Solutions posted

Name: ____________

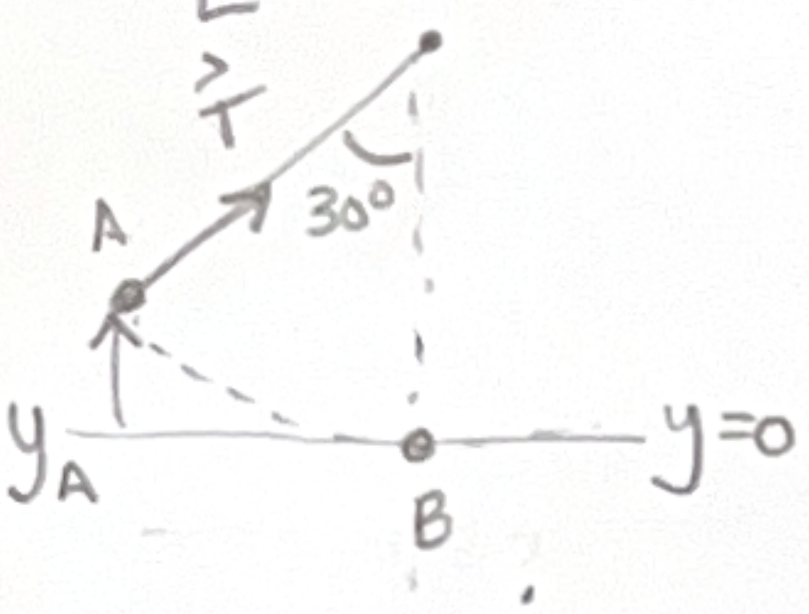
Date: ____________

Work and Energy 2

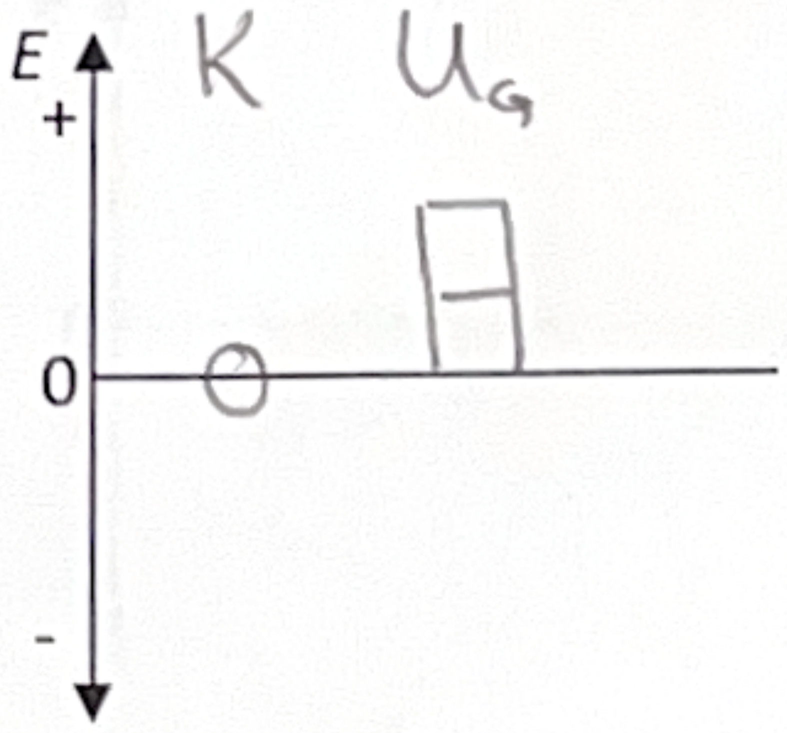
1. Memory check: Cover up your answers from yesterday's memory check and try it again.

2. p.256 #9: Show the problem-solving steps.

