Name ____________________ Date ________________

Master 2.17

Extra Practice 1

Lesson 2.1: What Is a Power?

1. Identify the base of each power.
a) 6^3 **b)** 2^7 **c)** $(-5)^4$ **d)** -7^0

2. Use repeated multiplication to show why 3^5 is not the same as 5^3.

3. Complete this table.

Power	Base	Exponent	Repeated Multiplication	Standard Form
4^4				
$(-10)^3$				
	-6	2		
			$1 \times 1 \times 1 \times 1 \times 1$	

4. Write each product as a power, then evaluate.
a) 6×6
b) $3 \times 3 \times 3 \times 3 \times 3 \times 3$
c) $10 \times 10 \times 10 \times 10$
d) $-(8 \times 8 \times 8)$
e) $(-8)(-8)(-8)$
f) $-(-8)(-8)(-8)$

5. Write each power as repeated multiplication, then evaluate.
a) 7^5 **b)** 4^6 **c)** -9^3 **d)** $(-5)^5$

6. Evaluate each power. For each power:
- Are the brackets needed?
- If your answer is yes, what purpose do the brackets serve?

a) $(-6)^5$ **b)** $-(6)^5$ **c)** $-(-6)^5$ **d)** (-6^5)

7. Predict whether each answer is positive or negative, then evaluate.
a) $(-3)^2$ **b)** $(-3)^3$ **c)** -3^2 **d)** $-(-3)^3$

8. Is the value of -2^4 different from the value of $(-2)^4$? Explain.

9. Stamps are sold in a 10 by 10 sheet. The total value of a sheet of stamps is $60.00.
a) Express the number of stamps as a power and in standard form.
b) Use grid paper. Draw a picture to represent this power.
c) What is the value of one stamp?

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Master 2.18

Extra Practice 2

Lesson 2.2: Powers of Ten and the Zero Exponent

1. Evaluate each power.

a) 4^0 **b)** 23^0 **c)** $(-6)^0$
d) 1^0 **e)** -1^0 **f)** $(-1)^0$

2. Write each number as a power of 10.

a) 10 000 **b)** 1 000 000 **c)** one billion
d) ten **e)** 1

3. Use powers of 10 to write each number.

a) 700 000 000 000 **b)** 7000
c) 77 077 **d)** 7 000 007

4. Write each number in standard form.

a) (8×10^5)
b) $(9 \times 10^7) + (9 \times 10^6) + (5 \times 10^5)$
c) $(2 \times 10^3) + (2 \times 10^2) + (6 \times 10^0)$
d) $(5 \times 10^5) + (4 \times 10^8) + (8 \times 10^0) + (3 \times 10^4)$

5. Write these numbers in standard form, then order them from least to greatest.

fifty-five hundred 50 500 $(5 \times 10^6) + (5 \times 10^0)$
five hundred thousand 5×10^4 500 500

6. **a)** Complete this table for a base of 10.

Exponent	Power	Standard Form
6	10^6	
5		
4		
3		
2		
1		
0		

b) Use patterns to describe why the power with an exponent of 0 is equal to 1.

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Master 2.19

Extra Practice 3

Lesson 2.3: Order of Operations with Powers

1. Evaluate.

a) $5^2 + 3$ **b)** $5^2 – 3$ **c)** $5 + 3^2$ **d)** $5 – 3^2$

e) $(5 + 3)^2$ **f)** $(5 – 3)^2$ **g)** $5^2 + 3^2$ **h)** $5^2 – 3^2$

2. Evaluate.

a) $4^3 \times 2$ **b)** $4^3 \div 2$ **c)** 4×2^3 **d)** $4 \div 2^3$

e) $(4 \times 2)^3$ **f)** $(4 \div 2)^3$ **g)** $4^3 \times 2^3$ **h)** $4^3 \div 2^3$

3. Evaluate.

a) $(18 \div 3^2 + 1)^4 – 4^2$ **b)** $3^3 \div 9(3^0 – 2^2)$ **c)** $(12^2 + 5^3)^0 – 2[(–3)^3]$

d) $(7 – 5)^3 \times (8 + 2)^4$ **e)** $(4^2 \times 1^5)^2$ **f)** $[(–3)^4 – (–2)^3]^0 \div [(–4)^3 – (–3)^2]^0$

