Math 9 Adapted LG 2 – Expectation 1
Exponents

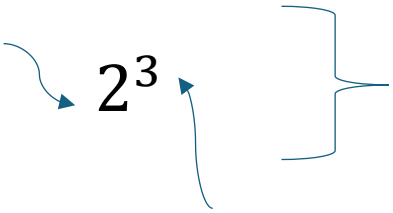
Understanding Exponents:

We use exponents as a quick way to show **repeated multiplication**.

For instance, if I multiplied 2 three times,

instead of writing it as repeated multiplication: 2 x 2 x 2 ⟶ I could write it like this: 2^3

The number being multiplied is the **BASE**.



How many times it is multiplied is shown with the **EXPONENT**.

Evaluate means "what does it actually equal?" 2^3 = 2 x 2 x 2 = 8

Repeated multiplication	Base	Exponent	Exponential Form	Evaluate
2 x 2 x 2	2	3	2^3	8
2 x 2 x 2 x 2 x 2				
3 x 3				
	5	3		
			10^4	

Ask a teacher to show you the exponent button on your calculator to evaluate these:

2^{10} = 3^9 = 1.3^7 = 1^{999} =

Exponential Form	Base	Exponent	Repeated multiplication	Evaluate
2^3	2		2 x 2 x 2	8
3^2		2		9
5^4			5 x 5 x 5 x 5	
	6	2		
	8		8 x 8 x 8	
			9x9x9x9x9x9	
10^3				
	7			49
	2			16
		3		27

2^3	2	**3**	2 x 2 x 2	8
3^2	**3**	2	**3 x 3**	9
5^4	**5**	**4**	5 x 5 x 5 x 5	**625**
6^2	6	2	**6 x 6**	**36**
8^3	8	3	8 x 8 x 8	**512**
9^6	**9**	**6**	9x9x9x9x9x9	**531,441**
10^3	**10**	**3**	**10 x 10 x 10**	**1,000**
7^2	7	**2**	**7 x 7**	49
2^4	2	**4**	**2 x 2 x 2 x 2**	16
3^3	**3**	3	**3 x 3 x 3**	27

Be sure to always check your work!

RULE: If the exponent is 1, the answer is the base.

$2^1 = 2$ $345^1 =$ $45.29^1 =$ $12345^1 =$

Evaluate WITHOUT USING A CALCULATOR (you can use a multiplication table):

1 a. 2^1 **1 b.** 5^2

2 a. 3^3 **2 b.** 8^2

3 a. 0^{82} **3 b.** 100^1

4 a. 10^7 **4 b.** 0^{20}

5 a. 8^1 **5 b.** 5^1

6 a. 10^4 **6 b.** 6^2

7 a. 4^2 **7 b.** 7^2

8 a. 100^6 **8 b.** 1^9

9 a. 9^2 **9 b.** 1^{99}

10 a. 100^2 **10 b.** 2^3

Answer Key

1 a.	2	1 b.	25
2 a.	27	2 b.	64
3 a.	0	3 b.	100
4 a.	10000000	4 b.	0
5 a.	8	5 b.	5
6 a.	10000	6 b.	36
7 a.	16	7 b.	49
8 a.	1000000000000	8 b.	1
9 a.	81	9 b.	1
10 a.	10000	10 b.	8

RULE: If the exponent is 0, the answer is ALWAYS 1.

$2^0 = 1$ $555^0 =$ $7.23^0 =$ $12345^0 =$

We can write these rules using the letter x to represent *any* number. So…..

$$x^1 = x \qquad x^0 = 1$$

The Product Rule

Ways to show multiplication**:** 2 x 2 x 2 can also be written like: $2 \cdot 2 \cdot 2$ or (2)(2)(2)

RULE: When **multiplying** like bases, keep the base and **add** the exponents to write as a single power (one base with one exponent).

