

Product Properties of Exponents

Learning Target: I can simplify exponential expression using the Product of Powers Property

Fill in the tables below and write down any patterns you see.

Expression	Expanded expression	Number of factors	Simplified expression
$x^3 \cdot x^2$	$x \cdot x \cdot x \cdot x \cdot x$	5	x^5
$r \cdot r^7$	$r \cdot r \cdot r \cdot r \cdot r \cdot r \cdot r \cdot r$	8	r^8
$(-y)^5 \cdot (-y)^3$	$(-y)(-y)(-y)(-y)(-y)(-y)(-y)(-y)$	8	$(-y)^8$
$w \cdot w^3 \cdot w^2$	$w \cdot w \cdot w \cdot w \cdot w \cdot w$	6	w^6

Describe the pattern you see: the exponents are being added

Product of Powers Property

$$a^m \cdot a^n = a^{m+n}, \text{ which means:}$$

add the exponents when you have the same base.

Examples: Simplify the expression.

1. $x^4 \cdot x^6$
 x^{10}

2. $y \cdot y^2$
 y^3

3. $(-4)^3 \cdot (-4)^3$
 $(-4)^6$

4. $x^2 \cdot x^4 \cdot x^3$
 x^9

5. $5^4 \cdot 5^8$
 5^{12}

6. $n \cdot n^3 \cdot n$
 n^5

7. $a^{10} \cdot a^2 \cdot a^6$
 a^{18}

8. $p^8 \cdot p^2 \cdot p$
 p^{11}

Learning Target: I can simplify exponential expression using the Power of a Power Property

Expression	Expanded expression	Number of factors	Simplified expression
$(x^2)^3$	$x^2 \cdot x^2 \cdot x^2$	6	x^6
$(a^5)^2$	$a^5 \cdot a^5$	10	a^{10}
$[(-2)^3]^3$	$(-2)^3 \cdot (-2)^3 \cdot (-2)^3$	9	$(-2)^9$
$(5^3)^4$	$5^3 \cdot 5^3 \cdot 5^3 \cdot 5^3$	12	5^{12}

Describe the pattern you see: multiply the exponents

Power of a Power Property

$$(a^m)^n = a^{mn}, \text{ which means:}$$

multiply the exponents when the base is the same.

Examples: Simplify the expression.

9. $(x^4)^2$
 x^8

10. $[(-5)^2]^5$
 $(-5)^{10}$

11. $(r^7)^6$
 r^{42}

12. $(y^3)^4$
 y^{12}

13. $(n^3)^8$
 n^{24}

14. $(w^6)^5$
 w^{30}

15. $[(-x)^4]^2$
 $(-x)^8$

16. $(p^9)^7$
 p^{63}

Learning Target: I can simplify exponential expression using the Power of a Product Property

Expression	Expanded expression	Number of factors	Simplified expression
$(xy)^3$	$(xy)(xy)(xy)$	x: <u>3</u> ; y: <u>3</u>	x^3y^3
$(4a^2)^3$	$4a^2 \cdot 4a^2 \cdot 4a^2$	4: <u>3</u> ; a: <u>6</u>	4^3a^6
$(2xy^2)^4$	$(2xy^2)(2xy^2)(2xy^2)(2xy^2)$	2: <u>4</u> ; x: <u>4</u> ; y: <u>8</u>	$2^4x^4y^8$
$(3b^4)^2$	$3b^4 \cdot 3b^4$	3: <u>2</u> ; b: <u>8</u>	3^2b^8

Describe the pattern you see: exponent gets applied to all terms

Power of a Product Property

$$(ab)^m = a^m b^m, \text{ which means:}$$

"distribute" exponent to all terms

Examples: Simplify the expression.

17. $(4x^2)^3$

$$4^3 x^6$$

OR

$$\boxed{64x^6}$$

18. $(xy)^5$

$$x^5 y^5$$

19. $(3r^2)^7$

$$3^7 r^{14}$$

20. $(x^4y^5z)^2$

$$x^8 y^{10} z^2$$

21. $(2x^5)^3$

$$2^3 x^{15}$$

22. $(mn)^6$

$$m^6 n^6$$

23. $(4d^5)^7$

$$4^7 d^{35}$$

24. $(r^6s^3t^2)^3$

$$r^{18} s^9 t^6$$

Learning Target: I can simplify exponential expressions using any combination of the three product properties.

More Examples

Now, let's put the properties together. Simplify the expression as much as possible.

★ 25. $x^3 \cdot y^5 \cdot x^2 \cdot y^4$
 $x^3 \cdot x^2 \cdot y^5 \cdot y^4$
 $x^5 y^9$

26. $(3xy^2)^2 \cdot x^3$
 $3^2 x^2 y^4 \cdot x^3$
 $9x^5 y^4$

27. $x^6 \cdot (2x^2y)^5$

28. $5a^2 \cdot (3a)^3$

29. $-(c^4)(2c)^3$

★ 30. $(-4xy)^2(3xy^2)^3$
 $-4^2 x^2 y^2 \cdot 3^3 x^3 y^6$
 $-4^2 \cdot 3^3 \cdot x^2 \cdot x^3 \cdot y^2 \cdot y^6$
 $16 \cdot 27$
 $432 x^5 y^8$

31. $4p^2 \cdot 3p^5$

32. $(7m^2n)^2(2m^3n)^3$

33. $-(u^3)(4u^2)^4$

★ 34. $(5f^2g)^2(-3fg^2)^6$
 $5^2 f^4 g^2 \cdot -3^6 f^6 g^{12}$
 $5^2 \cdot -3^6 f^4 f^6 g^2 g^{12}$
 $25 \cdot 729$