4. Insert brackets to make each statement true.

a) $15 \div 3 + 2 \times 4^2 – 5 = 43$ **b)** $15 \div 3 + 2 \times 4^2 – 5 = 27$

c) $15 \div 3 + 2 \times 4^2 – 5 = 107$ **d)** $15 \div 3 + 2 \times 4^2 – 5 = 64$

5. The formula for the volume, V, of a cylinder with height, h, and radius, r, is $V = \pi r^2h$.
Janet made 3 L of salsa and stores it in jars with a radius of 4 cm and a height of 10 cm.
She uses this expression to determine the number of jars she will need: $\dfrac{3000}{\pi(4)^2 \times 10}$
About how many jars will Janet need for the salsa?

6. Aftab, Shane, and Kyra got different answers when they evaluated this expression:
$(–4)^2 – 3[(–9) \div 3]^2$ Aftab's answer was 97, Shane's answer was 43, and Kyra's answer was 19.

a) Show the correct solution.
b) Show and explain how the students who got the wrong answer may have evaluated. Where did each student go wrong?

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Master 2.20

Extra Practice 4

Lesson 2.4: Exponent Laws 1

1. Write each product as a single power.

a) $4^3 \times 4^2$ **b)** $5^0 \times 5^0$ **c)** $(-2)^2 \times (-2)^4$

d) $-6^3 \times 6^1$ **e)** $(-7)^0 \times (-7)^2$ **f)** $(-9)^6 \times (-9)^3$

2. Write each quotient as a single power.

a) $8^7 \div 8^5$ **b)** $10^4 \div 10^0$ **c)** $(-1)^6 \div (-1)^3$

d) $\dfrac{-3^4}{3^4}$ **e)** $\dfrac{(-9)^{10}}{(-9)^5}$ **f)** $\dfrac{11^9}{11^6}$

3. Express as a single power.

a) $2^3 \times 2^6 \div 2^9$ **b)** $(-5)^8 \div (-5)^4 \times (-5)^3$ **c)** $\dfrac{6^3 \times 6^5}{6^2 \times 6^4}$

4. Simplify, then evaluate.

a) $2^2 - 2^0 \times 2 + 2^3$ **b)** $(-2)^6 \div (-2)^5 - (-2)^5 \div (-2)^3$ **c)** $-2^2(2^3 \div 2^1) - 2^3$

5. Simplify, then evaluate.

a) $4^3 \div 4^2 + 2^4 \times 3^2$ **b)** $3^2 + 4^2 \times 4^1 \div 2^3$ **c)** $\dfrac{3^4}{3^3} + \dfrac{4^2 \times 4^0}{2^4}$

6. Write each relationship as a product of powers or a quotient of powers.

a) One million is 1000 times as great as one thousand.

b) One billion is 1000 times as great as one million.

c) One hundred is one-tenth of one thousand.

d) One is one-millionth of one million.

e) One trillion is 1000 times as great as one thousand million.

7. Identify, then correct any errors in these answers.
Explain how you think the errors occurred.

a) $5^3 \times 5^2 = 5^6$ **b)** $2^3 \times 4^2 = 8^5$ **c)** $(-3)^8 \div (-3)^4 = (-3)^4$

d) $1^2 \times 1^4 - 1^3 = 1^3$ **e)** $\dfrac{4^2 \times 4^4}{4^2 \times 4^1} = 4^2$