Multiplying	Repeated multiplication	Single power
2^2 x 2^3	2 x 2 x 2 x 2 x 2	2^5
13^1 x 13^2		
9^3 x 9^4		
2^7 x 3^7	*The base is not the same!!*	*Can't write as a single power!*

This only works if the BASE IS THE SAME! Write as a single power if it is possible:

1. 2^1 x 2^{10} =
2. 3^{10} x 2^{10} =
3. (-23^3) x (-23^4) =
4. 1.3^4 x 1.3^2 =
5. 23^3 x 23^4 =
6. 1^1 x 2^2 =
7. 5^{10} x 5^{10} =
8. 7.3^3 x 73^4 =
9. 9^{41} x 9^{22} =
10. 123^4 x 123^{10} =

We can write this rule using the letter x and *m* and *n* to represent *any different* numbers.

$$x^m \cdot x^n = x^{m+n}$$

Simplify these expressions:

1. $6^7 \cdot 6^8$

2. $3^1 \cdot 3^8$

3. $8^9 \cdot 8^9$

4. $8^5 \cdot 8^6$

Check your work:

1. $6^7 \cdot 6^8$
   $= 6^{15}$

2. $3^1 \cdot 3^8$
   $= 3^9$

3. $8^9 \cdot 8^9$
   $= 8^{18}$

4. $8^5 \cdot 8^6$
   $= 8^{11}$

5. $3^7 \cdot 3^2$
   $= 3^9$

6. $5^3 \cdot 5^6$
   $= 5^9$

7. $3^9 \cdot 3^7$
   $= 3^{16}$

8. $5^0 \cdot 5^0$
   $= 5^0 = 1$

9. $3^5 \cdot 3^8$
   $= 3^{13}$

10. $3^1 \cdot 3^8$
    $= 3^9$

5. $3^7 \cdot 3^2$

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

7. $3^9 \cdot 3^7$

8. $5^0 \cdot 5^0$

9. $3^5 \cdot 3^8$

10. $3^1 \cdot 3^8$

Try these toughies…remember your rules when adding negative and positive numbers:

1) $(-5)^{-10} \cdot (-5)^{15}$

2) $\left(\frac{4}{5}\right)^{-6} \cdot \left(\frac{4}{5}\right)^{-9}$

3) $(1.4)^{-12} \cdot (1.4)^{5}$

4) $\left(-\frac{7}{6}\right)^{9} \cdot \left(-\frac{7}{6}\right)^{3}$

5) $(-13)^{0} \cdot (-13)^{-19}$

6) $8^{-14} \cdot 8^{-4}$

The Quotient Rule

Ways to show division**:** $12 \div 2$ can also be written like: 12/2 or $\frac{12}{2}$

RULE: When **dividing** like bases, keep the base and **subtract** the exponents to write as a single power (one base with one exponent).

Dividing	Exponent Work	Single power
$2^5 \div 2^2$	*Subtract the exponents* $5 - 2 = 3$	2^3
$8^{10} / 8^5$		
$\frac{4^9}{4^7}$		
$5^7 \div 3^7$	*The base is not the same!!*	*Can't write as a single power!*
$\frac{99^{20}}{99^7}$		
$\frac{7^6}{7^4}$		
$10^{10} / 8^5$		
$(-5)^5 \div (-5)^2$		
$4^{12} / 4^{11}$		
$3^{22} \div 3^2$		

Simplify these expressions:

1. $\frac{4^6}{4^2}$

2. $\frac{4^8}{4^2}$

3. $\frac{9^7}{9^6}$

4. $\frac{8^6}{8^1}$

5. $\frac{3^4}{3^4}$

6. $\frac{7^6}{7^1}$

7. $\frac{7^2}{7^1}$

8. $\frac{9^8}{9^4}$

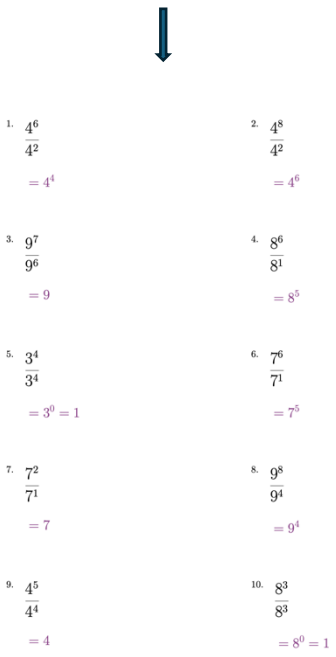
9. $\frac{4^5}{4^4}$

10. $\frac{8^3}{8^3}$

We can write this rule using the letter x and m and n to represent *any different* numbers.

$$\frac{x^m}{x^n} = x^{m-n}$$

Check your work!



Sometimes we use a variable (letter) to represent an unknow number.

