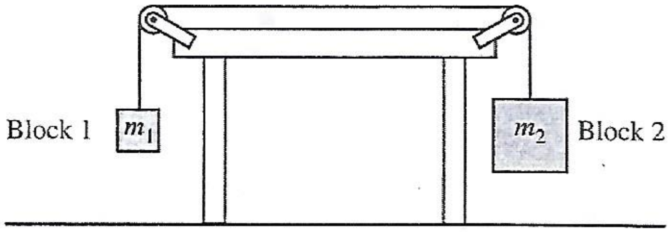
Name ______________________________ Date ______________________________

AP Physics AP Review # 13

Period __________ Mrs. Nadworny

AP Review # 13



Note: Figure not drawn to scale.

1. (7 points, suggested time 13 minutes)

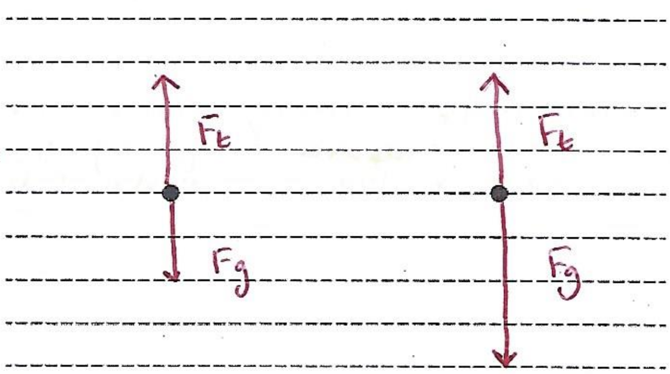
Two blocks are connected by a string of negligible mass that passes over massless pulleys that turn with negligible friction, as shown in the figure above. The mass m_2 of block 2 is greater than the mass m_1 of block 1. The blocks are released from rest.

(a) The dots below represent the two blocks. Draw free-body diagrams showing and labeling the forces (not components) exerted on each block. Draw the relative lengths of all vectors to reflect the relative magnitudes of all the forces.

(1) F_t - draw both, same size, point up

(1) F_g - draw both, F_{g2} longer, point down

-1 if $F_{g1} > F_t$



(b) Derive the magnitude of the acceleration of block 2. Express your answer in terms of m_1, m_2, and g.

(1) block 1
(1) block 2
(1) final eqn

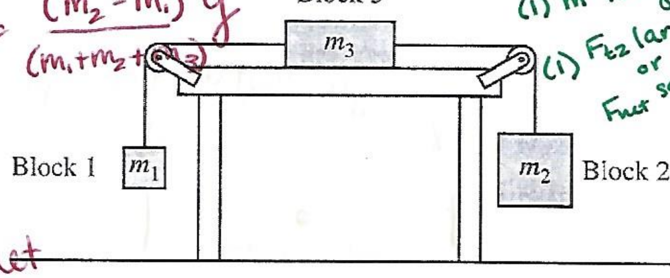
$$a = \frac{F_{net}}{m_{net}} = \frac{F_{g2} - F_{g1}}{m_1 + m_2} = \frac{(m_2 - m_1)g}{(m_1 + m_2)}$$

or (1) $F_{net} = (m_2 - m_1)g$ (1) $F_{net} = (m_2 + m_1)a$ (1) combine

Block 3 of mass m_3 is added to the system, as shown below. There is no friction between block 3 and the table.

$$a = \frac{F_{net}}{m_{net}} = \frac{F_2 - F_1}{m_1 + m_2 + m_3} = \frac{(m_2 - m_1)g}{(m_1 + m_2 + m_3)}$$

(1) m larger
(1) F_{t2} larger or F_{net} same

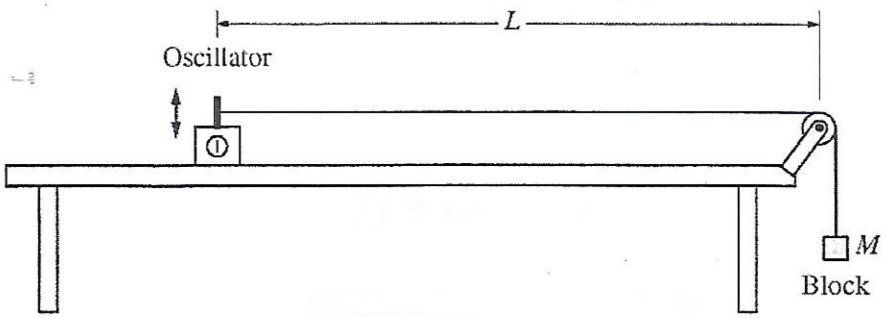


Note: Figure not drawn to scale.

