

2. Express in decimal notation.

- a. 1.3×10^6 *1300000*
 b. 2.75×10^9 *2750000000*
 c. 8.4×10^5 *840000*
 d. 7.2×10^7 *72000000*
 e. 1.1×10^{-5} *0.000011*
 f. 3.4×10^{-7} *0.00000034*
 g. 5.25×10^{-3} *0.00525*
 h. 8.9×10^{-6} *0.0000089*
 i. 9.04×10^{-4} *0.000904*
 j. 6.6×10^8 *660000000*
 k. 3.47×10^{10} *34700000000*
 l. 2.601×10^{-8} *0.00000002601*

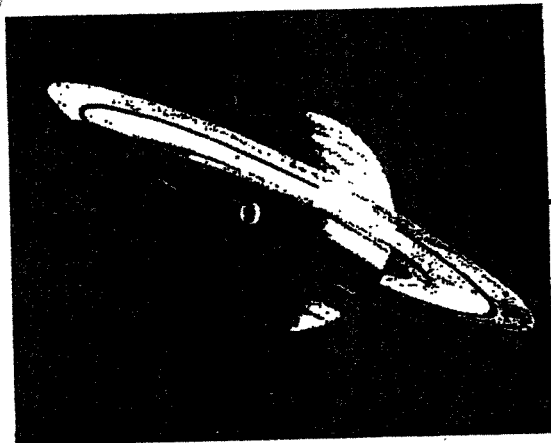
B 3. In astronomy, distances are very large. To measure distances to the stars and galaxies beyond our solar system, the light year is used. One light year, the distance that light travels in 1 year, is 9 460 528 405 000 km. *9,460528405* ~~1000~~ $\times 10^{12}$
 The speed of light is 299 792 458 m/s. Express both in scientific notation. *2.99792458* $\times 10^8$

4. Express the distance in decimal notation.

- a. The most massive known star is 1.79×10^6 light years away. *1790000*
 b. Our solar system is 2.8×10^5 light years from the centre of our galaxy, the Milky Way. *280000*
 c. The Virgo cluster of galaxies is 5×10^7 light years away. *50000000*
 d. The Lynx-Ursa Major and Pisces-Perseus Superclusters are 7×10^8 light years long. *700000000*

5. Express each measurement in scientific notation.

- a. The average distance from Earth to the sun is 149 600 000 km. *1.496* $\times 10^8$
 b. Our solar system revolves around the centre of the Milky Way every 225 000 000 years. *2.25* $\times 10^8$
 c. The largest sun spot has an area of 18 000 000 000 km². *1.8* $\times 10^{10}$
 d. The internal temperature of the sun is about 14 000 000°C. *1.4* $\times 10^7$
 e. Pluto, the most distant planet, is 5 898 000 000 km from the sun. *5.898* $\times 10^9$
 f. Saturn, the ringed planet, has a diameter of 119 300 km. *1.193* $\times 10^5$



7. Express the measurement of each virus in decimal notation.

- a. A polio virus has a diameter of 12×10^{-6} mm. *0.000012*
 b. A yellow fever virus has a diameter of 22×10^{-7} cm. *0.0000022*
 c. An influenza virus has a diameter of 11.5×10^{-5} mm. *0.000115*

~~3.~~ Calculate the following using the laws of exponents.

- a) $2^3 \cdot 2^{-5} \cdot 2 =$ _____
 b) $(2^3 \times 3^{-1})^{-2} =$ _____
 c) $\left(\frac{3}{5}\right)^{-2} =$ _____
 d) $\left(-\frac{2}{3}\right)^{-3} \times \left(\frac{4}{9}\right)^2 =$ _____

4. Write the following numbers in scientific notation.

- a) 3 485 000 3.485×10^6 b) 0.000 256 2.56×10^{-4}
 c) 345.62 3.4562×10^2 d) 0.005 620 5.62×10^{-3}
 e) 356 000 000 3.56×10^8 f) 0.000 005 5×10^{-6}
 g) 12 000 000 000 1.2×10^{10} h) 0.000 000 002 2×10^{-9}

5. Determine the following real numbers.

- a) 1.56×10^5 156000 b) 2.5×10^{-4} 0.00025
 c) 3.14×10^{-6} 0.00000314 d) 1.28×10^6 1280000
 e) 7.0562×10^5 705620 f) 4.18×10^0 4.18

7. Write the following quantities in scientific notation.

- a) 1 light year (distance traveled in one year at the speed of light) is equal to 9 461 000 000 000 km. 9.461×10^{12}
 b) 1 astronomical unit is approximately equal to 149 600 000 km. 1.496×10^8
 c) 1 angstrom is equal to 0.1 nanometres. 1×10^{-1}
 d) 1 micron is equal to a thousandth of a millimetre. $0.001 = 1 \times 10^{-3}$
 e) 1 nautical mile is equal to 1852 m. 1.852×10^3

8. a) Write, in decimal notation, the surface area of the North American great lakes.

