

MTH 28.5 LECTURE NOTES (Ojakian)

Topic 4: Exponents and Order of Operations

OUTLINE

References (1.5)

1. Exponents
 - (a) Evaluating expression with exponents
 - (b) Expressing a product using exponents
 2. Order of operations
-

1. Evaluating expression with exponents

PROBLEM 1. Evaluate the following

- (a) 2^3
- (b) 3^2
- (c) 118^1
- (d) $(-2)^3$
- (e) $(-2)^4$
- (f) $(-1)^{557}$
- (g) $(-1)^{502}$
- (h) 0^{53}

PROBLEM 2. Using the examples from the previous problem describe a rule for answering this question: When a negative number is raised to an exponent, is it positive or negative?

2. Exponents: Negative sign done first or second?

Issue: $(-2)^4$ versus -2^4

- (a) The first means: $(-2)(-2)(-2)(-2)$, which is 16
- (b) The second means: $(-1) \cdot 2^4$, which = $(-1)(16) = -16$

PROBLEM 3. Compute the following

- i. $(-4)^2$
- ii. -4^2
- iii. $(-4)^3$
- iv. -4^3

3. Express product in exponential form

PROBLEM 4. Write each product using exponents; do **not** evaluate.

(a) $4 \cdot 4 \cdot 4 \cdot 4 \cdot 4 \cdot 4$

(b) $(-9) \cdot (-9) \cdot (-9) \cdot (-9) \cdot (-9)$

4. When Order Does Not Matter

PROBLEM 5. Notice the changing of orders in the following computations. Figure out when the order matters and when it does not.

(a) $5 - 2$

(b) $2 - 5$

(c) $5 + 2 + (-4)$

(d) $2 + (-4) + 5$

(e) $(2)(-4)(3)$

(f) $(-4)(3)(2)$

(g) $6 \div 2$

(h) $2 \div 6$

Recall the following facts.

Theorem. (Addition Fact) A sum can be evaluated in any order.

Theorem. (Product Fact) A product can be evaluated in any order.

5. Order of operations

- (a) The order (**PE(MD)(AS)**):
- i. Inside parentheses first (*and absolute value*)
 - ii. Exponents
 - iii. Products and division
 - iv. Addition and subtraction
 - v. Read left to right

- (b) Note: Often put in extra parentheses for emphasis.

PROBLEM 6. Compute the following

i. $7 + 8 \cdot (-1)$

ii. $(7 + 8) \cdot (-1)$

iii. $7 \cdot (-3) + 5 \cdot 2$

iv. Insert parentheses into the last expression so that it is evaluated from left to right. Then evaluate it.

v. Insert parentheses into the last expression so that it is evaluated from right to left. Then evaluate it.

PROBLEM 7.

i. $4 + 8 \div 2 - (7)(-3)$

ii. $|-7| - |3 - 7|$

iii. $3 + (-1)2^4$

iv. $3 + (-2)^4$

v. $---(- - 2)^3$

vi. $-(- - -2)^3 - (-1)^{177}$

6. Distributive Property

PROBLEM 8. Compute

(a) $2(-3 + 4)$

(b) $(2)(-3) + (2)(4)$

(c) $(6 + 3)(-2)$

(d) $(6)(-2) + (3)(-2)$

PROBLEM 9. Based on problem 8, complete the following theorem.

Theorem. (*Distributive Property*) For any real numbers a, b, c the following are true:

• $a \cdot (b + c) = \dots$ [FILL IT IN]

• $(b + c) \cdot a = \dots$ [FILL IT IN]

7. Group Work: Order of Operations Game