The acceleration will decrease. The third block does not contribute to the net force of the system, but it does increase the net mass of the system. This increased mass decreases the acceleration of this system.

(c) Indicate whether the magnitude of the acceleration of block 2 is now larger, smaller, or the same as in the original two-block system. Explain how you arrived at your answer.

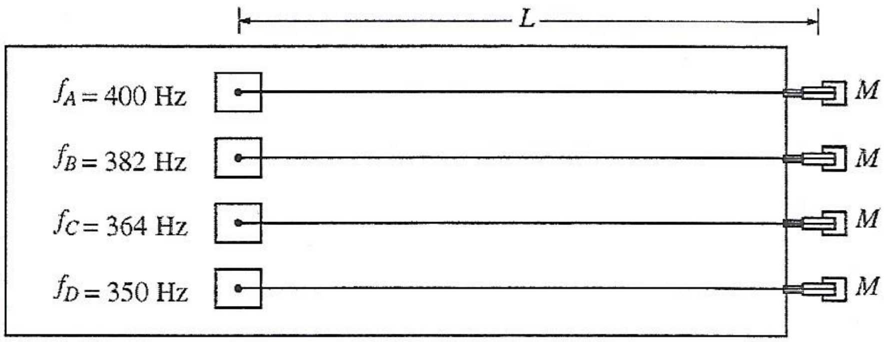
continued on back →



Side View

5. (7 points, suggested time 13 minutes)

The figure above shows a string with one end attached to an oscillator and the other end attached to a block. The string passes over a massless pulley that turns with negligible friction. Four such strings, *A*, *B*, *C*, and *D*, are set up side by side, as shown in the diagram below. Each oscillator is adjusted to vibrate the string at its fundamental frequency *f*. The distance between each oscillator and pulley *L* is the same, and the mass *M* of each block is the same. However, the fundamental frequency of each string is different.



Top View

$L = \frac{1}{2}\lambda$

$\lambda = 2L$

(1) same λ
(1) diff f means diff v
(1) F_t same so μ diff

a) Each string has a different linear density. Since each wave has the same wavelength ($\lambda = 2L$) but different frequency they must travel at different speeds. Since $v = \sqrt{F_t/m/L}$ and each has the same F_t + L, the actual mass of the string must be different.

The equation for the velocity v of a wave on a string is $v = \sqrt{\dfrac{F_T}{m/L}}$, where F_T is the tension of the string and m/L is the mass per unit length (linear mass density) of the string.

(a) What is different about the four strings shown above that would result in their having different fundamental frequencies? Explain how you arrived at your answer.

(b) A student graphs frequency as a function of the inverse of the linear mass density. Will the graph be linear? Explain how you arrived at your answer.

(1) eqn
(1) explain

$v = f\lambda$

$f = \frac{v}{\lambda} = \sqrt{\frac{F_t}{m/L}}\left(\frac{1}{\lambda}\right)$

$f = \left(\frac{1}{\sqrt{\mu}}\right)\left(\frac{\sqrt{F_t}}{\lambda}\right)$

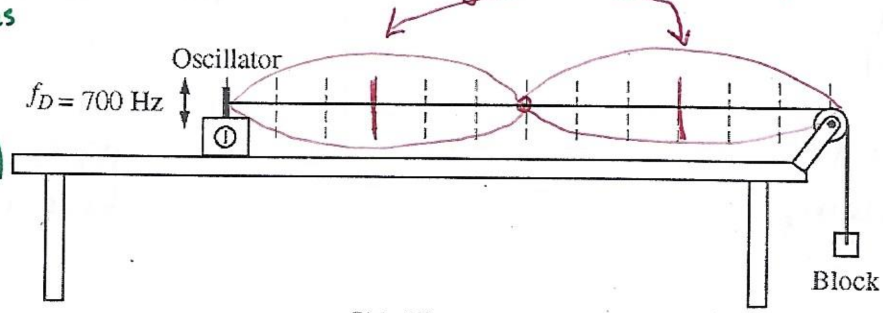
f vs $1/\mu$

When the student graphs f vs $\frac{1}{\mu}$ they will not get a linear graph. As shown in the equation f is proportional to the inverse square root of μ. The student should graph f vs $\frac{1}{\sqrt{\mu}}$ to get a linear graph.

(c) The frequency of the oscillator connected to string *D* is changed so that the string vibrates in its second harmonic. On the side view of string *D* below, mark and label the points on the string that have the greatest average vertical speed.

greatest vertical speed

(1) Wave drawn
(1) mark antinodes
(full credit for mark correct spots w/o wave)



Side View