Exam #1

1) Distance from earth to sun in light minutes

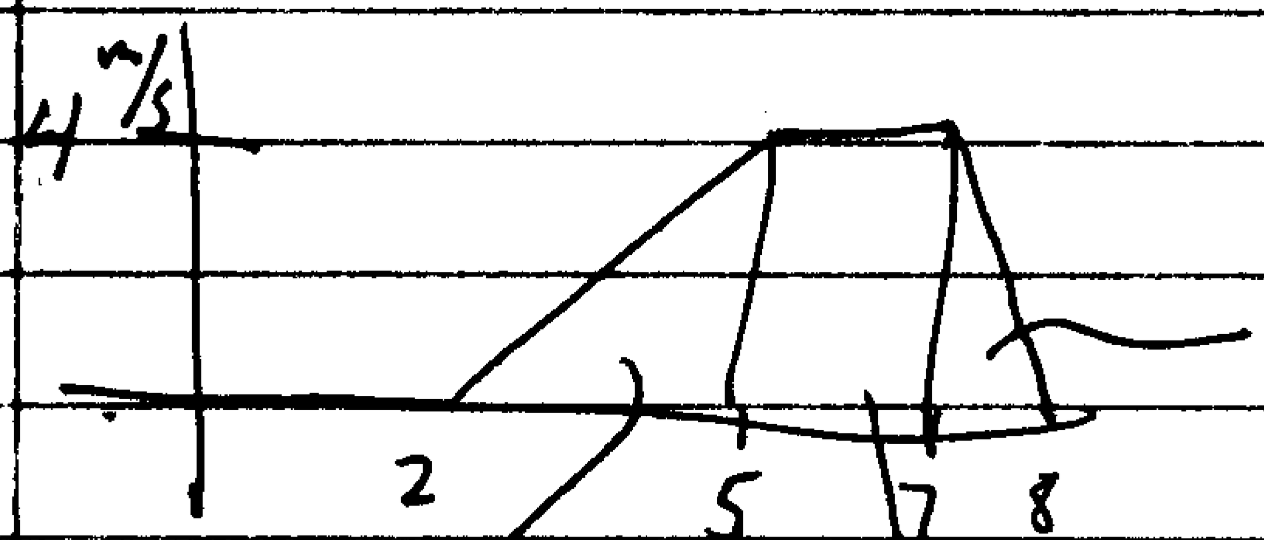
$$1.5 \times 10^8 \cancel{km} \times \frac{1000 m}{1 \cancel{km}} \times \frac{1}{3 \times 10^8 m/s} = 500 s \times \frac{1 min}{60 s} = 8.3 \text{ light minutes}$$

from earth to sun.

Distance from earth to moon

$$3.84 \times 10^5 km \times \frac{1000 m}{1 km} \times \frac{1}{3 \times 10^8 m/s} = 1.28 s$$ = # of light seconds from earth to moon

