17.   A 150-N bird feeder is supported by three cables as shown in Figure P4.17. Find the tension in each cable.

Solution   The bird feeder as well as the junction in the supporting cables are held in equilibrium by the forces acting on them.   Thus, the first condition of equilibrium may be applied to each of these objects. Consider the free-body diagrams (a) and (b) for these objects.
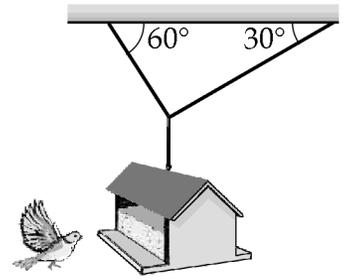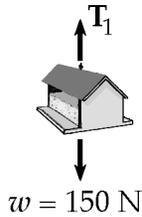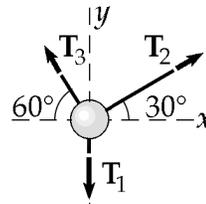
Figure P4.17

(a)   Free-body diagram   (b)   Free-body diagram
       of feeder   of junction

Note: Newton's third law has been observed in the directions of the action-reaction forces labeled T_1 in these diagrams.   Considering diagram (a) gives:

$$\sum F_y = +T_1 - 150 \text{ N} = 0, \qquad \text{or} \qquad T_1 = 150 \text{ N} \qquad \Diamond$$

Consideration of diagram (b) yields two equations:

$$\sum F_x = +T_2 \cos 30° - T_3 \cos 60° = 0 \qquad\qquad \sum F_y = T_2 \sin 30° + T_3 \sin 60° - T_1 = 0$$

which become, respectively

$$T_3 = \left(\frac{\cos 30°}{\cos 60°} \right) T_2 = 1.73\, T_2 \quad \textbf{[1]} \qquad\qquad (0.500)T_2 + (0.866)T_3 = 150 \text{ N} \qquad \textbf{[2]}$$

Substituting [1] into [2], $\left[0.500 + (0.866)(1.73) \right] T_2 = 150 \text{ N}$

Thus, $T_2 = 75 \text{ N}$ $\Diamond$

Then Equation 1 yields: $T_3 = (1.73)(75 \text{ N}) \text{ or } T_3 = 130 \text{ N}$ $\Diamond$