1. A.
   I.
   Center to Down (Force of gravity)
   Normal force o
   Point of contact to left parallel (force of static friction)
   II.
   Static friction. This is because the force of gravity does not actually turn the wheel, it is in fact the force of friction turning the wheel, because it is applying torque.
   B.
   $F_S = 0.4Mg\ sin(\theta)$
   $\Sigma F = Mg\ sin(\theta) - 0.4Mg\ sin(\theta) = 0.6Mg\ sin(\theta)$
   $Ma = \Sigma F$
   $a = 0.6g\ sin(\theta)$
   C.
   I.
   The net force on the block allowing it to move is $mg\ sin(\theta)$, however, the wheel rolls without slipping, which means that the net force on the block must be $mg\ sin(\theta) - F_S$, causing it to be less. With less force, the lower the velocity. The block therefore be the fastest
   II.
   The same principle can be applied, except in terms of energy. Each of the objects start with the same potential energy, being $PE = mgy$. 100% of the blocks energy is translated into translational kinetic energy $KE = \frac{1}{2}mv^2$, however only some part for the wheel is translated into translational kinetic energy, the rest must go towards rotational kinetic energy, or $\frac{1}{2}I\omega^2$. Therefore, since $mgy = \frac{1}{2}mv^2$ for the block and $mgy = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2$ for the wheel, that means block will have a higher translation kinetic, therefore higher velocity
2. A.
   I.
   Height of drop
   II.
   Meter stick, used to measure initial height and bounce peak height
   III.
   Drop the ball from a specific height, then record the peak height. Repeat this, starting from lower heights to higher heights.
   B.
   Plot the data onto a graph. A perfectly elastic ball can be represented with $y = x$, so compare the best line of fit with a perfectly elastic ball. If $m = 1$, then the ball is perfectly elastic, and if $m < 1$, that means the ball has lost energy.
   C.
   I.
   An example of a low-speed elastic collision would be dropping the ball 1 meter up in the air, and seeing that it bounced back up and reached a peak height of 1 meter. An example of a high-speed

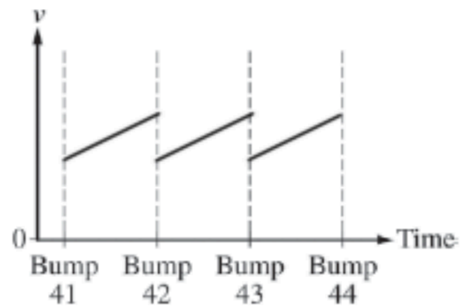
collision violating basic physics principles would be dropping one from 10 meters, and seeing that it bounced up with a peak of 15 meters.

II.

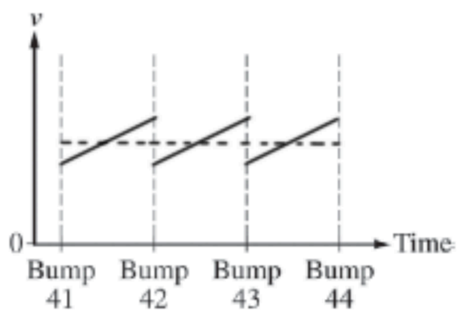
If the slope for the best line of fit is over 1, then something is violating physics principles. This is because the height of the bounce can never be higher than the initial without any external forces. Energy is conserved and it is not created

3. A.

I.



II.



B.

Greater. This is because the decrease in velocity is spaced out, which means there is less deceleration, or in other words, less of the energy is transferred to the bumps, which means more of the energy can go into the translation energy.

C.

It should increase because an increase in the angle will increase the force $mg\ sin(\theta)$, which causes an increase in acceleration, thus causing a faster maximum speed

D.

I.

No, this is because it isn't directly proportional

II.

No, because increasing distance should not decrease average velocity; instead it should increase it

4. A.

A > B = C > D

The change in voltage or potential difference is the same. This means whichever bulb is first has the highest, and the last bulb will have the lowest.

B.

Increase.

The original total resistance of the circuit can be modeled with $3R$, R being the resistance of one of the resistors. After the modification, the total resistance of the circuit is $\frac{5}{2}R$, or $2.5R$. Because total resistance has decreased, the total current must increase. Now the modification converted the circuit to series, meaning that the current flowing through A must have increased when compared to the previous.

C.

Increase

Because C was originally in parallel, this means that it was getting $\frac{1}{2}$of the total system current. Because system current was proven to increase in the previous problem, and that resistors in series circuits share the same current, the current through C must have increased

5. A.

The tension on point P is larger because it is supporting more of the rope's mass, it needs to support the mass on Q and inbetween.

B.

Because the velocity is determined by $v = \sqrt{\frac{F_T L}{m}}$, and because the frequency is constant across the whole string, then wavelength must have changed as $v = \lambda f$. This equation can be re-written as $\sqrt{\frac{F_T L}{m}} = \lambda f$. When tension increases, then wavelength must also increase, which is represented in the drawing