

"I HAD MY DOCTOR DO A D.N.A. BLOOD ANALYSIS.
AS I SUSPECTED, I'M MISSING THE MATH GENE."

MPM1DI

Unit 3: Powers

Name: _____

Worksheet #1- Preview Worksheet on Evaluating Powers

On lined paper, evaluate each of the following from both columns, showing all work. Each answer in Column 1 should have a match in Column 2, **but** they will not be in the **same order**. Note: The answers for #1 from Column 1 and #11 from column 2 are shown.

Column 1

1. $3^3 = 27$
2. 4^3
3. $(-1)^6 + 5 + 5^2$
4. $6^3 \div 3^3$
5. $1^3 + 2^3 + 3^3$
6. $(-1)^{100}$
7. -4^2
8. $(-7 + 6)^3$
9. $(-12 + 10)^5$
10. -10^2
11. $\frac{5^4 - 5^2}{8^2 - 2^2}$
12. $\frac{6^2 + 8^2}{5^2}$
13. $2a^2 + a^3$, for $a = 4$
14. $3x^2 + 1$, for $x = -4$
15. $-6^2 + (-6)^2$
16. $3x^3 - 2x^2 - x$, for $x = -2$
17. $5x^5 + 4x^4 + 3x^3$, for $x = -1$

Column 2

1. $-8^2 - 6^2$
2. $3^2 - 5^2$
3. 2^3
4. $12^2 - 3(-2)^4$
5. 7^2
6. $2^4 - 4^2$
7. $-10^2 \div (-5)^2$
8. $(-1)^{201}$
9. $3^4 - 2(-5)^2$
10. $x - x^2$, for $x = 6$
11. $\frac{15^2 + 7^2 - 2^2}{10} = 27$
12. $\frac{x^4}{4}$, for $x = 2$
13. $\frac{(-3)^5}{-3^5}$
14. $(-6)^2$
15. $44 - 2(3^4 - 4^3)$
16. 2^6
17. $2^2 - 6^2$

3.1 Exponent Laws for Multiplying and Dividing Powers with the Same Base

Question	Long Expansion	Short Expansion
1. $(-5)^2 \times (-5)^4$	$(-5)(-5) \times (-5)(-5)(-5)(-5) =$	
2. $7^5 \div 7^3$	$\frac{7 \times 7 \times 7 \times 7 \times 7}{7 \times 7 \times 7} =$	
3. $\frac{(y^5)(y^2)}{y^4}$	$\frac{(y)(y)(y)(y)(y)(y)(y)}{(y)(y)(y)(y)} =$	
4. $\frac{(x^4y)(xy^3)}{x^3y^2}$	$\frac{x \cdot x \cdot x \cdot x \cdot y \cdot x \cdot y \cdot y \cdot y}{x \cdot x \cdot x \cdot y \cdot y} =$	

$a^m \times a^n =$ _____. To multiply powers with the **same base**, _____ the base and _____ the exponents.

$a^m \div a^n =$ _____. To divide powers with the **same base**, _____ the base and _____ the exponents.

Ex. 1. Simplify to a single power.

a) $(2^{15})(2^{25})$

b) $\frac{x^{18}}{x^{12}}$

c) $3^{-18} \times 3^{-13}$

d) $y^{-10} \div y^{-6}$

e) $6^{-\frac{1}{3}} \times 6^{0.5}$

f) $\left(\frac{8}{9}\right)^{15} \left(\frac{8}{9}\right)^{10} \div \left(\frac{8}{9}\right)^5$

g) $(4^5)(x^8)(4)(x^2)(x)$

h) $\frac{(-3)^7(x^8)(x^{16})}{(-3)(x^{10})(x)(-3)^2}$

Ex. 2. Simplify to a single power, and then evaluate.

a) $\frac{4^5}{4^2}$

b) $(10^3)(10^2)$

c) $(-3)^{-1.2}(-3)^{5.2}$

d) $\frac{6^{\sqrt{100}}}{6^{\sqrt{49}}}$

e) $\left(-\frac{2}{3}\right)^7 \div \left(-\frac{2}{3}\right)^5 \left(-\frac{2}{3}\right)$

f) $\frac{(5^3)(3)(5^4)(3^8)}{(3^2)(5^6)(3^5)}$

Ex. 3. Simplify using the exponent laws, and then evaluate for $x = 5$ and $y = -2$.

