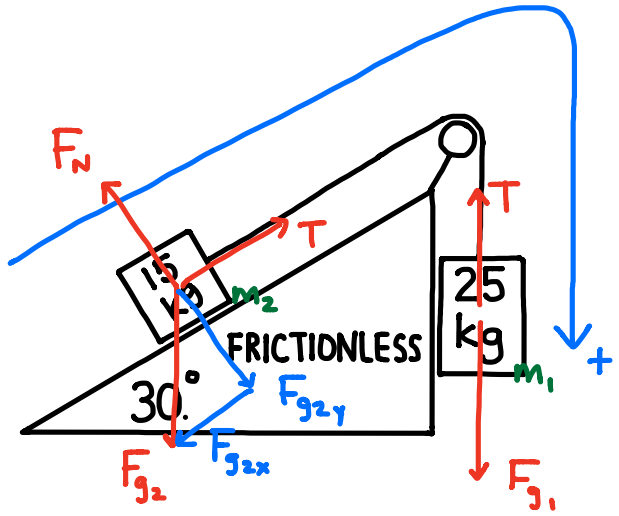
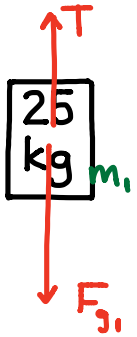
MULTI-BODY SYSTEMS II - SOLUTIONS

1.



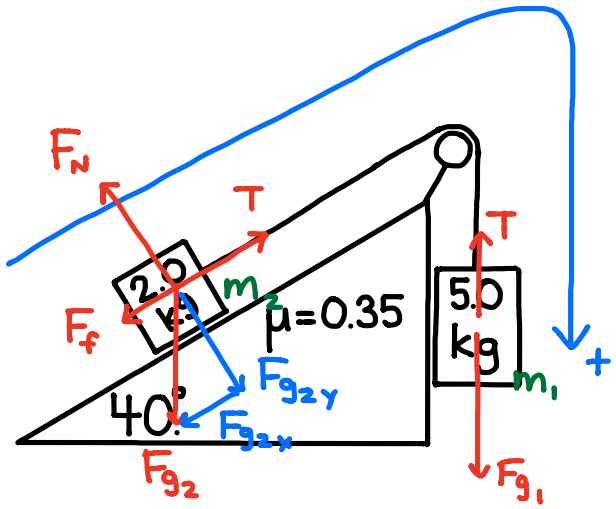
$$F_{g_{2x}} = F_{g_2}\sin 30.^\circ$$
$$= m_2 g \sin 30.^\circ$$

$$F_{NET} = Ma$$
$$F_{g_1} - \cancel{T} + \cancel{T} - F_{g_{2x}} = (m_1 + m_2)a$$
$$m_1 g - m_2 g \sin 30.^\circ = (m_1 + m_2)a$$
$$a = \frac{m_1 g - m_2 g \sin 30.^\circ}{m_1 + m_2}$$
$$= \frac{(25)(9.8) - (15)(9.8)\sin 30.^\circ}{25 + 15}$$
$$= 4.2875 \ \tfrac{m}{s^2} \rightarrow 4.3 \ \tfrac{m}{s^2} \text{ RIGHT}$$



$$F_{NET} = ma$$
$$F_{g_1} - T = m_1 a$$
$$m_1 g - T = m_1 a$$
$$T = m_1 g - m_1 a$$
$$= m_1 (g - a)$$
$$= 25(9.8 - 4.2875)$$
$$= 140 \text{ N}$$

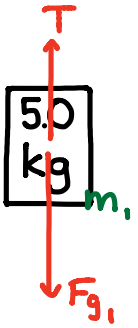
2.



$$F_{g_2x} = F_{g_2}\sin 40.^\circ = m_2 g \sin 40.^\circ$$
$$F_{g_2y} = F_{g_2}\cos 40.^\circ = m_2 g \cos 40.^\circ$$

