25:

Free-body diagram:

a) Friction is negligible as the sled is on ice. Further, 
\[ N_s = M_s g \] as the sled is not going up and down. Hence, the only force on the sled is 5.2N and the acceleration of the sled is
\[ a_s = \frac{F_s}{M_s} = -\frac{5.2}{8.4} \, \text{m/s}^2 = -0.62 \, \text{m/s}^2 \]

b) According to Newton's third law, the force of the sled on the girl is 5.2N towards the sled.
\[ a_g = \frac{F_g}{M_g} = \frac{5.2}{40} \, \text{m/s}^2 = 0.13 \, \text{m/s}^2 \]

c) The accelerations of the girl and sled are in opposite directions and as they are moving towards each other.

\[ x_g = x_{0g} + \frac{1}{2} a_g t^2 = \frac{1}{2} (0.13) t^2 \]
\[ x_s = x_{0s} + \frac{1}{2} a_s t^2 = 15 + \frac{1}{2} (-0.62) t^2 \]

They meet when 
\[ x_g = x_s \Rightarrow 0.065 t^2 = 15 - 0.31 t^2 \]
\[ 0.375 t^2 = 15 \Rightarrow t = 40 \Rightarrow t = 6.32 \, \text{s} \]

\[ x_g = \frac{1}{2} (0.13) (40) = 2.6 \, \text{m} \]

The girl has covered a distance of 2.6m!!
36:  

a) The net force (horizontal) on the system (on the three objects) is $T_3$. The acceleration of the system is given by 

$$T_3 = (m_1 + m_2 + m_3) \frac{a}{m} = \frac{T_3}{m_1 + m_2 + m_3} = 650 \text{ N}$$

$$a = \frac{650}{67 \text{ kg}} = 0.970 \text{ m/s}^2$$

b) **Draw force body diagram:**

\[ m_1: T_1 = m_1 a \] (i)

\[ m_2: T_2 - T_1 = m_2 a \] (ii)

\[ m_3: T_3 - T_2 = m_3 a \] (iii)

\[ T_1 = 12 \times 0.97 = 11.64 \text{ N} \]

\[ T_2 = T_1 + m_2 a \]

\[ = 11.64 + 24 \times 0.97 \]

\[ T_2 = 34.9 \text{ N} \]

38: As the block is moving only horizontally 15.0

\[ N + F \sin 38^\circ = M g \]

The net horizontal force is

\[ F_{net} = F - f = 450 \cos 38^\circ - 125 = 229.6 \text{ N} \]

a) $a = \frac{229.6 \text{ N}}{31.0 \text{ kg}} = 0.74 \text{ m/s}^2$

b) In this case mass of the crate is $M = \frac{310 \text{ N}}{9.8 \text{ m/s}^2} = 31.6 \text{ kg}$

\[ a = \frac{229.6 \text{ N}}{31.6 \text{ kg}} = 7.27 \text{ m/s}^2 \]

\[ \therefore a = 7.3 \text{ m/s}^2 \]
44:

Free-body diagrams:

\[ \begin{align*}
 m_1: F + T &= m_1 a \quad (i) \\
m_2: m_2 g \sin 30^\circ - T &= m_2 a \quad (ii)
\end{align*} \]

Adding (i) & (ii):

\[ (m_1 + m_2) a = m_2 g \sin 30^\circ + F \]

\[ a = \frac{m_2 g \sin 30^\circ + F}{m_1 + m_2} = \frac{1 \times 9.8 \times 0.5 + 2.3}{3.0 + 1.0} \]

\[ a = \frac{7.2}{4.0} = 1.8 \text{ m/s}^2 \]

a) So

\[ T = m a - F = 5.4 - 2.3 = 3.1 \text{ N} \]

b) For the string to become slack, \( T = 0 \):

Hence

\[ F = m a = 5.4 \text{ N} \]

52:

\[ N = F \sin \theta + mg \cos \theta \]

\[ F \cos \theta - mg \sin \theta = ma = 0 \]

\[ F \cos \theta = mg \sin \theta \]

a) \[ F = mg + tan \theta = 100 \times 9.8 + 0.57 \times 9.8 \]

\[ = 565.8 \text{ N} = 566 \text{ N} \]

b) \[ N = 566 \sin 30^\circ + 100 \times 9.8 \times 0.5766 = 283 + 84.67 \]

\[ = 113.68 = 1.13 \times 10^2 \text{ N} \]