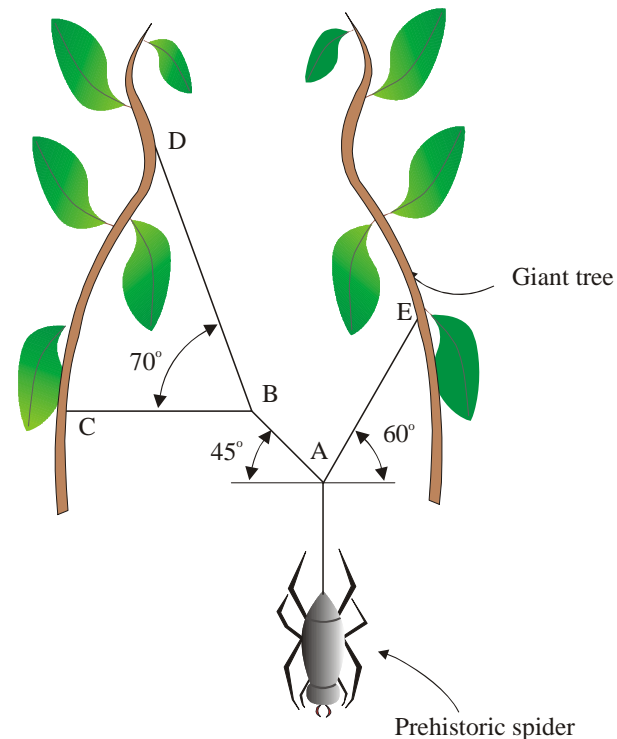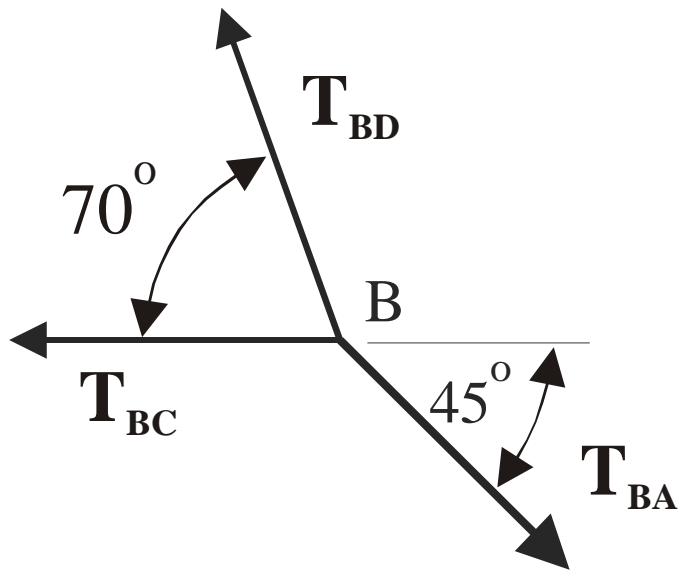# Example 2.12

J. Frye

Example 2.12

A prehistoric spider of mass 7 kg is suspended from a portion of its web attached to two giant trees as shown in the figure. Assuming that the spider is in static equilibrium, determine the magnitude of the tension in strings AB, AE, BD and BC. String BC is horizontal.
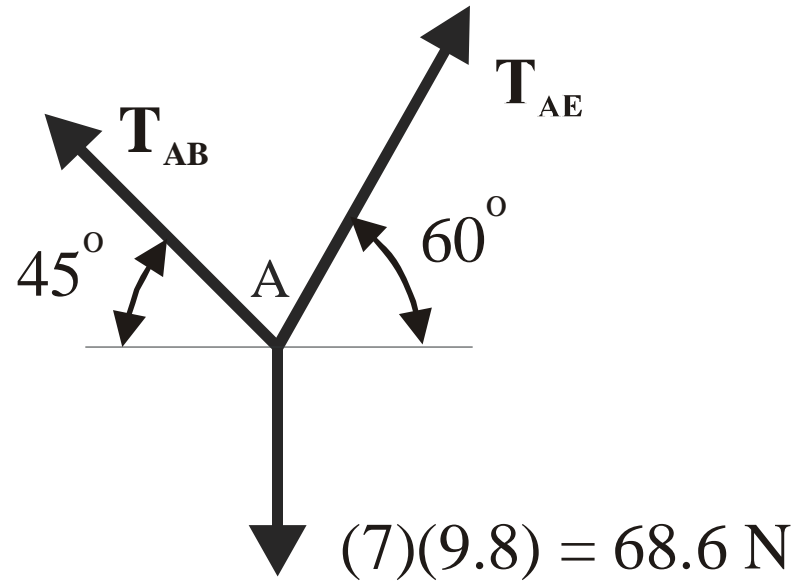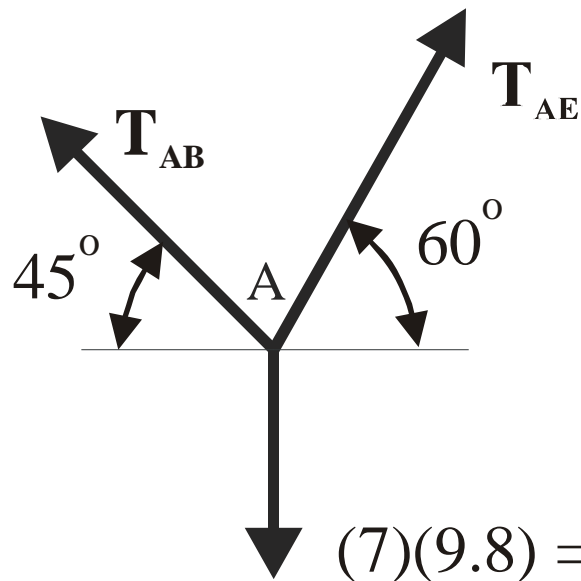
(Use g = 9.8m/sec^2)

