MATH 90 – CHAPTER 5 Name: ____________________.

5.1 Multiplication of Exponents

Need To Know

- Recall exponents
- The idea of exponent properties
- Apply exponent properties

Exponents

Exponents mean repeated multiplication.

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

-2^4 $(-2)^4$

Exponent Properties - Multiply

Use the pattern to discover the property.

Simplify:	Exponent Properties
$5^2 \cdot 5^6$	1) ______________
$x^3 \cdot x^7$	

Exponent –Division of Same Base

Use the pattern to discover the property.

Simplify:

$$\frac{3^7}{3^4}$$

$$\frac{x^{11}}{x^5}$$

Exponent Properties

1) $a^m \cdot a^n = a^{m+n}$

2) ______________

Exponent – Zero Power

Look at the pattern and draw a conclusion.

3^4	
3^3	
3^2	
3^1	

Exponent Properties

1) $a^m \cdot a^n = a^{m+n}$

2) $\frac{a^m}{a^n} = a^{m-n}$

3) ______________

Exponent - Power on Power

Use the pattern to discover the property.

Simplify:

$(3^2)^4$

$(x^3)^5$

Exponent Properties

1) $a^m \cdot a^n = a^{m+n}$

2) $\frac{a^m}{a^n} = a^{m-n}$

3) $a^0 = 1$, for all a except 0.

4) ______________

Exponent – Power on Product

Use the pattern to discover the property.

Simplify:

$(2b)^3$

$(xy)^5$

Exponent Properties

1) $a^r \cdot a^s = a^{r+s}$

2) $\frac{a^r}{a^s} = a^{r-s}$

3) $a^0 = 1$, for all a except 0.

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

5) ______________

Exponent – Power on Fractions

Use the pattern to discover the property.

Simplify:

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

$\left(\frac{a}{z}\right)^2$

Exponent Properties

1) $a^m \cdot a^n = a^{m+n}$

2) $\frac{a^r}{a^s} = a^{r-s}$

3) $a^0 = 1$, for all a except 0.

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

5) $(ab)^n = a^n b^n$

6) ______________

Exponent Practice – Simplify each

1. $n^3 \cdot n^{20}$

2. $(2t)^8(2t)^{17}$

3. $(a^3b)(ab)^4$

4. $\frac{x^7}{x}$

5. $\frac{a^{10}b^{12}}{a^6b^0}$

6. $(-3x)^3$

7. $(a^4b^6)(a^2b)^5$

8. $\left(\frac{x^3y^6}{y^4z}\right)^5$

5.2 Negative Exponents

Need To Know

- Review Exponents Properties
- Idea of Negative Exponents
- Negative Exponent Properties and Calculation

- What is Scientific Notation?
- How to write numbers in Scientific Notation
- How to do calculations in Scientific Notation

Review Exponent Properties

Recall:

The Product Rule	$a^m \cdot a^n = a^{m+n}$
The Quotient Rule	$\frac{a^m}{a^n} = a^{m-n}$
The Power Rule	$(a^m)^n = a^{mn}$
Raising a Product to a power	$(ab)^n = a^n b^n$
Raising a quotient to a power	$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

Idea of Negative Exponents

Look a the pattern and draw a conclusion.

3^4	
3^3	
3^2	
3^1	

Definitions:

for all real numbers ($a \neq 0$),

____

Definition:

for $a \neq 0$ and n is a positive,

____

Practice – Simplify Each

5^{-3}

$\left(\frac{2}{5}\right)^{-1}$

$(-2)^{-2}$

$\frac{y^{-3}}{x^{-5}}$

$5x^{-4}$

$\frac{a^{-3}}{z^{5}}$

Exponent Properties

Exponent of 1	$a^1 = a$	The Product Rule	$a^m \cdot a^n = a^{m+n}$
Exponent of 0	$a^0 = 1$	The Quotient Rule	$\frac{a^m}{a^n} = a^{m-n}$
Negative Exponents	$a^{-n} = \frac{1}{a^n}$	The Power Rule	$(a^m)^n = a^{mn}$
Think – **RECIPROCAL**		Raising a Product to a power	$(ab)^n = a^n b^n$
Think – **RECIPROCAL**		Raising a quotient to a power	$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