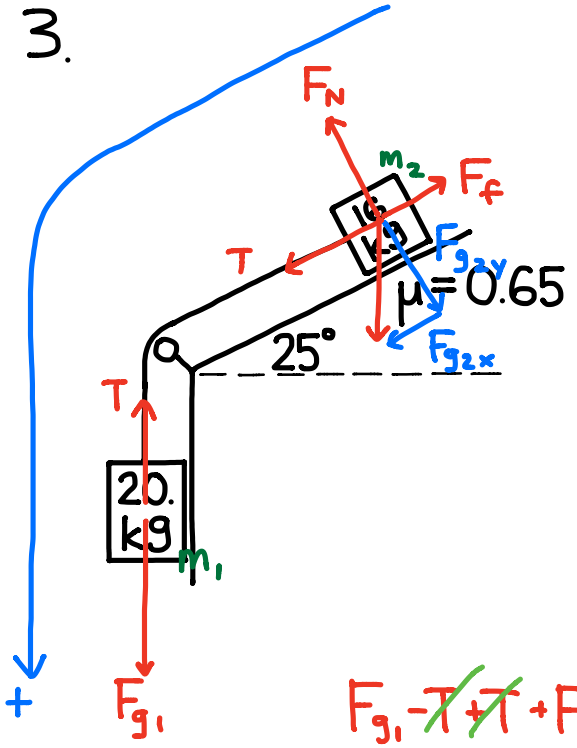
$$F_N = F_{g_2y} = m_2 g \cos 40.^\circ$$

$$F_{NET} = Ma$$
$$F_{g_1} - \cancel{T} + \cancel{T} - F_{g_2x} - F_f = (m_1 + m_2)a$$
$$m_1 g - m_2 g \sin 40.^\circ - \mu F_N = (m_1 + m_2)a$$
$$m_1 g - m_2 g \sin 40.^\circ - \mu m_2 g \cos 40.^\circ = (m_1 + m_2)a$$
$$a = \frac{m_1 g - m_2 g \sin 40.^\circ - \mu m_2 g \cos 40.^\circ}{m_1 + m_2}$$
$$= \frac{(5.0)(9.8) - (2.0)(9.8)\sin 40.^\circ - (0.35)(2.0)(9.8)\cos 40.^\circ}{5.0 + 2.0}$$
$$= 4.4495 \ \tfrac{m}{s^2} \rightarrow 4.4 \ \tfrac{m}{s^2} \text{ RIGHT}$$



$$F_{NET} = m_1 a$$
$$F_{g_1} - T = m_1 a$$
$$m_1 g - T = m_1 a$$
$$T = m_1 g - m_1 a$$
$$= m_1 (g - a)$$
$$= (5.0)(9.8 - 4.4495)$$
$$= 27 \text{ N}$$

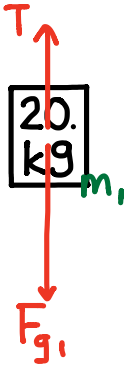
3.



$$F_{g2x} = F_{g2}\sin 25^\circ = m_2 g \sin 25^\circ$$
$$F_{g2y} = F_{g2}\cos 25^\circ = m_2 g \cos 25^\circ$$

