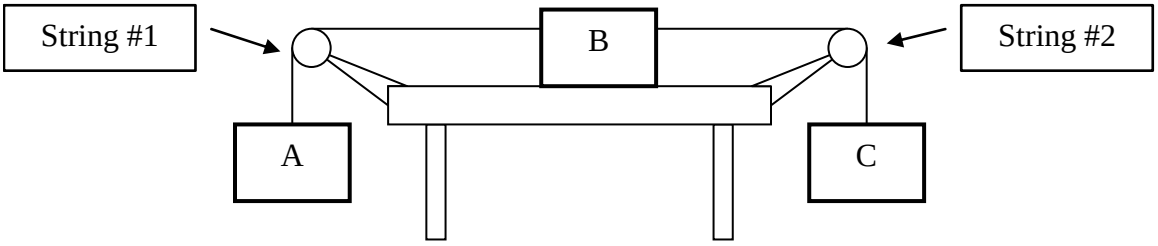
Quiz #6 Physics 201

NAME: **SOUTION**

$\sum \vec{F} = \frac{d\vec{p}}{dt} = m\vec{a}$ (if mass is constant), $\vec{F}_{AB} = -\vec{F}_{BA}$ (always), $1\,newton = 1\frac{kg\ m}{s^2}$

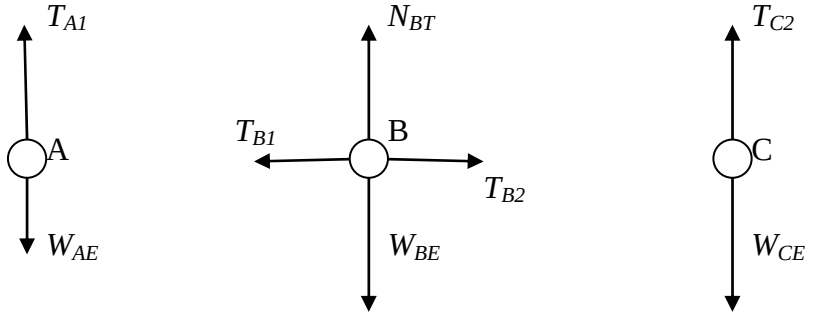
Two blocks (block A and block C) hang from strings that run over pulleys attached to opposite ends of a small table. The other end of each string is attached to a third block (block B) which is on the horizontal surface of the table. The strings that attach to block B are horizontal. For the purposes of this question ignore the masses of the strings, the masses of the pulleys and friction in the pulleys.

Throughout this quiz: Block A has a mass of 1.3 kg, Block B has a mass of 2.5 kg, and Block C has a mass of 2.2 kg. The acceleration of objects in free fall is 10.0 m/s^2.



a) For part (a) of this quiz, assume there is no friction between the table and block B (so there is no friction anywhere).

i) Find the acceleration of block B.



$T_{A1} = T_{B1} = T_1$ $\quad T_{A2} = T_{B2} = T_2$ (massless strings)

Block A: $\Sigma F_y = T_1 - W_{AE} = m_A a$

Block B: $\Sigma F_y = N_{BT} - W_{BE} = 0$

$\Sigma F_x = T_2 - T_1 = m_B a$

Block C: $\Sigma F_y = W_{CE} - T_2 = m_C a$

Add 'em up: $W_{CE} - W_{AE} = \left(m_A + m_B + m_C\right) a$

$$a = \frac{m_C g - m_A g}{\left(m_A + m_B + m_C\right)} = 1.5\ m/s^2$$

ii) (part a, continued: still no friction)
Find the tension in the cord that connects block B to block C.

Block C: $\Sigma F_y = W_{CE} - T_2 = m_C a$

$$a = \frac{m_C g - m_A g}{\left(m_A + m_B + m_C\right)} = 1.5\ m/s^2$$

$$W_{CE} - T_2 = m_C a = m_C\left(1.5\ m/s^2\right)$$

$$T_2 = m_C g - m_C\left(1.5\ m/s^2\right) = 18.7\ N$$

b) Now assume that there is friction between the table and block B but nowhere else. The velocity of block B points to the right and the coefficient of friction between block B and the table is 0.24.

i) Find the acceleration of block B.

We need to add a friction force pointing to the left on Block B.

Block A: $\Sigma F_y = T_1 - W_{AE} = m_A a$

Block B: $\Sigma F_y = N_{BT} - W_{BE} = 0 \qquad f_{BT} = \mu N_{BT} = \mu W_{BE}$

$$\Sigma F_x = T_2 - T_1 - f_{BT} = m_B a$$

Block C: $\Sigma F_y = W_{CE} - T_2 = m_C a$

Add 'em up: $W_{CE} - W_{AE} - \mu W_{BE} = \left(m_A + m_B + m_C\right) a$

$$a = \frac{m_C g - m_A g - \mu m_B g}{\left(m_A + m_B + m_C\right)} = 0.50\ m/s^2$$

ii) Find the tension in the cord that connects block B to block C.

Block C: $\Sigma F_y = W_{CE} - T_2 = m_C a$

$$a = \frac{m_C g - m_A g - \mu m_B g}{\left(m_A + m_B + m_C\right)} = 0.50\ m/s^2$$

$$W_{CE} - T_2 = m_C a = m_C\left(0.50\ m/s^2\right)$$

$$T_2 = m_C g - m_C\left(0.50\ m/s^2\right) = 20.9\ N$$