- Lake Superior: $8.27 \times 10^4 \text{ km}^2$ 82700
 Lake Michigan: $5.83 \times 10^4 \text{ km}^2$ 58300
 Lake Huron: $6.16 \times 10^4 \text{ km}^2$ 61600
 Lake Erie: $2.5 \times 10^4 \text{ km}^2$ 25000
 Lake Ontario: $1.95 \times 10^4 \text{ km}^2$ 19500

calcul

b) Express the total surface area of the great lakes in scientific notation. _____

9. a) Of all the planets in our solar system, Mercury is the closest to the sun, located 57 900 000 km from the sun. Earth, on the other hand is 149 600 000 km away.

Express these two distances using scientific notation.

Mercury: 5.79×10^7 Earth: 1.496×10^8

b) Of all the planets in our solar system, Jupiter is the biggest, with its diameter equal to 142 800 km. Earth's diameter is equal to 12 756 km. Express these two measures in scientific notation.

Jupiter: 1.428×10^5 Earth: 1.2756×10^4

4. Express each result in the form a^n .

- a) $5^{-2} \times 5 \times 5^3 =$ _____ b) $2^{-2} \times \frac{1}{2^4} \times 2^3 =$ _____
 c) $(-3)^2 \times (-3)^{-3} \times (-3)^{-1} =$ _____ d) $\left(\frac{2^{-2} \times 2^4}{2^3}\right)^{-2} =$ _____

13.7 SCIENTIFIC NOTATION

Mathematicians have developed a compact method to write very large and also very small numbers that contain many zeros. This method is known as **scientific notation**. The examples below show how we would write a number in scientific notation given its standard form.

Standard Form	Scientific Notation	To convert any number into scientific notation, we must first locate the decimal and then move the decimal behind the first non-zero digit . We then count the number of places we have moved the decimal and this becomes the exponent. If we moved the decimal to the left, the exponent will be positive, if we moved the decimal to the right, the exponent will be negative. Numbers greater than one have positive or zero exponents, and numbers less than one, have negative exponents.
1. 95 000 000 000	9.5×10^{10}	
2. 865 000 000	8.65×10^8	
3. 0.000 000 035	3.5×10^{-8}	
4. -156 200 000 000 000	-1.562×10^{14}	
5. 0.000 808	8.08×10^{-4}	

A. Multiply the following by the powers of ten indicated by moving the decimal the required number of spaces.

$$1. 5.4778 \times 10^6 = 5477800$$

$$2. 0.087844706 \times 10^8 = 8784470.6$$

$$3. 389.8116798 \times 10^{13} = 3898116798000000 \quad (6 \text{ zeroes})$$

$$4. 842121094.22 \times 10^{-7} = 84.212109422$$

$$5. 486 \times 10^{-9} = 0.000000486$$

$$6. 56.7 \times 10^0 = 56.7$$

$$7. 8.34 \times 10^4 = 83400$$

$$8. 7.6 \times 10^{-5} = 0.000076$$

$$9. 8.3652 \times 10^3 = 8365.2$$

$$10. 76.35 \times 10^8 = 7635000000$$

B. Write each of the following in standard form.

$$1. 3.45 \times 10^6 = 3450000$$

$$2. -6.786 \times 10^5 = -678600$$

$$3. 5.7429 \times 10^9 = 5742900000$$

$$4. 8.54 \times 10^{-7} = 0.000000854$$

$$5. 7.951 \times 10^{-3} = 0.007951$$

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C. Write the following as powers of ten. (The first one is done for you.)

