

# Section 8: Monomials and Radicals

In this section, we are going to learn skills for:

## *NGSS Standards*

- ☀ **MA.912.A.4.1** Simplify monomials and monomial expressions using the laws of integral exponents.
  
- ☀ **MA.912.A.6.1** Simplify radical expressions. (Assessed with MA.912.A.6.2.)
  
- ☀ **MA.912.A.6.2** Add, subtract, multiply, and divide radical expressions (square roots and higher). (Also assesses MA.912.A.6.1.)

## *CCS Standards*

- ☉ **MACC.912.N-RN.1.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents.



## Section 8 – Video 1

# Multiplying Monomials

“Multiply Coefficients, Add the Exponents”

$$(4c^2)(2c^3r^3)$$

$$(-6j^3n^2)(7c^2n^3)$$

$$(8x^2y^0)(-10x^3y^2z)$$

*Try it!*

$$(-3a)(-6a^3d^3)$$

$$de^3(4d^3r^3)$$



## BEAT THE TEST!

1. Carolina simplified the expression shown below.

$$(h^3k)(h^3k^3)$$

Her final answer was in the form  $h^m k^n$ . If she simplified the expression correctly, what is the value of  $n$ , the exponent on  $k$ ?

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## Section 8 – Video 2

### Dividing Monomials

“Divide Coefficients, Subtract the Exponents”

- Simplify the coefficients.
- For the variables:
  - If there is no match for a variable, leave it alone!
  - If there is a match, subtract the exponents.

$$\frac{30j^5n^2vx}{20j^3n^4v}$$

$$\frac{6fg^2r^6}{-8fg^3r^4}$$



*Try it!*

$$\frac{27j^4k m}{10j^3m^3}$$

$$\frac{-15e^3h^5}{10e^2m^5}$$



## BEAT THE TEST!

1. Barry Schmelly was given the following problem to solve as part of a larger riddle:

$$\frac{y^{14}z^7}{y^7z^3}$$

His final answer was in the form  $y^m z^n$ . If he simplified the expression correctly, what is the value of  $m$ , the exponent on  $y$ ?

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## Section 8 – Video 3

### Monomials to Powers

Apply the power to the coefficients. Remember: when you have a power raised to a power, you multiply the exponents.

$$(2bd^5h^2)^3$$

$$(2a^7g^2)^2$$

*Try it!*

$$(2c^2d^3)^4$$

$$(-3a^4c^2)^3$$



Here is a summary in one box:

**Study Edge Tip**

Multiplying Monomials – Multiply Coefficients, Add Exponents

Dividing Monomials – Divide Coefficients, Subtract Exponents

Monomials to Powers – Power to the Coefficients, Multiply the Exponents





## BEAT THE TEST!

1. The expression  $(2h^3k^{-4}m^3)^2$  is equivalent to which of the following?

A.  $\frac{2h^5m^5}{k^2}$

B.  $\frac{4h^5m^5}{k^2}$

C.  $\frac{2h^6m^6}{k^8}$

D.  $\frac{4h^6m^6}{k^8}$



## Section 8 – Video 4

### Radical Monomials

Let's look at our perfect squares by filling in the table to the right:

For numbers that are on the chart, just write the answer:

$$\sqrt{49} =$$

$$\sqrt{16} =$$

If the number is not a perfect square, see if a perfect square goes into it.

$$\sqrt{50} =$$

$$\sqrt{18} =$$

| $x$ | $x^2$ |
|-----|-------|
| 1   |       |
| 2   |       |
| 3   |       |
| 4   |       |
| 5   |       |
| 6   |       |
| 7   |       |
| 8   |       |
| 9   |       |
| 10  |       |



*Try it!*

$$\sqrt{27} =$$

$$\sqrt{8} =$$

For variables with exponents, if the exponent is even:

$$\sqrt{x^2} =$$

*Try it!*

$$\sqrt{y^{10}} =$$

$$\sqrt{a^{10}c^6} =$$



If the exponent is odd:

$$\sqrt{y^{13}} =$$

$$\sqrt{v^7} =$$

*Try it!*

$$\sqrt{k^5} =$$

$$\sqrt{c^3} =$$



You can combine the coefficients and variables:

$$\sqrt{49a^{12}} =$$

$$\sqrt{8w^7} =$$

*Try it!*

$$\sqrt{12p^6} =$$

$$\sqrt{50g^7} =$$



## BEAT THE TEST!

1. The expression  $\sqrt{m^9}$  is equivalent to which of the following?

A.  $m^3$

B.  $m^3\sqrt{m}$

C.  $m^4$

D.  $m^4\sqrt{m}$

2. Simplify the following expression:

$$\sqrt{8j^8}$$

In the final answer, what is the exponent on  $j$ ?

