13. **REASONING** The shortest distance between the two towns is along the line that joins them. This distance \( h \) is the hypotenuse of a right triangle whose other sides are \( h_o = 35.0 \text{ km} \) and \( h_a = 72.0 \text{ km} \), as shown in the drawing below.

**SOLUTION** The angle \( \theta \) is given by

\[
\theta = \tan^{-1}\left(\frac{h_o}{h_a}\right) = 25.9^\circ \text{ S of W}
\]

We can then use the Pythagorean theorem to find \( h \).

\[
h = \sqrt{h_o^2 + h_a^2} = \sqrt{(35.0 \text{ km})^2 + (72.0 \text{ km})^2} = 80.1 \text{ km}
\]

25. **REASONING** When a vector is multiplied by \(-1\), the magnitude of the vector remains the same, but the direction is reversed. Vector subtraction is carried out in the same manner as vector addition except that one of the vectors has been multiplied by \(-1\).

**SOLUTION** Since both vectors point north, they are colinear. Therefore their magnitudes may be added by the rules of ordinary algebra.

a. Taking north as the positive direction, we have

\[
\mathbf{A} - \mathbf{B} = \mathbf{A} + (-\mathbf{B}) = +2.43 \text{ km} + (-7.74 \text{ km}) = -5.31 \text{ km}
\]

The minus sign in the answer for \( \mathbf{A} - \mathbf{B} \) indicates that the direction is south so that

\[
\mathbf{A} - \mathbf{B} = 5.31 \text{ km, south}
\]

b. Similarly,

\[
\mathbf{B} - \mathbf{A} = \mathbf{B} + (-\mathbf{A}) = +7.74 \text{ km} + (-2.43 \text{ km}) = + 5.31 \text{ km}
\]

The plus sign in the answer for \( \mathbf{B} - \mathbf{A} \) indicates that the direction is north, so that

\[
\mathbf{B} - \mathbf{A} = 5.31 \text{ km, north}
\]
27. **REASONING AND SOLUTION** The single force needed to produce the same effect is equal to the resultant of the forces provided by the two ropes. The figure below shows the force vectors drawn to scale and arranged tail to head. The magnitude and direction of the resultant can be found by direct measurement using the scale factor shown in the figure.

![Force Vectors](image)

**Scale:** 1000 N

a. From the figure, the magnitude of the resultant is 5600 N.

b. The single rope should be directed along the resultant vector shown in the drawing.

39. **REASONING AND SOLUTION** The force F can be first resolved into two components; the z component $F_z$ and the projection onto the x-y plane, $F_p$ as shown in the following figure on the left. According to that figure,

$$F_p = F \sin 54.0^\circ = (475 \text{ N}) \sin 54.0^\circ = 384 \text{ N}.$$ 

The projection onto the x-y plane, $F_p$, can then be resolved into x and y components.

![Resolution of Force](image)

a. From the figure on the right,

$$F_x = F_p \cos 33.0^\circ = (384 \text{ N}) \cos 33.0^\circ = 322 \text{ N}$$

b. Also from the figure on the right,

$$F_y = F_p \sin 33.0^\circ = (384 \text{ N}) \sin 33.0^\circ = 209 \text{ N}$$

c. From the figure on the left,

$$F_z = F \cos 54.0^\circ = (475 \text{ N}) \cos 54.0^\circ = 279 \text{ N}$$