2) The displacement is the area under the graph from $t=0$ to $t=12s$



$\frac{4 m/s \times 1 s}{2}$

So $6m + 8m + 2m = 16m$

a) $\frac{4 m/s \cdot 3s}{2}$ $\quad 4 m/s \times 2s$

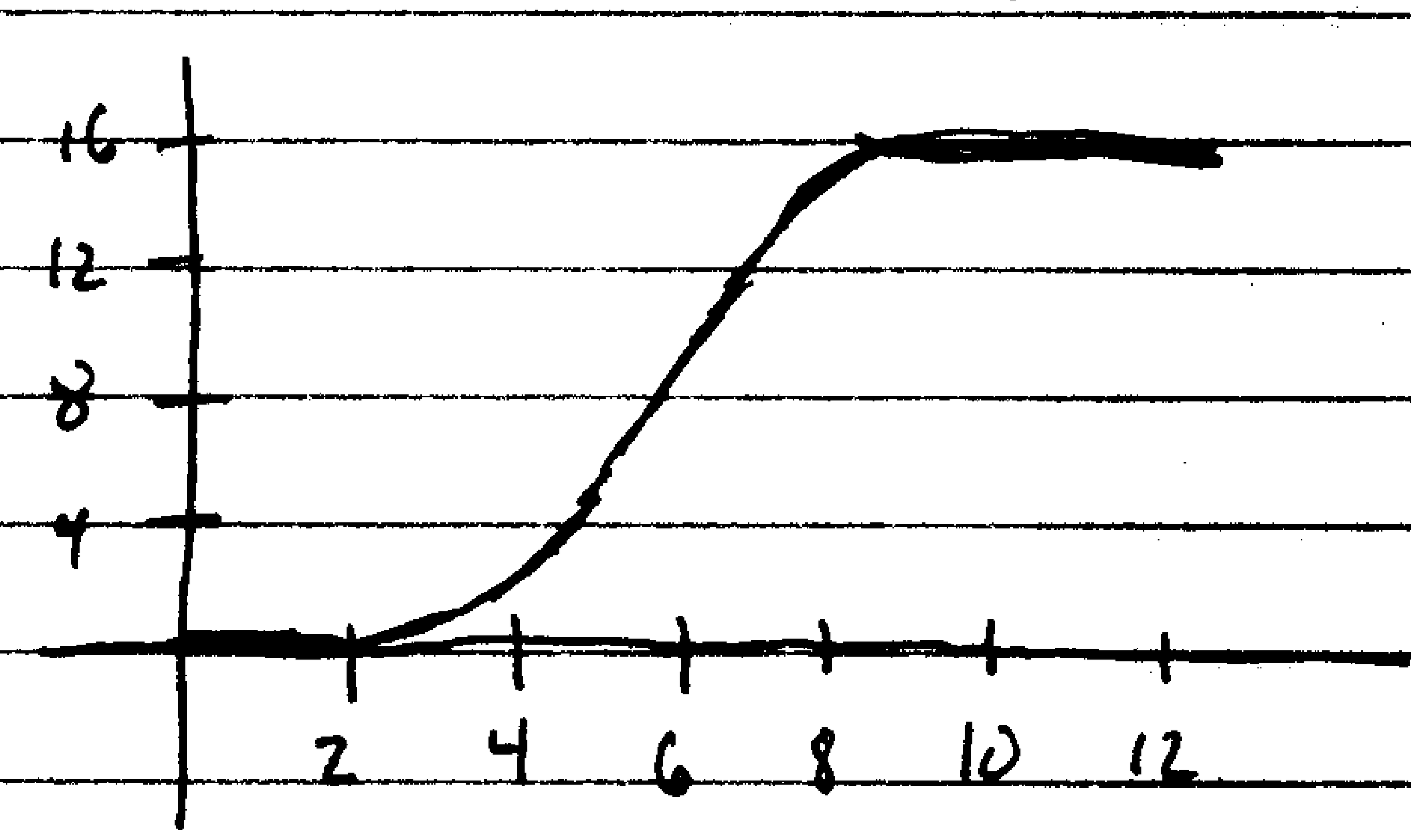
b) the acceleration is the slope of the graph.

@ 3s $\quad a = \frac{\Delta v}{\Delta t} = \frac{4 m/s - 0 m/s}{3s} = 4/3 \; m/s^2$

@ 6s $\quad a = \frac{\Delta v}{\Delta t} = 0$

@ 7.5s $\quad a = \frac{\Delta v}{\Delta t} = \frac{0 - 4 m/s}{1s} = -4 m/s^2$

c)



3)  $\longrightarrow +x$

a) $\vec{F}_{N\to I} = 2N\,\hat{i}$

b) $\vec{F}_{N\to I} = -2N\,\hat{i}$ (By Newton's 3rd law)

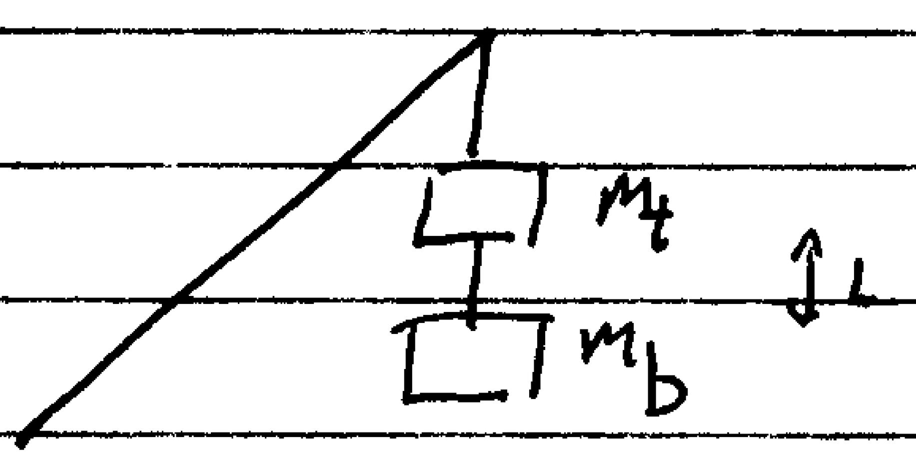
c) $\vec{a} = \frac{\Sigma\vec{F}}{m}$ which for the ice cube is just

