Section 8.2 The Sine Ratio, Build Your Skills, p499-502
Student Resource p343-345

## Build Your Skills

1. $\sin 16^{\circ}=0.2756$
$\sin 28^{\circ}=0.4695$
$\sin 51^{\circ}=0.7771$
$\sin 83^{\circ}=0.9925$
2. a) Diagram 1: Using the sine function.
$\sin \mathrm{X}=\frac{x}{h}$
$\sin \mathrm{X}=\frac{6.3}{12.6}$
$\sin X=0.5$
Diagram 2: Find side $x$ using the Pythagorean theorem.
$x^{2}+y^{2}=z^{2}$
$x^{2}+8^{2}=10^{2}$
$x^{2}+64=100$
$x^{2}=100-64$
$x^{2}=36$
$x=\sqrt{36}$
$x \approx 6$
$\sin \mathrm{X}=\frac{x}{n}$
$\sin \mathrm{X}=\frac{6}{10}$
$\sin \mathrm{X}=0.6$
Diagram 3: Find the hypotenuse as above.
$x^{2}+y^{2}=z^{2}$
$9.5^{2}+19.8^{2}=z^{2}$
$90.25+392.04=z^{2}$
$482.29=z^{2}$
$\sqrt{482.29}=z$
$22.0=z$
$\sin \mathrm{X}=\frac{x}{z}$
$\sin \mathrm{X}=\frac{9.5}{22.0}$
$\sin \mathrm{X}=0.4318$
b) Diagram 1:

Method 1: Using similar triangles,
$\triangle X Y Z \sim \Delta R S T$. Then,
$\frac{x}{z}=\frac{r}{t}$
$\frac{6.3}{12.6}=\frac{2.6}{t}$
$12.6 t \times \frac{6.3}{12.6}=\frac{2.6}{t} \times 12.6$
$6.3 t=32.76$

Multiply both
sides by the same

$\frac{6.3}{6.3} t=\frac{32.76}{6.3}$
Divide both sides by 6.3 .
$t=5.2$
Method 2: Using the sine function.
In part a ), $\sin \mathrm{X}$ was determined to be 0.5 . Therefore $\sin \mathrm{R}$ equals 0.5 .
$\sin \mathrm{R}=\frac{r}{t}$
$0.5=\frac{2.6}{t}$
$t \times 0.5=\frac{2.6}{t} \times t \quad$ Multiply both sides by $t$.
$\frac{0.5 t}{0.5}=\frac{2.6}{0.5}$
Divide both sides by 0.5 .
$t=5.2$
Method 3: Some students may notice that 12.6 equals 2 times 6.3. Therefore,
$t=2 \times 2.6$
$t=5.2$
The slide is 5.2 m long.
Diagram 2: Follow steps as in Diagram 1.
Method 1: Using similar triangles. From part a), $x$ equals 6 .
$\Delta X Y Z \sim \Delta R S T$
$\frac{x}{z}=\frac{r}{t}$
$\frac{6}{10}=\frac{2.6}{t}$
$10 t \times \frac{6.3}{10}=\frac{2.6}{t} \times 10 t \quad$ Multiply both sides by the same number.
$6 t=26$
$\frac{6}{6} t=\frac{26}{6}$
Divide both sides by 6 .
$t=4.3$
Method 2: Using the sine function. In part a), $\sin \mathrm{X}$ was determined to be 0.6 . Therefore $\sin \mathrm{R}$ equals 0.6.
$\sin \mathrm{R}=\frac{r}{t}$
$0.6=\frac{2.6}{t}$
$t \times 0.6=\frac{2.6}{t} \times t$
$\frac{0.6 t}{0.6}=\frac{2.6}{0.6}$
$t=4.3$
The slide is approximately 4.3 m long.
Diagram 3: Follow the steps from Diagram 1.
Method 1: Using similar triangles. From part a), $z$ is 22 cm .
$\triangle X Y Z \sim \Delta R S T$
$\frac{x}{Z}=\frac{r}{t}$
$\frac{9.5}{22}=\frac{2.6}{t}$
$22 t \times \frac{9.5}{22}=\frac{2.6}{t} \times 22 t$
$9.5 t=57.2$
$\frac{9.5}{9.5} t=\frac{57.2}{9.5}$
$t=6.0$
Method 2: Using the sine function. From part a), $\sin \mathrm{X}$ equals 0.4318 . Therefore $\sin \mathrm{R}$ equals 0.4318 .
$\sin R=\frac{r}{t}$
$0.4318=\frac{2.6}{t}$
$t \times 0.4318=\frac{2.6}{t} \times t$
$\frac{0.4318 t}{0.4318}=\frac{2.6}{0.4318}$
$t=6.0$
The slide is approximately 6 m long.
Alternative Solution
Some students may have noticed that if $\sin \mathrm{R}>0.5$ the angle is greater than $30^{\circ}$ and if $\sin \mathrm{R}<$ 0.5 , the angle is less than $30^{\circ}$.
3. $a^{2}+b^{2}=c^{2}$
$\left(\frac{6}{2}\right)^{2}+b^{2}=4^{2}$
$9+b^{2}=16$
$b^{2}=16-9$
$b^{2}=7$
$x=\sqrt{7}$
$x \approx 2.6 \mathrm{~m}$
The mamateek would be about 2.6 m tall.
You can find out more about Beothuk mamateeks at the following website: http://www.heritage.nf.ca/aboriginal/beo_housing.html.
4. a)