m = 500g
L = .75 m



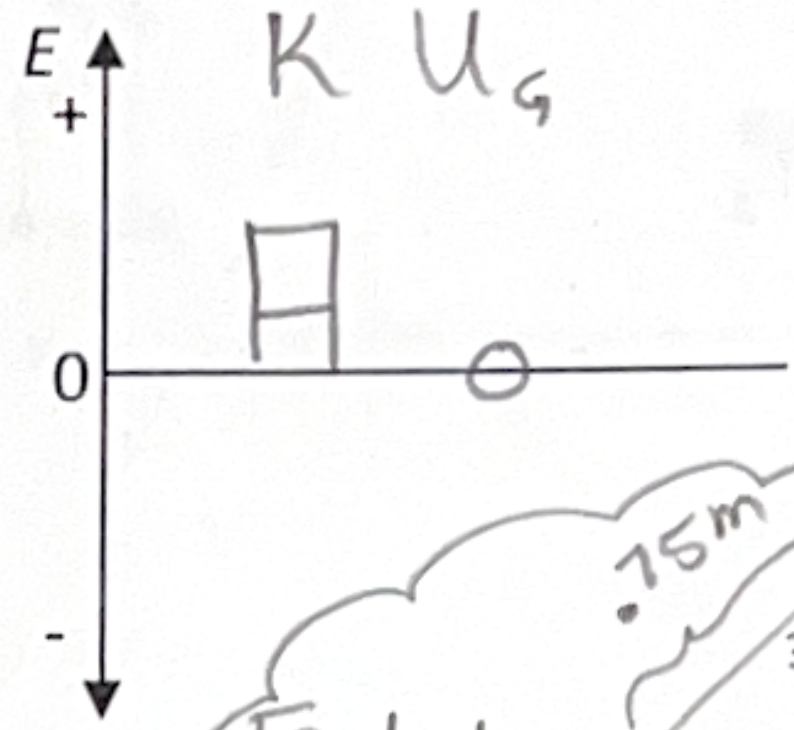
Initial time: at release (A)



string
pendulum
Earth

no transfers

Final time: at lowest point (B)



Ext forces: $\vec{T}$

$\vec{T}$ is ⊥ to $\Delta\vec{r}$ at any instant, so $W_{T\ on\ Ball} = 0$

$E_i + \Sigma transfers = E_f$

$U_{GA} = K_B$

$mgy_A = \frac{1}{2} m v_B^2$

$\sqrt{2gy_A} = v_B$

Find y_A:

$\cos 30 = \frac{D}{.75m}$

$D = .65m$

$y_A = .75m - D = .10\ m$

$= \sqrt{2(10\frac{N}{kg})(.10\ m)} = \boxed{1.4\ m/s}$

3. A particle moving along the y-axis experience the force $\vec{F} = \left(\frac{q}{y^2}\right)\hat{j}$, where q is a constant.

a. Sketch the force vector if the particle is at position y, where (i) y is a small positive position, (ii) y is a larger positive position, and (iii) y is infinity.

(i) ↑ (ii) ↑ (smaller $\vec{F}$) (iii) $\vec{F} = 0$

d. If the particle had a displacement in the positive y direction, what work is done on the particle? (0, -, or +) ↑$\vec{F}$ ↑$\Delta\vec{r}$ **W is +**

e. If the particle had a displacement in the negative y direction, what work is done on the particle? (0, -, or +) ↑$\vec{F}$ ↓$\Delta\vec{r}$ **W is −**

f. Derive an expression for the work done by this force on the particle during a displacement from during a displacement in the + y-direction from y_i to y_f.

$W = \int_a^b \vec{F} \cdot d\vec{r}$ → ($d\vec{r}$ is $(dy)\hat{j}$)

$= \int_a^b \left(\frac{q}{y^2}\right)\hat{j} \cdot (dy)\hat{j}$

$= \int_{y_i}^{y_f} \left(\frac{q}{y^2}\right) dy$

$= q \int_{y_i}^{y_f} y^{-2}\, dy$

$= q \left[\frac{1}{-1} y^{-1}\right]_{y_i}^{y_f}$

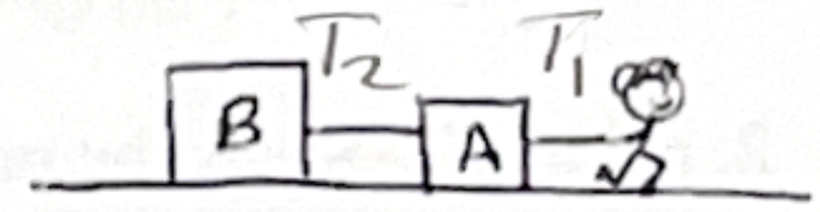
$= q \left[\frac{1}{-1} y_f^{-1} - \left(\frac{1}{-1} y_i^{-1}\right)\right]$

$= q \left(-\frac{1}{y_f} + \frac{1}{y_i}\right)$

$\boxed{W = q\left(\frac{1}{y_i} - \frac{1}{y_f}\right)}$

4. Jill pulls on string 1 which is attached to block A (mass m_A) on a horizontal surface with negligible friction. Block B (mass m_B) is attached to block A by string 2. The tension exerted by string 1 is T_1, and the tension exerted by string 2 is T_2.

