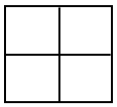
2.1 – What is a Power?

Math 9

Square

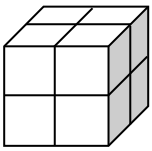


What is the area of the square? _____

Express the area as a product. _____

Express the area using exponents. _____

Cube



What is the volume of the cube? _____

Express the volume as a product. _____

Express the volume using exponents. _____

When an integer, other than 0, can be written as a product of equal factors,

we can write this integer as a _____.

4 is the _____.

3 is the _____.

4^3 is the _____.

4^3

A power with an integer base and exponent **2** is called a _____ _____.

A power with an integer base and exponent **3** is called a _____ _____.

Ex. 1: Write the following as powers.

a) $6 \times 6 \times 6 \times 6$ b) 8 c) $(-2) \times (-2) \times (-2)$

Ex. 2: Write the following as *i*) repeated multiplication and *ii*) in standard form

a) 5^4 *i*)

ii)

b) 2^6 *i*)

ii)

Whenever powers involve **negative numbers** make sure to use brackets.

Ex. 3: *i*) Identify the base of each power, then evaluate.
ii) Write as repeated multiplication then evaluate

a) $(-5)^4$

i)

ii)

b) -5^4

i)

ii)

c) $-(-5^4)$

i)

ii)

Ex. 4: Write the following as powers, then evaluate.

a) $(-3) \times (-3) \times (-3) \times (-3) \times (-3)$

b) $-(6)(6)(6)(6)$

c) $-(-5)(-5)(-5)(-5)(-5)(-5)(-5)(-5)$

HW Assignment
Section 2.1 pg. 55 # 4, 5, 7-9, 13, 14, 16, 17, 20

2.2 – Powers of Ten and Zero Exponent

Math 9

Zero Exponent Law

A power with an integer base, other than 0, and an exponent 0 is equal to 1.

$$n^0 = 1 \quad , \quad n \neq 0$$

Ex. 1: Evaluate.

a) 13^0 b) -13^0 c) $(-13)^0$

Powers of 10

Number in Words	Standard Form	Power
One Billion	1 000 000 000	
One Hundred Million		
Ten Million		
One Million		
One Hundred Thousand		
Ten Thousand		
One Thousand		
One Hundred		
Ten		
One		

Ex. 2: Write the following numbers using powers of 10.

a) 500 b) 10300 c) 5432

HW Assignment

Section 2.2 pg. 61 # 4–6, 9–11, 14

2.3 – Order of Operations with Powers

Math 9

B E D M A S

Steps to evaluate

1. Identify the operation to perform according to BEDMAS and underline it.
2. Perform the underlined operation only.
3. Repeat steps 1 & 2 until fully evaluated.

Ex. 1: Evaluate.

a) $4^2 + 3^4$

b) $12 - 2^4$

c) $(4+2)^3$

d) $2^2 \times 3^3$

e) $(-3)^4 + 5^6$

f) $4 - 3 \times 2^4$

Ex. 2: Evaluate.

a) $(-2)^3 \times 3^2 + 15$

b) $[3^0 \times (-4)^3 - 12]^2$

Ex. 3: Evaluate.

a) $5^3 - 3 \times 2^5 + 32$

b) $5^2 \div [(-10)^2 \div (-4)]$

c) $\dfrac{(10-2^2)^2-6}{-2^4+10}$

Ex. 4: Congratulations! You've just won a raffle for a $10,000 shopping spree at Metrotown. All you need to do is answer the skill testing question below and the prize is yours. Good luck!

Skill Testing Question: $-(40-3\times 2^3)\div[(-4)^2-40^0\times 12]$

Quiz Next Class on 2.1 to 2.3
HW Assignment
Section 2.3 pg. 66 # 3–5 (ace…), 7, 10, 12, 15, 16, 19, 21, 22

Mid-Unit Review

2.1

1. Write each power in standard form.

a) 14^2 b) 5^1 c) -8^3

d) $-(-4)^4$ e) $(-6)^3$ f) $(-2)^8$

2. Copy and complete this table.

	Power	Base	Exponent	Repeated Multiplication	Standard Form
a)	4^3				
b)	2^5				
c)	8^6				
d)		7	2		
e)				$3 \times 3 \times 3 \times 3$	

3. a) Evaluate the first 8 powers of 7. Copy and complete this table.

