Name: NOTES KEY

Date: _____

SQUARE ROOT UNIT

Calendar of Chapter: See the 'Homework' link on the webpage

What You'll Learn:

Square Roots – What a square root is, how it's related to squaring, and how to evaluate for whole numbers, decimals, fractions, and negative numbers

Estimating Square Roots – How to estimate the square root of any number, including fractions

Pythagorean Theorem – What the theorem is, and how it is evaluated

Research and describe an ancient use for the Pythagorean Theorem:

Square Roots

Focus: To understand what a square root is and how it can be evaluated.

Warmup:
Every operation in math has an opposite.
Complete the table:

Operation	Opposite Operation
+	−
-	+
x	÷
÷	x
squaring^2	$\sqrt{}$ sq root

What is the symbol for a square root?

$\sqrt{}$

Ex1 – Simplify
a) 2^2
b) 5^2
c) 8^2
Ex2 – Now, square root the answer to each. Can you predict what will happen?
Test on your calculator.

a) 2^2 = 4, $\sqrt{4}$ = 2

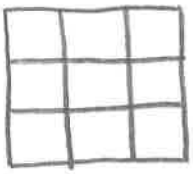
b) 5^2 = 25, $\sqrt{25}$ = 5

c) 8^2 = 64, $\sqrt{64}$ = 8

You get the base from your original power

One application of square roots is when finding side lengths of squares:

Ex3
A square rug has an area of 9m^2.
a) Sketch the rug as a grid.
b) What is the side length of the rug?
c) How can you get the side length without using the picture?
d)Explain in a sentence how the side length and area of a square are related.



b) 3m

c) $\sqrt{9} = 3$

d) - square root area to get side length
- square side length to get area

Ex4 –
a) Which numbers between 1 & 100 can you square root & get a whole number answer?
b) Do these numbers have only one square root?

a) 1, 4, 9, 16, 25, 36, 49, 64, 81, 100

b) No, they have two!
for example, $\sqrt{4} = 2$ and $\sqrt{4} = -2$
b/c $2 \times 2 = 4$ and $-2 \times -2 = 4$

How can you square root a fraction? *(very similar to the exponent law for squaring fractions!)*

use $\frac{4}{9}$ as an example: $\sqrt{\frac{4}{9}} = \frac{\sqrt{4}}{\sqrt{9}} = \frac{2}{3}$

$$\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$$

Ex5 - Simplify

a) $\sqrt{\frac{81}{25}}$

b) $\sqrt{\frac{1}{16}}$

a) $\sqrt{\frac{81}{25}} = \frac{\sqrt{81}}{\sqrt{25}} = \frac{9}{5}$

b) $\sqrt{\frac{1}{16}} = \frac{\sqrt{1}}{\sqrt{16}} = \frac{1}{4}$

Ex6 – Simplify without a calculator, then confirm with a calculator:

a) $\sqrt{0.49}$

b) $\sqrt{0.81}$

c) $\sqrt{0.04}$

a) $\sqrt{0.49} = 0.7$ b/c $0.7 \times 0.7 = 0.49$

(b) $\sqrt{0.81} = 0.9$ b/c $0.9 \times 0.9 = 0.81$

c) $\sqrt{0.04} = 0.2$ b/c $0.2 \times 0.2 = 0.04$

Can you explain the trend for square rooting decimals without a calculator?

However many digits are after the decimal in the multiplication is how many digits are after the decimal in the product.

Ex7 – Simplify without a calculator:

a) $\sqrt{0.36}$

b) $\sqrt{0.0036}$

c) $\sqrt{0.0009}$

a) $\sqrt{0.36} = 0.6$ $0.6 \times 0.6 = 0.36$

(b) $\sqrt{0.0036} = 0.06$ $0.06 \times 0.06 = 0.0036$

c) $\sqrt{0.0009} = 0.03$

Ex8 –

a) What is the square root of -49?

b) Try to square root it on your calculator. What is the result?

c) Why?

a) $\sqrt{-49}$ no answer

b) Error

c) You can't multiply two identical numbers and get a negative number.

pos × pos = pos, neg × neg = pos

neg × pos = neg

↑ can't be ↑ identical

Estimating Square Roots

Focus: Approximate the square roots of whole numbers, decimals, and fractions.

Warmup
List all the numbers between 1 and 100 that you know the square root of.

