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
Base:	6	2	-5	7
Exponent:	3	7	4	0

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

(3)(3)(3)(3)(3) = 243 (5)(5)(5) = 125

3. Complete this table.

Power	Base	Exponent	Repeated Multiplication	Standard Form
4^4	4	4	4x4x4x4	256
$(-10)^3$	-10	3	(-10)(-10)(-10)	-1000
$(-6)^2$	-6	2	(-6)(-6)	36
$(1)^5$	1	5	1 × 1 × 1 × 1 × 1	1

4. Write each product as a power, then evaluate.

a) $6 \times 6 = 6^2 = 36$

b) $3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^6 = 729$

c) $10 \times 10 \times 10 \times 10 = 10^4 = 10\,000$

d) $-(8 \times 8 \times 8) = -(8)^3 = -512$

e) $(-8)(-8)(-8)$ $(-8)^3 = -512$

f) $-(-8)(-8)(-8)$ $-(-8)^3 = 512$

5. Write each power as repeated multiplication, then evaluate.

a) 7^5 (7)(7)(7)(7)(7) = 16 807

b) 4^6 4x4x4x4x4x4 = 4096

c) -9^3 = -9x9x9 = -729

d) $(-5)^5$ = (-5)(-5)(-5)(-5)(-5) = -3125

Evaluate each power. For each power:

- Are the brackets needed?
- If your answer is yes, what purpose do the brackets serve?

a) $(-6)^5$

$= -7776$

Brackets Needed

b) $-(6)^5$

$= -7776$

Brackets Not Needed

c) $-(-6)^5$

$= 7776$

Brackets Not Needed

d) (-6^5)

$= -7776$

Brackets Needed

Predict whether each answer is positive or negative, then evaluate.

a) $(-3)^2$

(+)

$= 9$

b) $(-3)^3$

(−)

-27

c) -3^2

(−)

-9

d) $-(-3)^3$

+

27

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

$-(2)(2)(2)(2)$

$= -16$

$(-2)(-2)\ (-2)(-2)$

$(4)\quad (4)$

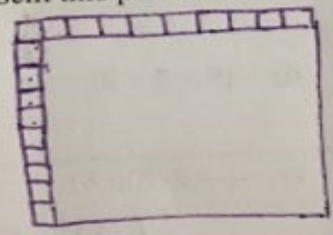
$= 16$

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.

$10 \times 10 = 10^2 = 100$

b) Draw a picture to represent this power.



c) What is the value of one stamp?

$\$60 \div 100 = \$0.60$

Lesson 2.2: Powers of Ten and the Zero Exponent

1. Evaluate each power.

a) 4^0 = 1 **b)** 23^0 = 1 **c)** $(-6)^0$ = 1

d) 1^0 = 1 **e)** -1^0 = −1 **f)** $(-1)^0$ = 1

2. Write each number as a power of 10.

a) 10 000 10^4 **b)** 1 000 000 10^6 **c)** one billion 10^9 **d)** ten 10^1 **e)** 1 10^0

3. Use powers of 10 to write each number.

a) 700 000 000 000 7×10^{11}

b) 7000 7×10^3

c) 77 077 $(7 \times 10^4) + (7 \times 10^3) + (7 \times 10^1) + (7 \times 10^0)$

d) 7 000 007 $(7 \times 10^6) + (7 \times 10^0)$

4. Write each number in standard form.

a) (8×10^5) = 800 000

b) $(9 \times 10^7) + (9 \times 10^6) + (5 \times 10^5)$ → 7 6 5 4 3 2 1 0 → 9 9 5 0 0 0 0 0

c) $(2 \times 10^3) + (2 \times 10^2) + (6 \times 10^0)$ → 2206

d) $(5 \times 10^5) + (4 \times 10^8) + (8 \times 10^0) + (3 \times 10^4)$ → 8 7 6 5 4 3 2 1 0 → 4 0 0 5 3 0 0 0 8

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

fifty-five hundred 5500

50 500 50 500

$(5 \times 10^6) + (5 \times 10^0)$ 5 000 005

five hundred thousand 500 000

5×10^4 50 000

500 500 500 500

least to greatest

fifty-five hundred, 5×10^4, 50500, five hundred thousand, 500 500, $(5 \times 10^6) + (5 \times 10$

a) Complete this table for a base of 10.

