

## ALGEBRA

### Lesson 1 Exponents and Square Roots

#### 1. WHOLE NUMBERS WITH EXPONENTS

An exponent says how many times to multiply a base number times itself.

$5^2$  means multiply 5 times itself two times, or,  $5 \times 5$ , which equals 25.

The raised number  $^2$  is called the exponent.

The regular number 5 is called the base.

$5^2$  is read as “five squared” or “five to the second power.”

$5^2$  does NOT mean  $5 \times 2$ .

$5^3$  means multiply 5 times itself three times, or,  $5 \times 5 \times 5$ , which equals 125.

$5^3$  is read as “five cubed” or “five to the third power” or “five to the third.”

$5^3$  does NOT mean  $5 \times 3$ .

$5^4$  means multiply 5 times itself four times, or,  $5 \times 5 \times 5 \times 5$  which equals 625.

$5^4$  is read as “five to the fourth” or “five to the fourth power.”

$5^4$  does NOT mean  $5 \times 4$ .

**CAREFUL** – A very common mistake is to multiply the base times the exponent.

For example,  $5^2$  is often mistakenly calculated as  $5 \times 2 = 10$  instead of  $5 \times 5 = 25$ .

$$6^2 = 6 \times 6 = 36$$

$$4^3 = 4 \times 4 \times 4 = 64$$

$$3^5 = 3 \times 3 \times 3 \times 3 \times 3 = 243$$

Practice doing these on your calculator. You can use multiplication, or you can use the  $x^2$  key, found on the top row of keys, or the  $x^y$  key found on the bottom row of keys.

#### Using the $x^2$ key

Use the  $x^2$  key when working with the  $^2$  exponent. Press base number, then  $x^2$  key.

To calculate  $12^2$  Press 12  $x^2$  and the answer 144 is displayed.

**OR** Press  $12 \times 12 =$  and the answer 144 is displayed.

#### Using the $x^y$ key

Use the  $x^y$  key when working with larger exponents. To use this key press base number, then  $x^y$  key, then exponent, then = key.

For  $7^4$  press 7  $x^y$  4 = to get 2,401 **OR** press  $7 \times 7 \times 7 \times 7 =$  to get 2,401

Note that you do not press the equal key when you use the  $x^2$  key.

You do need to press the equal key when you use the  $x^y$  key.

### Examples

$7^2$  Press 7 x 7 = and you'll get 49

**OR** Press 7  $x^2$  and you'll get 49

$2^3$  Press 2 x 2 x 2 = and you'll get 8

**OR** Press 2  $x^y$  3 = and you'll get 8

$4^5$  Press 4 x 4 x 4 x 4 x 4 = and get 1,024

**OR** Press 4  $x^y$  5 = and get 1,024

### **Practice One** Answers – p. 7

1.  $4^2 =$        $8^2 =$        $3^3 =$        $12^2 =$        $7^3 =$        $6^7 =$        $15^4 =$        $9^3 =$

2. What is the value of  $6^3$  ?

A) 18

B) 36

C) 24

D) 216

E) 1,296

## **2. FRACTIONS WITH EXPONENTS**

**TIP** – To enter a fraction on the calculator, enter top number, then abc key, then bottom number.

$\left(\frac{2}{3}\right)^2$  means  $\frac{2}{3} \times \frac{2}{3} = \frac{4}{9}$

The base is  $\frac{2}{3}$ , and the exponent is 2, so multiply  $\frac{2}{3}$  times itself two times.

Here are two ways to calculate the value of a fraction with an exponent.

**Method One** – Multiply using the abc key to enter the fraction.

$\left(\frac{2}{3}\right)^2 = \frac{2}{3} \times \frac{2}{3} = \frac{4}{9}$  Press 2 abc 3 x 2 abc 3 = and you'll get  $\frac{4}{9}$ .

**Method Two** – Calculate the top and bottom of the fraction separately using multiplication, the  $x^2$  key, or the  $x^y$  key.

$\left(\frac{2}{3}\right)^2 = \frac{2^2}{3^2} = \frac{4}{9}$  Press 2  $x^2$  OR 2 x 2 = to get 4 for the top of the fraction.  
Press 3  $x^2$  OR 3 x 3 = to get 9 for the bottom of the fraction.

**NOTE** – If you use the  $x^2$  key on the whole fraction, you will get a decimal answer.

Press 2 abc 3  $x^2$  and 0.444444 will display on the calculator. This has the same value as  $\frac{4}{9}$ , but if you want an answer in fraction form, use Method 1 or Method 2.