1, 4, 9, 16, 25, 36, 49, 64, 81, 100

Ex1
a) **Estimate** the square root of 7
b) How did you make your estimate?
c) Let's estimate it using **benchmarks**

a) $\sqrt{7}$ answers will vary

b) answers will vary

c) $\sqrt{4}$ 2 — $\sqrt{7}$ 2.6 or 2.7 — $\sqrt{9}$ 3

actual $\sqrt{7} = 2.64575...$

Ex2 – Estimate the square root using benchmarks. Show your work
a) 55
b) 79
c) 20

a) $\sqrt{49}$ 7 — $\sqrt{55}$ 7.4 — $\sqrt{64}$ 8

b) $\sqrt{64}$ 8 — $\sqrt{79}$ 8.9 — $\sqrt{81}$ 9

c) $\sqrt{16}$ 4 — $\sqrt{20}$ 4.4 or 4.5 — $\sqrt{25}$ 5

Ex3 - Check the square root of each using a calculator

$\sqrt{55} = 7.416...$ $\sqrt{79} = 8.888...$ $\sqrt{20} = 4.472...$

Ex4 - Construct a benchmark chart for numbers between 0 & 1

$\sqrt{0.01}$	$\sqrt{0.04}$	$\sqrt{0.09}$	$\sqrt{0.16}$	$\sqrt{0.25}$	$\sqrt{0.36}$	$\sqrt{0.49}$	$\sqrt{0.64}$	$\sqrt{0.81}$	$\sqrt{1}$
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1

Ex5 – Estimate the square root using benchmarks. Show your work
a) 0.14
b) 0.4
c) 0.05

a) $\sqrt{0.09}$ 0.3 — $\sqrt{0.14}$ 0.37 — $\sqrt{0.16}$ 0.4

b) $\sqrt{0.36}$ 0.6 — $\sqrt{0.4}$ 0.63 — $\sqrt{0.49}$ 0.7

c) $\sqrt{0.04}$ 0.2 — $\sqrt{0.05}$ 0.22 — $\sqrt{0.09}$

Ex6 – Check the square root of each using a calculator

$\sqrt{0.14} = 0.374...$ $\sqrt{0.4} = 0.632...$ $\sqrt{0.05} = 0.2236...$

Ex7 – Estimate without a calculator:

$\sqrt{\frac{35}{50}}$

Check with a calculator

Discuss strategies as a class as to how this was estimated:

① $\sqrt{\frac{35}{50}}$

close to $\sqrt{\frac{36}{49}}$

$= \frac{\sqrt{36}}{\sqrt{49}}$

$= \frac{6}{7}$

$= 0.86$

② $\sqrt{\frac{35 \div 5}{50 \div 5}}$

$= \sqrt{\frac{7}{10}}$

$= \sqrt{0.7}$

$\sqrt{0.64}$ ⋮ $\sqrt{0.81}$

0.8 ↓ 0.9

0.83 or 0.84

① - keep in fraction form and find the nearest perfect square for both numerator and denominator

② change to decimal and use benchmarks

ACTUAL

$\sqrt{\frac{35}{50}} = 0.83666...$

Ex8 – Estimate without a calculator:

$\sqrt{\frac{70}{13}}$

Exchange estimations with a partner, then use your calculator and see who was closer. Discuss strategies used.

$\sqrt{\frac{70}{13}}$

five 13s make 65

so $\sqrt{5\frac{5}{13}} \doteq \sqrt{5.4}$

$\sqrt{5.4}$

$\sqrt{4}$ ⋮ $\sqrt{9}$

2 ↓ 3

2.3 estimate

ACTUAL:

$\sqrt{\frac{70}{13}} = 2.32...$

Ex9 – Evaluate 2^3. *Square rooting* is the opposite of *squaring*. What do you think is the opposite of *cubing*?

$2^3 = 2 \times 2 \times 2 = 8$

cube rooting: $\sqrt[3]{\ }$

Ex10 – Simplify

a) 4^3

b) 5^3

Ex11 – Now, cube root the answer to each and confirm using your calculator.

a) 4^3

$= 4 \times 4 \times 4$

$= 64$

$\sqrt[3]{64}$

$= 4$

b) 5^3

$5 \times 5 \times 5$

$= 125$

$\sqrt[3]{125}$

$= 5$

The Pythagorean Theorem

Focus: To understand what the Pythagorean Theorem is, and how it is used.

Warmup:

a) What is the Pythagorean Theorem?
b) What is it used for?
c) Are there any details about how the Theorem works mathematically that are important to know?

Watch 'ACT ONE' of the 'TACO CART'

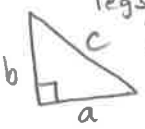
To find out which path is faster, what do we need to know?