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

1. Evaluate.

a) $5^2 + 3$

$25 + 3$

28

b) $5^2 - 3$

$25 - 3$

22

c) $5 + 3^2$

$5 + 9$

14

d) $5 - 3^2$

$5 - 9$

$= -4$

e) $(5 + 3)^2$

$(8)^2$

$= 64$

f) $(5 - 3)^2$

$(2)^2$

$= 4$

g) $5^2 + 3^2$

$25 + 9$

$= 34$

h) $5^2 - 3^2$

$= 25 - 9$

$= 16$

2. Evaluate.

a) $4^3 \times 2$

64×2

$= 128$

b) $4^3 \div 2$

$64 \div 2$

$= 32$

c) 4×2^3

4×8

$= 32$

d) $4 \div 2^3$

$4 \div 8$

$= 0.5$

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

$= (8)^3$

$= 512$

f) $(4 \div 2)^3$

$= (2)^3$

$= 8$

g) $4^3 \times 2^3$

$= 64 \times 8$

$= 512$

h) $4^3 \div 2^3$

$= 64 \div 8$

$= 8$

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Evaluate.

a) $(18 \div 3^2 + 1)^4 - 4^2$

$(18 \div 9 + 1)^4 - 4^2$

$(2 + 1)^4 - 4^2$

$3^4 - 4^2$

$81 - 9$

$= 72$

b) $3^3 \div 9(3^0 - 2^2)$

$3^3 \div 9(1 - 4)$

$3^3 \div 9(-3)$

$27 \div 9(-3)$

$3(-3)$

$= -9$

c) $(12^2 + 5^3)^0 - 2[(-3)^3]$

$(1) - 2(-27)$

$1 - (-54)$

$= 55$

d) $(7 - 5)^3 \times (8 + 2)^4$

$(2)^3 \times (10)^4$

$8 \times 10\,000$

$= 80\,000$

e) $(4^2 \times 1^5)^2$

$(16 \times 1)^2$

$(16)^2$

$= 256$

f) $[(-3)^4 - (-2)^3]^0 \div [(-4)^3 - (-3)^2]^0$

$[1] \div [1]$

$= 1$

5. The formula for the volume, V, of a cylinder with height, h, and radius, r, is $V = \pi r^2 h$.
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: $\frac{3000}{\pi(4)^2 \times 10}$

About how many jars will Janet need for the salsa? $\frac{3000}{3.14(16) \times 10} = \frac{3000}{502.4} = 5.9 = 6$

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.