1. $1000 = 10^3$

2. $100 = 10^2$

3. $10\ 000 = 10^4$

4. $1\ 000\ 000 = 10^6$

5. $1\ 000\ 000\ 000 = 10^9$

6. $10 = 10^1$

7. $10\ 000\ 000\ 000 = 10^{10}$

8. $100\ 000 = 10^5$

9. $100\ 000\ 000 = 10^8$

10. $100\ 000\ 000\ 000\ 000 = 10^{14}$

11. $\frac{1}{100} = 10^{-2}$

12. $\frac{1}{1000} = 10^{-3}$

13. $\frac{1}{100\ 000} = 10^{-5}$

14. $\frac{1}{1\ 000\ 000\ 000} = 10^{-9}$

15. $\frac{1}{10} = 10^{-1}$

16. $\frac{1}{1\ 000\ 000\ 000\ 000\ 000\ 000} = 10^{-18}$

17. $\frac{1}{10\ 000} = 10^{-4}$

18. $\frac{1}{100\ 000\ 000} = 10^{-8}$

19. $\frac{1}{1} = 10^0$

20. $\frac{100}{1000} = 0.1 = 10^{-1}$

D. Write each of the following in scientific notation.

1. $866\ 000 = 8.66 \times 10^5$

2. $58\ 700 = 5.87 \times 10^4$

3. $4\ 700\ 000 = 4.7 \times 10^6$

4. $0.000\ 687\ 3 = 6.873 \times 10^{-4}$

5. $0.000\ 84 = 8.4 \times 10^{-4}$

6. $156\ 800\ 000 = 1.568 \times 10^8$

7. $0.000\ 35 = 3.5 \times 10^{-4}$

8. $-6\ 536\ 000\ 000 = -6.536 \times 10^9$

9. $500\ 000\ 000 = 5 \times 10^8$

10. $55\ 000\ 000 = 5.5 \times 10^7$

11. $-0.000\ 000\ 000\ 792 = -7.92 \times 10^{-11}$

12. $0.000\ 000\ 000\ 600\ 05 = 6.0005 \times 10^{-10}$

13. $-4\ 790\ 000\ 000 = -4.79 \times 10^9$

14. $500 = 5 \times 10^2$

15. $6\ 306\ 000 = 6.306 \times 10^6$

16. $54\ 000\ 000\ 000 = 5.4 \times 10^{10}$

17. $763\ 000\ 000 = 7.63 \times 10^8$

18. $-300\ 700\ 000\ 000 = -3.007 \times 10^{11}$

19. $0.000\ 000\ 67 = 6.7 \times 10^{-7}$

20. $5\ 632.87 = 5.63287 \times 10^3$

HOMEWORK

Working with Powers and Exponents

Name: _____



Repeated Multiplication

Remember multiplication is a way to write repeated addition. To say $3+3+3+3$ we write 3×4 .

Sometimes multiplication is done over and over and over. To write $3 \times 3 \times 3 \times 3$ we write 3^4 .

4^2 (read "four squared") means 4×4 so $4^2 = 16$ 5^3 (read "five cubed") is $5 \times 5 \times 5 = 125$

→ Practice: Write the indicated operation using exponents. Then perform the operation.

- | | | |
|---|--|--|
| a) $4 \times 4 \times 4 =$ | $10 \times 10 \times 10 \times 10 \times 10 =$ | $2 \times 2 \times 2 \times 2 \times 2 \times 2 =$ |
| b) $5 \times 5 =$ | $3 \times 3 \times 3 \times 3 =$ | $9 \times 9 \times 9 =$ |
| c) $0.3 \times 0.3 \times 0.3 =$ | $5.1 \times 5.1 =$ | $(-1.2)(-1.2)(-1.2) =$ |
| d) $0.2 \times 0.2 \times 0.2 \times 0.2 =$ | $0.01 \times 0.01 \times 0.01 \times 0.01 =$ | $1.5 \times 1.5 =$ |
| e) $(-3) \times (-3) \times (-3) \times (-3) =$ | $(-100) \times (100) \times (100) =$ | $(-1) \times (-1) \times (-1) \times (-1) \times (-1) =$ |
| f) $aaaaa =$ (answer: a^5) | $xxxxxxxxxxxx =$ | $2f \cdot 2f \cdot 2f \cdot 2f =$ |

→ Practice: Perform the indicated operation.

