

Operations with Radicals

simplify, add and subtract

Learning Goals

- Simplify and add/subtract radicals

Radical - root of a number or variable

ex $\sqrt{48}$ $\sqrt{x^6}$

Entire Radical - radical with a coefficient of 1

$$\sqrt{48} = 1\sqrt{48}$$

Mixed Radical - radical with a coefficient other than 1

$$2 \cdot \sqrt{48}$$

↑
multiplication

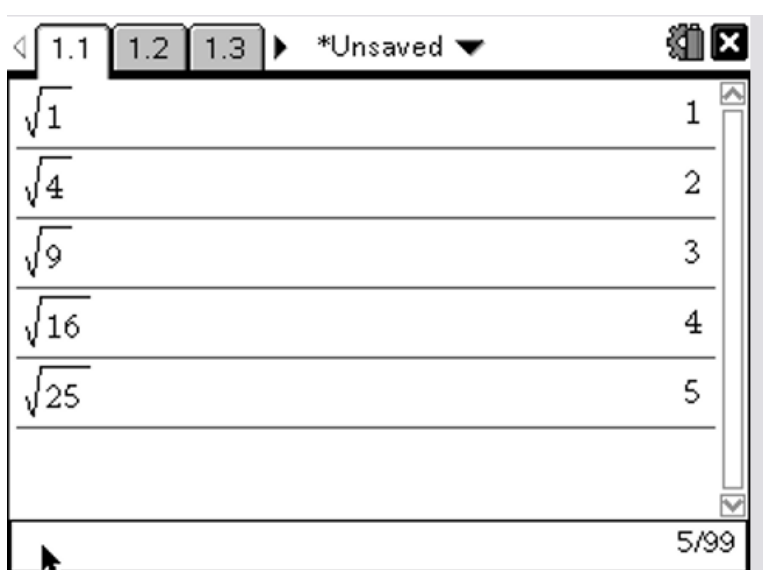
On the Boards...

Use the TI-Nspire to find a pattern in each group of questions.

Can you come up with a general rule?

Investigation: Simplifying Radicals

Try these on your TI-Nspire.



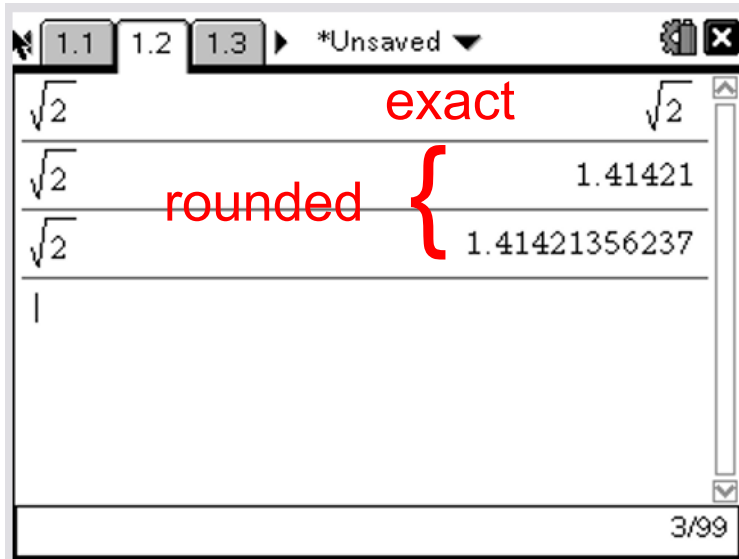
$\sqrt{\quad}$	
$\sqrt{1}$	1
$\sqrt{4}$	2
$\sqrt{9}$	3
$\sqrt{16}$	4
$\sqrt{25}$	5

1. What do we call these special numbers?

perfect squares

2. What is the $\sqrt{\quad}$ sign called?

root or radical



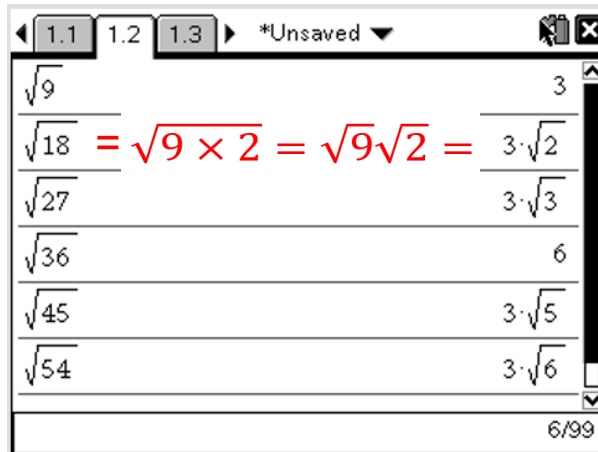
1. What is the square root of 2?