$(-4)^2 - 3[(-9) \div 3]^2$

$16 - 3[-3]^2$

$16 - 3(9)$

$16 - 27$

$= -11$

Lesson 2.4: Exponent Laws 1

1. Write each product as a single power.

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

4^5

b) $5^0 \times 5^0$

5^0

c) $(-2)^2 \times (-2)^4$

$(-2)^6$

d) $-6^3 \times 6^1$

-6^4

e) $(-7)^0 \times (-7)^2$

$(-7)^2$

f) $(-9)^6 \times (-9)^3$

$(-9)^9$

2. Write each quotient as a single power.

a) $8^7 \div 8^5$

8^2

b) $10^4 \div 10^0$

10^4

c) $(-1)^6 \div (-1)^3$

$(-1)^3$

d) $\frac{-3^4}{3^4}$

-3^0

-1

e) $\frac{(-9)^{10}}{(-9)^5}$

$(-9)^5$

f) $\frac{11^9}{11^6}$

11^3

3. Express as a single power.

a) $2^3 \times 2^6 \div 2^9$

$2^9 \div 2^9$

2^0

1

b) $(-5)^8 \div (-5)^4 \times (-5)^3$

$(-5)^4 \times (-5)^3$

$(-5)^7$

c) $\frac{6^3 \times 6^5}{6^2 \times 6^4}$

$\frac{6^8}{6^6}$

6^2

4. Simplify, then evaluate.

a) $2^2 - 2^0 \times 2 + 2^3$

$2^2 - 2^0 + 2^3$

$4 - 1 + 8$

b) $(-2)^6 \div (-2)^5 - (-2)^5 \div (-2)^3$

$(-2)^1 - (-2)^2$

$(-2) - (4)$

c) $-2^2(2^3 \div 2^1) - 2^3$

$-2^2(2^2) - 2^3$

$-2^4 - 2^3$

$-16 - 8$

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

$= 4^1 + 2^4 \times 3^2$

$= 4 + 16 \times 9$

$= 4 + 144$

$= 148$

b) $3^2 + 4^2 \times 4^1 \div 2^3$

$= 3^2 + 4^3 \div 2^3$

$= 9 + 64 \div 8$

$= 9 + 8$

$= 17$

c) $\frac{}{3^3} + \frac{}{2^4}$

$= 3 + \frac{4^2}{2^4}$

$= 3 + \frac{16}{16}$

$= 3 + 1$

$= 4$

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.

$10^3 \times 10^3 = 10^6$

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

$10^6 \times 10^3 = 10^9$

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

$\frac{10^3}{10} = 10^2$

d) One is one-millionth of one million.

$\frac{10^6}{10^6} = 10^0$

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

$10^9 \times 10^3 = 10^{12}$

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

a) $5^3 \times 5^2 = 5^6$ ✗

$= 5^1$

They multiplied the exponents instead of adding

b) $2^3 \times 4^2 = 8^6$ ✗

They multiplied the bases, but you can't. They should have just evaluated

$8 \times 16 = 128$

c) $(-3)^5 \div (-3)^4 = (-3)^4$

$(-3)^4$ is correct.

d) $1^2 \times 1^4 - 1^3 = 1^0$ ✗

They multiplied 2 x 4 then subtracted 3 to get an exponent of 3.

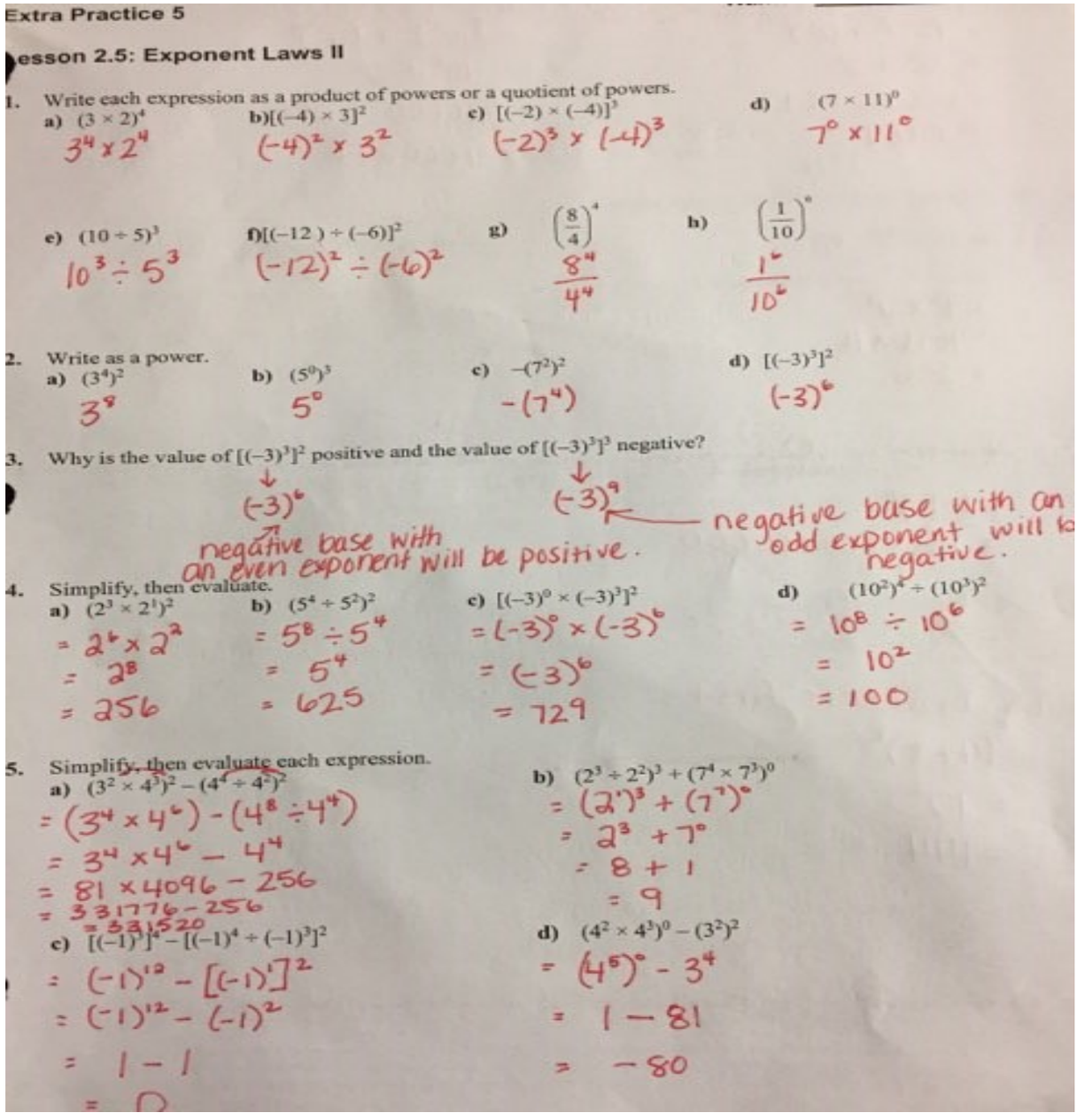
They should have added 2+4. Then evaluated:

$1^6 - 1^3$

e) $\frac{4^2 \times 4^4}{4^2 \times 4^1} = 4^0$ ✗

$\frac{4^6}{4^3} = 4^3$

When they got to this step they divided the exponents but the law when we are dividing powers with the same



Extra Practice 5

Lesson 2.5: Exponent Laws II

1. Write each expression as a product of powers or a quotient of powers.
   a) $(3 \times 2)^4$ → $3^4 \times 2^4$
   b) $[(-4) \times 3]^2$ → $(-4)^2 \times 3^2$
   c) $[(-2) \times (-4)]^3$ → $(-2)^3 \times (-4)^3$
   d) $(7 \times 11)^0$ → $7^0 \times 11^0$
   e) $(10 \div 5)^3$ → $10^3 \div 5^3$
   f) $[(-12) \div (-6)]^2$ → $(-12)^2 \div (-6)^2$
   g) $\left(\frac{8}{4}\right)^4$ → $\frac{8^4}{4^4}$
   h) $\left(\frac{1}{10}\right)^6$ → $\frac{1^6}{10^6}$

2. Write as a power.
   a) $(3^4)^2$ → 3^8
   b) $(5^0)^3$ → 5^0
   c) $-(7^2)^2$ → $-(7^4)$
   d) $[(-3)^3]^2$ → $(-3)^6$

3. Why is the value of $[(-3)^3]^2$ positive and the value of $[(-3)^3]^3$ negative?
   $(-3)^6$ → negative base with an even exponent will be positive.
   $(-3)^9$ → negative base with an odd exponent will be negative.

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

5. Simplify, then evaluate each expression.
   a) $(3^2 \times 4^3)^2 - (4^4 \div 4^2)^2$ → $= (3^4 \times 4^6) - (4^8 \div 4^4) = 3^4 \times 4^6 - 4^4 = 81 \times 4096 - 256 = 331776 - 256 = 331520$
   b) $(2^3 \div 2^2)^3 + (7^4 \times 7^3)^0$ → $= (2^1)^3 + (7^7)^0 = 2^3 + 7^0 = 8 + 1 = 9$
   c) $[(-1)^3]^4 - [(-1)^4 \div (-1)^3]^2$ → $= (-1)^{12} - [(-1)^1]^2 = (-1)^{12} - (-1)^2 = 1 - 1 = 0$
   d) $(4^2 \times 4^3)^0 - (3^2)^2$ → $= (4^5)^0 - 3^4 = 1 - 81 = -80$

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

$= (5^2)^3 + (2^2)^3$

$= 5^6 + 2^6$

$= 15625 + 64$

$= 15689$

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

$= (10^3)^2 + (2^2)^4$

$= 10^6 + 2^8$

$= 1000000 + 256$

$= 1000256$

6. Find and correct any errors in each solution.

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

You try $(4^3 \times 2^2)^2 = (8^5)^2$

$= 4^6 \times 2^4$

$= 4096 \times 16$

$= 256$

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

You try $[(-10)^3]^4 = (-10)^7$

$= (-10)^2$

$= 1000000\,000000$

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

You try $(2^2 + 2^3)^2 = (2^5)^2$

Do brackets first

$= (4 + 8)^2$

$= 12^2$

$= 144$

Simplify. Your answer should contain only one base.