Practice - Simplify

1. $\frac{11^7}{11^9}$

3. $x^{-6} \cdot x^2$

2. $\frac{3^{-4}}{3^{-6}}$

4. $(2x^4)^{-2}$

Practice - Simplify

5. $\frac{(2x^3)^2}{x^4}$

7. $\left(\frac{y^{-8}}{y^{-3}}\right)^2$

6. $\frac{x^{-6}}{(x^3)^4}$

8. $\frac{a^5(a^{-2})^4}{(a^{-3})^2}$

Scientific Notation

Scientific Notation is a way to write big or small numbers in a compact and simple way.

____

where **N** is a decimal at least one and less than 10 ($1 \leq N < 10$) and **m** is an integer exponent.

Examples of scientific notation

1) The national debt: $ 16,749,209,149,306.58 ≈ ______________
   http://www.brillig.com/debt_clock/

2) The mass of a hydrogen atom:
   0.0000000000000000000000016738 grams = ______________

Scientific Notation

Converting: Scientific notation into expanded form.

$3.8497 \times 10^1 = 3.8497 \times 10$

$3.8497 \times 10^2 = 3.8497 \times 100$

$3.8497 \times 10^5 = 3.8497 \times 100000$

$3.8497 \times 10^{-1} = 3.8497 \times 0.1$

$3.8497 \times 10^{-3} = 3.8497 \times 0.001$

9.2×10^{-5}

7.083×10^7

Scientific Notation

Converting: Expanded form into scientific notation.

35,900,000 0.000029

We use the exponent properties to multiply and divide number in scientific notation.

Examples:

$$\frac{8 \times 10^{12}}{4 \times 10^{-3}}$$

$$(7.8 \times 10^7)(8.4 \times 10^{23})$$

5.3 Polynomials

Need To Know

- Recall like terms
- Some new vocabulary
- Like Terms and polynomials
- Evaluate polynomials

Vocabulary

RECALL - Definitions

A **term** is a _________________made of numbers & variables often combined with parentheses, multiplication or division.

Like terms are terms with the ________________________.

A **polynomial** is a finite sum of terms.

Examples:

Monomials	Binomials	Trinomials	Other

New Vocabulary

The **degree of a term** is ____________________factors in the term. (If there is only one variable, then the degree is the exponent.)

The **degree of a polynomial** equals ________________ _____________where the leading term is the term in the expression with the highest degree.

The **numerical coefficient** is the ________ factor which multiplies the term.

Complete the table for the polynomial

$$12w^5 - 9 + 4w^7 + \tfrac{1}{2}w - w^3$$

Terms	Coefficients	Degree of Term	Leading Term	Degree of Polynomial

Polynomials Practice

When x = -3
find the value of
$2x^2 - x + 3$

Recall
3x+ 6x

Combine like terms:

$7x^2 + x + x - 5x^2$

$9b^5 + 3b^2 - 2b^5 - 3b^2$

$8x^5 - x^4 + 2x^5 + 7x^4 - 4x^4 - x^6$

Application with Polynomials

The electricity consumption in a city can be estimated by E = 0.028t + 1.17 where E is electricity consumption in million of gigawatt hours and t is years since 2000.
Find the consumption in 2013.