**TIP** – You can think of the fraction bar as a division sign.

$\frac{4}{9} \rightarrow 4 \div 9 = 0.444444$

### Example 1

$$\left(\frac{1}{2}\right)^2 = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4} \quad \text{Press 1 abc 2 x 1 abc 2 = and you'll get } \frac{1}{4}.$$

**OR**

$$\left(\frac{1}{2}\right)^2 = \frac{1^2}{2^2} = \frac{1}{4} \quad \begin{array}{l} \text{Press 1 } x^2 \\ \text{Press 2 } x^2 \end{array} \quad \begin{array}{l} \text{OR} \quad 1 \times 1 = \text{ to get 1 for the top of the fraction.} \\ \text{OR} \quad 2 \times 2 = \text{ to get 4 for the bottom of the fraction.} \end{array}$$

### Example 2

$$\left(\frac{2}{3}\right)^3 = \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} = \frac{8}{27} \quad \text{Press 2 abc 3 x 2 abc 3 x 2 abc 3 = to get } \frac{8}{27}.$$

**OR**

$$\left(\frac{2}{3}\right)^3 = \frac{2^3}{3^3} = \frac{8}{27} \quad \begin{array}{l} \text{Press 2 } x^y 3 = \\ \text{Press 3 } x^y 3 = \end{array} \quad \begin{array}{l} \text{OR} \quad 2 \times 2 \times 2 = \text{ to get 8 for the top of the fraction.} \\ \text{OR} \quad 3 \times 3 \times 3 = \text{ to get 27 for the bottom of the fraction.} \end{array}$$

### Example 3

$$\left(\frac{3}{5}\right)^6 = \frac{3}{5} \times \frac{3}{5} \times \frac{3}{5} \times \frac{3}{5} \times \frac{3}{5} \times \frac{3}{5} = \frac{729}{15,625}$$

Press 3 abc 5 x 3 abc 5 x 3 abc 5 x 3 abc 5 x 3 abc 5 x 3 abc 5 = and you'll get  $\frac{729}{15,625}$ .

**OR**

$$\left(\frac{3}{5}\right)^6 = \frac{3^6}{5^6} = \frac{729}{15,625} \quad \begin{array}{l} \text{Press 3 } x^y 6 = \\ \text{Press 5 } x^y 6 = \end{array} \quad \begin{array}{l} \text{OR} \quad 3 \times 3 \times 3 \times 3 \times 3 \times 3 = \text{ to get 729 for the top.} \\ \text{OR} \quad 5 \times 5 \times 5 \times 5 \times 5 \times 5 = \text{ to get 15,625 for the} \\ \text{bottom.} \end{array}$$

**TIP** – As you can see in Example 3, with large exponents, it is easier and faster to calculate the top and bottom of the fraction separately using the  $x^y$  key.

### **Practice Two** Answers – p. 7

1.  $\left(\frac{4}{5}\right)^2 =$        $\left(\frac{5}{6}\right)^3 =$        $\left(\frac{1}{5}\right)^4 =$        $\left(\frac{2}{5}\right)^6 =$        $\left(\frac{5}{7}\right)^3 =$        $\left(\frac{7}{10}\right)^2 =$

2. Which of the following equals  $\left(\frac{3}{4}\right)^2$  ?

- A)  $\frac{6}{8}$       B)  $\frac{9}{16}$       C)  $\frac{1}{4}$       D)  $\frac{6}{4}$       E)  $\frac{9}{4}$

3. What is the value of  $\left(\frac{2}{3}\right)^4$  ?

A)  $\frac{8}{12}$

B)  $\frac{8}{3}$

C)  $\frac{16}{3}$

D)  $\frac{16}{81}$

E)  $\frac{6}{7}$

4.  $\left(\frac{3}{5}\right)^3$  is equal to which fraction?

A)  $\frac{9}{125}$

B)  $\frac{27}{125}$

C)  $\frac{9}{25}$

D)  $\frac{9}{15}$

E)  $\frac{6}{8}$

### 3. SQUARE ROOTS

$\sqrt{25}$  is read as “the square root of 25.”

It means: what number multiplied times itself is equal to 25?

Answer: 5 is the square root of 25 because  $5 \times 5 = 25$ .

$\sqrt{25} = 5$  is read as “the square root of 25 equals 5.”

$\sqrt{100} = 10$  because  $10 \times 10 = 100$

$\sqrt{225} = 15$  because  $15 \times 15 = 225$

$\sqrt{9} = 3$  because  $3 \times 3 = 9$

$\sqrt{64} = 8$  because  $8 \times 8 = 64$

Use your calculator to get the square root of any number. Enter the number, the shift key, then the  $x^2$  key, and the answer will be displayed. You do not hit the = key.