Power of 7	Standard Form
7^1	
7^2	
7^3	
7^4	
7^5	
7^6	
7^7	
7^8	

b) What pattern do you see in the ones digits of the numbers in the second column?

c) Verify that the pattern continues by extending the table for as many powers of 7 as your calculator displays.

d) Use the pattern. Predict the ones digit of each power of 7. Explain your strategy.

i) 7^{12} ii) 7^{14}

iii) 7^{17} iv) 7^{22}

2.2

4. Write in standard form.

a) 10^6 b) 10^0 c) 10^8 d) 10^4

5. Write as a power of 10.

a) one billion b) one

c) 100 d) 100 000

6. Evaluate.

a) $(-5)^0$ b) 25^0 c) -6^0 d) 9^0

7. The area of land is measured in hectares (ha). One hectare is the area of a square with side length 100 m. Write the number of square metres in 1 ha as a power.

2.3

8. Evaluate. State which operation you do first.

a) $(-21 - 6)^2 + 14$

b) $6 \div (-2) + (2 \times 3)^2$

c) $[5 - (-4)]^3 - (21 \div 7)^4$

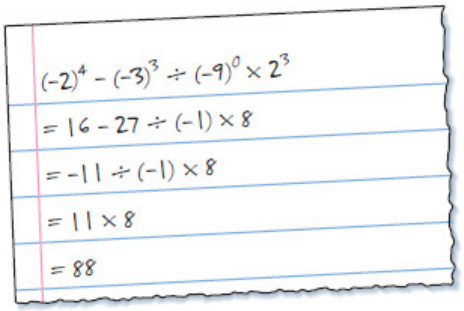
d) $[(6 - 21)^3 \times (2 + 2)^6]^0$

e) $(3 - 5)^5 \div (-4)$

f) $-30 - (7 - 4)^3$

9. Both Sophia and Victor evaluated this expression: $-2^4 \times 5 + 16 \div (-2)^3$ Sophia's answer was -82 and Victor's answer was 78. Who is correct? Find the likely error made by the other student.

10. Identify, then correct, any errors in the student work below. How do you think the errors occurred?



Mid-Unit Review Answers

1. a) 196 b) 5
   c) –512 d) –256
   e) –216 f) 256

2.

	Power	Base	Exponent	Repeated Multiplication	Standard Form
a)	4^3	4	3	4 × 4 × 4	64
b)	2^5	2	5	2 × 2 × 2 × 2 × 2	32
c)	8^6	8	6	8 × 8 × 8 × 8 × 8 × 8	262 144
d)	7^2	7	2	7 × 7	49
e)	3^4	3	4	3 × 3 × 3 × 3	81

3. a)

Power of 7	Standard Form
7^1	7
7^2	49
7^3	343
7^4	2401
7^5	16 807
7^6	117 649
7^7	823 543
7^8	5 764 801

   b) The pattern in the ones digits is 7, 9, 3, 1, 7, 9, 3, 1, …

   c)

Power of 7	Standard Form
7^9	40 353 607
7^{10}	282 475 249
7^{11}	1 977 326 743

   d) i) 1 ii) 9
   iii) 7 iv) 9

4. a) 1 000 000 b) 1
   c) 100 000 000 d) 10 000

5. a) 10^9 b) 10^0
   c) 10^2 d) 10^5

6. a) 1 b) 1
   c) –1 d) 1

7. 10^4 m^2

8. a) Subtract: (–21 – 6); 743
   b) Multiply: (2 × 3); 33
   c) Subtract: [5 – (–4)]; 648
   d) Evaluate the power with exponent 0; 1
   e) Subtract: (3 – 5); 8
   f) Subtract: (7 – 4); –57

9. Sophia is correct. Victor might have included the negative sign in the power -2^4 and evaluated it as 16.

10. $(-3)^3 = -27$, not 27; $(-9)^0 = 1$, not –1
    Correction:
    $(-2)^4 - (-3)^3 \div (-9)^0 \times 2^3$
    $= 16 - (-27) \div 1 \times 8$
    $= 16 - (-27) \times 8$
    $= 16 - (-216)$
    $= 232$

2.4 – Exponent Laws I

Math 9

Investigate:

Product of Powers	Product as Repeated Multiplication	Product as a Power
$3^3 \times 3^4$		
$5^4 \times 5^2$		
$(-2)^3 \times (-2)^2$		

Exponent Law for a Product of Powers

To multiply powers with the same base, we **add** the exponents.

$$a^m \times a^n = a^{m+n}$$

The variable a is any integer, except 0; m and n are any whole numbers.