$\frac{x^7}{x^3} = x^4$ or $(q^7)(q^2) = q^5$ or $y^0 = 1$ or $m^1 = m$

Try these:

$\frac{r^{10}}{r^3} =$	$k^0 =$	$(j^{25})(j^{20}) =$	$h^1 =$
$(s^9)(s^6) =$	$p^1 =$	$g^0 =$	$\frac{s^{60}}{s^{35}} =$

Ask your teacher for mini quiz 1

Raising a Power to a Power Rule

Power to power	Expanded form	Single power
$(5^2)^3$	$(5^2)(5^2)(5^2)$	5^6
$(10^9)^4$		
$(-3.5^4)^3$		

Write as a single power:

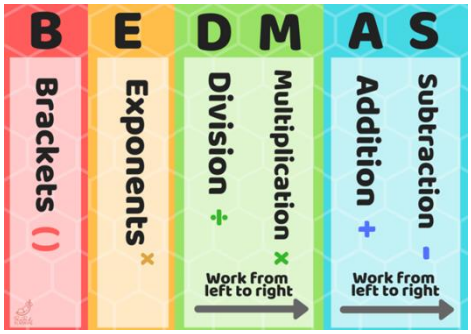
Rule: when raising a power to a power, keep the base and multiply the exponents.

$$(x^m)^n = x^{mn}$$

1. $(9^4)^2$
2. $(3^9)^9$
3. $(4^4)^3$
4. $(8^2)^6$
5. $(3^1)^7$
6. $(4^6)^8$
7. $(8^1)^2$
8. $(7^0)^3$
9. $(6^1)^0$
10. $(2^6)^7$

1. $(9^4)^2$ $= 9^8$
2. $(3^9)^9$ $= 3^{81}$
3. $(4^4)^3$ $= 4^{12}$
4. $(8^2)^6$ $= 8^{12}$
5. $(3^1)^7$ $= 3^7$
6. $(4^6)^8$ $= 4^{48}$
7. $(8^1)^2$ $= 8^2$
8. $(7^0)^3$ $= 7^0 = 1$
9. $(6^1)^0$ $= 6^0 = 1$
10. $(2^6)^7$ $= 2^{42}$

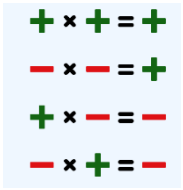
Order of Operations



Example 1. $60 - 25 \times 4 \div 2 + 3^2$

Example 2. $(10^2 - 80) \div 5 + (2^3 + 6^1)$

Remember your multiplication rules when dealing with negative bases:



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

Example 5. $(-2)^3 = (-2)(-2)(-2) =$

If there is nothing to do inside a bracket move on…

Example 6. $(-2) \times 5 + (-5)^2$

Sometimes you can have a bracket within a bracket – work from the inside out:

Example 7. $((5+2) - 4) \times 2 =$

Example 8. $(4 - (-2)) + (2^2 - 14^0)$

Try these:

$(-5)^2 - 2 \times (-9) + 6$

$3 \times 10 + 8 - 4^2$

$(-9) - (-8) + 2 \times 4^2$

$(-3)^3 - 2 + 8 \div (-8)$

$8 \div (-4) \times (-6)^2 + 7$

$4 \times (-8) + 6 - (-2)^3$

$10 \times 5 - (-6)^2 + (-8)$

$(-5)^2 \times 3 \div 5 + 9$

$(10 \div (-5) - (-2)) \times (-3)^3$

$4 \times (-6) \div 8 + 3^3$

Ask your teacher for mini quiz 2

Check your work carefully!