$$\vec{a} = \frac{2N\,\hat{i}}{0.05\,kg} = 40\,m/s^2\,\hat{i}$$

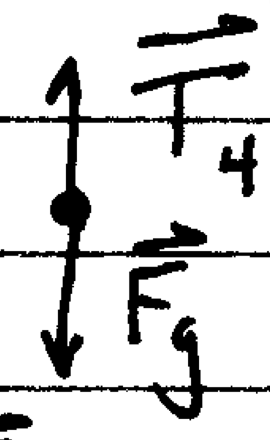
d) $x = \cancel{x_0}^{\,0} + \cancel{v_0}^{\,0}t + \frac{1}{2}at^2$ and $v = \cancel{v_0}^{\,0} + at$ for constant a.

$$x = \frac{1}{2}at^2 \quad \text{and} \quad v = at \Rightarrow t = \frac{v}{a}$$

$$x = \frac{1}{2}a\left(\frac{v}{a}\right)^2 = \frac{1}{2}\frac{v^2}{a} = \frac{(15\,m/s)^2}{2\;40\,m/s^2} = 2.8\,m$$

4) 

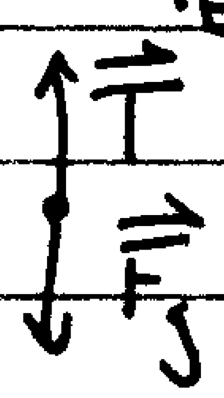
treat m_t and m_b as a single object



$$\vec{a} = \frac{\Sigma\vec{F}}{m} = \frac{\vec{T}_H + \vec{F}_g}{m} = \frac{T_H\,\hat{i} - (m_t+m_b)g\,\hat{i}}{m_t+m_b}$$

$$a\,\hat{i} = \left(\frac{T_H - (m_t+m_b)g}{m_t+m_b}\right)\hat{i}$$

b) treat m_b as our object



$$a\hat{i} = \frac{\Sigma\vec{F}}{m} = \frac{T\hat{i} - m_b g\,\hat{i}}{m_b}$$

$$\frac{T_H - (m_t+m_b)g}{m_t+m_b} = \frac{T}{m_b} - g$$

$$\frac{T_H}{m_t + m_b} - \cancel{g} = \frac{T}{m_b} - \cancel{g}$$

$$T = \frac{m_b T_H}{m_t + m_b}$$ this is the tension in the rope connecting the two boxes.

c) since the acceleration is constant we can use the kinematics equation

$\Delta x = v_0 t + \frac{1}{2} a t^2$ to relate distance to time

$$H = 0 + \frac{1}{2} a t^2$$

$$t = \sqrt{\frac{2H}{a}} = \sqrt{\frac{2H(m_t + m_b)}{T_H - (m_t + m_b)g}}$$

(extra credit)

d) if we now ~~...~~ calculate v at the time of snap w $t=0$ @ start of lift

$$V = \cancel{V_0}^{\,0} + at$$

$$= a\sqrt{\frac{2H}{a}} = \sqrt{2Ha} = \sqrt{2H\left(\frac{T_H - (m_t + m_b)g}{m_t + m_b}\right)}$$

so that if we reset $t=0$ to the moment of snap:

$$X = X_0 + V_0 t + \frac{1}{2} a t^2$$

$$X = H + \sqrt{2H\left(\frac{T_H - (m_t + m_b)g}{m_t + m_b}\right)}\, t + \frac{1}{2}(-g) t^2$$

where the only force acting now is gravity and $x=0$ is the ground, up is $+x$.