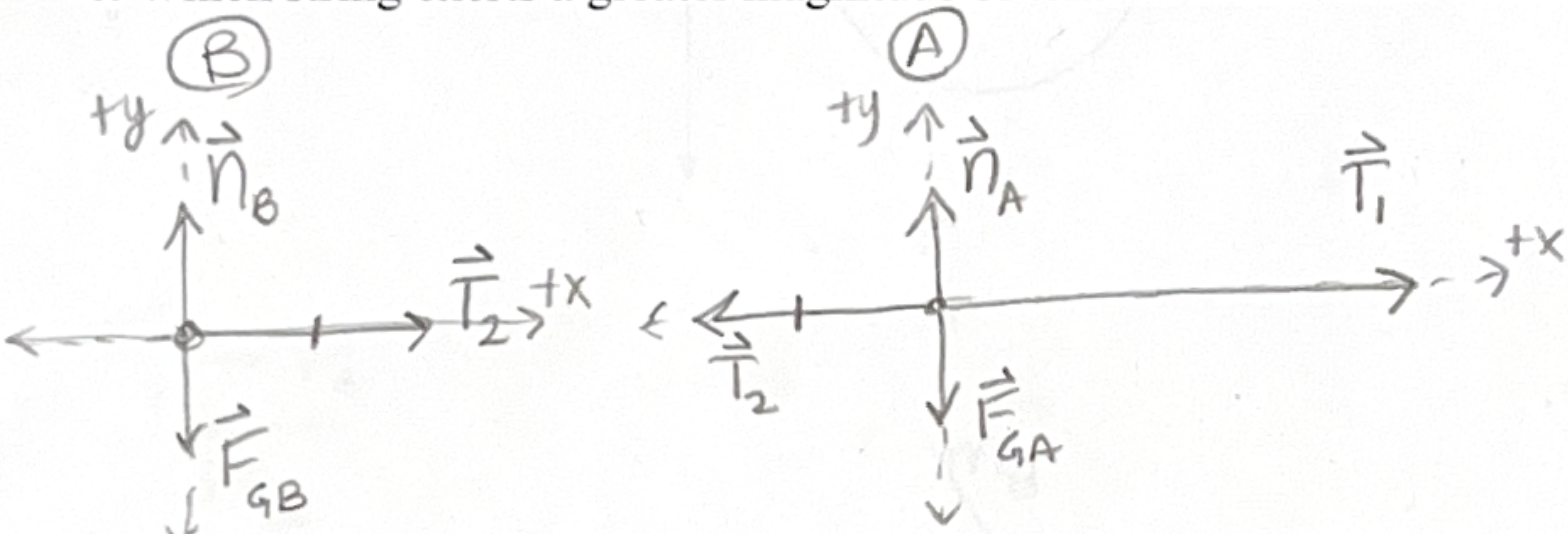
(Show the steps of the General Strategy from the Two-Body Problems activity sheet. You ONLY need to do the x-direction in the force organizer and when writing the Newton's second law equations.)



a. Find the acceleration of block B in terms of the m_A, m_B, T_1, and fundamental constants.

b. Find the magnitude of the tension force T_2 in terms of m_A, m_B, T_1, and fundamental constants.

c. Which string exerts a greater magnitude of tension force? Does this make sense?



Did you make $T_1 > T_2$?

Force Organizers:

(B)

$\vec{T}_2$	$T_{2x} = +T_2$

(A)

$\vec{T}_1$	$T_{1x} = +T_1$
$\vec{T}_2$	$T_{2x} = -T_2$

Newton's 2nd Law: $a_{Bx} = \frac{\Sigma F_{on\,B\,x}}{m_B}$ $\quad a_{Ax} = \frac{\Sigma F_{on\,A\,x}}{m_A}$

$a_{Bx} = \frac{T_2}{m_B}$ $\quad a_{Ax} = \frac{T_1 - T_2}{m_A}$

common variables:

$a_{Bx} = a_{Ax} = a$ $\quad m_B a = T_2$ $\quad m_A a = T_1 - T_2$

a. add equations to find a: $m_B a = T_2$

$+ \; m_A a = T_1 - T_2$

$(m_B + m_A) a = T_1$

$$a = \frac{T_1}{m_A + m_B}$$

b. Find T_2: using the N2L eqn for B:

$T_2 = m_B a$

$$T_2 = \left(\frac{m_B}{m_A + m_B}\right) T_1$$

c. Since $\left(\frac{m_B}{m_A + m_B}\right)$ must be a fraction, $T_2 < T_1$. So T_1 exerts a greater magnitude of tension.

This makes sense because T_1 could be thought of as pulling the whole thing, of mass $m_A + m_B$ → T_1, whereas T_2 only pulls one object m_A.