Understanding Math

Concept: The Meaning of Exponents

Name:

- **You should have completed Exponents Outline A for Topic 1: The Meaning of Exponents before beginning this handout.**

Warm Up

Complete the following. Show all your steps.

(a) $2 \times 2 = \underline{4}$

(b) $3 \times 3 \times 3 = \underline{27}$

(c) $4 \times 4 \times 4 \times 4 = \underline{256}$

(d) $5 \times 5 \times 5 \times 5 \times 5 \times 5 = \underline{15,625}$

(e) $6 \times 6 \times 6 \times 6 \times 6 \times 6 = \underline{46,656}$

f) $7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7 = \underline{823,543}$

COMPUTER COMPONENT

Instructions: Select the computer program *Understanding Exponents* (Neufeld)
Follow the instructions to the Main Menu.
Select *The Meaning of Exponents* from the Main Menu.

Notice: You will need to use the ***Jump To*** *feature of the program (found on the top left of your screen) in order to get to the section where you left off.*

Work through all sections of this topic **in order**:

- *Exponents, Powers, Bases*
- *Powerful Explosions*
- *Introductory Examples*
- *Examples – Substitution*
- *Examples – Order of operations*
- *Practice Questions*

As you work through the computer exercises, make your notes in the **NOTES** section of this page.

When you reach the end of the section *Practice Questions* on the computer, move on to the **OFF COMPUTER EXERCISES** below**.**

NOTES:

Fill in the following blanks:

- Exponents are used to write *number* expressions that have repeated *multiplication.*

$$2^4$$

- The base is *2* Use the base as the *factor.*
- The exponent is *4.* The exponent indicates how many *times* to use the base as a *factor.*
- The entire *expression* is called a *power.*

2^{10}

- is read as *"2 to the exponent of 10 ."*
- is read as *" 2 to the 10th."*

It means that you use *2 as a factor 10 times.*

Fill in the chart.

Power	Base	Exponent	Factor	Standard Form
2	2	1	2	2
2^2	2	2	2×2	4
2^3	2	3	$2 \times 2 \times 2$	8
2^4	2	4	$2 \times 2 \times 2 \times 2$	16
2^5	2	5	$2 \times 2 \times 2 \times 2 \times 2$	32
2^6	2	6	$2 \times 2 \times 2 \times 2 \times 2 \times 2$	64
2^7	2	7	$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$	128
2^8	2	8	$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$	256
2^9	2	9	$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$	512
2^{10}	2	10	$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$	1024
2^{11}	2	11	$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$	2048

Power	Base	Exponent	Factor	Standard Form
3	3	1	3	3
3^2	3	2	3×3	9
3^3	3	3	$3 \times 3 \times 3$	27
3^4	3	4	$3 \times 3 \times 3 \times 3$	81
3^5	3	5	$3 \times 3 \times 3 \times 3 \times 3$	243
Power	**Base**	**Exponent**	**Factor**	**Standard Form**
4	4	1	4	4
4^2	4	2	4×4	16
4^3	4	3	$4 \times 4 \times 4$	64
4^4	4	4	$4 \times 4 \times 4 \times 4$	256
Power	**Base**	**Exponent**	**Factor**	**Standard Form**
5	5	1	5	5
5^2	5	2	5×5	25
5^3	5	3	$5 \times 5 \times 5$	125
5^4	5	4	$5 \times 5 \times 5 \times 5$	625
Power	**Base**	**Exponent**	**Factor**	**Standard Form**
6	6	1	6	6
6^2	6	2	6×6	36
6^3	6	3	$6 \times 6 \times 6$	216

Power	Base	Exponent	Factor	Standard Form
10	10	1	10	10
10^2	10	2	10×10	100
10^3	10	3	$10 \times 10 \times 10$	1000
10^4	10	4	$10 \times 10 \times 10 \times 10$	10000
10^5	10	5	$10 \times 10 \times 10 \times 10 \times 10$	100000
10^6	10	6	$10 \times 10 \times 10 \times 10 \times 10 \times 10$	1000000
10^7	10	7	$10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$	10000000

Interesting Fact: ***Descartes invented the exponent notation.***

http://books.google.ca/books?id=7juWmvQSTvwC&pg=PA346&lpg=PA346&dq=exponents+Descartes&source=web&ots=KWflCmK8Ss&sig=eTUkAqRdrQlDf8PUXpqlZCiRCOU&hl=en&sa=X&oi=book_result&resnum=8&ct=result

$$S^6$$

- **"*S*" is multiplied by itself *6* times.**

Remember:

- *A power with a negative base is **positive** when exponent is even.*
- *A power with a negative base is **negative** when exponent is odd.*

Practice:

Fill in the chart.

