Chapter 2: Exponents



Learning Outcomes:

* Identifying the base, exponent and standard form of a power
* Writing powers of ten
* Solving problems with a zero exponent
* Solving problems that involve multiple operations (BEDMAS)
* Solving problems that involve the exponent laws
* Converting to and from scientific notation

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2.1 What is a Power?

A power is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

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|  | **Standard Form** | **Repeated Multiplication** | **Power** |
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 Terminology:

 25

Examples: Write the following as powers

1. 3 x 3 x 3 x 3 x 3 x 3 x 3 =
2. 7 =
3. (-9) x (-9) x (-9) x (-9) =

What if there’s a negative?

Example:

(-3)2 = -32 = - (-3)2 =

Evaluate:

1. -33 =
2. (-3)3 =
3. - (-3)3 =

Summary:

* 1. **Worksheet**

**What is a Power?**

1. Write each product as a power.
	1. 
	2. 
	3. 
	4. 
	5. 
	6. 
2. Write each phrase as a power.
	1. six cubed
	2. nine to the fourth power
	3. twenty squared
	4. four to the *n*th power
3. Evaluate (this means solve…).
	1. 
	2. 
	3. 
	4. 
	5. 
	6. 
	7. 
	8. 
	9. 



* 1. 
	2. 
	3. 
	4. 
	5. 
	6. 
	7. 
1. Evaluate.
	1. 
	2. 
	3. 
	4. 
	5. 
	6. 
	7. 
	8. 

2.2 Powers of Ten and the Zero Exponent

Powers of Ten:

|  |  |  |
| --- | --- | --- |
| **Number (in words)** | **Standard Form** | **Power** |
|  |  |  |
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|  |  |  |
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Zero Exponent Law: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Example:

 40 = -40 = (-4)0 =

Example: Express the following as a power of ten

1. 1000 =
2. 1 000 000 000 =
3. 1 000 000 000 000 =

Write the following numbers using the powers of ten:

1. 3452

Use a place value chart

|  |  |  |  |
| --- | --- | --- | --- |
| Thousands | Hundreds | Tens | Ones |
|  |  |  |  |

1. 152 300

|  |  |  |  |  |  |
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2.2 Powers of Ten and the Zero Exponent Worksheet

1. Complete the table below

|  |  |  |
| --- | --- | --- |
| Power | Repeated Multiplication | Standard Form |
| 54 | 5 x 5 x 5 x 5 | 625 |
| 53 | 5 x 5 x 5 |  |
| 52 |  |  |
| 51 |  |  |
| 50 |  |  |

1. Evaluate each power
	1. 20 = \_\_\_\_\_\_\_\_\_\_
	2. 90 = \_\_\_\_\_\_\_\_\_\_\_
	3. (-2)0 = \_\_\_\_\_\_\_\_\_
	4. -20 = \_\_\_\_\_\_\_\_\_\_\_
	5. 101 = \_\_\_\_\_\_\_\_\_\_
	6. (-8)1 = \_\_\_\_\_\_\_\_\_
2. Write each number as a power of 10.
	1. 10 000 = 10\_\_
	2. 1 000 000 = 10\_\_
	3. Ten million = \_\_\_\_\_
	4. One = \_\_\_\_\_
	5. 1 000 000 000 = \_\_\_\_\_
	6. 10 = \_\_\_\_
3. Evaluate each power of 10.
	1. -106 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_
	2. -100 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_
	3. -108 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_
	4. -101 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Write each number in standard form

ex/ (4 x 102) + (3 x 101) + ( 5 x 100) = (4x100) + (3 x 10) + (5 x 1)

 = 400 + 30 + 5

 = 435

* 1. 5 x 104 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

= \_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. (4 x 102) + (3 x 101) + (7 x 100) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. (2 x 103) + (6 x 102) + (4 x 101) + (9 x 100) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. (7 x 103) + (8 x 100) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. **- 2.2 Extra Practice Review**

*Show all of your work!*

1. Indicate the base for each of the following powers:

2. Write each of the following as a single power:

3. Evaluate each of the following powers:

4. Write each of the following in standard form:



5. Solve for “x” in each of the following:

6. Rearrange all the powers below from the lowest to highest without using a calculator:

27, 36, 45, 54, 63, 72

7. Given each statement, indicate which symbol >, <, *or* = should be placed in the box:



Lesson 2.3 Order of Operations with Powers

To avoid getting different answers when we evaluate an expression, we use order of operations:

* Evaluate the expression in the brackets first (B)
* Evaluate the power (E)
* Multiply and divide, in order, from left to right (DM)
* Add and subtract, in order, from left to right (AS)

What do we use to remember this?

|  |
| --- |
|  |

Evaluate the following:

1. 2.