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Master 2.21

Extra Practice 5

Lesson 2.5: Exponent Laws II

1. Write each expression as a product of powers or a quotient of powers.

a) $(3 \times 2)^4$

b) $[(-4) \times 3]^2$

c) $[(-2) \times (-4)]^3$

d) $(7 \times 11)^0$

e) $(10 \div 5)^3$

f) $[(-12) \div (-6)]^2$

g) $\left(\dfrac{8}{4}\right)^4$

h) $\left(\dfrac{1}{10}\right)^6$

2. Write as a power.

a) $(3^4)^2$

b) $(5^0)^3$

c) $-(7^2)^2$

d) $[(-3)^3]^2$

3. Why is the value of $[(-3)^3]^2$ positive and the value of $[(-3)^3]^3$ negative?

4. Simplify, then evaluate.

a) $(2^3 \times 2^1)^2$

b) $(5^4 \div 5^2)^2$

c) $[(-3)^0 \times (-3)^3]^2$

d) $(10^2)^4 \div (10^3)^2$

5. Simplify, then evaluate each expression.

a) $(3^2 \times 4^3)^2 - (4^4 \div 4^2)^2$

b) $(2^3 \div 2^2)^3 + (7^4 \times 7^3)^0$

c) $[(-1)^3]^4 - [(-1)^4 \div (-1)^3]^2$

d) $(4^2 \times 4^3)^0 - (3^2)^2$

e) $(5^2 \times 5^0)^3 + (2^5 \div 2^3)^3$

f) $(10^6 \div 10^3)^2 + (2^3 \div 2^1)^4$

6. Find and correct any errors in each solution.

a) $(4^3 \times 2^2)^2 = (8^5)^2$
$= 8^{10}$
$= 1\,073\,741\,824$

b) $[(-10)^3]^4 = (-10)^7$
$= -10\,000\,000$

c) $(2^2 + 2^3)^2 = (2^5)^2$
$= 2^{10}$
$= 1024$

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Master 2.22

Extra Practice Sample Answers

Extra Practice 1 – Master 2.17

Lesson 2.1

1. **a)** 6 **b)** 2 **c)** –5 **d)** 7

2. $3^5 = 3 \times 3 \times 3 \times 3 \times 3 = 243$ and $5^3 = 5 \times 5 \times 5 = 125$

3.

Power	Base	Exponent	Repeated Multiplication	Standard Form
4^4	4	4	$4 \times 4 \times 4 \times 4$	256
$(-10)^3$	–10	3	(–10)(–10)(–10)	–1000
$(-6)^2$	–6	2	(–6)(–6)	36
1^5	1	5	$1 \times 1 \times 1 \times 1 \times 1$	1

4. **a)** $6^2 = 36$ **b)** $3^6 = 729$
c) $10^4 = 10\ 000$
d) $-8^3 = -512$ **e)** $(-8)^3 = -512$
f) $-(-8)^3 = 512$

5. **a)** $7 \times 7 \times 7 \times 7 \times 7 = 16\ 807$
b) $4 \times 4 \times 4 \times 4 \times 4 \times 4 = 4096$
c) $-9 \times 9 \times 9 = -729$
d) $(-5)(-5)(-5)(-5)(-5) = -3125$

6. **a)** $(-6)^5 = -7776$; the brackets are needed; they indicate that the base is –6.
b) $-(6)^5 = -7776$; the brackets are not needed; the base is 6 and the power is negative.
c) $-(-6)^5 = 7776$; the brackets are needed; they indicate that the base is –6 and the sign of the expression is opposite to the sign of the value of $(-6)^5$.
d) $(-6^5) = -7776$; the brackets are not needed.

7. **a)** $(-3)^2$ is positive because the answer is the product of an even number of negative integers: 9
b) $(-3)^3$ is negative because the answer is the product of an odd number of negative integers: –27
c) -3^2 is negative because the answer is the opposite of the product of an even number of positive integers: –9
d) $-(-3)^3$ is positive because the answer is the opposite of the product of an odd number of negative integers: 27

8. Yes, their values are different; $-2^4 = -2 \times 2 \times 2 \times 2 = -16$ and $(-2)^4 = (-2)(-2)(-2)(-2) = 16$

9. **a)** $10^2 = 100$
b) Students should draw a 10 by 10 square on grid paper.
c) 60¢ or $0.60

Extra Practice 2 – Master 2.18

Lesson 2.2

1. **a)** 1 **b)** 1 **c)** 1
d) 1 **e)** –1 **f)** 1

2. **a)** 10^4 **b)** 10^6 **c)** 10^9
d) 10^1 **e)** 10^0

3. **a)** 7×10^{11} **b)** 7×10^3
c) $(7 \times 10^4) + (7 \times 10^3) + (7 \times 10^1) + (7 \times 10^0)$
d) $(7 \times 10^6) + (7 \times 10^0)$