Power	Expanded Form	Standard Form
10^2	(10) (10)	*100*
3^3	(3) (3) (3)	*27*
$\left(\frac{2}{3}\right)^2$	$\left(\frac{2}{3}\right)\left(\frac{2}{3}\right)$	$\frac{4}{9}$
$(-7)^3$	(-7) (-7) (-7)	*-343*
$(-7)^4$	(-7) (-7) (-7) (-7)	*2401*
$(-1)^{23}$	(-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1)	*-1*
$(-1)^{44}$	(-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1)	*1*
4^3	(4) (4) (4)	*64*
3^4	(3) (3) (3) (3)	*81*
$(-2)^4$	(-2) (-2)	*16*
$-(2)^4$	-(2) (2) (2) (2)	*-16*

Interesting fact:

Computer Memory

A byte is a unit of storage capable of storing one letter of the alphabet. For example, the word "math" requires four bytes to store in a computer.

Bytes of computer memory are often manufactured in amounts equal to powers of 2.

1 kilobyte (1K) = 2^{10} *= 1024 bytes*

1 megabyte (1 MB) = 2^{20} *= 1, 048, 576 bytes*

1 gigabyte (1 GB) = 2^{30} *= 1, 073, 741, 824 bytes*

http://www.webopedia.com/TERM/b/byte.html

OFF COMPUTER EXERCISES

1. Complete the chart.

Power	Expand the Power	Answer
2^4	(2) (2) (2) (2)	16
$(-2)^{16}$	(-2) (-2) (-2) (-2) (-2) (-2) (-2) (-2) (-2) (-2) (-2) (-2) (-2) (-2) (-2) (-2)	*65536*
-4^4	-(4) (4) (4) (4)	*-256*
$(-4)^4$	(-4) (-4) (-4) (-4)	*256*
$(-1)^{33}$	(-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1)	*-1*
$(0.75)^3$	(0.75) (0.75) (0.75)	*0.421875*

Power	Expand the Power	Answer
$(-3)^5$	(-3) (-3) (-3) (-3) (-3) (-3)	*-243*
$(-1)^{22}$	(-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1) (-1)	*1*
$(-2)^3$	(-2) (-2) (-2)	*-8*

2. Find the number that makes each expression true.

(a) $2^{(\ 5\ )} = 32$

(b) $(-4)^{(\ 3\ )} = -64$

(c) $(\ -3\ )^3 = -27$

(d) $(0.5)^{(2)} = 0.25$

(e) $(10)^{(4)} = 10\,000$

(f) $1^3 + 2^3 + 3^3 + 4^3 = (10)^{(2)}$

3. For each of the following substitute, the given value and then evaluate the expression. (*Use good form*.)

Example: $x^2 + 2y^3$ when $x = 2$ and $y = -1$

$x^2 + 2y^3 = (\underline{\ 2\ })^2 + 2(\underline{\ -1\ })^3$

$= 4 + 2(-1)$

$= 4 + (-2)$

$= 2$

(a) $2x^3$ when $x = -2$

$= 2(-2)^3$

$= 2(-8)$

$= -16$

(b) $-3x^3 - y^3$ when $x = -1$ and $y = 2$

$= -3(-1)^3 - (2)^3$

$= 3 - 8$

$= -5$

(c) $2x^3 - 3y$ when $x = -3$ and $y = -4$

$= 2(-3)^3 - 3(-4)$

$= -54 + 12$

$= -42$

(d) $-4x^2y^3$ when $x = -3$ and $y = -2$

$$= -4\{(-3)^2(-2)^3\}$$

$$= -4(-72)$$

$$= 288$$

4. Evaluate. *Remember to use **Order of Operations** rules.*

(a) $33 - 3^3$ *= 6*

(b) $21 + 2^3$ *= 29*

(c) $3^4 + 2(-17)$ *= 47*

(d) $2^5 - (5)(5)$ *= 7*

(e) $(2 + 3)^2$ *= 25*

(f) $(2)^3 + (3)^2 = 17$

(g) $(-4)^2 + (-1)^3 = 15$

(h) $(3)^4 + (4)^3 = 145$

5. Fill in the blanks.

   In an expression $(-5)^3$, _3_ is the exponent, _-5_ is the base and

   $(-5)^3$ is the *power.*

6. Is it possible for a person's age to be expressed as an exponent? *Explain your answer*.

   My age is $2^5 = 32$

7. On my first birthday, my parents gave me a dollar. On each birthday after that, they tripled my previous amount.

    (a) How much money did I receive on my 13th birthday?

    You will receive $531, 441 on your 13th birthday. WOW!!!

    (b) If I saved my birthday money, how much money in total will I have on my 13th birthday?

1 + 3 + 9 + 27 + 81 + 243 + 729 + 2,187 + 6, 567 + 19, 683 + 59, 049 + 177, 147 + 531, 441

$797, 167