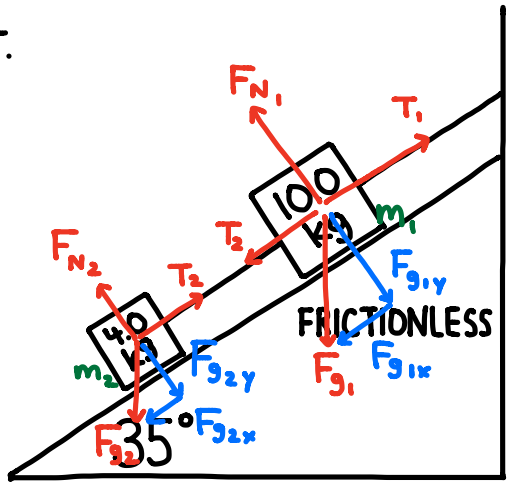
$$F_N = F_{g2y} = m_2 g \cos 25^\circ$$

$$F_{NET} = Ma$$
$$F_{g1} - \cancel{T} + \cancel{T} + F_{g2x} - F_f = (m_1 + m_2)a$$
$$m_1 g + m_2 g \sin 25^\circ - \mu F_N = (m_1 + m_2)a$$
$$m_1 g + m_2 g \sin 25^\circ - \mu m_2 g \cos 25^\circ = (m_1 + m_2)a$$
$$a = \frac{m_1 g + m_2 g \sin 25^\circ - \mu m_2 g \cos 25^\circ}{m_1 + m_2}$$
$$= \frac{(20.)(9.8) + (16)(9.8)\sin 25^\circ - (0.65)(16)(9.8)\cos 25^\circ}{20. + 16}$$
$$= 4.7913 \ \frac{m}{s^2} \rightarrow 4.7 \ \frac{m}{s^2} \text{ LEFT}$$



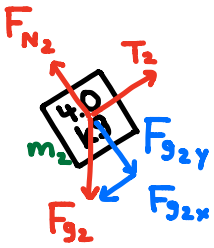
$$F_{NET} = m_1 a$$
$$F_{g1} - T = m_1 a$$
$$m_1 g - T = m_1 a$$
$$T = m_1 g - m_1 a$$
$$= m_1 (g - a)$$
$$= (20.)(9.8 - 4.7913)$$
$$= 102 \text{ N} \rightarrow 1.0 \times 10^2 \text{ N}$$

4.



$$F_{g_1x} = F_{g_1}\sin 35^\circ$$
$$= m_1 g \sin 35^\circ$$

$$F_{g_2x} = F_{g_2}\sin 35^\circ$$
$$= m_2 g \sin 35^\circ$$



$F_{NET} = m\cancel{a}$ ($a = 0$)

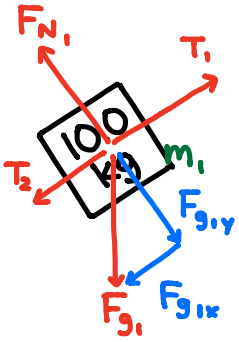
$T_2 - F_{g_2x} = 0$

$T_2 = F_{g_2x}$

$= m_2 g \sin 35^\circ$

$= (4.0)(9.8)\sin 35^\circ$

$= 22.4842\ \text{N} \longrightarrow$ **22 N**



$F_{NET} = m_1\cancel{a}$ ($a = 0$)

$T_1 - T_2 - F_{g_1x} = 0$

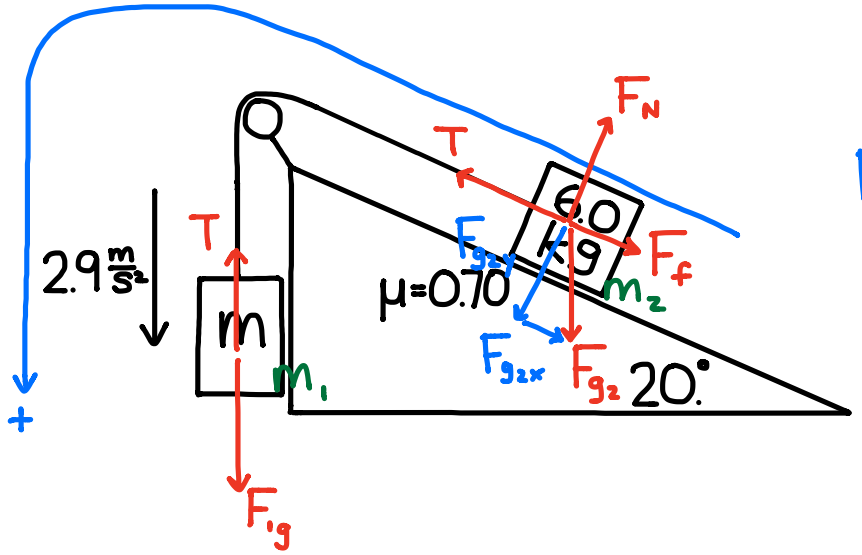
$T_1 = T_2 + F_{g_1x}$

$= T_2 + m_1 g \sin 35^\circ$

$= 22.4842 + (10.0)(9.8)\sin 35^\circ$

$=$ **79 N**

5.



