1. Book problem 4-8.28

Since none of the masses are moving, we know that the net force is $F_{\text{net}} = 0$ N. So, to calculate tension we have to look at each contact point individually and sum up the forces acting at that point.

Here, the two forces acting on the 1 kg mass are gravity and tension. Thus, $T = |F_g| = (1.0)(9.8) = 9.8$ N. The forces at A and C are thus $T = 9.8$ N, since there is only one tension per string. The tension at C must be supporting the weight of the mass (because if the string were cut, the mass would fall). So, here we also have a tension of 9.8 N in C.

Both ends of the string are supporting the entire mass, so we must have $2T = |F_g|$, which means that $T = 4.9$ N is the tension at D. This is essentially the same as two identical ropes holding up a mass.
In this case, we have to look at each individual contact point again. Since neither mass is moving, this means that $F_{\text{net}} = 0 \text{ N}$, and therefore the tension at each contact must be preventing the masses from moving. So, $T = |F_g| = 9.8 \text{ N}$ at point E. This is effectively the same situation as A.

2. Book problem 4-8.35

Since the hammock is not moving, we know that the tensions must counteract the pull of gravity: $\vec{F}_{\text{net}} = \vec{F}_{g} + \vec{T}_1 + \vec{T}_2 = 0$.

In terms of the components $T_{1x}, T_{1y}$ and $T_{2x}, T_{2y}$, we have:

\[
T_{1x} = T_{2x} \quad \text{no motion in the x – direction}
\]

and

\[
T_{1y} + T_{2y} = F_g \quad \text{no motion in the y – direction}
\]

In this case, $T_{1x} = T_1 \cos(30)$, $T_{1y} = T_1 \sin(30)$, $T_{2x} = T_2 \cos(45)$, and $T_{2y} = T_2 \sin(45)$. So, from the two equations above we find:

\[
\begin{align*}
T_{1x} &= T_{2x} \\
T_1 \cos(30) &= T_2 \cos(45) \\
T_1 &= T_2 \frac{\cos(45)}{\cos(30)}
\end{align*}
\]

(1)

From the vertical force equation, we get:

\[
\begin{align*}
T_{1y} + T_{2y} &= F_g \\
T_1 \sin(30) + T_2 \sin(45) &= 710 \text{ N}
\end{align*}
\]
so we can substitute our equation for $T_1$ into this and find:

$$T_2 \frac{\cos(45)}{\cos(30)} \sin(30) + T_2 \sin(45) = 710$$

$$T_2 \left( \frac{\cos(45)}{\cos(30)} \sin(30) + \sin(45) \right) = 710$$

$$1.11T_2 = 710$$

$$T_2 = 636.6 \text{ N}$$

Thus, the tension in rope 1 is $T_1 = 636.6 \frac{\cos(45)}{\cos(30)} = 519.8 \text{ N}$.

3. Book problem 5.43 (extra problems)

The free body diagram above shows all component forces acting on the two masses. Since the 2 kg mass will always fall, we know that the friction acting on mass 1 ($f_1$) will act down the incline (since $m_1$ will be pulled up the incline). From the “linear” force diagram, we can piece together the net force equation:

$$F_{\text{net}} = F_{2g} - T + T - F_{1||} - f_1$$

where $F_{2g} = m_2g$, $F_{1||} = m_1g \sin(30)$, and $f_1 = \mu_k N_1 = \mu_k m_1g \cos(30)$. Since $F_{\text{net}} = m_T a_{\text{net}} = (m_1 + m_2)a_{\text{net}}$, we can find the acceleration of each mass:

$$F_{\text{net}} = F_{2g} - T + T - F_{1||} - f_1$$

$$(m_1 + m_2)a_{\text{net}} = m_2g - m_1g \sin(30) - \mu_k m_1g \cos(30)$$

$$a_{\text{net}} = \frac{m_2g - m_1g \sin(30) - \mu_k m_1g \cos(30)}{m_1 + m_2}$$

$$a_{\text{net}} = \frac{(2)(9.8) - (1)(9.8) \sin(30) - (0.5)(1)(9.8) \cos(30)}{1 + 2}$$

$$a_{\text{net}} = 3.5 \text{ m/s}^2$$
The system will move as follows: $m_3 = 5$ kg will drop, $m_2 = 2$ kg will slide to the right, and $m_1 = 4$ kg will rise. From the “linear” free body diagram, the net force equation is:

$$F_{\text{net}} = F_{3g} - T_2 + T_2 - f_2 - T_1 + T_1 - F_{1g}$$

The tensions in each rope are different, but they cancel out of the net equation because they are internal forces (so we don’t care what they are). The net force is $F_{\text{net}} = (m_1 + m_2 + m_3)a_{\text{net}}$, since three masses are moving. So, we can find the net acceleration as follows:

$$F_{\text{net}} = F_{3g} - f_2 - F_{1g}$$

$$(m_1 + m_2 + m_3)a_{\text{net}} = m_3g - \mu km_2g - m_1g$$

$$a_{\text{net}} = \frac{m_3g - \mu km_2 g - m_1g}{m_1 + m_2 + m_3}$$

$$a_{\text{net}} = \frac{(5)(9.8) - (0.1)(2)(9.8) - (4)(9.8)}{4 + 2 + 5}$$

$$a_{\text{net}} = 0.7 \text{ ms}^2$$