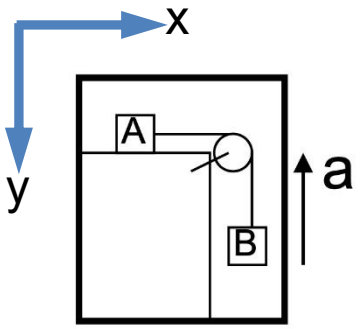
Sample mid-term exam

(https://canvas.ust.hk/courses/66207/files/folder/Exams/Midterm)

24. The system in the lift is moving upwards with an acceleration a=g/2 as shown in the figure (ignore all frictions). Objects A and B have the same mass *m*, and are connect by a string over a pulley. The masses of the string and the pulley can be neglected. Gravity points downwards. The tension of the string is

(a) *mg* (b) *mg*/2 (c) 3*mg*/4 (d) 2*mg* (e) 3*mg*/2



Relative motion

Let L as the lift-frame and S as the stationary frame

$$\vec{r}_{A/S} = \vec{r}_{A/L} + \vec{r}_{L/S} \qquad \vec{r}_{B/S} = \vec{r}_{B/L} + \vec{r}_{L/S}$$

differentiate

$$\vec{a}_{A/S} = \vec{a}_{A/L} + \vec{a}_{L/S} \qquad \vec{a}_{B/S} = \vec{a}_{B/L} + \vec{a}_{L/S}$$

$$\vec{a}_{L/S} = -\frac{g}{2}\,\hat{j}$$

also note: $(a_{A/S})_x = (a_{A/L})_x = (a_{B/L})_y$ The blocks move together in the L-frame

$$(a_{B/S})_y = (a_{B/L})_y - \frac{g}{2}$$

Newton's Law in the stationary (inertial) frame of reference

A: motion in x-direction

$$T = m_A (a_{A/S})_x$$

$$(a_{A/S})_x = \frac{T}{m_A}$$

B: motion in y-direction

$$m_B g - T = m_B (a_{B/S})_y$$

$$= m_B \left[(a_{A/S})_x - \frac{g}{2} \right]$$

Do algebra:

$$T = \frac{m_A m_B}{m_A + m_B} \left(\frac{3}{2} g \right)$$