1) $\left[2^2 \cdot (2^2)^3\right]^2 = 2^{16}$

2) $\left[6^3 \cdot 6^3 \cdot 6^2\right]^2 = 6^{16}$

3) $5^3 \cdot 5^2 \cdot (5^0)^3 = 5^5$

4) $6 \cdot (6^2)^3 = 6^7$

5) $(4^3)^2 \cdot 4^2 = 4^8$

6) $6 \cdot (6^3)^2 = 6^7$

7) $\frac{3^3 \cdot 3^3}{3^3} = 3^3$

8) $\frac{2^0 \cdot 2^3}{2^2} = 2^1$

9) $\frac{6^3 \cdot 6^2}{6^5} = 6^0 = 1$

10) $\frac{4 \cdot 4^3}{4^2 \cdot 4^2}$ $4^0 = 1$

11) $\frac{6^2 \cdot 6^0}{6^2} = 6^0$

12) $\frac{3^2}{3 \cdot 3^0} = 3^1$

13) $\left(\frac{5}{5^3}\right)^3 = 5^{-6}$

14) $\frac{6^3}{6^3} = 6^0 = 1$

15) $\left(\frac{5^2}{5^3}\right)^0 = 5^0 = 1$

16) $\left(\frac{4^2}{(4^0)^2}\right)^3 = 4^6$

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

18) $\frac{(2^3)^2}{2} = 2^5$

19) $\frac{(3^2)^3}{3^2 \cdot 3^3} = 3^1$

20) $\frac{4^3 \cdot (4^2)^2}{4^2} = 4^5$

21) $\frac{(2^2)^2}{2 \cdot 2^2} = 2^1$

22) $\frac{\left[5^3 \cdot 5^2\right]^2}{5} = 5^9$

23) $\frac{6^3 \cdot (6^3)^3}{6^0} = 6^{12}$

24) $\frac{\left[2 \cdot (2^3)^0 \cdot (2^3)^2\right]^3}{2^0} = 2^{21}$

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Laws Of Exponents 2

Simplify.

1) $\frac{2^2 \cdot (2^4)^0}{2} = \frac{2^2}{2^1} = 2^1$

2) $\left(\frac{2^9}{2^4 \cdot 2^3}\right)^2 = 2^4$

3) $\frac{2 \cdot 2^4}{2^2} = 2^3$

4) $-\frac{2 \cdot (-2)^3}{(-2)^3} = -2$

5) $\left(\frac{(-2)^0 \cdot (-2)^0}{(-2)^4}\right)^2 = \left(\frac{1}{(-2)^4}\right)^2 = \frac{1^2}{(-2)^8} = \frac{1}{(-2)^8}$

6) $\frac{(-2)^4 \cdot (-2)^2}{(-2)^2} = (-2)^4$

7) $-\frac{2 \cdot (-2)^4}{(-2)^3} = -2 \cdot (-2)^1$

8) $\frac{(2^4)^4}{2 \cdot 2^2} = 2^{13}$

9) $\frac{(-2)^2 \cdot (-2)^4}{(-2)^4} = (-2)^2$

10) $\frac{2 \cdot 2^4 \cdot 2^4}{2^2} = 2^7$

11) $\frac{(-2)^4 \cdot ((-2)^4)^3}{(-2)^4} = (-2)^{12}$

12) $\frac{(-2)^3 \cdot ((-2)^3)^2}{(-2)^3 \cdot (-2)^2} = (-2)^4$

13) $\frac{(2^3)^2 \cdot 2^2}{2^4} = 2^4$

14) $\frac{2^3 \cdot (2^4)^3}{2^0} = 2^{15}$

15) $\frac{2}{(2 \cdot 2^2)^0} = 2^1$

16) $\frac{((-2)^4)^4}{(-2)^3 \cdot (-2)^4} = (-2)^9$

17) $\frac{(2^1 \cdot 2^0)^4}{2^2}$ $\frac{(2^1)^4}{2^2} = \frac{2^4}{2^2} = 2^2$

18) $\left(\frac{2^3 \cdot 2^4}{2^0}\right)^3 = 2^{21}$

Laws of Exponents (3.)

