The CENTRE for EDUCATION in MATHEMATICS and COMPUTING

WATERLOO MATHEMATICS

Grade 8

Key

Number Sense and Numeration: Square Roots

Play **Square Root Tic-Tac-Toe** first.
Click on http://www.funbrain.com/cgi-bin/ttt.cgi?A1=s&A2=17&A3=0
Read the **Lesson on Square Roots** at http://argyll.epsb.ca/jreed/math8/strand1/1105.htm#17
You can go to *www.wiredmath.ca* for the links.

The square root of 16 is written as $\sqrt{16}$. The value of $\sqrt{16}$ is 4 since $(4)\times(4)=16$.
The **square root** of a number is one of its two *equal* factors.
For example, $\sqrt{144}=12$ since $(12)\times(12)=144$.

The symbol $\sqrt{\ }$ is called a radical sign. The number under a radical sign is called the radicand. For example, for $\sqrt{5}$, 5 is the radicand.

1. Determine each square root.

a. $\sqrt{25}=5$ b. $\sqrt{49}=7$ c. $\sqrt{121}=11$ d. $\sqrt{9}=3$

e. $\sqrt{0}=0$ f. $\sqrt{64}=8$ g. $\sqrt{36}=6$ h. $\sqrt{4}=2$

i. $\sqrt{81}=9$ j. $\sqrt{100}=10$ k. $\sqrt{1}=1$ l. $\sqrt{256}=16$

m. $\sqrt{225}=15$ n. $\sqrt{169}=13$ o. $\sqrt{196}=14$ p. $\sqrt{400}$

q. $\sqrt{625}=25$ r. $\sqrt{1024}=32$

Note: $\sqrt{\frac{9}{4}}=\frac{\sqrt{9}}{\sqrt{4}}=\frac{3}{2}$

2. Determine each square root.

a. $\sqrt{\frac{49}{36}}=\frac{7}{6}$ b. $\sqrt{\frac{121}{64}}=\frac{11}{8}$ c. $\sqrt{\frac{25}{16}}=\frac{5}{4}$ d. $\sqrt{\frac{100}{16}}=\frac{10}{4}$

e. $\sqrt{\frac{144}{225}}=\frac{12}{15}$ f. $\frac{\sqrt{0}}{\sqrt{81}}=\frac{0}{9}=0$ g. $\sqrt{\frac{9\times9}{3\times3}}=\frac{9}{3}$ h. $\sqrt{\frac{12\times12}{6\times6}}=\frac{12}{6}$

i. $\sqrt{\frac{10\times10}{4\times4}}=\frac{10}{4}$ j. $\sqrt{\frac{8\times8}{12\times12}}=\frac{8}{12}$ k. $\sqrt{\frac{2\times2}{3\times3}}=\frac{2}{3}$ l. $\sqrt{\frac{6\times6}{7\times7}}=\frac{6}{7}$

Expectations: i) represent, compare, and order square roots; ii) estimate, and verify using a calculator, the positive square roots of whole numbers, and distinguish between whole numbers that have whole-number square roots (i.e., perfect square numbers) and those that do not.

For more activities and resources from the University of Waterloo's Faculty of Mathematics, please visit www.cemc.uwaterloo.ca.

The square root of a positive integer that is not a perfect square is an approximate value.

For example, $\sqrt{54}$ *is close to* $\sqrt{49}$ *which equals 7.*

Using a calculator $\sqrt{54} \doteq 7.3$*, correct to one decimal place.*

3. a. Estimate each square root without a calculator.

   b. Use a calculator to determine each square root correct to one decimal place.

   i. $\sqrt{12} \cong 3$ ii. $\sqrt{18} \cong 4$ iii. $\sqrt{29} \cong 5$ iv. $\sqrt{72} \cong 8$ v. $\sqrt{83} \cong 9$ $\doteq 9.1$

   $\doteq 3.5$ $\doteq 4.2$ $\doteq 5.4$ $\doteq 8.5$

   vi. $\sqrt{119}$ vii. $\sqrt{0.25}$ viii. $\sqrt{1.44}$ ix. $\sqrt{2.25}$ x. $\sqrt{0.9} \cong 1$ / $\doteq 0.9$

   $\cong 11$ $\doteq 10.9$ $\doteq 0.5$ $\doteq 1.2$ $\doteq 1.5$

4. It can be shown that from a height of h metres, a person can see a distance d kilometres to the horizon, where $d = 3.53\sqrt{h}$.
   When the elevator of the CN Tower reaches the 200 m height, how far can the passengers in the elevator see across Lake Ontario?

   $d = 3.53\sqrt{200} = 3.53(14.14) = 49.9$ km

Did You Know?

The process of putting together the top antenna of the CN Tower took more than 3.5 weeks.

5. Determine the length of a side of a square that has an area of 100 cm^2.

   $\sqrt{100} = 10$ cm

6. Two sides of rectangles are given.

   a. Determine the area of each rectangle.