4. **a)** 800 000 **b)** 99 500 000
c) 2206 **d)** 400 530 008

5. In standard form: 5500, 50 500, 5 000 005, 500 000, 50 000, 500 500
From least to greatest: 5500, 50 000, 50 500, 500 000, 500 500, 5 000 005

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Master 2.23

Extra Practice Sample Answers

6. a)

Exponent	Power	Standard Form
6	10^6	1 000 000
5	10^5	100 000
4	10^4	10 000
3	10^3	1000
2	10^2	100
1	10^1	10
0	10^0	1

b) In the 2nd column, the exponents are decreasing by 1 each time. In the 3rd column, the number of zeros after the 1 decreases by 1; each time we divide by 10 to get the number below, and in the last row: $10 \div 10 = 10^0 = 1$

Extra Practice 3 – Master 2.19

Lesson 2.3

1. a) 28 **b)** 22 **c)** 14
d) –4 **e)** 64 **f)** 4
g) 34 **h)** 16

2. a) 128 **b)** 32 **c)** 32 **d)** $\frac{1}{2}$
e) 512 **f)** 8 **g)** 512 **h)** 8

3. a) 65 **b)** –9 **c)** 55
d) 80 000 **e)** 256 **f)** 1

4. a) $15 \div (3 + 2) \times 4^2 - 5 = 43$
b) $15 \div 3 + 2 \times (4^2 - 5) = 27$
c) $(15 \div 3 + 2) \times 4^2 - 5 = 107$
d) $15 \div 3 + (2 \times 4)^2 - 5 = 64$

5. About 6 jars

6. a) The correct solution:
$(-4)^2 - 3[(-9) \div 3]^2 = (-4)^2 - 3(-3)^2 = 16 - 3(9) = 16 - 27 = -11$
b) Shane probably thought that $(-3)^2 = -9$; here is a possible incorrect solution:
$(-4)^2 - 3[(-9) \div 3]^2 = (-4)^2 - 3(-3)^2 = 16 - 3(-9) = 16 + 27 = 43$
Aftab probably multiplied –3 and –9 before evaluating in the brackets and applying the exponent. Here is a possible incorrect solution:
$(-4)^2 - 3[(-9) \div 3]^2 = 16 + (27 \div 3)^2 = 16 + 9^2 = 16 + 81 = 97$
Kyra probably squared the 3 before doing any other operation. Here is a possible incorrect solution:
$(-4)^2 - 3[(-9) \div 3]^2 = 16 - 3[(-9) \div 9] = 16 - 3(-1) = 16 + 3 = 19$

Extra Practice 4 – Master 2.20

Lesson 2.4

1. a) 4^5 **b)** 5^0 **c)** $(-2)^6$
d) -6^4 **e)** $(-7)^2$ **f)** $(-9)^9$

2. a) 8^2 **b)** 10^4 **c)** $(-1)^3$
d) -3^0 **e)** $(-9)^5$ **f)** 11^3

3. a) 2^0 **b)** $(-5)^7$ **c)** 6^2

4. a) 10 **b)** –6 **c)** –24

5. a) $4^3 \div 4^2 + 2^4 \times 3^2 = 4 + 16 \times 9 = 148$
b) $3^2 + 4^2 \times 4^1 \div 2^3 = 9 + 64 \div 8 = 17$
c) $\frac{3^4}{3^3} + \frac{4^2 \times 4^0}{2^4} = 3 + \frac{16}{16} = 3 + 1 = 4$

6. a) $1\ 000\ 000 = 10^3 \times 10^3$
b) $1\ 000\ 000\ 000 = 10^3 \times 10^6$
c) $100 = \frac{10^3}{10^1}$ **d)** $1 = \frac{10^6}{10^6}$
e) $1\ 000\ 000\ 000\ 000 = 10^3 \times 10^3 \times 10^6$

7. a) The exponents were multiplied instead of added. $5^3 \times 5^2 = 5^5$
b) The bases were multiplied. $2^3 \times 4^2 = 8 \times 16 = 128$
c) This solution is correct.
d) The exponent 3 was subtracted from the sum of exponents 2 and 4.
$1^2 \times 1^4 - 1^3 = 1^6 - 1^3 = 1 - 1 = 0$