The circumference of a circle of radius r is given by the polynomial C = 2πr where π is an irrational number.
Use 3.14 to approximate π.
Find the circumference if the radius is 6 cm.

end

5.4 Add and Subtract Polynomials

Need To Know

- Adding polynomials
- Opposites of a polynomial
- Subtracting polynomials
- Polynomials problems solving

Adding Polynomials

$(x^2 + 4x - 9) + (7x - 3)$

$$\left(\frac{4}{5}x^9 + \frac{1}{2}x^5 - 3x^2 + 7\right) + \left(-\frac{3}{5}x^9 + \frac{3}{4}x^5 + 2x - 5\right)$$

Add:

$$\begin{array}{r} 2x^4 + 3x^3 + 4x \\ \underline{5x^3 - 6x - 3} \end{array}$$

The Opposite of a Polynomial

Write the opposite of $(2x^2 + 3x - 4)$ in two ways

Simplify:

$-(5x^2 - 6x + 3)$

$$-\left(7x^9 + 11x^5 - \frac{3}{4}x - 5\right)$$

Subtracting Polynomials

Subtract:

$(9x + 7) - (5x - 3)$

$(2x^2 + 3x + 4) - (5x^2 - 6x + 3)$

Subtract:

$x^2 + 5x - 3$

$\underline{4x^2 - 4x - 5}$

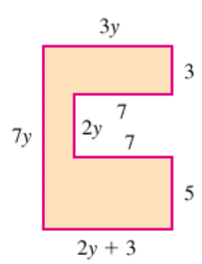
Practice

Simplify:

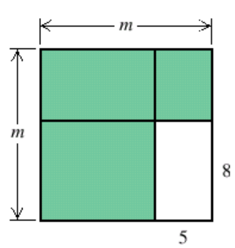
$(2y^2 - 7y - 8) - (6y^2 + 6y - 8) + (4y^2 - 2y + 3)$

Polynomial Problem Solving

Find the perimeter



Find shaded area



5.5 Multiplication of Polynomials

Need To Know

- Multiply a monomial times a monomial
- Multiply a monomial times a polynomial
- Multiply a polynomial times a polynomial

Monomial times Monomial

Recall Multiplication:

$(-x^3)(x^4)$

$(-4y^4)(6y^2)(-3y^2)$

Exponent Properties

1) ____________

2) ____________

3) ____________

Monomial times Polynomial

Recall:

$a(b + c) =$

Multiply:

$2x(4x^2 + 5x - 3) =$

Exponent Properties

1) $a^m \cdot a^n = a^{m+n}$

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

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

Polynomial times Polynomial

Multiply:

$(x + 2)(x^2 - 3x + 4)$

Recall Column Multiply

$$\begin{array}{r} 324 \\ \underline{\times\ 13} \end{array}$$

Polynomial times Polynomial

Multiply: columns

$(z - 4)(z + 5)$

Multiply:

$(2x^2 + x + 1)(x^2 - 4x + 3)$

5.6 Binomial Multiplication & Short Cuts

Need To Know

- Binomials times Binomials – Short Cut
- Product of a Sum and a Difference Binomial
- Squares of Binomials

Binomial times Binomial

Multiply:

x + 7

<u>x – 5</u>

Multiply:

(x + 7)(x – 5)

<u>Short Cut: **FOIL**</u>

Multiply:

F – ___________

O – ___________

I – ___________

L – ___________

Binomial times Binomial

Multiply by distributive law:

(y + 6)(y – 3)

(3x + 5)(x – 2)

(x + 2y)(a + 7b)

<u>Short Cut: **FOIL**</u>

Multiply:

F – first terms

O – outer terms

I – inner terms

L – last terms

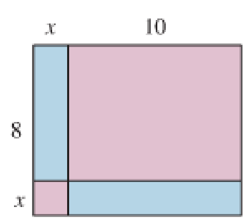
Binomial times Binomial

Multiply

$(x^2 – 3)(x – 6)$

$(1 + 2t^2)(1 – 3t^3)$

Find the area:



Product of a Sum and Difference

Simplify:

$(w + 3)(w - 3)$

Formula:

$(A + B)(A - B) =$

$(2x - 5)(2x + 5)$

$(3n + 6m)(3n - 6m)$

Squares of Binomials

Simplify:

$(x + 3)^2$

Formula:

$(A + B)^2 =$ _____

Multiply:

$(4x - 5)^2$

Formula:

$(A - B)^2 =$ _____

$(2p - 7q)^2$

Squares of Binomials

Simplify:

$(x + 6y)^2$

Formulas to Know

1. $(A+B)(A - B) = A^2 - B^2$
2. $(A + B)^2 = A^2 + 2AB + B^2$
3. $(A - B)^2 = A^2 - 2AB + B^2$

$(3x^4 + 2)(3x^4 - 2)$

$(4n - 7b)^2$

end

5.7 Multivariable Polynomials

<u>Need To Know</u>

- Evaluating a Polynomial
- Like Terms and Degree
- Addition and Subtraction of Polynomials
- Multiplication of Polynomials

Evaluating Polynomials

An amount of money P invested at a yearly rate r for t years will grow to an amount of A given by $A = P(1 + r)^t$. What will you have from investing $1000 at 6% for 3 years?

New Vocabulary

The **<u>degree of a term</u>** is the number of variable factors in the term. The **<u>degree of a polynomial</u>** is the degree of the leading term, and the <u>leading term</u> is the term with the highest degree.

$$6 - xy + 3x^2y^2 - 2x^3yz^2 + y^5$$

Terms	Coefficients	Degree of Term	Leading Term	Degree of Polynomial

Add and Subtract Polynomials

Simplify:

$(2x^2 - 3xy + y^2) + (-4x^2 - 6xy - y^2) + (4x^2 + xy - y^2)$

$(a^3 + b^3) - (-5a^3 + 2a^2b - ab^2 + 3b^3)$

Multiplying Polynomials

Multiply:

$(5cd + c^2d + 6)(cd - d^2)$

FOILing Polynomials

Multiply:

$(m^3n + 3)(2m^3n - 11)$

$(4r + 3t)^2$

$(p^3 - 5q)(p^3 + 5q)$

end

5.8 Dividing a Polynomial

<u>Need To Know</u>

- Two ways to work division
- Recall the distributive property
- Divide a polynomial by a monomial
- Recall long division
- Divide a polynomial by a polynomial

The Distributive Property

Recall:
a(b + c) = ab + ac

Also:
(b + c)a = ________

With a new twist:
(b + c) a = __________

$$\frac{b+c}{a} = \_\_\_\_\_\_\_\_$$

$$\frac{Polynomial}{mono} = \frac{A+B+C}{D} =$$

Divide a Polynomial by a Mono

$(5x^2 – 10) \div 5$

$$\frac{8x^3 - 12x^2}{4x}$$

Divide a Polynomial by a Mono

$(9x^3y^2 - 12x^2y^3) \div (-9xy)$

$\dfrac{21a^3z^2 - 14a^2z^2 + 7a^2z^3}{7a^2z}$

Recall Long Division

$24\overline{)8580}$

Steps for Division

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________

Polynomial Division

Steps for Division

1. Guess
2. Multiply
3. Subtract
4. Bring Down
5. Repeat

$x-2\overline{)x^2 - 5x + 6}$

$(8x^2 - 6x - 5) \div (2x - 3)$

Polynomial Division

$$\frac{2t^3 - 9t^2 + 11t - 3}{2t - 3}$$

$$\frac{w^3 + 10}{w + 2}$$

Deciding on **which way** to DIVIDE

Next to each problem circle the correct way to divide it.

1. $(5x^2 - 16x) \div (5x - 1)$ a) Fraction b) Long Division
2. $(20t^3 + 5t^2 - 15t) \div (5t)$ a) Fraction b) Long Division
3. $(36a^6 - 27a^5 - 45a^2 + 9a) \div (-9a)$ a) Fraction b) Long Division
4. $\dfrac{x^4 - 3x^2 + 4x - 3}{x^2 - 5}$ a) Fraction b) Long Division
5. $\dfrac{4x^4y - 8x^6y^2 + 12x^8y^6}{4x^4y}$ a) Fraction b) Long Division