$r \sin 6^{\circ}=1.9$
Multiply both sides by $r$.
$r=\frac{1.9}{\sin 6^{\circ}}$
Divide both sides by $\sin 6^{\circ}$.
$r \approx 18.2 \mathrm{~m}$
The ramp must be 18.2 m long.
b) Use the Pythagorean theorem.
$h^{2}+b^{2}=r^{2}$
$1.9^{2}+b^{2}=18.2^{2}$
$b^{2}=18.2^{2}-1.9^{2}$
$b^{2}=327.63$
$b=\sqrt{327.63}$
$b \approx 18.1 \mathrm{~m}$

The ramp will start about 18.1 m from the base of the porch.
c) If the ramp were too steep, the person in the wheelchair might not have control. The degree of steepness that is safe also depends on the climate of the area. If it is a snowy/icy area, the ramp must be less steep to be safe.
5. First find the slant height of the lean-to. Use this plus the length of the barn to find the area of the roof.
$\sin \mathrm{H}=\frac{h}{w}$
$w \times \sin 21^{\circ}=\frac{(4.8-2)}{w} \times w \quad$ Multiply both sides by $w$.
$w=\frac{2.8}{\sin 21^{\circ}} \quad$ Divide both sides by $\sin 21^{\circ}$.
$w=7.8 \mathrm{~m}$
Area $=l w$
Area $=12.3 \times 7.8$
Area $=95.9 \mathrm{~m}^{2}$
He will need approximately $95.9 \mathrm{~m}^{2}$ of roofing.
6. a)

$\sin \mathrm{A}=\frac{a}{c}$
$\sin 9^{\circ}=\frac{a}{250}$
$a=250 \sin 9^{\circ}$
Multiply both sides by 250 .
$a \approx 39 \mathrm{~m}$
The road rises about 39 m .
b) Answers will vary, but this is considered steep in road construction.
7. a) $\sin ($ angle of elevation $)=\frac{\text { height }}{\text { string length }}$
$\sin 50^{\circ}=\frac{h}{210}$
$h=210 \sin 50^{\circ}$
Multiply both sides by 210 .
$h \approx 161 \mathrm{~m}$
The kite is about 161 m above the ground.
b) Substitute the new angle of elevation into the equation.
$\sin 65^{\circ}=\frac{h}{210}$
$h=210 \sin 65^{\circ}$
Multiply both sides by
210.
$h \approx 190 \mathrm{~m}$
The kite is about 190 m above the ground.
8. $\sin \mathrm{H}=\frac{h}{l}$


Low side:
$\sin 84.5^{\circ}=\frac{55.86}{l}$
$l \sin 84.5^{\circ}=55.86 \quad$ Multiply both sides by $l$.
$l=\frac{55.86}{\sin 84.5^{\circ}}$
Divide both sides by
$\sin 84.5^{\circ}$.
$h \approx 56.1 \mathrm{~m}$
High side:
$\sin 84.5^{\circ}=\frac{56.70}{l}$
$l \sin 84.5^{\circ}=56.70$
$l=\frac{56.70}{\sin 84.5^{\circ}}$
Multiply both sides by $l$.
Divide both sides by
$\sin 84.5^{\circ}$.
$h \approx 57.0 \mathrm{~m}$
The sides are about 56.1 m and 57 m long.

## Extend Your Thinking

9. Both the length of the rafter and the vertical distance will increase.

Suppose the angle is increased and the width stays the same-then the height must be greater, and then the angular distance must also be increased. See accompanying diagram.

10. Zero is less than $\sin x$ which is less than 1, as explained in Activity 8.3. That is, since the sine is defined as the ratio of the side opposite an acute angle to the hypotenuse, if the angle is very small, the opposite side is very small, and this ratio is close to zero, but if the angle is close to $90^{\circ}$, the opposite side is close in length to the hypotenuse and the ratio would be close to 1 .