- | | | |
|----------------|-------------|-------------|
| g) $2^5 =$ | $7^2 =$ | $8^2 =$ |
| h) $12^2 =$ | $15^2 =$ | $25^2 =$ |
| i) $(-4)^2 =$ | $(-10)^2 =$ | $(-13)^2 =$ |
| j) $(-4)^3 =$ | $(-12)^2 =$ | $(-5)^3 =$ |
| k) $(-10)^3 =$ | $(0.5)^4 =$ | $(0.2)^5 =$ |

Exponent Rules

Multiplying

Remember: $3^4 = 3(3)(3)(3)$ so $3^4(3^3) = 3(3)(3)(3)(3)(3)(3) = 3^7$

$x^3x^3 = xxxxxxxx = x^6$ and $2^3s^23^2s^5 = 8ss9sssss = 72sssssss = 72s^7$

Rule: $a^m a^n = a^{m+n}$

so $f^{52} f^{123} = f^{175}$ and $2w^{1/8} 3w^{3/4} = 6w^{7/8}$

(don't worry what fractional exponents mean...yet.)

When multiplying like bases, add the exponents. $3y^3z4y^5z^5 = 12y^{3+5}z^{1+5} = 12y^8z^6$

→ Practice: Simplify.

- | | | | |
|----------------|-------------|-------------|-------------|
| a) $a^1 a^1 =$ | $c^2 c^7 =$ | $e^2 e^2 =$ | $g^9 g^7 =$ |
| b) $b^6 b^3 =$ | $d^3 d^1 =$ | $f^4 f^8 =$ | $h^3 h^5 =$ |

Negative exponents

Notice what happens with the example $\frac{h^3}{h^6} = \frac{\cancel{h}\cancel{h}\cancel{h}}{\cancel{h}\cancel{h}\cancel{h}\cancel{h}\cancel{h}\cancel{h}} = \frac{1}{hhh} = \frac{1}{h^3} = h^{3-6} = h^{-3}$

This leads to another rule.

<p>Rule: $a^{-n} = \frac{1}{a^n}$ and $\frac{1}{a^{-n}} = a^n$</p>

$$s^{-3} = \frac{1}{s^3} \quad \text{and} \quad \frac{1}{d^{-5}} = d^5$$

➔ Practice: Write each answer two ways, as a fraction with positive exponents and without using fractions but using negative exponents.

f) $\frac{w^4}{w^7} = w^{-3}$ or $\frac{1}{w^3}$	$\frac{x}{x^5} =$	$\frac{w^{32}}{w^{34}} =$	$\frac{w^4}{w^2} =$
g) $\frac{a^7}{a^{12}} =$	$\frac{q^{41}}{q^{52}} =$	$\frac{s^4}{s^5} =$	$\frac{z^{14}}{z^{15}} =$

Dividing Monomials

$$\frac{36r^2r^3s^{12}}{45r^7s^7} = \frac{9 \cdot 4 \cdot 2rr^3s^{12}}{9 \cdot 5r^7s^7} = \frac{8r^6s^{12}}{5r^7s^7} = \frac{8}{5}r^{6-7}s^{12-7} = \frac{8s^5}{5r} = \frac{8}{5}r^{-1}s^5$$

h) $\frac{3e^3}{4e^6}$	$\frac{7f^7}{4f^6}$	$\frac{9p^3}{3p^5}$	$\frac{36y^{13}}{6y^{16}}$
i) $\frac{30j^{30}}{25j^{60}}$	$\frac{j^3}{5j^{10}}$	$\frac{12t^8}{15t^{15}}$	$\frac{56r^{98}}{48r^{123}}$
j) $\frac{28x^5y^5}{21x^3y^7}$	$\frac{81m^3n^5}{144m^3n^7}$	$\frac{35s^2t^5}{21s^3t^{17}}$	$\frac{32x^{51}y^{15}}{12x^{30}y^{71}}$
k) $\frac{32t^{16}}{56t^{25}}$	$\frac{2t}{6t}$	$\frac{42e^{65}}{48e^{79}}$	$\frac{12t^{80}}{48t^{205}}$
l) $\frac{10k^{12}l^{51}}{45k^{36}l^{27}}$	$\frac{k^{31}l}{5k^{36}l^7}$	$\frac{3m^{14}3m^{13}}{45m^{61}}$	$\frac{24f^{12}e^{41}}{4e^{26}f^{27}}$

Zero Exponent

$\frac{x^3}{x^3} = x^{3-3} = x^0$ or the powers cancel for an answer of 1.

<p>Rule: $a^0 = 1$</p>
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Anything to the zero power is 1.