Giant tree

70°

B

C

45°   A   60°

E

D

Prehistoric spider

$\mathbf{T_{BD}}$

70°

B

$\mathbf{T_{BC}}$

45°

$\mathbf{T_{BA}}$

FBD at B

Note: $T_{BA} = T_{AB}$

$\mathbf{T_{AB}}$

$\mathbf{T_{AE}}$

45°

A

60°

$(7)(9.8) = 68.6 \text{ N}$

FBD at A

T_{AE}

T_{AB}

45°

A

60°

$(7)(9.8) = 68.6 \text{ N}$

The are 3 unknowns in FBD at A and Only 2 unknowns in FBD at B. We Will apply equilibrium at B first.

$$\sum F_x = 0 \rightarrow$$

$$-T_{AB}\cos 45^o + T_{AE}\cos 60^o = 0 \quad (1)$$

$$\sum F_y = 0 \uparrow$$

$$T_{AB}\sin 45^o + T_{AE}\sin 60^o - 68.6 = 0 \quad (2)$$

From (1):

$$T_{AE} = \frac{T_{AB}\text{Cos}45^o}{\cos 60^o} = 1.414 T_{AB}$$

Substitute in (2):

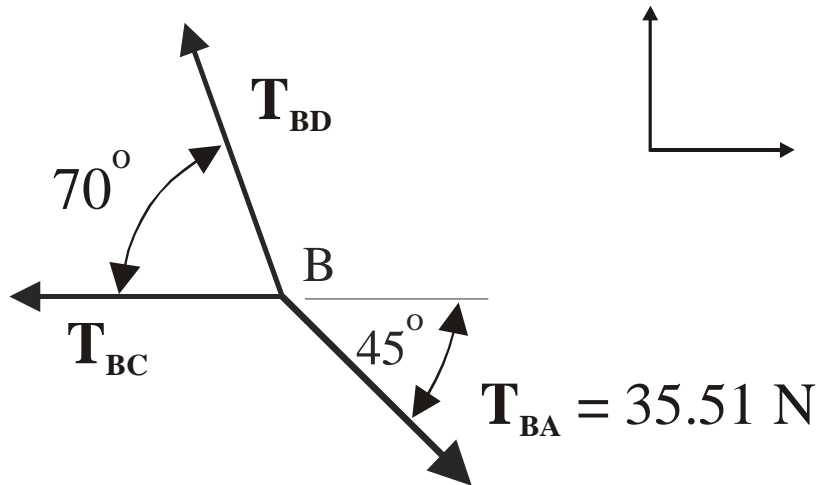$$T_{AB}\sin 45^o + 1.414 T_{AB}\sin 60^o = 68.6$$

$$1.932 T_{AB} = 68.6$$

$$T_{AB} = 35.51\text{N}$$

$$T_{AE} = 1.414(35.51) = 50.22\text{N}$$

We now apply equilibrium at B noting $T_{BA} = T_{AB}$

T_{BD}

70°

B

T_{BC}

45°

$T_{BA} = 35.51$ N

$$\sum F_X = 0 \rightarrow$$

$$-T_{BC} - T_{BD}Cos70^o + 35.51Cos45^o = 0 \quad (1)$$

$$\sum F_y = 0 \uparrow$$

$$T_{BD}Sin70^o - 35.51Sin45^o = 0 \quad (2)$$

$$T_{BD} = 26.72N$$

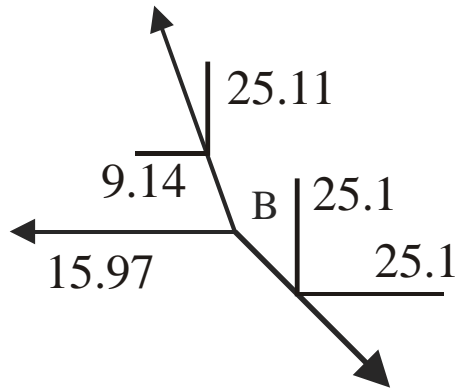Substitute in (1):

$$T_{BC} = -26.72Cos70^o + 35.51Cos45^o$$

$$T_{BC} = 15.97kN$$

Check – Resolve sloping forces into rectangular components ant put on placeholders:
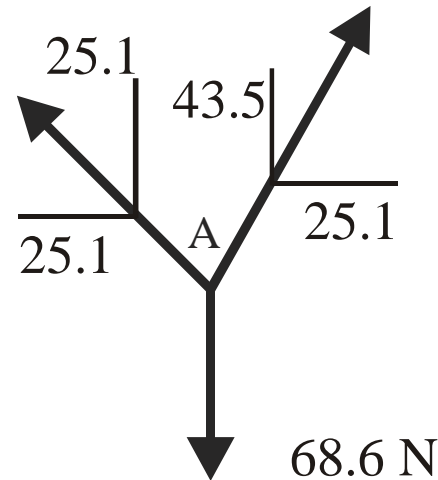

$$\sum F_x = 0 \rightarrow$$
$$-15.97 - 9.14 + 25.1 = 0$$
$$-0.01 \approx 0$$
$$\sum F_y = 0 \uparrow$$
$$25.11 - 25.1 = 0$$
$$0.01 \approx 0$$

$$\sum F_x = 0 \rightarrow$$
$$-25.1 + 25.1 = 0$$
$$0 = 0$$
$$\sum F_y = 0 \uparrow$$
$$25.1 + 43.5 - 68.6 = 0$$
$$0 = 0$$