$\sqrt{36} = 6$  Enter 36 shift  $x^2$  and the answer 6 is displayed on the calculator.

$\sqrt{49} = 7$  Enter 49 shift  $x^2$  and the answer 7 is displayed on the calculator.

$\sqrt{400} = 20$  Enter 400 shift  $x^2$  and the answer 20 is displayed on the calculator.

$\sqrt{65} = 8.06$  Enter 65 shift  $x^2$  and the answer 8.06 is displayed on the calculator.

If there is an operation like addition or subtraction inside the square root symbol, do the operation first, and then get the square root.

$\sqrt{16 + 48} = \sqrt{64} = 8$  Enter 64 shift  $x^2$  and the answer 8 is displayed.

$\sqrt{150 - 29} = \sqrt{121} = 11$  Enter 121 shift  $x^2$  and the answer 11 is displayed.

$\sqrt{64 + 225} = \sqrt{289} = 17$  Enter 289 shift  $x^2$  and the answer 17 is displayed.

**Practice Three** Answers – p. 8

- |                      |                    |                     |
|----------------------|--------------------|---------------------|
| 1. $\sqrt{81} =$     | $\sqrt{92 - 43} =$ | $\sqrt{75} =$       |
| 2. $\sqrt{12 + 4} =$ | $\sqrt{196} =$     | $\sqrt{1} =$        |
| 3. $\sqrt{121} =$    | $\sqrt{1,225} =$   | $\sqrt{25 + 144} =$ |

**4. SQUARE ROOT WORD PROBLEMS**

**Example 1**

Which of the following is equal to  $\sqrt{75 + 121}$  ?

- A) 196                  B) 14                  C) 28                  D) 98                  E) 7

$\sqrt{75 + 121} = \sqrt{196} = 14$  so the **answer is B) 14**.

**Example 2**

The square root of 22 falls between which pair of integers?

- A) 2 and 3                  B) 3 and 4                  C) 4 and 5                  D) 5 and 6                  E) 6 and 7

The fastest and easiest way to solve this is to use your calculator to get the square root of 22 by entering 22 shift  $x^2$ . The answer 4.69 is displayed. You can see that 4.69 is between 4 and 5, so the **answer is C) 4 and 5**.

**Example 3**

Calculate the square root of 15.

- A) 225                  B) 30                  C) 7.5                  D) 3.87                  E) 17

Enter 15 shift  $x^2$  on the calculator, and 3.87 is displayed, so the **answer is D) 3.87**.

**CAREFUL** – The questions asks for the square root of 15, so calculate  $\sqrt{15}$ .

A common mistake would be to calculate  $15^2$  instead of  $\sqrt{15}$ .

**Practice Four** Answers – p. 8

1. The square root of 29 is between which of the following pairs of integers?
- A) 3 and 4
  - B) 4 and 5
  - C) 5 and 6
  - D) 6 and 7
  - E) 7 and 8

2. What is the value of  $\sqrt{21 + 60}$  ?
- A) 81
  - B) 162
  - C) 9
  - D) 8
  - E) 4
3. The value of  $\sqrt{110 + 40}$  falls between which pair of numbers?
- A) 11 and 12
  - B) 12 and 13
  - C) 13 and 14
  - D) 15 and 16
  - E) 16 and 17
4. The square root of 16 is equal to which of the following numbers?
- A) 256
  - B) 12
  - C) 32
  - D) 8
  - E) 4
5. Which of the following is equal to  $\sqrt{36 + 64}$  ?
- A) 100
  - B) 14
  - C) 200
  - D) 10
  - E) 16
6. The square root of 88 is between which of the following pairs of numbers?
- A) 5 and 6
  - B) 6 and 7
  - C) 7 and 8
  - D) 8 and 9
  - E) 9 and 10

## ANSWER KEY Lesson 1 Exponents and Square Roots

### Practice One

1.  $4^2 = 16$        $8^2 = 64$        $3^3 = 27$        $12^2 = 144$   
 $7^3 = 343$        $6^7 = 279,936$        $15^4 = 50,625$        $9^3 = 729$
2. What is the value of  $6^3$ ?      **Answer D) 216**

