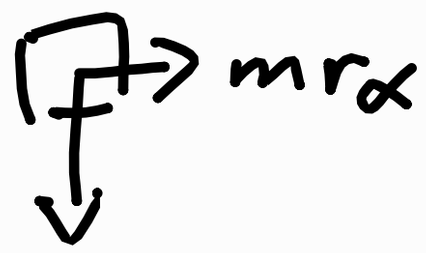
1a) $mg - N = mr\omega^2$

$$2 \times 9.81 - N = 2(1.8)\left(\frac{3}{1.8}\right)^2$$

$$N = 9.62N$$



b) When $N = 0$.

$$mg = mr\omega^2$$

$$\omega^2 = \frac{g}{r}$$

$$\frac{v}{r} = \sqrt{\frac{g}{r}}$$

$$v = r\sqrt{\frac{g}{r}}$$

$$= \sqrt{gr}$$

$$= \sqrt{9.81 \times 1.8}$$

$$= 4.202142311$$

$$\simeq 4.2\ ms^{-1}$$

2) $N_A = m_A g$

$m_A a = f_A - F$

$m_A a = 0.2 m_A g - F$

$N_B = m_B g$

$m_B a = f_B + F$

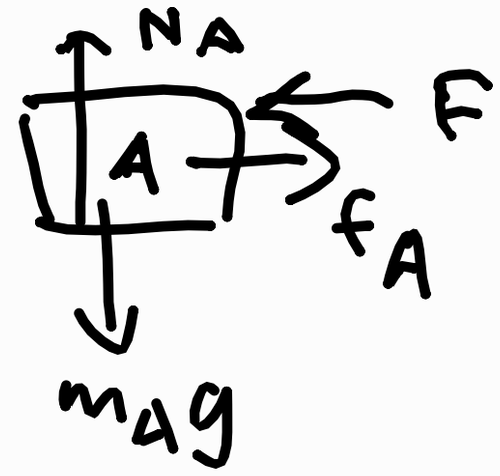
$24a + F = 47.088$

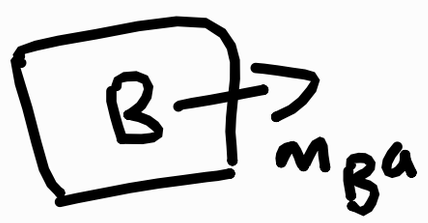
$30a - F = 29.43$

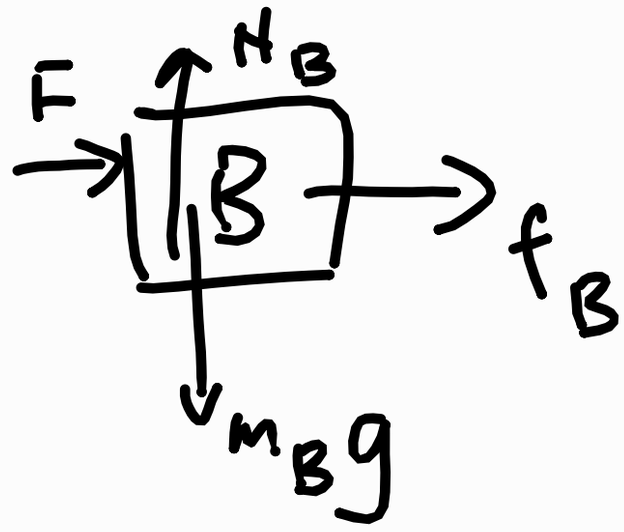
Solving,

a) $a = 1.417 ms^{-2}$

b) $F = 13.08 N$





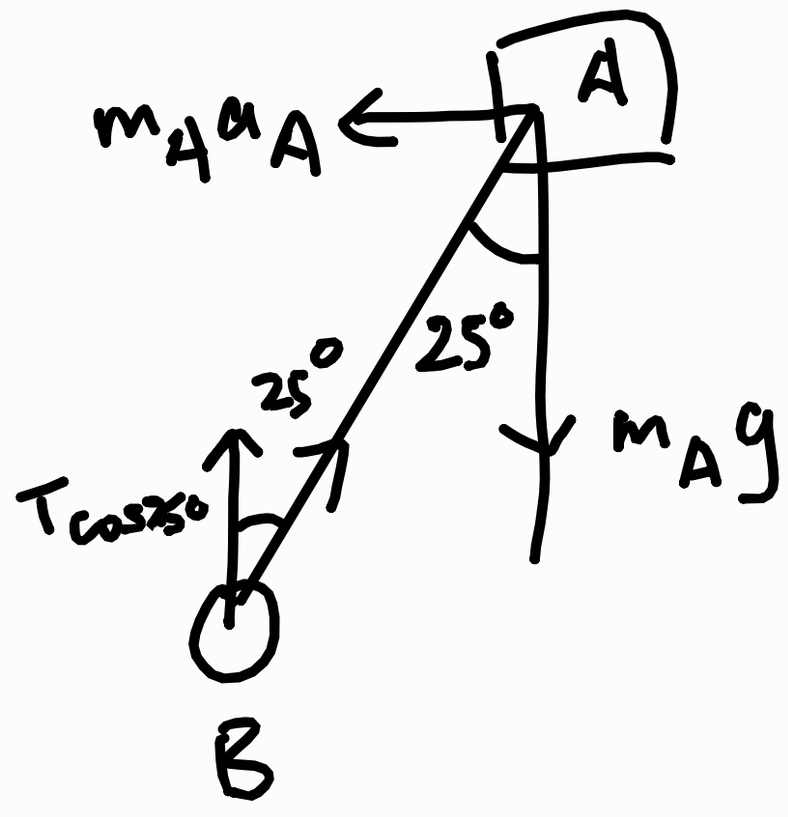


3a) $\vec{a}_A = -a_A \underset{\sim}{i}$

$\vec{a}_B = \vec{a}_A + \vec{a}_{B/A}$

$= -a_A \underset{\sim}{i} + (\vec{a}_{B/A}^{\,t} + \vec{a}_{B/A}^{\,n})$

$= -a_A \underset{\sim}{i} + a_{B/A} \angle(-25°) - (1)$



$T\sin 25° = m_A a_A - (2)$

$T(\sin 25° \underset{\sim}{i} + \cos 25° \underset{\sim}{j}) - m_B g \underset{\sim}{j} = m_B \vec{a}_B$

$T(\sin 25° \underset{\sim}{i} + \cos 25° \underset{\sim}{j}) - m_B g \underset{\sim}{j} = m_B [-a_A \underset{\sim}{i} + a_{B/A} \angle(-25°)]$

$T\sin 25° \underset{\sim}{i} + T\cos 25° \underset{\sim}{j} - m_B g \underset{\sim}{j} = -m_B a_A \underset{\sim}{i} + m_B a_{B/A} \cos(-25°) \underset{\sim}{i} + m_B a_{B/A} \sin(-25°) \underset{\sim}{j}$