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Master 2.24

Extra Practice and Activating Prior Knowledge Sample Answers

e) The exponents were multiplied then divided instead of added and subtracted.
$\frac{4^2 \times 4^4}{4^2 \times 4^1} = \frac{4^6}{4^3} = 4^3$

Extra Practice 5 – Master 2.21

Lesson 2.5

1. a) $3^4 \times 2^4$ **b)** $(-4)^2 \times 3^2$
c) $(-2)^3 \times (-4)^3$ **d)** $7^0 \times 11^0$
e) $10^3 \div 5^3$ **f)** $(-12)^2 \div (-6)^2$
g) $\frac{8^4}{4^4}$ **h)** $\frac{1^6}{10^6}$

2. a) 3^8 **b)** 5^0
c) -7^4 **d)** $(-3)^6$

3. $[(-3)^3]^2$ is positive because it is the square of a power, and the square of any number is positive. $[(-3)^3]^3$ is negative because it simplifies to $(-3)^9$, and the product of an odd number of negative factors is negative.

4. a) $(2^3 \times 2^1)^2 = (2^4)^2 = 2^8 = 256$
b) $(5^4 \div 5^2)^2 = (5^2)^2 = 5^4 = 625$
c) $[(-3)^0 \times (-3)^3]^2 = [(-3)^3]^2 = (-3)^6 = 729$
d) $(10^2)^4 \div (10^3)^2 = 10^8 \div 10^6 = 10^2 = 100$

5. a) $(3^2 \times 4^3)^2 - (4^4 \div 4^2)^2 = (9 \times 64)^2 - (4^2)^2$
$= 576^2 - 4^4 = 331\ 776 - 256 = 331\ 520$
b) $(2^3 \div 2^2)^3 + (7^4 \times 7^3)^0 = 2^3 + 1 = 8 + 1 = 9$
c) $[(-1)^3]^4 - [(-1)^4 \div (-1)^3]^2 = (-1)^{12} - (-1)^2$
$= 1 - 1 = 0$
d) $(4^2 \times 4^3)^0 - (3^2)^2 = 1 - 3^4 = 1 - 81 = -80$
e) $(5^2 \times 5^0)^3 + (2^5 \div 2^3)^3 = 5^6 + 2^6 = 15\ 625 + 64 = 15\ 689$
f) $(10^6 \div 10^3)^2 + (2^3 \div 2^1)^4 = (10^3)^2 + (2^2)^4 = 10^6 + 2^8 = 1\ 000\ 000 + 256 = 1\ 000\ 256$

6. a) $(4^3 \times 2^2)^2 = 4^6 \times 2^4 = 4096 \times 16 = 65\ 536$
b) $[(-10)^3]^4 = (-10)^{12} = 1\ 000\ 000\ 000\ 000$
c) $(2^2 + 2^3)^2 = (4 + 8)^2 = 12^2 = 144$

Activating Prior Knowledge Master 2.25a

1. a) 100 m^2 **b)** 16 cm^2
c) 144 mm^2 **d)** 36 cm^2

2. a) *Students should draw a square with side length 1.*
b) *Students should draw a square with side length 3.*
c) *Students should draw a square with side length 8.*
d) *Students should draw a square with side length 11.*
e) *Students should draw a square with side length 2.*
f) *Students should draw a square with side length 9.*
g) *Students should draw a square with side length 10.*
h) *Students should draw a square with side length 4.*
i) *Students should draw a square with side length 6.*
j) *Students should draw a square with side length 12.*
k) *Students should draw a square with side length 20.*
l) *Students should draw a square with side length 15.*

Activating Prior Knowledge Master 2.25b

1. a) 80 **b)** –80 **c)** –5 **d)** 5

2. a) –1 000 000 **b)** 10

3. a) $(-3) \times (-9) = 27$ **b)** $6 \times (-3) = -18$
c) $36 \div (-6) = -6$

Activating Prior Knowledge Master 2.25c

1. a) 43 **b)** –2
c) –6 **d)** 19

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Master 2.25a

Activating Prior Knowledge

What Is a Square Number?