3. 4.

5.

Explain why the answers to and are different\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2.3 Worksheet

1. Evaluate

a) 22 + 1 =

b) 22 – 1 =

c) (2 + 1)2 =

d) (2 – 1)2 =

2. Evaluate

a) 4 x 22 =

b) 42 x 2 =

c) (4 x 2)2 =

d) (-4)2 ÷ 2 =

3. Evaluate

a) 23 + (-1)3 =

b) (2 – 1)3 =

c) 23 – (-1)3 =

d) (2 + 1)3 =

4. Evaluate

a) 32 ÷ (-1)2 =

b) (3 ÷ 1)2 =

c) 32 x (-2)2 =

d) 52 ÷ (-5)1 =

5. Evaluate

a) (-2)0 x (-2) =

b) 23 ÷ (-2)2 =

c) (3 + 2)0 + (3 x 2)0 =

d) (3 x 52)0 =

e) (2)(3) – (4)2 =

f) 3(2 – 1)2 =

g) (-2)2 + (3)(4) =

h) (-2) + 30 x (-2) =

6. Amy wants to replace the hardwood floor in her house. Here is how she calculates the cost:

70 x 62 + 60 x 62

How much will it cost Amy to replace the hardwood floor?

2.1 – 2.3 Mid-Unit Review

2.1

1. Give the base and exponent of each power

a) 62 Base:

 Exponent:

b) 45 Base:

 Exponent:

c) (-3)8 Base:

 Exponent:

d) -38 Base:

 Exponent:

2. Write as a power

a) 7 x 7 x 7 x 7 x 7 x 7 =

b) 2 x 2 x 2 x 2 =

c) 5 =

d) (-5) (-5) (-5) (-5) (-5) =

3. Write each power as repeated multiplication **and** in standard form\

a) 52 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_

b) 23 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_

c) 34 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_

2.2

4. a) Complete the table

|  |  |  |
| --- | --- | --- |
| **Power** | **Repeated Multiplication** | **Standard Form** |
| 73 |  |  |
| 72 |  |  |
| 71 |  |  |

b) What is the value of 70? \_\_\_\_\_\_\_\_

5. Write each number in standard form **and** as a power.

a) One Hundred = \_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

b) Ten Thousand = \_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

c) One Million = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

d) One = \_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_

6. Evaluate

a) 60 =

b) (-8)0 =

c) 121 =

d) -80 =

7. Write each number in standard form

a) 4 x 103 =

b) (1 x 103) + (3 x 102) + (2 x 101) + (1 x 100) =

c) (4 x 103) + (2 x 102) + (3 x 101) + (6 x 100) =

d) (8 x 102) + (1 x 101) + (9 x 100) =

2.3

8. Evaluate

a) 32 + 5 =

b) 52 - 23 =

c) (2 + 3)3 =

d) 23 + (-3)3 =

9. Evaluate

a) 5 x 32 =

b) 82 ÷ 4 =

c) (10 + 2) ÷ 22 =

d) (72 + 1) ÷ (23 + 2) =

10. Evaluate **and** state which operation you do first

a) 32 + 42 = 1st Operation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

b) [(-3) – 2]3 = 1st Operation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

c) (-2)3 + (-3)0 = 1st Operation: \_\_\_\_\_\_\_\_\_\_\_\_\_

d) [(6-3)3 x (2 + 2)2]0 = 1st Operation: \_\_\_\_\_\_\_\_\_\_\_\_\_

Lesson 2.4 Exponent Laws

Definitions:

**Product:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Quotient:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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| **Product of powers** | **Repeated multiplication** | **Product as a power** |
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| --- | --- | --- |
| **Quotient of Powers** | **Repeated multiplication** | **Quotient as a Power** |
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What patterns do you see?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Exponent Law for Product of a Power**

|  |
| --- |
|  |

**Exponent Law for Quotient of a Power**

|  |
| --- |
|  |

Use these Laws to evaluate the following:

1.  2. 

