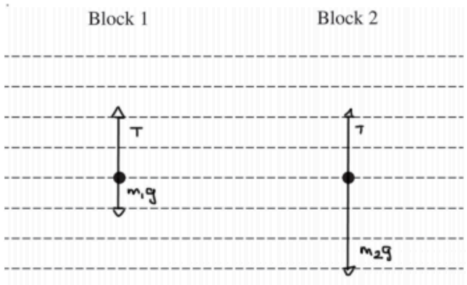
1. A.



B.

Newton's second law: $F = ma$

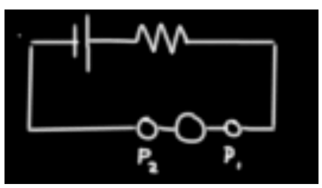
Calculate net force: $\Sigma F = m_2g - m_1g$

Substitute, solve, and simplify: $a = \frac{\Sigma F}{m_1+m_2} = \frac{g(m_2-m_1)}{m_1+m_2}$

C.

The magnitude of acceleration should be smaller. The new equation would be $a = \frac{g(m_1+m_2)}{m_1+m_2+m_3}$, and because mass is inversely related with acceleration, acceleration will decrease.

2. A.



Build the circuit like the following. The bulb goes in between P_1 and P_2. Using a multimeter, measure and record the amp difference from P_1 to P_2. Do the same again, except measure and record voltage.

B.

I.

Using the difference in current (or amps) across P_1 and P_2, you can test to see if there is a difference in the amount of electrons entering/leaving the bulb. The difference should basically be 0 in ideal situations.

II.

The voltage difference from across P_1 and P_2 represents the electric potential energy difference. A bulb should have some voltage difference, and it cannot be 0.

C.

I.

Replace the constant power source with a variable power source

II.

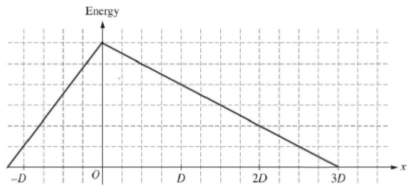
With the variable power source, adjust and record the voltage and the current P_1 and P_2.

D.

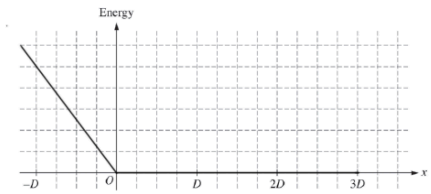
With a normal lightbulb, the voltage is proportional to its current. A non ohmic light bulb current will not be proportional to the voltage because of the resistance change.

3. A.

I.



II.



B.

I.

The student was right about the block having more energy if it was compressed twice as much as before, and that it will slide farther along the track. This is because the potential energy is proportional to the square of displacement in $PE = \frac{1}{2}kx^2$. The more potential energy, the more kinetic energy there is, allowing to to have a higher launch velocity which causes it to go further

II.

The part where the student said that it will go twice it's original distance is false. Because $PE = \frac{1}{2}kx^2$, and x is increased by 2 times, this means the total energy is increased by 4 times

C.

Friction: $F_{fr} = \mu F_N$

Work relationships: $W = \frac{1}{2}kx^2 = F_{fr}D$

Substitute:$\frac{1}{2}kD^2 = \mu F_N 3D$

Substitute:$\frac{1}{2}k(2D)^2 = \mu F_N 3D \times 2^2$

$4kD = 12\mu F_N D$

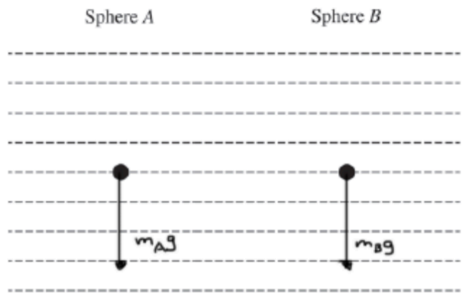
$kD = 3\mu F_N D$

The distance has increased by 3 times. If the original distance was $3D$, and spring displacement increased by 2, then the final distance must be $12D$

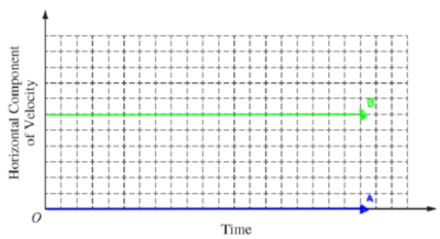
D.

The spring was compressed twice as much, which is represented when displacement of the spring is multiplied by 2. The student got that part right. When the displacement is multiplied by two, the total potential energy increases, which causes the friction to do more work, thus causing a higher block displacement. The student also got this part right. The student did not get the part about block displacement being proportional to the square of spring displacement.

4. A.



B.



C.

The spheres reach the ground at the same time because the vertical component of force is identical. Both objects will still accelerate towards the ground at the acceleration of gravity, which is $9.8\frac{m}{s}$. Because the objects are accelerating down at the same rate, they will hit the ground at the same time. The horizontal components on sphere B do not impact the vertical component, as they are perpendicular.

5. A.

Because fundamental frequencies are calculated using $f = \frac{v}{2L}$, and since $L$is constant, $v$must change. It is given that $v = \sqrt{\frac{F_T}{\frac{m}{l}}}$, and since $F_T = Mg$ and that it is constant, the linear mass density must vary from string to string.

B.

$$f = \frac{1}{\frac{v}{2L}} = \frac{1}{\frac{\sqrt{\frac{F_T}{\frac{m}{l}}}}{2L}} = \frac{2L}{\sqrt{\frac{f}{\frac{m}{l}}}}$$

No, this is not linear. Linear functions typically follow a pattern of $y = mx + b$, but this follows the form of $y = \sqrt{x}$

C.