2. Which of these is the correct answer?

the most accurate answer is

$$\sqrt{2}$$

Try these ...



1. What is the pattern?

multiples of 9

2. How would I do this without a calculator?

break up into a perfect square and another number

Now try these ones ...

Before you hit Enter, think of the answer!

$\sqrt{8}$	$2\sqrt{2}$
$\sqrt{32} = \sqrt{16 \times 2} = 4\sqrt{2} =$	$4\sqrt{2}$
$\sqrt{98}$	$7\sqrt{2}$
$\sqrt{75}$	$5\sqrt{3}$
$\sqrt{80}$	$4\sqrt{5}$
$\sqrt{82}$	$\sqrt{82}$

OR

$$\begin{aligned}\sqrt{4 \times 8} &= \sqrt{4}\sqrt{8} \\ &= 2\sqrt{4 \times 2} \\ &= 2 \times 2\sqrt{2} \\ &= 4\sqrt{2}\end{aligned}$$

Simplifying Radicals

Handout

How do you simplify $\sqrt{48}$

1. Look for a perfect square to divide.

$$48 = 16 \times 3$$

2. Write it under the square root.

$$\sqrt{48} = \sqrt{16 \times 3}$$

3. Separate so each has a square root.

$$\sqrt{48} = \sqrt{16} \times \sqrt{3}$$

4. Reduce - take square root of the perfect square.

$$\sqrt{48} = 4 \times \sqrt{3}$$

5. Remove the multiplication sign.

$$\sqrt{48} = 4\sqrt{3}$$

Practise Express each of the following in simplest form.

a) $\sqrt{40}$

$$= \sqrt{4 \times 10}$$

$$= 2\sqrt{10}$$

b) $\sqrt{75}$

c) $\sqrt{80}$

d) $\sqrt{45}$

$$= \sqrt{9 \times 5}$$

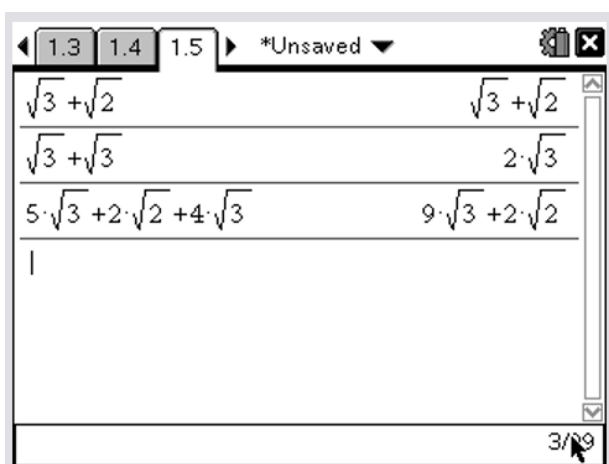
$$= 3\sqrt{5}$$

e) $\sqrt{90}$

f) $\sqrt{99}$

Must show your steps

Investigation - Adding/Subtracting Radicals



Is this similar to adding polynomials?

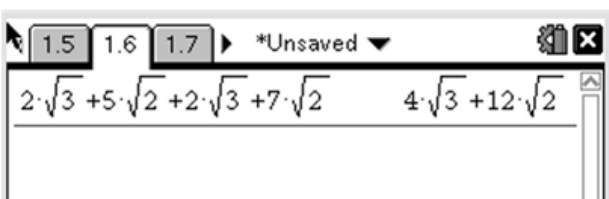
$$x + y = x + y$$

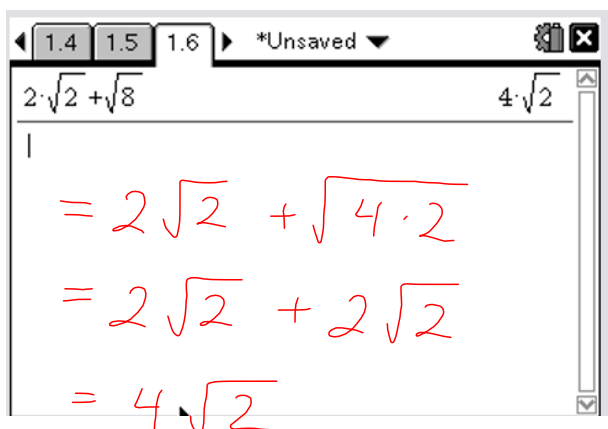
$$x + x = 2x$$

$$5x + 2y + 4x = 9x + 2y$$

Rule:

Add / Subtract like roots





How do we add if there are no like terms?

How would you get the answer without using your calculator?

Steps:

1. Change all radicals so they have like terms.
2. Add / Subtract

Adding/Subtracting Radicals

When adding or subtracting radicals, we

1. Change all radicals so they have like terms.
2. Add / Subtract

Simplify.