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## Section 8 – Video 5

### Adding and Subtracting Radicals

We are familiar with combining like terms:

$$4a + 5a + 3b + 8b =$$

We can do the same when radicals have the same number underneath (they act like variables).

$$12\sqrt{2} + 3\sqrt{2} =$$

$$4\sqrt{5x} + 5\sqrt{5x} + 3\sqrt{7x} =$$

*Try it!*

$$2\sqrt{2} + 5\sqrt{6} - 2\sqrt{2} + 6\sqrt{6} =$$



Simplify before adding if necessary.

$$6\sqrt{3} + 4\sqrt{12} =$$

$$2\sqrt{3} + 3\sqrt{27} =$$

*Try it!*

$$2\sqrt{45} - \sqrt{5} + 4\sqrt{20} =$$





## BEAT THE TEST!

1. Simplify the following expression:

$$6\sqrt{2} + 4\sqrt{2} + 5\sqrt{8}$$

A.  $10\sqrt{2} + 5\sqrt{8}$

B.  $10\sqrt{8}$

C.  $15\sqrt{12}$

D.  $20\sqrt{2}$

2. Simplify the following expression:

$$3\sqrt{2g} + 4\sqrt{8g} - \sqrt{2g}$$

A.  $6\sqrt{2g}$

B.  $7\sqrt{2g}$

C.  $9\sqrt{2g}$

D.  $10\sqrt{2g}$



## Section 8 – Video 6

### Multiplying and Dividing Radicals

- To multiply radicals:
  - Multiply the numbers in front together.
  - Multiply the numbers inside together.

$$4\sqrt{3} * 2\sqrt{5} =$$

$$4\sqrt{5} * 4\sqrt{6} =$$

$$4\sqrt{5} * 6\sqrt{10} =$$

*Try it!*

$$6\sqrt{3} * 3\sqrt{6} =$$



- To divide radicals:
  - Simplify the numbers in front.
  - Simplify the numbers inside together.

$$\frac{12\sqrt{6}}{3\sqrt{2}} =$$

$$\frac{6\sqrt{6}}{4\sqrt{6}} =$$

*Try it!*

$$\frac{2\sqrt{6}}{4\sqrt{2}} =$$



## BEAT THE TEST!

1. Simplify the following expression:

$$5\sqrt{6} * 4\sqrt{2}$$

- A.  $9\sqrt{8}$
- B.  $20\sqrt{12}$
- C.  $40\sqrt{3}$
- D.  $80\sqrt{3}$

2. Alan was told by a group of aliens to simplify the following expression as part of a quest to find the meaning of the universe.

$$\frac{2\sqrt{10}}{2\sqrt{5}}$$

How should he respond?

- A.  $\sqrt{2}$
- B.  $\sqrt{5}$
- C.  $\sqrt{10}$
- D.  $\sqrt{50}$



## Section 8: Monomials and Radicals

### Practice Problems

1. Easton simplified the following expression:  $(x^2y^6z^5)(x^4y^5z^3)$ .

If he writes his answer in the form  $x^a y^b z^c$ , what is the value of  $b$ ?

2. The equation  $(a^4b^3)(a^2b^{-3})$  is equivalent to which of the following?

A.  $\frac{a^8}{b^9}$

B.  $a^6$

C.  $a^6b^9$

D.  $\frac{a^6}{b^9}$



3. What is the quotient of the expression below?

$$\frac{(3x^4y^3)^3}{3x^2}$$

4. The expression  $(m^6n^{-5}q^3)^2$  is equivalent to which of the following?

A.  $m^{12}n^{10}q^6$

B.  $\frac{m^{36}q^9}{n^{25}}$

C.  $\frac{m^{12}q^6}{n^{10}}$

D.  $2m^{12}n^{10}q^6$



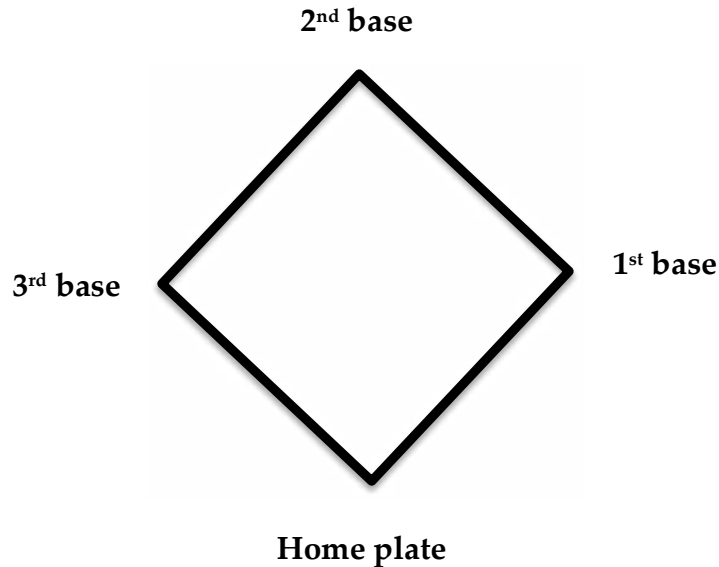
5. The length of each side of a square wooden box, in inches, is represented by the expression  $8x^2$ . The volume of the box, in cubic inches, is  $(8x^2)^3$ .

Which simplified expression represents the volume of the box?

- A.  $8x^6$
- B.  $24x^5$
- C.  $512x^5$
- D.  $512x^6$



6. The area of the softball field below is  $3600 \text{ ft}^2$ . The bases of the softball diamond are located at the corners. How far is a throw from 3<sup>rd</sup> base to home plate?



7. Assuming  $y > 0$ , which of these expressions is equivalent to  $5\sqrt{125y^3} + 2\sqrt{80y^3}$ ?

- A.  $33y\sqrt{5y}$
- B.  $17y\sqrt{5y}$
- C.  $33\sqrt{5y}$
- D.  $9y\sqrt{5y}$



8. Which of the following is equivalent to  $(4\sqrt{6})(3\sqrt{15})$ ?

A.  $36\sqrt{10}$

B.  $12\sqrt{80}$

C.  $12\sqrt{10}$

D.  $7\sqrt{21}$

9. Simplify the following expression:

$$\frac{3\sqrt{6}}{12\sqrt{54}}$$



10. What is the area of the triangle below?

(Remember:  $Area = \frac{1}{2}bh$ )

