person

(D) The direction of the net force cannot be determined

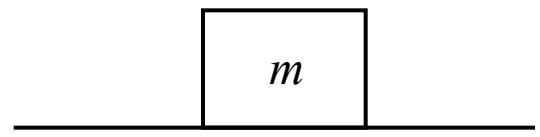
A **Correct**

The person is accelerating downwards so the net force acting on the person must be downwards (Newton's 2nd law of motion).

B Incorrect

C Incorrect

D Incorrect



4. A block with a mass of m is sitting on the surface of a planet where the gravitational field strength is 20% of the gravitational field strength near the surface of earth. If the weight of the block on this planet is 100 N the mass of the block is most nearly

(A) 10 kg

(B) 50 kg

(C) 2 kg

(D) 13 kg

A Incorrect

This answer incorrectly uses 10 m/s² for the gravitational field strength or the acceleration due to gravity on the planet.

B Correct

The weight of the block is equal to the mass multiplied by the gravitational field strength or the acceleration due to gravity. The gravitational field strength on the planet would be 20% of 10 m/s² (or 10 N/kg).

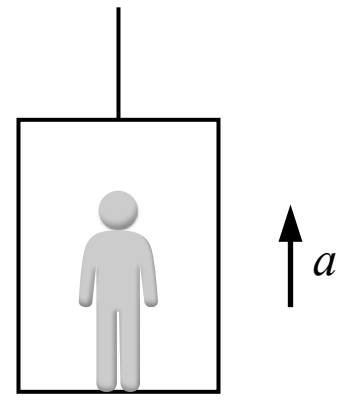
$w = F_g = mg \qquad (100\ \text{N}) = m(0.2)(10\ \text{m/s}^2) \qquad m = 50\ \text{kg}$

C Incorrect

This answer incorrectly divides 10 m/s² by 0.2 to get 50 m/s² for the gravitational field strength or the acceleration due to gravity on the planet.

D Incorrect

This answer incorrectly uses 80% of 10 m/s² for the gravitational field strength of the acceleration due to gravity on the planet.



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(A) The person's apparent weight is zero

(B) The person's apparent weight is equal to the person's weight

(C) The person's apparent weight is less than the person's weight, but is not zero

(D) The person's apparent weight is greater than the person's weight

A Incorrect

The person's apparent weight would be zero if the elevator and the person were in free fall and accelerating downwards at 10 m/s², when the normal force on the person would be zero.

B Incorrect

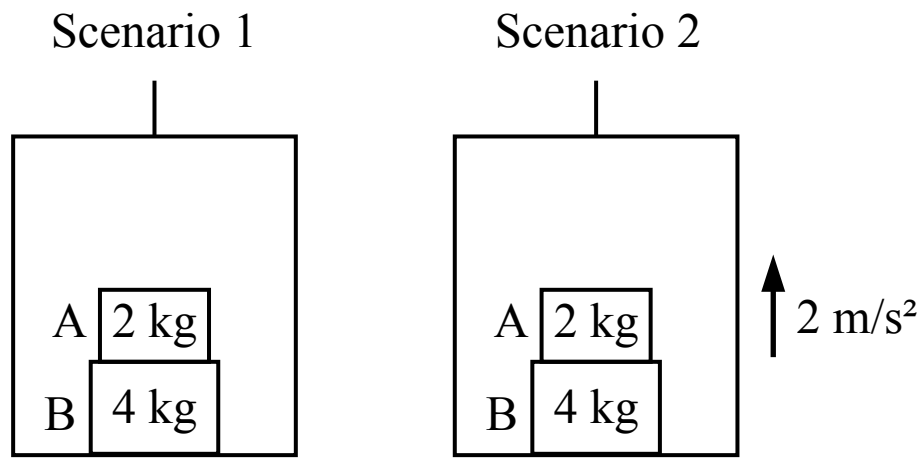
The person's apparent weight would be equal to their true weight if they were not accelerating.

C Incorrect

The person's apparent weight would be less than the true weight, but not zero, if the elevator and the person were accelerating downwards at a rate less than 10 m/s².

D Correct

There is a downwards weight force (gravitational force) and an upwards normal force acting on the person. The person is accelerating upwards so the net force on the person is upwards (Newton's 2nd law) and the upwards normal force must be greater than the downwards weight force. The person's apparent weight is the magnitude of the normal force acting on them, which is greater than the weight force.



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(B) The weight of block B in scenario 1 is greater than the weight of block A in scenario 2

(C) The weight of block B in scenario 1 is equal to the weight of block A in scenario 2

(D) The weight of block A in scenario 1 is equal to the weight of block B in scenario 1

A Incorrect

The weight of block A in scenario 1 is 20 N and the weight of block B in scenario 2 is 40 N.

B Correct

The question is asking about the weight of the blocks, not the apparent weight. The weight of an object is always the mass of the object multiplied by the gravitational acceleration (or the gravitational field strength), $w = F_g = mg$, regardless of the motion of the object.

Weight of block A in both scenarios: $F_g = mg = (2\ \text{kg})(10\ \text{m/s}^2) = 20\ \text{N}$

Weight of block B in both scenarios: $F_g = mg = (4\ \text{kg})(10\ \text{m/s}^2) = 40\ \text{N}$

C Incorrect

The weight of block B in scenario 1 is 40 N and the weight of block A in scenario 2 is 20 N.

D Incorrect

The weight of block A in scenario 1 is 20 N and the weight of block B in scenario 1 is 40 N.