➔ Practice: Simplify

m) $3^0 =$	$x^0 =$	$(4y)^0 =$	$(3st^5)^0 =$	$(5-8+9-7-12)^0 =$
n) $4x^0 =$	$8e^0 =$	$2s5x^0 =$	$2(3st^5)^0 =$	$\frac{1}{2}(3st^5)^0 =$

Name: Solution Key. Polynomials Booklet

Classify as a monomial, binomial, or trinomial.

1. $-20x^2 + 15x + 17$ <input type="checkbox"/> Monomial <input type="checkbox"/> Binomial <input checked="" type="checkbox"/> TRI	2. $43s^4$ <input checked="" type="checkbox"/> Monomial <input type="checkbox"/> Binomial <input type="checkbox"/> TRI
3. $-13x^2 + 10x + 15$ <input type="checkbox"/> Monomial <input type="checkbox"/> Binomial <input checked="" type="checkbox"/> TRI	4. $15x^2 + 13x - 16$ <input type="checkbox"/> Monomial <input type="checkbox"/> Binomial <input checked="" type="checkbox"/> TRI
5. $12x^5 + 4x$ <input type="checkbox"/> Monomial <input checked="" type="checkbox"/> Binomial <input type="checkbox"/> TRI	6. 62 <input checked="" type="checkbox"/> Monomial <input type="checkbox"/> Binomial <input type="checkbox"/> TRI
7. $6x + 4$ <input type="checkbox"/> Monomial <input checked="" type="checkbox"/> Binomial <input type="checkbox"/> TRI	8. $64d$ <input checked="" type="checkbox"/> Monomial <input type="checkbox"/> Binomial <input type="checkbox"/> TRI
9. $-15x - 11$ <input type="checkbox"/> Monomial <input checked="" type="checkbox"/> Binomial <input type="checkbox"/> TRI	10. $16x^2 - 9x$ <input type="checkbox"/> Monomial <input checked="" type="checkbox"/> Binomial <input type="checkbox"/> TRI
11. $43g$ <input checked="" type="checkbox"/> Monomial <input type="checkbox"/> Binomial <input type="checkbox"/> TRI	12. $-13x^2 - 16x - 8$ <input type="checkbox"/> Monomial <input type="checkbox"/> Binomial <input checked="" type="checkbox"/> TRI
13. $17x^2 + 12x$ <input type="checkbox"/> Monomial <input checked="" type="checkbox"/> Binomial <input type="checkbox"/> TRI	14. $35e$ <input checked="" type="checkbox"/> Monomial <input type="checkbox"/> Binomial <input type="checkbox"/> TRI
15. $5x^2 + 12$ <input type="checkbox"/> Monomial <input checked="" type="checkbox"/> Binomial <input type="checkbox"/> TRI	16. $-16x^2 - 9x - 19$ <input type="checkbox"/> Monomial <input type="checkbox"/> Binomial <input checked="" type="checkbox"/> TRI

GROUP LIKE TERMS

Add	1. $24x + 10$	2. $16x + 32$
	3. $26x^2 + 22x + 25$	4. $32x^2 + 31x + 28$
	5. $-27x^2 - 52x$	6. $6x^2 - 32x - 15$
	7. $-15x^2 - 21x - 11$	8. $-27x^2 - 25x - 6$
	9. $20z^7 - 16x^6 - 21x^5 - 23x^4 + 9x$	10. $-9x^2 - 16$
	11. $-6x - 34$	12. $-3x^6 + 18x^3 + 30$
	13. $29x^2 + 22x + 23$	14. $-14x^2 - 4x + 31$
	15. $18x^2 + 9x + 34$	16. $-14x^7 + 19x^6 + 5x^5 - 10x^4 + 1$
	17. $9x^6 + 10x^5 - 15x^4 + 10$	18. $-17x^6 - 10x^4 + 3x^3 - 20x - 18$
	19. $x^2 + 32x + 18$	20. $-9x^7 + 5x^6 + 9x^3 - 20x^2 - 12x$

Adding and Subtracting Polynomials

Simplify each expression.