a) $\frac{(2y^7)(-6y^3)}{(-4y)(3y^4)}$

b) $\frac{-5x^5y^6}{25x^4y^2}$

c) $\frac{(4^5)(x^4)(y^2)(x^6)}{(y)(x^8)(4^4)}$

3.1 Multiplying and Dividing Powers Homework

1. Simplify to a single power, and then evaluate.

a) $\frac{(-5)^6}{(-5)^3}$ b) $2^{2.4} \times 2^{1.6}$ c) $4^{\sqrt{81}} \div 4^{\sqrt{49}}$ d) $\left(\frac{1}{3}\right)^{-7} \left(\frac{1}{3}\right)^{10}$ e) $(-1)^{76} \times (-1)^{25}$

f) $\frac{(-3)^{-2}}{(-3)^{-6}}$ g) $\frac{\left(\frac{2}{7}\right)}{\left(\frac{2}{7}\right)^{-1}}$ h) $6^{\frac{1}{6}} \times 6^{\frac{1}{3}} \times 6^{\frac{1}{2}}$ i) $\left(-\frac{1}{2}\right)^4 \times \left(-\frac{1}{2}\right)^3 \div \left(-\frac{1}{2}\right)^2$

j) $10^{-9} \div 10^{-14} \div 10$ k) $\frac{\left(1\frac{1}{3}\right)^5 \left(1\frac{1}{3}\right)^6}{\left(1\frac{1}{3}\right)^7}$ l) $\frac{1.7^9}{1.7^2 \times 1.7^5}$ m) $\frac{\left(-\frac{4}{5}\right) \left(-\frac{4}{5}\right)^7}{\left(-\frac{4}{5}\right)^3 \left(-\frac{4}{5}\right)^2}$

2. Simplify to a product of single powers, and then evaluate.

a) $2^{-3} \times 3^4 \times 2^4 \times 3^{-2}$ b) $\frac{(2^{12})(5^8)}{(2^8)(5^6)}$ c) $\frac{(7^3)(3^6)(3^4)(7)}{(3^2)(7^2)(3^5)}$

3. Simplify each expression using the exponent laws.

a) $(x^4)(x^3)$

b) $y^9 \cdot y$

c) $\frac{z^{13}}{z^{-8}}$

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

e) $\frac{36y^{14}}{4y^5}$

f) $(x^4)(y^6)(x^4)(y^7)$

g) $(-4z^5)(-z^2)(3z^4)$

h) $(b^5)(3^2)(b^3)(3^2)(b^7)$

i) $(-a^6)(-2b^3)(a)(-3b^2)$

j) $\frac{(2x^3)(-9x^2)}{3x^4}$

k) $\frac{6y^{24}}{12y^{11} \cdot y^6}$

l) $\frac{(-5)^3(a^2)(a^6)}{(-5)(a)(a^5)}$

m) $\frac{10^{10}x^4y^5}{10^8xy}$

n) $\frac{(3p^2q)(4pq^3)}{-6p^2q^2}$

4. Simplify using the exponent laws, and then evaluate for $x = -2$ and $y = 3$.

a) $\frac{(y^3)(y^8)}{-y^9}$

b) $\frac{-60x^{15}}{(5x^4)(3x^7)}$

c) $\frac{4y^6x^4}{6^2x^3y^3}$

d) $\frac{(-12x^3y)(2x^2y^2)}{(3x^2y)(2xy)}$

Answers

1. a) $(-5)^3 = -125$ b) $2^4 = 16$ c) $4^2 = 16$ d) $\left(\frac{1}{3}\right)^3 = \frac{1}{27}$ e) $(-1)^{101} = -1$ f) $(-3)^4 = 81$ g) $\left(\frac{2}{7}\right)^2 = \frac{4}{49}$ h) $6^1 = 6$ i) $\left(-\frac{1}{2}\right)^5 = -\frac{1}{32}$

j) $10^4 = 10000$ k) $\left(\frac{4}{3}\right)^4 = \frac{256}{81}$ l) $1.7^2 = 2.89$ m) $\left(-\frac{4}{5}\right)^3 = -\frac{64}{125}$ 2. a) $2^1 \times 3^2 = 18$ b) $2^4 \times 5^2 = 400$ c) $3^3 \times 7^2 = 1323$