### Practice Two

1.  $\left(\frac{4}{5}\right)^2 = \frac{16}{25}$        $\left(\frac{4}{5}\right)^2 = \frac{4^2}{5^2} = \frac{16}{25}$       **OR**       $\left(\frac{4}{5}\right)^2 = \frac{4}{5} \times \frac{4}{5} = \frac{16}{25}$
- $\left(\frac{5}{6}\right)^3 = \frac{125}{216}$        $\left(\frac{5}{6}\right)^3 = \frac{5^3}{6^3} = \frac{125}{216}$       **OR**       $\left(\frac{5}{6}\right)^3 = \frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{125}{216}$
- $\left(\frac{1}{5}\right)^4 = \frac{1}{625}$        $\left(\frac{1}{5}\right)^4 = \frac{1^4}{5^4} = \frac{1}{625}$       **OR**       $\left(\frac{1}{5}\right)^4 = \frac{1}{5} \times \frac{1}{5} \times \frac{1}{5} \times \frac{1}{5} = \frac{1}{625}$
- $\left(\frac{2}{5}\right)^6 = \frac{64}{15,625}$        $\left(\frac{2}{5}\right)^6 = \frac{2^6}{5^6} = \frac{64}{15,625}$       **OR**       $\left(\frac{2}{5}\right)^6 = \frac{2}{5} \times \frac{2}{5} \times \frac{2}{5} \times \frac{2}{5} \times \frac{2}{5} \times \frac{2}{5} = \frac{64}{15,625}$
- $\left(\frac{5}{7}\right)^3 = \frac{125}{343}$        $\left(\frac{5}{7}\right)^3 = \frac{5^3}{7^3} = \frac{125}{343}$       **OR**       $\left(\frac{5}{7}\right)^3 = \frac{5}{7} \times \frac{5}{7} \times \frac{5}{7} = \frac{125}{343}$
- $\left(\frac{7}{10}\right)^2 = \frac{49}{100}$        $\left(\frac{7}{10}\right)^2 = \frac{7^2}{10^2} = \frac{49}{100}$       **OR**       $\left(\frac{7}{10}\right)^2 = \frac{7}{10} \times \frac{7}{10} = \frac{49}{100}$
2. Which of the following equals  $\left(\frac{3}{4}\right)^2$ ?      **Answer B)  $\frac{9}{16}$**

$$\left(\frac{3}{4}\right)^2 = \frac{3^2}{4^2} = \frac{9}{16} \quad \text{OR} \quad \left(\frac{3}{4}\right)^2 = \frac{3}{4} \times \frac{3}{4} = \frac{9}{16}$$

3. What is the value of  $\left(\frac{2}{3}\right)^4$ ?      **Answer D)  $\frac{16}{81}$**

$$\left(\frac{2}{3}\right)^4 = \frac{2^4}{3^4} = \frac{16}{81} \quad \text{OR} \quad \left(\frac{2}{3}\right)^4 = \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} = \frac{16}{81}$$

4.  $\left(\frac{3}{5}\right)^3$  is equal to which fraction?      **Answer B)  $\frac{27}{125}$**

$$\left(\frac{3}{5}\right)^3 = \frac{3^3}{5^3} = \frac{27}{125} \quad \text{OR} \quad \left(\frac{3}{5}\right)^3 = \frac{3}{5} \times \frac{3}{5} \times \frac{3}{5} = \frac{27}{125}$$

**Practice Three**

- $\sqrt{81} = 9$                        $\sqrt{92 - 43} = \sqrt{49} = 7$                        $\sqrt{75} = 8.66$
- $\sqrt{12 + 4} = \sqrt{16} = 4$                        $\sqrt{196} = 14$                        $\sqrt{1} = 1$
- $\sqrt{121} = 11$                        $\sqrt{1,225} = 35$                        $\sqrt{25 + 144} = \sqrt{169} = 13$

**Practice Four**

- The square root of 29 is between which of the following pairs of integers?

**Answer C) 5 and 6**                       $\sqrt{29} = 5.39$

- What is the value of  $\sqrt{21 + 60}$  ?

**Answer C) 9**                       $\sqrt{21 + 60} = \sqrt{81} = 9$

- The value of  $\sqrt{110 + 40}$  falls between which pair of numbers?

**Answer B) 12 and 13**                       $\sqrt{110 + 40} = \sqrt{150} = 12.25$

- The square root of 16 is equal to which of the following numbers?

**Answer E) 4**                       $\sqrt{16} = 4$

- Which of the following is equal to  $\sqrt{36 + 64}$  ?

**Answer D) 10**                       $\sqrt{36 + 64} = \sqrt{100} = 10$

**Careful** –  $\sqrt{36 + 64}$  is not the same as  $\sqrt{36} + \sqrt{64}$

To solve  $\sqrt{36 + 64}$  add  $36 + 64$ , then get the square root, as shown above.

To solve  $\sqrt{36} + \sqrt{64}$  get the square root of 36, get the square root of 64, then add together.  $\sqrt{36} + \sqrt{64} = 6 + 8 = 14$

- The square root of 88 is between which of the following pairs of numbers?

**Answer E) 9 and 10**                       $\sqrt{88} = 9.38$