1) $(5p^2 - 3) + (2p^2 - 3p^3) = -3p^3 + 7p^2 - 3$

$$5a^3 - 5a^2$$

3) $(4 + 2n^3) + (5n^3 + 2) = 7n^3 + 6$

4) $(4n - 3n^3) - (3n^3 + 4n)$

$$-6n^3$$

5) $(3a^2 + 1) - (4 + 2a^2) = a^2 - 3$

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

$$2r^4 + 9r^3$$

7) $(5a + 4) - (5a + 3) = 1$

8) $(3x^4 - 3x) - (3x - 3x^4)$

$$6x^4 - 6x$$

9) $(-4k^4 + 14 + 3k^2) + (-3k^4 - 14k^2 - 8)$
 $= -7k^4 - 11k^2 + 6$

10) $(3 - 6n^5 - 8n^4) - (-6n^4 - 3n - 8n^5)$

$$2n^5 - 2n^4 + 3n + 3$$

11) $(12a^5 - 6a - 10a^3) - (10a - 2a^5 - 14a^4)$

$$14a^5 + 14a^4 - 10a^3 - 16a$$

12) $(8n - 3n^4 + 10n^2) - (3n^2 + 11n^4 - 7)$

$$-14n^4 + 7n^2 + 8n + 7$$

13) $(-x^4 + 13x^5 + 6x^3) + (6x^3 + 5x^5 + 7x^4)$

$$18x^5 + 6x^4 + 12x^3$$

14) $(9r^3 + 5r^2 + 11r) + (-2r^3 + 9r - 8r^2)$

$$7r^3 - 3r^2 + 20r$$

15) $(13n^2 + 11n - 2n^4) + (-13n^2 - 3n - 6n^4)$

$$-8n^4 + 8n$$

16) $(-7x^5 + 14 - 2x) + (10x^4 + 7x + 5x^5)$

$$-2x^5 + 10x^4 + 5x + 14$$

17) $(7 - 13x^3 - 11x) - (2x^3 + 8 - 4x^5)$

$$4x^5 - 15x^3 - 11x - 1$$

18) $(13a^2 - 6a^5 - 2a) - (-10a^2 - 11a^5 + 9a)$

$$5a^5 + 23a^2 - 11a$$

Adding and Subtracting Polynomials

Simplify each expression.

- 1) $(8a - 4a^2) - (7a^3 - a) = -7a^3 - 4a^2 + 9a$
- 2) $(6a - 3a^2) + (2a^2 - 3a) = -a^2 + 3a$
- 3) $(x^2 - x) + (8x - 2x^2) = -x^2 + 7x$
- 4) $(2a^2 + 4a^3) - (3a^3 + 8) = a^3 + 2a^2 - 8$
- 5) $(5x^2 + 4) - (5 + 5x^3) = -5x^3 + 5x^2 - 1$
- 6) $(8n^2 - 2n^3) + (6n^3 - 8n^2) = 4n^3$
- 7) $(8b^3 + 8) - (6 - 7b^3) = 15b^3 + 2$
- 8) $(4x^3 - 6) + (5x^3 + 3) = 9x^3 - 3$
- 9) $(10p^4 + 11) - (11p^4 + 13 + 16p^2) = -p^4 - 16p^2 - 2$
- 10) $(20v^2 - 9v^3) - (7v^3 - 10v^4 - 14v^2) = 10v^4 - 16v^3 + 34v^2$
- 11) $(10x^4 - 16) + (12 - 6x^3 + 11x^4) = 21x^4 - 6x^3 - 4$
- 12) $(14 + 12a^3) + (17a^4 + 15 - 5a^3) = 17a^4 + 7a^3 + 29$
- 13) $(17v^2 - 8) + (17v^2 + 10 + v^3) = v^3 + 34v^2 + 2$
- 14) $(20n + 11n^4) - (15n + 16n^2 - 17n^4) = 28n^4 - 16n^2 + 5n$
- 15) $(10k^4 + 17k^3) - (14k^3 - 2k + 9k^4) = k^4 + 3k^3 + 2k$
- 16) $(9r + 6r^4) + (12r - 2r^4 - 17) = 4r^4 + 21r - 17$
- 17) $(11n + 7n^5 + 5) - (7n - 11n^5 + 6n^3) - (4 + 4n^5) = 14n^5 - 6n^3 + 4n + 1$
- 18) $(9a^4 + 1 - 11a^2) - (a + 8a^2 + 2) - (6a^2 - 9) = 9a^4 - 25a^2 - a + 8$
- 19) $(6k^5 - 6k^3 - 6k) + (4k + 11k^4 - 11) + (k^2 - 12) = 6k^5 + 11k^4 - 6k^3 + k^2 - 2k - 23$
- 20) $(12x^4 + 3x^5 + 3x^2) - (6x - 5x^2 + 4) + (5x^5 + 7x) = 8x^5 + 12x^4 + 8x^2 + x - 4$
- 21) $(10v^2 - 1 - v^3) + (10v^5 - 5v^3 + 5) - (4v^3 - 11v^5) = 21v^5 - 10v^3 + 10v^2 + 4$
- 22) $(7x^2 - 4x^4 - 12) + (4x^5 - 7x^4 - 5x^2) + (4x^2 - 3x^4) = 4x^5 - 14x^4 + 6x^2 - 12$
- 23) $(10 + 9v^5 - 8v^2) + (4v^4 + 3v^5 + 10) - (6 - 7v^4) = 12v^5 + 11v^4 - 8v^2 + 14$
- 24) $(8r - 7r^5 + 6r^3) + (10r^5 + r + 4r^3) + (2r + 12r^5) = 15r^5 + 10r^3 + 11r$