3.  4. 

5.  6. 

7.  8. 

Use your own words to explain how to:

multiply two powers with the **same** base\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

divide two powers with the **same** base\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

multiply and divide with **different** bases \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2.4 Worksheet

1. Write each product as a single power.

a) 76 x 72 =

b) (-4)5 x (-4)3 =

c) (-2) x (-2)3 =

d) 105 x 105 =

e) 70 x 71 =

2. Write each quotient as a power.

a) (-3)5 ÷ (-3)2 =

b) 56 ÷ 54 =

c) $\frac{4^{7}}{4^{4}}$=

d) $\frac{5^{8}}{5^{6}}$=

e) 64 ÷ 64 =

f) $\frac{(-6)^{8}}{(-6)^{7}}$=

3. Write as a single power.

a) 23 x 24 x 25 =

b) $\frac{3^{2}x 3^{2}}{3^{2}x 3^{2}}$ =

c) 103 x 105 ÷ 102 =

d) (-1)9 ÷ (-1)5 ÷ (-1)0 =

4. Simplify, then evaluate.

a) (-3)1 x (-3)2 x 2

Simplified:

Evaluated:

b) 99 ÷ 97 ÷ 90

Simplified:

Evaluated:

c) $\frac{5^{2}}{5^{0}}$ =

Simplified:

Evaluated:

d) $\frac{5^{5}}{5^{4}}$ x 5=

Simplified:

Evaluated:

5. Identify any errors and correct them.

a) 43 x 45 = 48

b) 25 x 25 = 225

c) (-3)6 ÷ (-3)2 = (-3)3

d) 70 x 72 = 70

e) 62 + 62 = 64

f) 106 ÷ 10 = 106

g) 23 x 52 = 105

2.4 Challenge Worksheet

Challenge yourself and see how many you can do!









6. (a · a · a · a)(a · a)

7. (y · y)(y · y · y)(y)

8. (3 · y · y)(5 · y · y · y)

9. (4 · p · p · p)(-6 · p · p · p)

10. x2x

11. c2c2

12. y4y5

13. q4 · q4

14. w10w10

15. 103(104)

16. 87(86)

17. (-10)8(-10)3

18. (-2y)(-6y)

19. (-a)(-12a5)

20. 5y3(-7y5)

21. (-5mp)(-m2p)

22. -12k6m(-k3m)

23. (-6a5bc7)(9ab3c2)

24. a7 · a3 · a2

25. -1(-cx2)(-5c4x)

2.5 Exponent Laws II

Exponent Law #3

When you have an exponent \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **and** an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ a bracket, you \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the exponents.

Examples:

1. (22)3 =

2. (x3)4 =

3. (-3y2)5 =

Exponent Law #4

When you have ‘stuff’ in a bracket (x or ÷) give each base \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Multiply each exponent by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Example:

1.

Exponent Law Summary

1.

2.

3.

4.

5.