- distance of each pathway
- speed on sand
- speed on cement

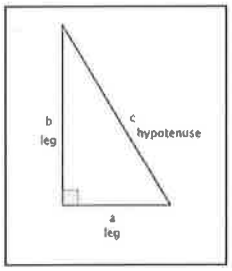
a) $a^2 + b^2 = c^2$

b) To find a missing side length on a right triangle if you already know the length of the other two sides

c) $a^2 + b^2 = c^2$ — legs of the triangle; must be the hypotenuse



The Pythagorean Theorem

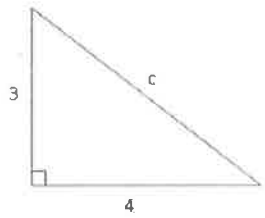


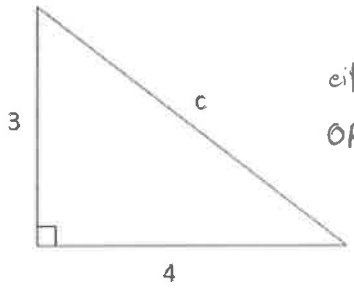
For any right triangle, the sides have the relationship

$$a^2 + b^2 = c^2$$

where a and b are the legs (non-hypot) and c is the hypotenuse

Ex1 – Find the length of the missing side:





$a^2 + b^2 = c^2$

either: $a=3, b=4$ OR $a=4, b=3$ } doesn't matter

$3^2 + 4^2 = c^2$

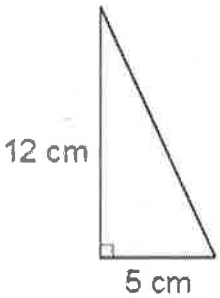
$9 + 16 = c^2$

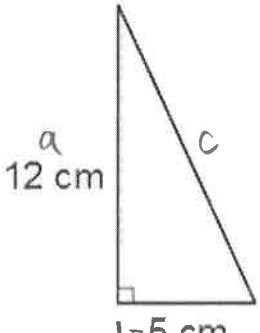
$25 = c^2$

$c = \sqrt{25}$

$c = 5$

Ex2 – Find the length of the missing side:





$a^2 + b^2 = c^2$

$12^2 + 5^2 = c^2$

$144 + 25 = c^2$

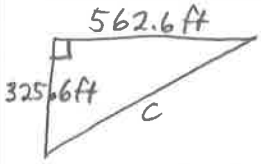
$169 = c^2$

$c = \sqrt{169}$

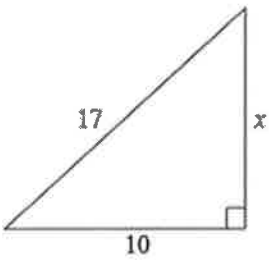
$c = 13\text{cm}$

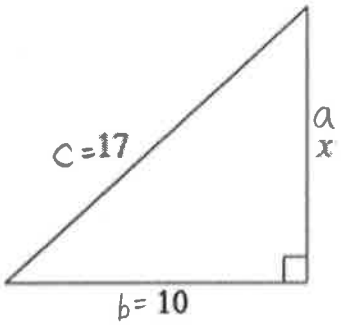
Back to the 'TACO CART' – ACT 2 'DIMENSIONS'

Solve for the missing side length to the nearest tenth:



Ex4 – Find the missing side length to the nearest tenth:





$a^2 + b^2 = c^2$

$x^2 + 10^2 = 17^2$

$x^2 + 100 = 289$

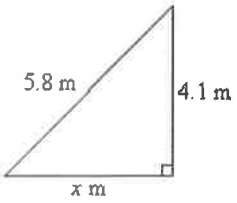
$-100 \quad -100$

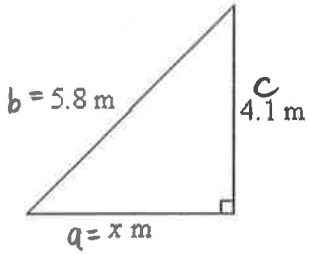
$x^2 = 189$

$x = \sqrt{189}$

$x = 13.7$

Ex5 – Find the missing side length to the nearest tenth:





$a^2 + b^2 = c^2$

$x^2 + (4.1)^2 = (5.8)^2$

$x^2 + 16.81 = 33.64$

$-16.81 \quad -16.81$

$x^2 = 16.83$

$x = \sqrt{16.83}$

$x = 4.1m$

Back to the 'TACO CART' – ACT 2 'SPEED'

Now, with a partner, find out which is the faster path for Dan & Ben:

Sand: 2 feet per second

Cement: 5 feet per second

'TACO CART' – ACT 3