Eliminate the brackets by distributing, then grouping "like" terms:

- 1) $-15e-12$ 2) $-6a-8b$ 3) $-5m+30$
 4) $36-12a$ 5) $-20m^2+8m-12$ 6) $49-17w$
 7) $7m-6$ 8) $-19m+39$
 9) $13y-6xy$ 10) $14w-10$
 11) $-17a+5b$ 12) $-24h+21m$
 13) $18x+4y-16xy$ 14) $-f-5$
 15) $-8a-10$ 16) $2x-17$

Multiply.

1.	$144x+132$	2.	$36x^2+18x$
3.	$9x^3+4x^2+3x$	4.	$10x^2+56x$
5.	$-32x^2-36x$	6.	$-30x^2-15x$
7.	$-55x^4+88x^3+99x^2+88x$	8.	$27x^3-81x^2-99x$
9.	$-32x^2+20x$	10.	$12x^3+30x^2-36x$
11.	$-22x^4+20x^3-8x^2-12x$	12.	$-9x^3+7x^2+4x$
13.	$66x^2+42x$	14.	$-22x^2-33x$
15.	$-63x^2+18x$	16.	$-35x^2-70$
17.	$90x^2+50x$	18.	$-21x^2-24x$
19.	$-30x^3+24x^2$	20.	$77x^3-44x^2$

Use FOIL.

1.	$121x^2+220x+110$	2.	$27x^2+54x+27$
3.	$40x^2+143x+121$	4.	$54x^2+78x+28$
5.	$-121x^2+77x+60$	6.	$-24x^2+15x+66$
7.	$-30x^2-3x+6$	8.	$35x^2+7x-28$
9.	$-70x^2-15x+55$	10.	$90x^2+4x-30$
11.	$160x^2-172x-143$	12.	$128x^2-280x+152$
13.	$-216x^2+132x+120$	14.	$-140x^2+244x-99$
15.	$380x^2+528x+180$	16.	$126x^2-365x+209$
17.	$-133x^2+307x+154$	18.	$120x^2+86x-63$
19.	$-144x^2+300x-156$	20.	$-128x^2+136x+195$

Multiplying a Polynomial and a Monomial

Find each product.

$$1) 8x(6x + 6) = 48x^2 + 48x$$

$$2) 7n(6n + 3) = 42n^2 + 21n$$

$$3) 3r(7r - 8) = 21r^2 - 24r$$

$$4) 8(8k - 8) = 64k - 64$$

$$5) 10a(a - 10b) = 10a^2 - 100ab$$

$$6) 2(9x - 2y) = 18x - 4y$$

$$7) 7x(6x + 4y) = 42x^2 + 28xy$$

$$8) 4a(8a - 8b) = 32a^2 - 32ab$$

$$9) 3n(n^2 - 6n + 5) = 3n^3 - 18n^2 + 15n$$

$$10) 2k^3(2k^2 + 5k - 4) = 4k^5 + 10k^4 - 8k^3$$

$$11) 8r^2(4r^2 - 5r + 7) = 32r^4 - 40r^3 + 56r^2$$

$$12) 3(3v^2 + 8v - 5) = 9v^2 + 24v - 15$$

$$13) 7(6x^2 + 9xy + 10y^2)$$

$$= 42x^2 + 63xy + 70y^2$$

$$14) 2u(6u^2 - 9uv + v^2) = 12u^3 - 18u^2v + 2uv^2$$

$$15) 9(x^2 + xy - 8y^2)$$

$$9x^2 + 9xy - 72y^2$$

$$16) 9v^2(u^2 + uv - 5v^2) = 9v^2u^2 + 9v^3u - 45v^4$$

Multiplying Binomials

Find each product.