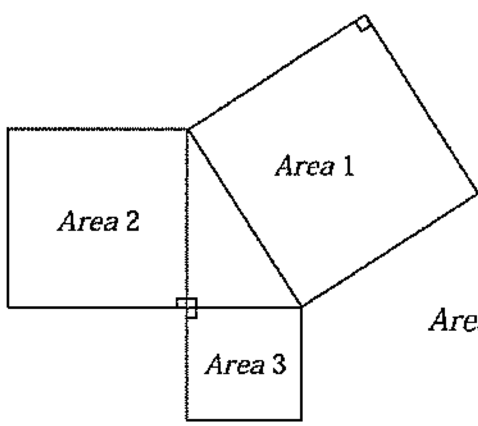
   b. Determine the length of a side of a square with the same area as the rectangle.

   i. 2 cm and 8 cm $A = 16 cm^2$ $l = 4 cm$ ii. 8 cm and 18 cm $A = 144 cm^2$ $l = 12 cm$ iii. 8 cm and 25 cm $A = 200 cm^2$ $l = 14.1$ cm

A Slice of History

Pythagoras (puh-thag-or-us) was a Greek philosopher and mathematician born in Samos. He and his followers tried to explain everything with numbers.

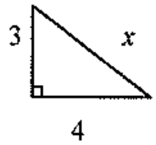
***Pythagoras**, 580 B.C. – 500 B.C. determined the relationship among the sides of a right-angled triangle.*
He concluded that the area of the square on the hypotenuse is equal to
the sum of the areas of the squares on the other two sides.



Area 1 = Area 2 + Area 3

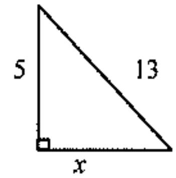
The Pythagorean Theorem to find an unknown side of a right triangle

To find the length of the hypotenuse:



$$x^2 = 3^2 + 4^2$$
$$x^2 = 9 + 16$$
$$x = \sqrt{25}$$
$$x = 5$$

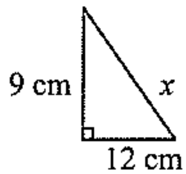
To find the length of a side when the hypotenuse is given:



$$5^2 + b^2 = 13^2$$
$$b^2 = 169 - 25$$
$$b = \sqrt{144}$$
$$b = 12$$

7. Determine the length of each unknown side of the following right-angled triangles.

a.

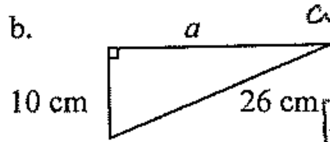


$x^2 = 9^2 + 12^2$

$x^2 = 225$

$\boxed{x = 15\text{cm}}$

b.

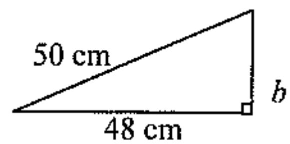


$a^2 + 10^2 = 26^2$

$a^2 = 576$

$\boxed{a = 24\text{cm}}$

c.

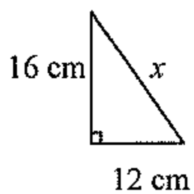


$b^2 + 48^2 = 50^2$

$b^2 = 196$

$\boxed{b = 14\text{cm}}$

d.

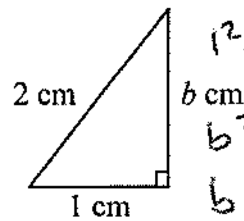


$x^2 = 12^2 + 16^2$

$x^2 = 400$

$\boxed{x = 20\text{cm}}$

e.

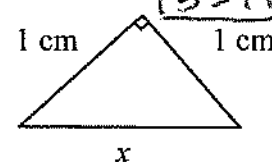


$1^2 + b^2 = 2^2$

$b^2 = 3$

$b = 1.7\text{cm}$

f.

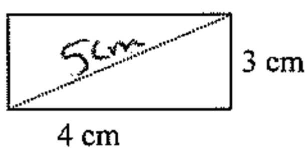


$x^2 = 1^2 + 1^2$

$x^2 = 2$ $x = 1.4$c

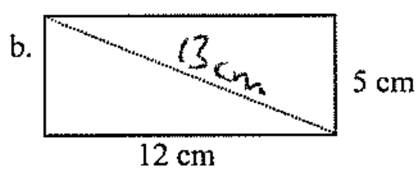
8. Find the length of a diagonal of each rectangle.

a.

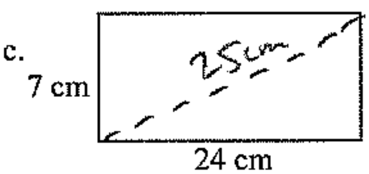


one of the diagonals is the dashed line

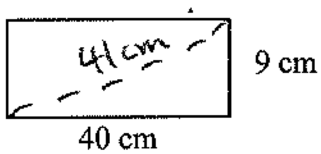
b.