Ex. $3\sqrt{7} + 2\sqrt{7} =$ $5\sqrt{3} - 7\sqrt{2} + 9\sqrt{3} + 2\sqrt{2} =$
 $= 14\sqrt{3} - 5\sqrt{2}$

Practice:

$$\begin{aligned} \text{c) } 3\sqrt{2} - \sqrt{28} + 5\sqrt{7} + \sqrt{50} & \qquad \text{d) } \sqrt{20} - \sqrt{24} + \sqrt{54} + \sqrt{45} \\ & = 3\sqrt{2} - \sqrt{4 \cdot 7} + 5\sqrt{7} + \sqrt{25 \cdot 2} \\ & = 3\sqrt{2} - 2\sqrt{7} + 5\sqrt{7} + 5\sqrt{2} \\ & = 7\sqrt{2} + 3\sqrt{7} \end{aligned}$$

$$\begin{aligned} \text{e) } 5\sqrt{11} + \sqrt{72} + 3\sqrt{2} - 3\sqrt{11} & \qquad \text{f) } \sqrt{98} + 5\sqrt{2} + \sqrt{28} + \sqrt{63} \\ & = 2\sqrt{11} + \sqrt{72} + 3\sqrt{2} \\ & = 2\sqrt{11} + \sqrt{9 \cdot 8} + 3\sqrt{2} \\ & = 2\sqrt{11} + 3\sqrt{8} + 3\sqrt{2} \\ & = 2\sqrt{11} + 3\sqrt{4 \cdot 2} + 3\sqrt{2} \\ & = 2\sqrt{11} + 3(2)\sqrt{2} + 3\sqrt{2} \\ & = 2\sqrt{11} + 6\sqrt{2} + 3\sqrt{2} \\ & = 2\sqrt{11} + 9\sqrt{2} \end{aligned}$$

Seatwork:

pg. 167 # 1, 3, 4, 6

1. Express each of these as mixed radicals in simplest form.

a) $\sqrt{27}$	c) $\sqrt{98}$
b) $\sqrt{50}$	d) $\sqrt{32}$
2. Simplify.

a) $\sqrt{5} \times \sqrt{7}$	c) $2\sqrt{3} \times 5\sqrt{2}$
b) $\sqrt{11} \times \sqrt{6}$	d) $-4\sqrt{3} \times 8\sqrt{13}$
3. Simplify.

a) $4\sqrt{5} + 3\sqrt{5}$	c) $3\sqrt{3} + 8\sqrt{2} - 4\sqrt{3} + 11\sqrt{2}$
b) $9\sqrt{7} - 4\sqrt{7}$	d) $\sqrt{8} - \sqrt{18}$

PRACTISING

4. Express as a mixed radical in simplest form.

a) $3\sqrt{12}$	c) $10\sqrt{40}$	e) $\frac{2}{3}\sqrt{45}$
b) $-5\sqrt{125}$	d) $-\frac{1}{2}\sqrt{60}$	f) $-\frac{9}{10}\sqrt{1200}$
6. Simplify.
 - a) $\sqrt{8} - \sqrt{32}$
 - b) $\sqrt{12} + \sqrt{18} - \sqrt{27} + \sqrt{50}$
 - c) $3\sqrt{98} - 5\sqrt{72}$
 - d) $-4\sqrt{200} + 5\sqrt{242}$
 - e) $-5\sqrt{45} + \sqrt{52} + 3\sqrt{125}$
 - f) $7\sqrt{12} - 3\sqrt{28} + \frac{1}{2}\sqrt{48} + \frac{2}{3}\sqrt{63}$

Answers

1. a) $3\sqrt{3}$ b) $5\sqrt{2}$ c) $7\sqrt{2}$ d) $4\sqrt{2}$
2. a) $\sqrt{35}$ b) $\sqrt{66}$ c) $10\sqrt{6}$ d) $-32\sqrt{39}$
3. a) $7\sqrt{5}$ b) $5\sqrt{7}$ c) $-\sqrt{3} + 19\sqrt{2}$ d) $-\sqrt{2}$
4. a) $6\sqrt{3}$ c) $20\sqrt{10}$ e) $2\sqrt{5}$
 b) $-25\sqrt{5}$ d) $-\sqrt{15}$ f) $-18\sqrt{3}$
5. a) $2\sqrt{3} - \sqrt{15}$ c) 32 e) $36\sqrt{2}$
 b) $2\sqrt{14} + 6\sqrt{6}$ d) $-24\sqrt{3}$ f) -140
6. a) $-2\sqrt{2}$ c) $-9\sqrt{2}$ e) $2\sqrt{13}$
 b) $-\sqrt{3} + 8\sqrt{2}$ d) $15\sqrt{2}$ f) $16\sqrt{3} - 4\sqrt{7}$