$(-5)^2 - 2 \times (-9) + 6$

$= 25 - 2 \times (-9) + 6$

$= 25 - (-18) + 6$

$= 43 + 6$

$= 49$

$(-9) - (-8) + 2 \times 4^2$

$= (-9) - (-8) + 2 \times 16$

$= (-9) - (-8) + 32$

$= (-1) + 32$

$= 31$

$8 \div (-4) \times (-6)^2 + 7$

$= 8 \div (-4) \times 36 + 7$

$= (-2) \times 36 + 7$

$= (-72) + 7$

$= -65$

$10 \times 5 - (-6)^2 + (-8)$

$= 10 \times 5 - 36 + (-8)$

$= 50 - 36 + (-8)$

$= 14 + (-8)$

$= 6$

$\big(10 \div (-5) - (-2)\big) \times (-3)^3$

$= \big((-2) - (-2)\big) \times (-3)^3$

$= 0 \times (-3)^3$

$= 0 \times (-27)$

$= 0$

$3 \times 10 + 8 - 4^2$

$= 3 \times 10 + 8 - 16$

$= 30 + 8 - 16$

$= 38 - 16$

$= 22$

$(-3)^3 - 2 + 8 \div (-8)$

$= (-27) - 2 + 8 \div (-8)$

$= (-27) - 2 + (-1)$

$= (-29) + (-1)$

$= -30$

$4 \times (-8) + 6 - (-2)^3$

$= 4 \times (-8) + 6 - (-8)$

$= (-32) + 6 - (-8)$

$= (-26) - (-8)$

$= -18$

$(-5)^2 \times 3 \div 5 + 9$

$= 25 \times 3 \div 5 + 9$

$= 75 \div 5 + 9$

$= 15 + 9$

$= 24$

$4 \times (-6) \div 8 + 3^3$

$= 4 \times (-6) \div 8 + 27$

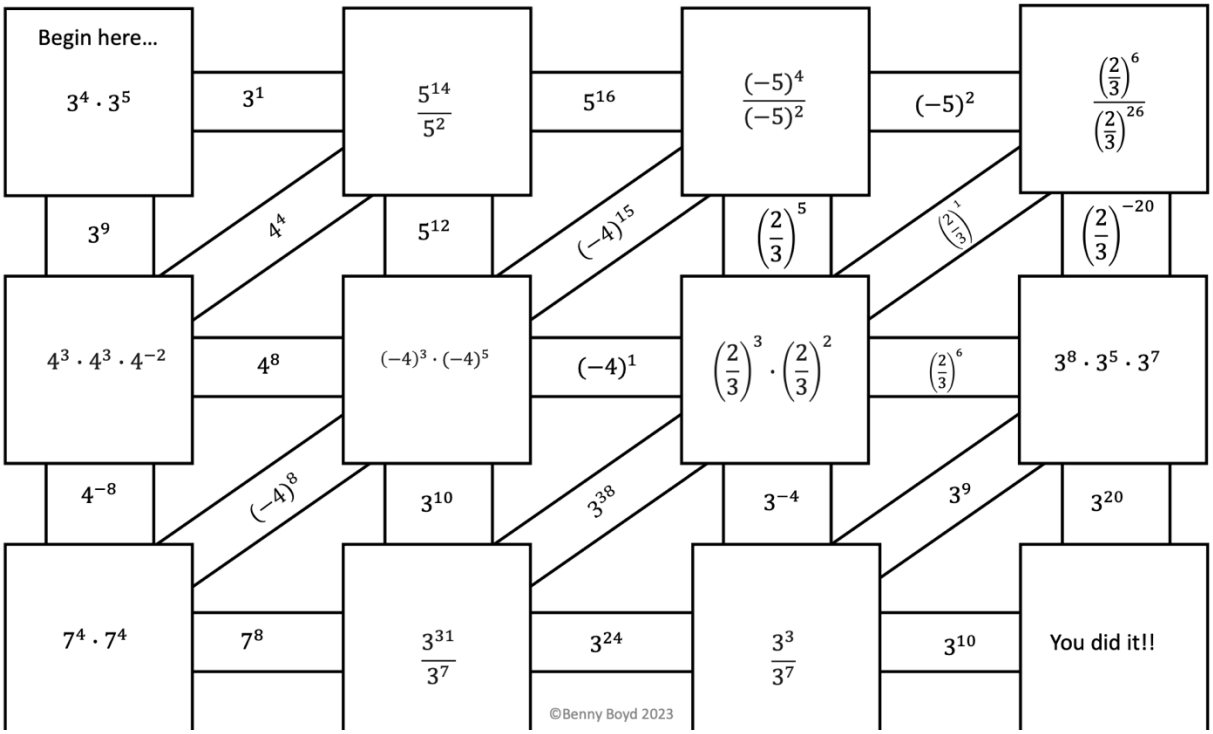
$= (-24) \div 8 + 27$

$= (-3) + 27$

$= 24$

Review LG 2 Quiz

Exponents Maze: Do each problem and shade the path with the correct answer on the maze with a highlighter or colored pencil.



Repeated multiplication	Base	Exponent	Exponential Form	Evaluate
5 x 5				
			2^5	
	3	4		

Evaluate:

44^0 = 78^1 = 13^0 = 125^1 = y^0 =

Write as a single power:

$(3^2)^4$ = $(5^3)^2$ = $(10^{-6})^5$ = $(48^2)^0$ =

Solve:

$44^0 + 3^2 \div 5 \times 6 + 8 \div (-2)$ =