

[~50 minute lesson]

# United States Public Release Lesson 3 Lesson Graph [8<sup>th</sup> grade]



[9 1/2 minutes]

**Public Class Work:** Teacher says that today we will learn about exponents. She holds up cubes linked together to represent  $2^2$ ,  $2^3$ ,  $2^4$ . She says, "look at the growth--very, very big".

Exponents (Power)

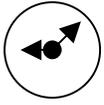
$2^3$  Exponent

Base

The exponent tells how many times the base is multiplied.

The teacher then plots a graph showing the growth from  $2^2$ ,  $2^3$  to  $2^4$ .

The teacher then works on three examples to demonstrate how to multiply exponents.



[3 1/2 minutes]

**Private Class Work:** Working on Section One of Worksheet

*Section one of the worksheet*

Teacher asks students to do first three problems and look for a pattern.

Students work individually for two minutes, then work in groups of five.

Students work in groups of five to discuss patterns found that have to do with exponents.

1.  $a^2 \cdot a^4$       2.  $a^2 \cdot a$       3.  $a^3 \cdot a \cdot a^4$

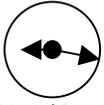
RULE:  $a^m \cdot a^n$

[2 1/2 minutes]

**Public Class Work:** Discussing Section One of Worksheet

After students give answers to the problems: (1)  $a^6$  (2)  $a^3$  (3)  $a^8$  (a student says  $3+1+4$ )

T: "When you multiply the same base, it's added". They come up the 1<sup>st</sup> rule: **RULE:  $a^m \cdot a^n = a^{m+n}$**



[4 1/2 minutes]

**Private Class Work:** Working on Section Two

*Section two of the worksheet*

Students work in groups on problems four to six to find a rule.

The teacher asks them to expand so that they can see the pattern more quickly.

4.  $(a^2)^3$       5.  $(a^3)^2$       6.  $(a^2)^4$

RULE:  $(a^m)^n$

[2 minutes]

**Public Class Work:** Whole Class Discussion of Section Two of Worksheet

Students give answers to the problems: (4)  $a^6$  (5)  $a^6$  (6)  $a^8$  and the rule: **RULE:  $(a^m)^n = a^{mn}$**



[5 minutes]

**Private Class Work:** Students Work on Section Three of Worksheet

Teacher asks students to notice there are two items being raised to a power. She says: "see if you can come up with a rule".

Teacher moves from group to group helping students with the three problems.

*Section three of the worksheet*

7.  $(a \cdot b)^3$       8.  $(a \cdot b)^5$       9.  $(a \cdot b)^4$

RULE:  $(a \cdot b)^m$



[4 minutes]

**Public Class Work:** Discussing Section Three of Worksheet

*On the whiteboard:*

Students give answers to problems:

(7)  $a^3 \cdot b^3$  (8)  $a^5 \cdot b^5$  (9)  $a^4 \cdot b^4$

and the rule: **RULE:  $(a \cdot b)^m = a^m \cdot b^m$**

T: "Now we will work on division."

Dividing Exponents

$$\frac{2^4}{2^2} = \frac{2 \cdot 2 \cdot 2 \cdot 2}{2 \cdot 2} = 2^2 \quad \left(\frac{4}{2}\right)^3 = \frac{4}{2} \cdot \frac{4}{2} \cdot \frac{4}{2} = \frac{4^3}{2^3}$$

[3 minutes]

**Private Class Work:** Students Work on Section Four

Students work on problems 10-12, while teacher circulates.

10.  $\frac{a^6}{a^2}$     11.  $\frac{a^4}{a}$     12.  $\frac{a^3}{a^2}$     RULE:  $\frac{a^m}{a^n}$

[1 minute]

**Public Class Work:** Whole Class Discussion Section Four of Worksheet

Students share their answers: (10)  $a^4$ , (11)  $a^3$ , (12)  $a$ . They come up with the 4<sup>th</sup> rule: **RULE:  $a^m \div a^n = a^{m-n}$**

[3 minutes]

**Private Class Work:** Students Work in Groups on Section Five

Students work on problems 13-15 while teacher circulates.

13.  $\left(\frac{a}{b}\right)^3$     14.  $\left(\frac{a}{b}\right)^5$     15.  $\left(\frac{a}{b}\right)^6$     RULE:  $\left(\frac{a}{b}\right)^m$

[1 minute]

**Public Class Work:** Discussing Section Five of Worksheet

Students share their answers: (13)  $\frac{a^3}{b^3}$ , (14)  $\frac{a^5}{b^5}$ , (15)  $\frac{a^6}{b^6}$ , (16)  $\frac{a^m}{b^m}$ . They then come up with the 5<sup>th</sup>

rule: **RULE:  $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$**



[12 minutes]

**Private Class Work** Students Work in Groups

The teacher asks the students to work in groups to prove the following

*On the whiteboard*

Prove  
 $a^0 = 1$   
 $a^{-n} = \frac{1}{a^n}$

"Come up with proofs and you will present them tomorrow"

"Think about how you are going to get 0 power.

Think what can I do mathematically to get  $a^0$ . How would you get  $-n$ ?

Use rules of multiplication and division to prove."