$$1) (3n+2)(n+3) = 3n^2 + 11n + 6$$

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

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

$$4) (r+1)(r-3) = r^2 - 2r - 3$$

$$5) (2n+3)(2n+1) = 4n^2 + 8n + 3$$

$$6) (3p-3)(p-1) = 3p^2 - 6p + 3$$

$$7) (3p+3)(3p+2) = 9p^2 + 15p + 6$$

$$8) (k-2)(k-3) = k^2 - 5k + 6$$

$$9) (v-1)(3v-3) = 3v^2 - 6v + 3$$

$$10) (2x-3)(3x+3) = 6x^2 - 3x - 9$$

$$11) (4n+4)(5n-8) = 20n^2 + 12n - 32$$

$$12) (5x-2)(5x-8) = 25x^2 - 50x + 16$$

$$13) (6x+2)(2x+8) = 12x^2 + 52x + 16$$

$$14) (3x+3)(x+4) = 3x^2 + 15x + 12$$

$$15) (5v+4)(3v-6) = 15v^2 - 18v - 24$$

$$16) (x-4)(x-7) = x^2 - 11x + 28$$

$$17) (5x+6)(8x-4) = 40x^2 + 28x - 24$$

$$18) (8b-1)(5b-5) = 40b^2 - 45b + 5$$

Divide.

1.	$\frac{1}{2}x^3 + \frac{5}{2}x^2 + 2x$	2.	
3.	$\frac{7}{3}x^3 + \frac{5}{3}x + 1$	4.	
5.	$2x^{11} + 2x^{10} + 1x^7$	6.	
7.	$x^6 + 3x^2 + \frac{1}{3}x$	8.	
9.	$\frac{4}{3}x^{10} - 2x^5 - \frac{4}{3}x^4$	10.	
11.	$-2x^{10} + \frac{3}{2}x^8 - \frac{1}{2}x^2 + \frac{3}{2}x + 4x$	12.	
13.		14.	
15.		16.	
17.		18.	
19.		20.	

$3x^3 + 4x^2 + x$
 $8x^3 + 9x + 1$
 $5x^{10} + 2x^8 + 2x$
 $3x^{10} + \frac{7}{2}x^7 + 4x^5$

Complete.

1.	$2x^3 - 2x$	2.	
3.	$x^3 - x^2 + 10x - 10$	4.	
5.	$x^3 - 12x^2 - 8x - 96$	6.	
7.	$x^3 + 12x^2 + 2x + 24$	8.	
9.	$-2x^4 - 6x^3 + 15x^2 + 60x + 50$	10.	
11.	$-3x^3 + 3x$	12.	
13.	$x^3 - 12x^2 - 6x + 72$	14.	
15.	$x^3 - 2x^2 - 5x + 10$	16.	
17.	$x^4 - 122x^2 + 121$	18.	
19.	$-2x^4 - 9x^3 - 10x^2 + 102x + 102$	20.	
21.	$x^3 - 5x^2 - 64x + 320$	22.	
23.	$x^4 + 88x^2 - 1200$	24.	
25.	$x^3 + 10x^2 - 10x - 100$	26.	
27.	$5x^4 - 2x^3 - 79x^2 + 32x - 16$	28.	
29.	$x^4 - 98x^2 - 200$	30.	

$-x^4 + 4x^3 - 2x^2 - 12x + 15$
 $4x^3 - 576x$
 $-3x^2 - 21x$
 $2x^3 - 32x$
 $x^3 + 7x^2 - 6x - 42$
 $x^4 - 99x^2 - 100$
 $22x^3 + 10x^2 - 6x$
 $-28x^3 + 48x^2 + 36x$
 $x^3 + 11x^2 + 144x + 1584$
 $-3x^3 - 18x$
 $-2x^3 - 18x^2 + 14x$
 $-5x^4 - 12x^3 + 21x^2 + 72x + 54$
 $+6x^4 - 9x^3 + 16x^2 - 36x - 32$
 $3x^3 - 24x$
 $3x^4 - 12x^3 - 374x^2 + 1452x + 1331$