2.5 Worksheet - Exponent Laws II

1. Simplify each of the following expressions into a single power. *Do not evaluate.*
	1. $\left(m^{4}\right)^{5}$
	2. $\left(2^{3}\right)^{4}$
	3. $p^{7}\left(p^{4}\right)^{2}$
	4. $\left(a^{3}\right)^{2}\left(a^{4}\right)^{2}$
	5. $\left[\left(-t\right)^{3}\right]^{5}$
	6. $\left[\left(-5\right)^{4}\right]^{3}$
	7. $\left(6m^{2}\right)^{3}$
	8. $\left(a^{2}b^{4}\right)^{3}$
	9. $\left(-10m^{3}\right)^{2}$
	10. $\left(-3r^{4}\right)^{3}$
	11. $\left(-2mn^{3}p^{4}\right)^{3}$
	12. $\left(3x^{2}y^{3}z\right)^{4}$
2. Simplify each of the following expressions into a single power. *Do not evaluate.*
	1. $\frac{\left(2k^{2}\right)^{3}}{k^{7}}$
	2. $\frac{\left(4a^{3}b^{2}c^{3}\right)^{3}}{\left(-3a^{2}b^{2}c\right)^{4}}$
	3. $\left(\frac{w^{2}}{xy^{3}}\right)^{6}$
	4. $\left(\frac{2r^{2}}{3p}\right)^{4}$
3. Simplify.
	1. $\frac{\left(ab\right)^{5}}{\left(ab\right)^{2}}$
	2. $\frac{\left(4a^{5}\right)^{3}\left(4a^{6}\right)^{2}}{4a^{4}}$
	3. $\left(5^{3}\right)^{4}÷\left(5^{2}\right)^{3}$
	4. $\left(3^{2}\right)^{5}×\left(3^{3}\right)^{2}$
4. Simplify, then evaluate.
	1. $\left(3^{2}\right)^{4}$
	2. $\left(\left(2^{2}\right)^{2}\right)^{3}$
	3. $\left(8^{3}×8^{5}\right)^{2}-\left(8^{12}÷8^{8}\right)^{4}$
	4. $\left(-7\right)^{7}×\left(-7\right)^{2}÷\left(-7\right)^{5}$
	5. $4^{2}×\left(4^{4}\right)^{2}$
5. Simplify
6. ($\frac{a}{3b}$)3
7. ($\frac{-2c}{d}$)6
8. ($\frac{-r}{2w}$)5
9. ($\frac{3x}{y}$)4
10. ($\frac{w^{2}}{xy^{3}}$)6
11. ($\frac{xy}{9}$)2
12. ($\frac{w^{2}}{xy^{3}}$)6
13. ($\frac{c^{5}}{k^{2}m}$)3
14. ($\frac{7d^{3}}{12a^{4}}$)2
15. ($\frac{2r^{2}}{3p}$)4

2.6 BEDMAS with Exponents

Example: Simplify

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

2. ($\frac{6x^{3}y^{4}}{8xy^{7}}$)2

2.6 BEDMAS with Exponents Worksheet

**2.3 – 2.6 Extra Practice Review**

*Show all of your work!*

 **Multiplication Rule: Division Rule: Power to another Power Rule:**



When **multiplying powers** with the When **dividing powers** with the same When **taking powers to another** same base, you **ADD** the exponents base, you **SUBTRACT** the exponents **exponent**, you **MULTIPLY** them



1. Simplify each of the following expressions by writing it as a single power:

2. Evaluate each of the following expressions:

3. Simplify each of the following expressions into a single power:

4. Evaluate each of the following expressions using BEDMAS:

5. Find the value of 🞟in each expression:

2.7 Scientific Notation

Large numbers can be awkward and hard to read. To express very large numbers (and very small numbers), we use \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Example:

1. 120 000 000 000

To express in scientific notation:

* + - 1.
			2.
			3.

1. 3 700 000 =
2. 100 000 000 =
3. 0.038 =
4. 0.000 000 1 =

Example: Rewrite **without** scientific notation

1. 32 x 104 =
2. 0.087 x 103 =
3. 49.2 x 107 =

2.7 Worksheet - Scientific Notation Worksheet

1. Rewrite *using* scientific notation.
	1. 50000
	2. 420
	3. 3000
	4. 826
	5. 31500000
	6. 15000000
	7. 90.6
	8. 22.8
	9. 0.007
	10. 0.00005
	11. 0.000064
	12. 0.063
	13. 0.0805
	14. 0.000127
2. Find each value of *n*.
	1. $1265=1.265×10^{n}$
	2. $76.3=7.63×10^{n}$
	3. $0.0041=4.1×10^{n}$
	4. $0.000 056 3=5.63×10^{n}$
	5. $4 961 000 000=4.961×10^{n}$
	6. $0.860=8.60×10^{n}$
3. Rewrite *without* scientific notation.
	1. $5×10^{4}$
	2. $2.6×10^{5}$
	3. $6.1×10^{1}$
	4. $3×10^{3}$
	5. $9.9×10^{7}$
	6. $7.02×10^{5}$