1) $\frac{4^4 \cdot 4^3}{(4^3)^2} = 4^1$

2) $\frac{(2^3)^3 \cdot 2^2}{(2^2)^2} = 2^7$

3) $\frac{3^4 \cdot (3^4)^0 \cdot 3^2}{3^2} = 3^4$

4) $\left(\frac{2^3}{2^0 \cdot 2^2}\right)^2 = 2^2$

5) $\left(\frac{(4^3)^3 \cdot 4^0}{(4^4)^2}\right)^0 = 1$

6) $\frac{(2^3)^2}{2^2 \cdot 2^4} = 1$

7) $\frac{(4^4)^3 \cdot 4^0}{4} = 4^{11}$

8) $\left(\frac{2^5}{2 \cdot 2^4}\right)^3 = 2^0 = 1$

9) $\frac{(3^4)^3}{3 \cdot 3^3} = 3^8$

10) $\left[\frac{(4^3)^0 \cdot (4^0)^2}{4^3}\right]^0 = 1$

11) $\frac{(3 \cdot 3^3)^2}{3^2} = 3^6$

12) $\frac{2^{18}}{(2^4)^3 \cdot (2^3)^2} = 2^0 = 1$

13) $\frac{2^{18} \cdot 2^3}{(2^4)^4} = 2^5$

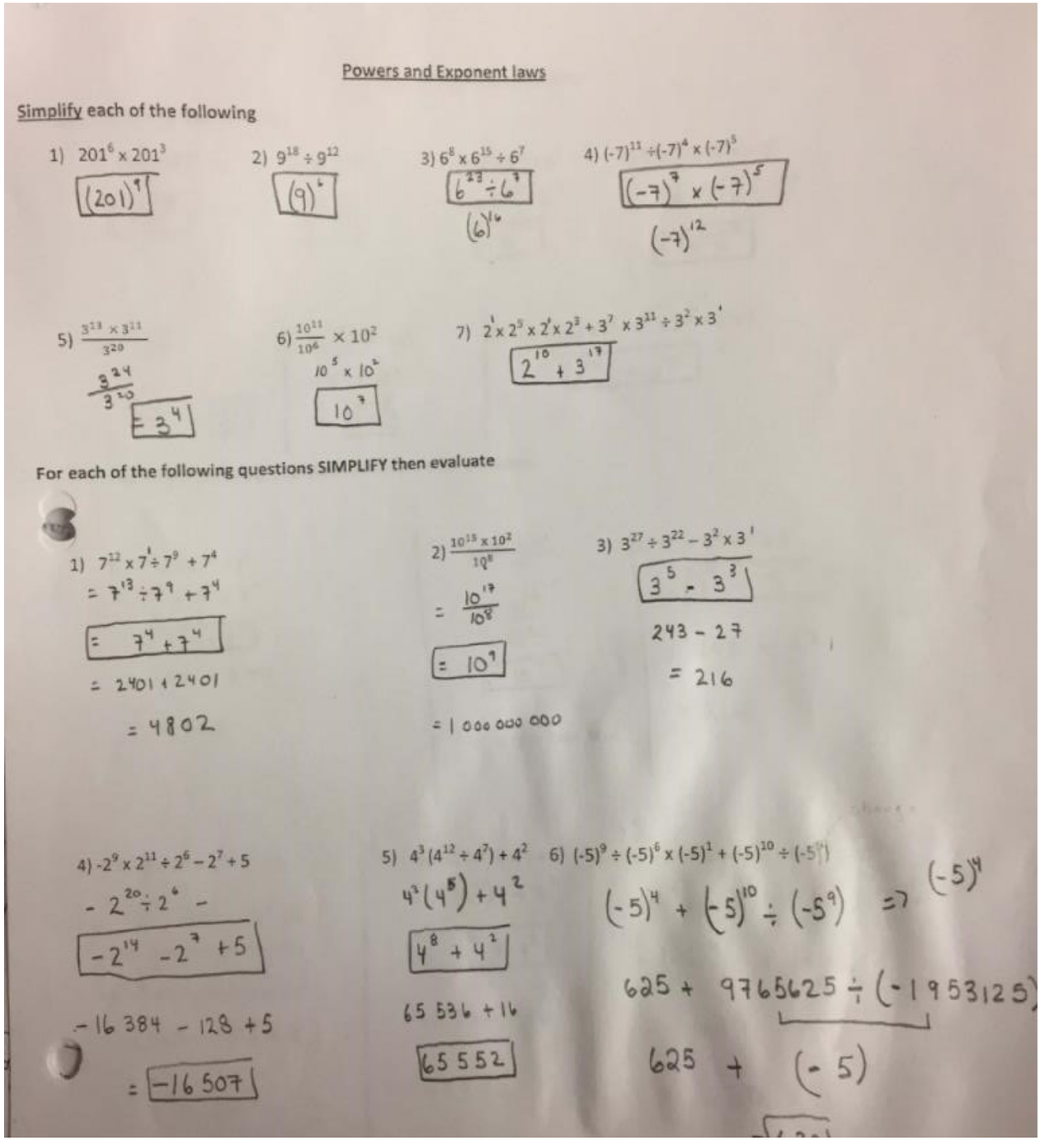
14) $\frac{(4^0)^4}{[4 \cdot 4^3]^0} = 4^0 = 1$