$T\sin 25° - 20 a_A + 0 a_{B/A} = 0$

$T\sin 25° + 15 a_A - 15\cos(-25°) a_{B/A} = 0$

$T\cos 25° + 0 a_A - 15\sin(-25°) a_{B/A} = 147.15$

Solving,

$T = 117.6089284$

$\simeq 117.6\,N$

$a_A = 2.485184045$

$\simeq 2.49\,ms^{-2}$

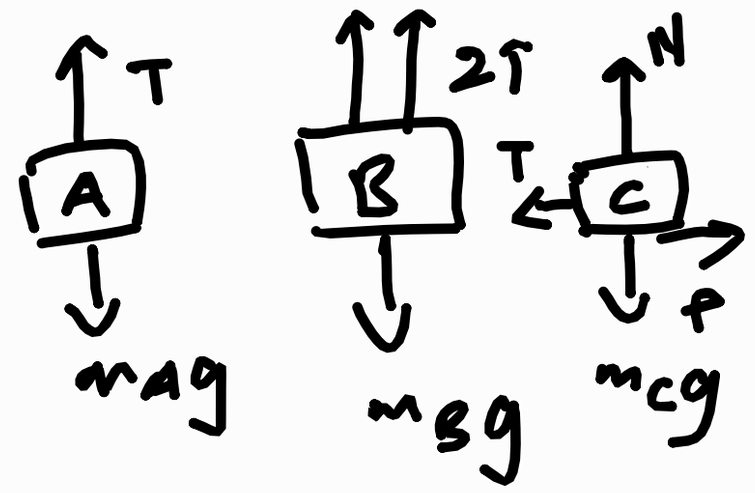
$a_{B/A} = 6.3982268\,ms^{-2}$

$\simeq 6.4\,ms^{-2}$

4) $x_A + 2x_B + x_C = \text{constant}$

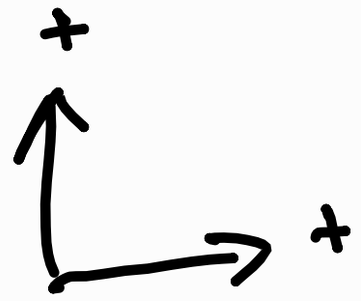
$\dot{x}_A + 2\dot{x}_B + \dot{x}_C = 0$

$\ddot{x}_A + 2\ddot{x}_B + \ddot{x}_C = 0 - (1)$



$T - 100g = 100\ddot{x}_A$

$T - 100\ddot{x}_A = 100g - (2)$



$2T - 300g = 300\ddot{x}_B$

$2T - 300\ddot{x}_B = 300g - (3)$

$f - T = -80\ddot{x}_C$

$-T + \mu N = -80\ddot{x}_C$

$-T + 0.4(80)g = -80\ddot{x}_C$

$-T + 80\ddot{x}_C = -32g - (4)$

$T = \frac{4080}{43} g \approx 930.8\,\text{N}$

$\ddot{x}_A = -\frac{11}{215} g \approx -0.502\,\text{ms}^{-2}$

$\ddot{x}_B = -\frac{79}{215} g \approx -3.60\,\text{ms}^{-2}$

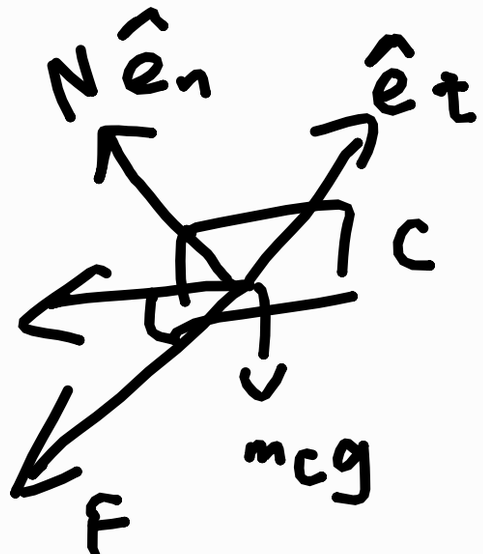
$\ddot{x}_C = \frac{169}{215} g \approx 7.71\,\text{ms}^{-2}$

5) $\vec{a}_c = \vec{a}_{clf} + \vec{a}_{c'} + \cancel{2\vec{\omega}_f \times \vec{v}_{clf}}$

$= \vec{a}_{clf} + \vec{a}_A + \cancel{\vec{\alpha} \times \vec{r}_{CA}} \cancel{-\omega^2 \vec{r}_{CA}}$

$= \vec{a}_{clf} + \vec{a}_A$

$= 4\underset{\sim}{j} + \vec{a}_{clf}$



$-mg\underset{\sim}{j} + N\hat{e} = m\vec{a}_{clf}$

$-mg\underset{\sim}{j} + N\hat{e}_n = m\left[4\underset{\sim}{j} + a_{clf}\hat{e}_t\right]$

$\underset{\sim}{j} = \cos 45^\circ \hat{e}_n + \sin 45 \hat{e}_t$

Resolving in the $\hat{e}_t$ direction,

$-\cancel{m}g\sin 45^\circ = m\left[4\sin 45^\circ + a_{clf}\right]$

$a_{clf} = -9.765144648 ms^{-2}$

$\simeq -9.765 ms^{-2}$

$\vec{a}_c = 4\underset{\sim}{j} - 6.905\underset{\sim}{i} - 6.905\underset{\sim}{j}$

$= -2.905\underset{\sim}{i} - 6.905\underset{\sim}{j} ms^{-2}$

Resolving in the $\hat{e}_n$ direction,

$-mg\cos 45^\circ + N = m(4\cos 45^\circ)$

$N = -19.5302893 N$

$\vec{N} = -13.81\underset{\sim}{i} - 13.81\underset{\sim}{j} N$