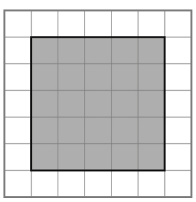
When we multiply a number by itself, we square the number.

For example, the square of 7 is $7 \times 7 = 49$.

We can model a square number by drawing a square with an area that is equal to the square number.

Example
Draw a diagram to show that 25 is a square number.

A Solution
25 is a square number because it is the area of a square with side length 5.



Check

1. Determine the area of a square with each side length.
a) 10 m
b) 4 cm
c) 12 mm
d) 6 cm

2. On grid paper, draw a diagram to show that each number below is a square number.

a) 1	**b)** 9	**c)** 64
d) 121	**e)** 4	**f)** 81
g) 100	**h)** 16	**i)** 36
j) 144	**k)** 400	**l)** 225

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Master 2.25b

Activating Prior Knowledge

Multiplying and Dividing Integers

The product of two integers with the same sign is a positive integer.
$3 \times 5 = 15$ $(-3) \times (-5) = 15$

The product of two integers with different signs is a negative integer.
$(-3) \times 5 = -15$ $3 \times (-5) = -15$

The quotient of two integers with the same sign is a positive integer.
$28 \div 4 = 7$ $(-28) \div (-4) = 7$

The quotient of two integers with different signs is a negative integer.
$(-28) \div 4 = -7$ $28 \div (-4) = -7$

The sign of a product with an even number of negative factors is positive.
$(-1)(-1)(-1)(-1)(-1)(-1) = 1$

The sign of a product with an odd number of negative factors is negative.
$(-1)(-1)(-1)(-1)(-1) = -1$

Example

Will each expression be positive or negative? How do you know?

a) $(-2)(-2)(-2)(+2)$ **b)** $\frac{-6}{2}$ **c)** $(+10) \div (-5) \times (-4)$

A Solution

a) The product of $(-2)(-2)(-2)(+2)$ is negative because there is an odd number of negative factors.
b) The quotient is negative because the integers have different signs.
c) The expression is positive because there is an even number of negative factors.

Check

1. Determine each product or quotient.

a) $(20)(4)$ **b)** $(20)(-4)$ **c)** $(-20) \div 4$ **d)** $\frac{-20}{-4}$

2. Simplify each expression.

a) $(+10)(-10)(-10)(-10)(+10)(+10)$ **b)** $\frac{(-10)(-10)(-10)}{(+10)(-10)}$

3. Fill in the blank to make each equation true.

a) _____ $\times (-9) = 27$ **b)** _____ $\times (-3) = -18$ **c)** $36 \div$ _____ $= -6$

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Master 2.25c

Activating Prior Knowledge

Order of Operations

Recall the order of operations with integers:

- Do the operations in brackets first.
- Multiply and divide, in order, from left to right.
- Add and subtract, in order, from left to right.

When an expression is written as a fraction, the fraction bar indicates division.
The operations in the numerator and the denominator must be done first before dividing the numerator by the denominator.

Example 1
Evaluate: $[(-5) + (-4)] \div (-3) + (-2)$

A Solution
$[(-5) + (-4)] \div (-3) + (-2)$ Do the operation in square brackets first.
$= (-9) \div (-3) + (-2)$ Divide.
$= +3 + (-2)$ Add.
$= 1$

Example 2
Evaluate: $\dfrac{[21+(-5)]\times(-2)}{4(-2)}$

A Solution
$\dfrac{[21+(-5)]\times(-2)}{4(-2)}$ Evaluate the numerator and denominator separately.
$= \dfrac{16\times(-2)}{4(-2)}$ Multiply.
$= \dfrac{-32}{-8}$ Divide.
$= 4$

Check

1. Evaluate. Show all the steps.

a) $(-15)(-3) + 14 \div (-7)$

b) $\dfrac{15-12\div 4}{-6}$

c) $\dfrac{[(-8)-(-2)]\times[6+(-3)]}{(-15)\div(-5)}$

d) $[8 + (-3)] \times 3 + (-36) \div (-9)$