15) $\frac{4 \cdot 4^3 \cdot 4^2}{4^2} = 4^4$

16) $\frac{3^9}{3^4 \cdot 3^3} = 3^2$

17) $\frac{2^4}{2 \cdot 2^3} = 1$

18) $\left(\frac{4 \cdot 4^2 \cdot 4^3}{4}\right)^4 = 4^{20}$



Powers and Exponent laws

Simplify each of the following

1) $201^6 \times 201^3$

$(201)^9$

2) $9^{18} \div 9^{12}$

$(9)^6$

3) $6^8 \times 6^{15} \div 6^7$

$6^{23} \div 6^7$

$(6)^{16}$

4) $(-7)^{11} \div (-7)^4 \times (-7)^5$

$(-7)^7 \times (-7)^5$

$(-7)^{12}$

5) $\frac{3^{13} \times 3^{11}}{3^{20}}$

$\frac{3^{24}}{3^{20}}$

$= 3^4$

6) $\frac{10^{11}}{10^6} \times 10^2$

$10^5 \times 10^2$

10^7

7) $2^1 \times 2^5 \times 2^1 \times 2^3 + 3^7 \times 3^{11} \div 3^2 \times 3^1$

$2^{10} + 3^{17}$

For each of the following questions SIMPLIFY then evaluate

1) $7^{12} \times 7^1 \div 7^9 + 7^4$

$= 7^{13} \div 7^9 + 7^4$

$= 7^4 + 7^4$

$= 2401 + 2401$

$= 4802$

2) $\frac{10^{15} \times 10^2}{10^8}$

$= \frac{10^{17}}{10^8}$

$= 10^9$

$= 1\,000\,000\,000$

3) $3^{27} \div 3^{22} - 3^2 \times 3^1$

$3^5 - 3^3$

$243 - 27$

$= 216$

4) $-2^9 \times 2^{11} \div 2^6 - 2^7 + 5$

$-2^{20} \div 2^6 -$

$-2^{14} - 2^7 + 5$

$-16\,384 - 128 + 5$

$= -16\,507$

5) $4^3(4^{12} \div 4^7) + 4^2$

$4^3(4^5) + 4^2$

$4^8 + 4^2$

$65\,536 + 16$

$65\,552$

6) $(-5)^9 \div (-5)^6 \times (-5)^1 + (-5)^{10} \div (-5^1)$

$(-5)^4 + (-5)^{10} \div (-5^9) \Rightarrow (-5)^4$

$625 + 9765625 \div (-1953125)$

$625 + (-5)$