> Exponents give us a shorthand for repeated multiplication.

Technology Integrated Mathematics
Class Notes
Pre-Algebra: Exponents and Square Roots (Section 6.4)

Recall an exponent's purpose. What does 5^3 really mean?

> Can be thought of as "repeated multiplication".

$$5^3 = 5 \cdot 5 \cdot 5$$

> "5 multiplied by itself 3 times"

What about $(-2)^4$?

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

> "–2 multiplied by itself 4 times"

What is the value of $(-2)^4$? How is that different than -2^4? The parentheses are very important.

We will also be simplifying expressions like -4×3^3 and $5 \times 6^2 - 3^4$. Order of operations will become important when we have more complicated expressions.

expl 1: Evaluate.

$$-4^3$$

expl 2: Evaluate.

$$(-4)^3$$

> What difference do the parentheses make?

> Earlier we saw $(-2)^4$ and -2^4 were different. But $(-4)^3$ and -4^3 were the same. Why?

Order of Operations:

When we see something like 2×3^2, we could either multiply first and then apply the exponent, or we could apply the exponent and then multiply. *But those would get us different answers! Eek! So, that's no good!* Luckily for us, old men, long ago, have set down rules for the rest of us to follow.

(Spoken in an authoritative old man, old-timey voice):
Let it be known henceforth that whensoever he encountereth numerical expressions such as 2×3^3 and $5 \times 6^2 - 3^4$, a plebeian shall forever after apply these rules!

> **First**, simplify all within thine parentheses.
> **Second**, apply any exponents thou encountereth.
> **Third**, performeth any multiplications or divisions (from left to right).
> **Fourth**, performeth subtractions or additions (from left to right).

Try it with thine 2×3^3 henceforth and with no delay or off with ye head!

PEMDAS
Parentheses
Exponents
Multiplication/**D**ivision
Addition/**S**ubtraction

expl 3: Evaluate.

$(7-5)^4$

expl 4: Find the value of this expression.

-4×3^3

Try some on the calculator.

To square numbers, look for an x^2 button. For exponents in general, look for a ^ or x^y button.

expl 5: Find the value of this expression.

$3^3 \times 5^2$

> **Special rule:**
> Any non-zero number raised to 0 is equal to 1.

expl 6: Find the value of this expression.

23^0

expl 7: Find the value of this expression.

$5 \times 6^2 - 3^4$

Square Roots:
We know that 6^2 is equal to 6×6 and so is 36. Now, we go the other way. We will find the square root of non-negative numbers. It will look like $\sqrt{36}$.

By using this notation (called a radical), we mean **find the non-negative number that when squared would give us 36.** (This is technically called the *principal* square root.) Being comfortable with the perfect squares is helpful for some of these problems.

Perfect Squares

$1^2 = 1$	$6^2 = 36$	$11^2 = 121$	$16^2 = 256$
$2^2 = 4$	$7^2 = 49$	$12^2 = 144$	$17^2 = 289$
$3^2 = 9$	$8^2 = 64$	$13^2 = 169$	$18^2 = 324$
$4^2 = 16$	$9^2 = 81$	$14^2 = 196$	$19^2 = 361$
$5^2 = 25$	$10^2 = 100$	$15^2 = 225$	$20^2 = 400$

expl 8: Use the table above to evaluate the following.

a.) $\sqrt{121}$ b.) $\sqrt{64}$ c.) $\sqrt{324}$

Square Roots of Non-Perfect Squares:
Some problems will ask for the square root of a number that is in between two perfect squares. For instance, if we asked for $\sqrt{40}$, we *cannot* find 40 on our table. We will evaluate these using the calculator. You will likely get an answer with a long string of decimal digits so you will be told how to round.

Since you *cannot* square a number and ever get a negative number, we *cannot* square root a negative number. In other words, to compute $\sqrt{-40}$ takes math we are *not* covering.

expl 9: Evaluate. Round to two decimal places.
a.) $\sqrt{40}$ b.) $\sqrt{250}$

expl 10: Evaluate. Round to two decimal places.
$3\sqrt{40}$

Find $\sqrt{40}$ and then multiply that by 3.

expl 11: The Golden Gate bridge expands on a warm day about 2 ft in length. Expansion joints are installed to accommodate this. If there were no expansion joints, a bulge would form on the bridge where the calculation $\sqrt{\left(\frac{5280}{2}+1\right)^2-\left(\frac{5280}{2}\right)^2}$ gives the height of the bulge. Find it to the nearest foot.

PEMDAS! Parentheses first.