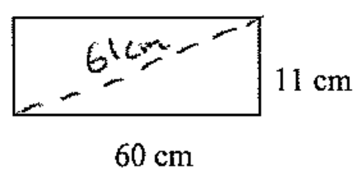
c.



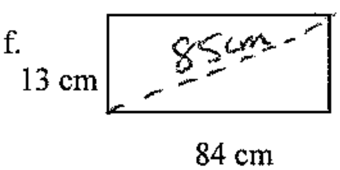
d.



e.



f.



Don't forget now! *Go to* *www.wiredmath.ca* for the link.

TRY THESE!

Square Root of a Perfect Square Number

http://www.quia.com/jg/65631.html

Square Root Flashcards

http://www.aplusmath.com/Flashcards/sqrt.html

Expectations: i) represent, compare, and order square roots; ii) estimate, and verify using a calculator, the positive square roots of whole numbers, and distinguish between whole numbers that have whole-number square roots (i.e., perfect square numbers) and those that do not.

For more activities and resources from the University of Waterloo's Faculty of Mathematics, please visit www.cemc.uwaterloo.ca.

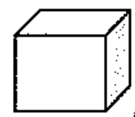
CHALLENGE YOURSELF

9. Without using a calculator, determine each value.

Write your answer as a fraction in the form $\frac{a}{b}$, $b \neq 0$.

a. $\sqrt{\frac{50}{32}} \cong \frac{7}{6}$ b. $\sqrt{\frac{128}{450}} \cong \frac{11}{21}$ c. $\sqrt{\frac{48}{147}} \cong \frac{7}{12}$ d. $\frac{\sqrt{45}}{\sqrt{125}} \cong \frac{7}{11}$ e. $\frac{\sqrt{288}}{\sqrt{200}} \cong \frac{17}{14}$

10. The cube, as shown, has a total surface area of $1176\ \text{cm}^2$.
Determine the length of one of its edges.



Area of one side $= \frac{1176}{6}$
$= 196$ cm

$l = \sqrt{196} = 14$ cm

> **A Slice of History**
> Sometimes called Hero, **Heron of Alexandria** was an important geometer and worker in mechanics.

11. If a, b and c represent the lengths of the sides of any triangle, the area is given by

Heron's Formula $A = \sqrt{s(s-a)(s-b)(s-c)}$ where $s = \frac{a+b+c}{2}$.

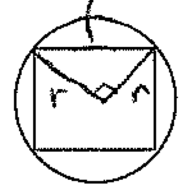
a. Determine the exact area of a triangle with sides 7 cm, 24 cm and 25 cm. $A = 84\ \text{cm}^2$
Discuss another method to find the area of this triangle. Why does the method work?

b. Determine the area of a triangle with sides of length 16 cm, 16 cm and 8 cm. Round the answer off to the nearest unit. $A = 62\ \text{cm}^2$

EXTENSIONS

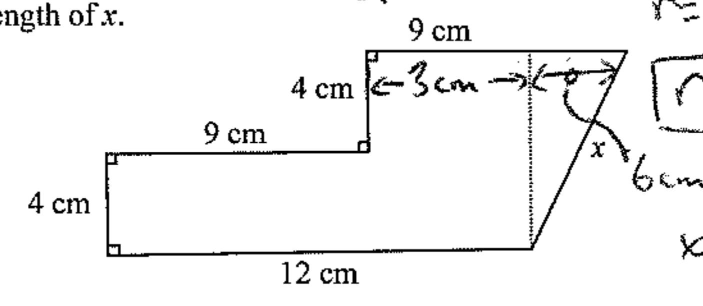
12. A square is inscribed in a circle, as shown. The area of the square is $98\ \text{cm}^2$.
Determine the radius of the circle.

$\sqrt{98} = 9.9$ cm



$r^2 + r^2 = 9.9$
$2r^2 = 9.9$
$r^2 = 4.95$
$r = \sqrt{4.95}$
$\boxed{r = 2.2\ \text{cm}}$

13. Determine the length of x.



$x^2 = 6^2 + 8^2$
$x^2 = 100$
$\boxed{x = 10\ \text{cm}}$

14. Observe that $1^3 + 2^3 = (1+2)^2$, $1^3 + 2^3 + 3^3 = (1+2+3)^2$ and $1^3 + 2^3 + 3^3 + 4^3 = (1+2+3+4)^2$.

If the same pattern holds, then what is the value of $\sqrt{1^3 + 2^3 + 3^3 + 4^3 + 5^3 + 6^3 + 7^3 + 8^3 + 9^3 + 10^3}$?

$= 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 = 55$

Expectations: i) represent, compare, and order square roots; ii) estimate, and verify using a calculator, the positive square roots of whole numbers, and distinguish between whole numbers that have whole-number square roots (i.e., perfect square numbers) and those that do not.