$F_{g2x} = F_{g2}\sin 20.° = m_2 g \sin 20.°$

$F_{g2y} = F_{g2}\cos 20.° = m_2 g \cos 20.°$

$F_N = F_{g2y} = m_2 g \cos 20.°$

$$F_{NET} = Ma$$

$$F_{g1} - T + T - F_{g2x} - F_f = (m_1 + m_2)a$$

$$m_1 g - m_2 g \sin 20.° - \mu F_N = m_1 a + m_2 a$$

$$m_1 g - m_2 g \sin 20.° - \mu m_2 g \cos 20.° = m_1 a + m_2 a$$

$$m_1 g - m_1 a = m_2 a + m_2 g \sin 20.° + \mu m_2 g \cos 20.°$$

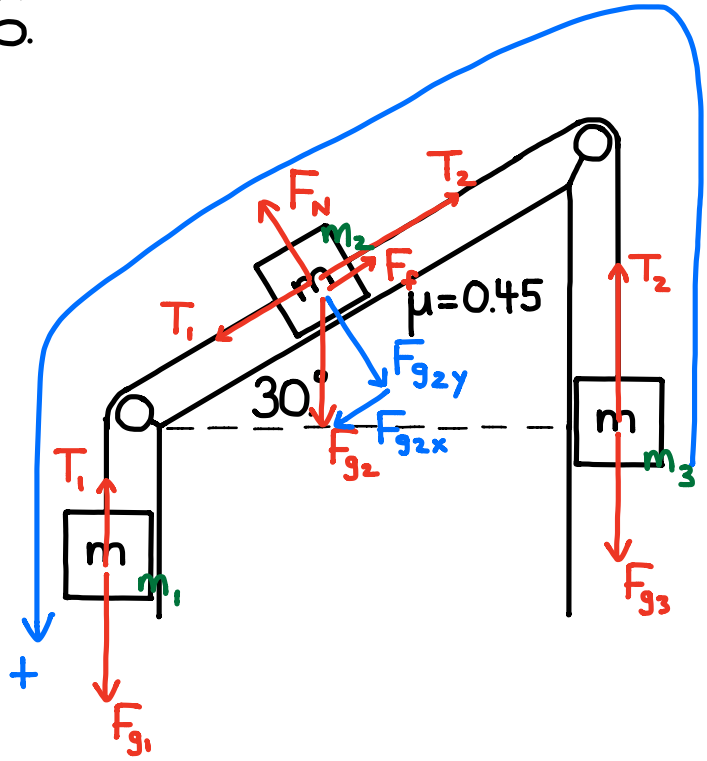
$$m_1 (g - a) = m_2 (a + g \sin 20.° + \mu g \cos 20.°)$$

$$m_1 = \frac{a + g \sin 20.° + \mu g \cos 20.°}{g - a} m_2$$

$$= \frac{2.9 + 9.8 \sin 20.° + (0.70)(9.8)\cos 20.°}{9.8 - 2.9} 6.0$$

$$= 11 \text{ kg}$$

6.



$$F_{g2x} = F_{g2}\sin 30.^\circ$$
$$= mg\sin 30.^\circ$$
$$F_{g2y} = F_{g2}\cos 30.^\circ$$
$$= mg\cos 30.^\circ$$

$$F_N = F_{g2y}$$
$$= mg\cos 30.^\circ$$

$$F_{NET} = Ma$$
$$F_{g1} - T_1 + T_1 + F_{g2x} - F_f - T_2 + T_2 - F_{g3} = 3ma$$
$$mg + mg\sin 30.^\circ - \mu F_N - mg = 3ma$$
$$mg\sin 30.^\circ - \mu mg\cos 30.^\circ = 3ma$$
$$a = \frac{g\sin 30.^\circ - \mu g\cos 30.^\circ}{3}$$
$$= \frac{\sin 30^\circ - \mu\cos 30.^\circ}{3}\, g$$
$$= \frac{\sin 30^\circ - (0.45)\cos 30.^\circ}{3}\, 9.8$$

$$= 0.36\ \frac{m}{s^2}\ \text{LEFT}$$