Ex. 1: Write each expression as a power.

a) $4^5 \times 4^7$

b) $3^9 \times 3$

c) $(-13)^{12} \times (-13)^{11}$

Ex. 2: Evaluate.

a) $5^2 \times 5^6$

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

c) $(-2)^5 \times (-2)^4$

Investigate:

Quotient of Powers	Quotient as Repeated Multiplication	Product as a Power
$3^5 \div 3^2 = \frac{3^5}{3^2}$		
$6^7 \div 6^4 = \frac{6^7}{6^4}$		
$(-4)^5 \div (-4)^3 = \frac{(-4)^5}{(-4)^3}$		

Exponent Law for a Quotient of Powers

To divide powers with the same base, we **subtract** the exponents.

$$a^m \div a^n = a^{m-n} \qquad m \geq n$$

The variable a is any integer, except 0; m and n are any whole numbers.

Ex. 3: Write each expression as a power, then evaluate.

a) $8^7 \div 8^3$ b) $3^{12} \div 3^8$ c) $(-5)^{10} \div (-5)^6$

Ex. 4: Evaluate using exponent laws and order of operations.

a) $3^3 + 3^2 \times 3^4$ b) $(-2)^5 \times (-2)^2 \div [(-2)^8 \div (-2)^5] + (-2)^3$

HW Assignment
Section 2.4 pg. 76 # 4–8, 10, 12, 13, 15

2.5 – Exponent Laws II

Math 9

Investigate:

Power	As Repeated Multiplication	As a Product of Factors	As a Power
$(2^3)^4$			
$(3^2)^4$			
$[(-4)^3]^2$			
$[(-5)^2]^3$			

Exponent Law for a Power of a Power

To raise a power to a power, we **multiply** the exponents.

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

The variable a is any integer, except 0; m and n are any whole numbers.

Ex. 1: Write each expression as a power, then evaluate.

a) $(4^2)^3$ b) $-(3^2)^7$ c) $[(-2)^3]^5$

Investigate:

Power	As Repeated Multiplication	As a Product of Factors	As a Product of Powers
$(2\times5)^3$			
$(3\times8)^2$			
$[(-5)\times 6]^3$			

Exponent Law for a Power of a Product

$(ab)^m = a^m b^m$ a and b are any integers, except 0.
m is any whole number.

Ex. 2: Write each expression as a product of powers, then evaluate.

a) $(5 \times 3)^2$ b) $(3 \times 2)^5$ c) $[5 \times (-2)]^4$

Investigate:

Power	As Repeated Multiplication	As a Quotient of Factors	As a Quotient of Powers
$\left(\frac{2}{5}\right)^3$			
$\left(\frac{3}{4}\right)^2$			
$\left(\frac{1}{6}\right)^4$			

Exponent Law for a Power of a Quotient.

$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$ $b \neq 0$ a and b are any integers, except 0.
m is any whole number.

Ex. 3: Write each expression as a quotient of powers, then evaluate.

a) $\left(\frac{8}{4}\right)^3$ b) $\left[\frac{27}{(-3)}\right]^2$ c) $(144 \div 6)^3$ d) $\left(\frac{2}{5}\right)^4$

Ex. 4: Simplify, then evaluate each expression.

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

b) $(4^5)^6 \div (4^{12})^2$

c) $(3^3 \times 3)^4 \div (3^8 \div 3^3)^2$

d) $[(-2)^3 \times (-2)^0]^5 + (-2)^{12} \div [(-2)^5]^2$

e) $[3 \times (-2)]^4 + (5^2)^3 - [(-4)^5 \div (-4)^2]^3$

HW Assignment
Section 2.5 pg. 84 # 4 - 8, 11, 14 – 16, 20

Study Guide

- A power represents repeated multiplication.

$2^5 = 2 \times 2 \times 2 \times 2 \times 2$
$= 32$
$(-3)^4 = (-3)(-3)(-3)(-3)$
$= 81$
$-3^4 = -(3)(3)(3)(3)$
$= -81$

- A power with an integer base, other than 0, and an exponent 0 is equal to 1.

$2^0 = 1$
$(-4)^0 = 1$
$-4^0 = -1$

- To evaluate an expression, follow this order of operations:
  Evaluate inside brackets.
  Evaluate powers.
  Multiply and divide, in order, from left to right.
  Add and subtract, in order, from left to right.

Exponent Laws

m and n are whole numbers.
a and b are any integers, except 0.

- Product of Powers

$a^m \times a^n = a^{m+n}$

- Quotient of Powers

$a^m \div a^n = a^{m-n} \quad m \geq n$

- Power of a Power

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

- Power of a Product

$(ab)^m = a^m b^m$

- Power of a Quotient

$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n} \quad b \neq 0$

HW Assignment
Chapter Review pg. 87 # 1 to 27 All