3. a) x^7 b) y^{10} c) z^{21} d) $-12x^5$ e) $9y^9$ f) x^8y^{13} g) $12z^{11}$ h) $81b^{15}$ i) $-6a^7b^5$ j) $-6x$ k) $\frac{y^7}{2}$ l) $25a^2$ m) $100x^3y^4$ n) $-2pq^2$

4. a) $-y^2; -9$ b) $-4x^4; -64$ c) $\frac{1}{9}xy^3$ or $\frac{xy^3}{9}; -6$ d) $-4x^2y; -48$

3.2 Exponent Law for Power of a Power

Warm-up: i) $a^m \times a^n =$ ii) $\frac{a^m}{a^n} =$

1. Simplify to a single power, and then evaluate.

a) $(4^8)(4^{-5})$

b) $2^{1.4} \times 2^{2.8} \times 2^{1.8}$

c) $\frac{(1.1)^{0.8}}{(1.1)^{-1.2}}$

d) $5^{\frac{5}{6}} \div 5^{\frac{1}{3}} \times 5^{\frac{1}{2}}$

e) $\left(-1\frac{1}{2}\right)^{-3} \div \left(-1\frac{1}{2}\right)^5 \div \left(-1\frac{1}{2}\right)^{-11}$

2. Simplify using the exponent laws and express the final answer using scientific notation.

a) $(5 \times 10^7)(6 \times 10^{13})$

b) $\frac{6 \times 10^{15}}{1.5 \times 10^4}$

3. Simplify the following expressions using the exponent laws and evaluate for $x = -1$ and $y = 4$.

a) $\frac{36x^6y^7}{-9xy^4}$

b) $\frac{(-2x^5)(6x^6y^4)}{(4y)(x^3y^2)}$

Power	Long Expansion	Short Expansion
$(2^2)^5$	$2^2 \times 2^2 \times 2^2 \times 2^2 \times 2^2$	
$(y^5)^4$	$(y^5)(y^5)(y^5)(y^5)$	

$(a^m)^n =$ _____ To simplify a **power of a power** _____ the base, _____ the exponents.

Ex. 1. Simplify to a power with a single exponent.

a) $(2^4)^8$

b) $\left(x^{\frac{1}{2}}\right)^{10}$

c) $[(9^2)^3]^4$

d) $(5^{-3})^3(5^{-2})^{-7}$

e) $\left(\frac{a^8}{a^4}\right)^6$

f) $\frac{(y^2y^4)^8}{(y^4y)^7}$

Ex. 2. Simplify to a single power, and then evaluate.

a) $\frac{(4^3)^5(4^3)^2}{(4^9)^2}$

b) $\frac{(6^{-4} \times 6)^{-5}}{(6^5 \times 6^2)^2}$

c) $\frac{(5^2)^5(3^2)}{(3^{-1})^2(5^3)^3}$

Ex. 3. Simplify using the exponent laws, and then evaluate for $y = -2$.

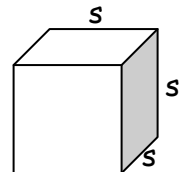
$$\frac{(y^4)^2}{(y^3)^2} - \frac{(y^6)^3}{(y^5)^3}$$

Ex. 4. Express 64^3 as a power of base:

i) 8

ii) 4

iii) 2



3.2 Exponent Law for Power of a Power Homework

1. Simplify to a single power with a single exponent.

a) $(7^3)^5$

b) $(3^{1.2})^5$

c) $[(-2)^7]^3$

d) $[(10^{-6})^3]^{-2}$

e) $\left[\left(\frac{2}{5}\right)^{27}\right]^{\frac{1}{3}}$

f) $(6^5)^2(6^{-5})$

g) $\frac{[(-3)^3]^3}{(-3)^{-6}}$

h) $(5^{-1})^4(5^3)^5$

2. Simplify to a single powers, and then evaluate.

a) $(3^4)^2(3^{-5})$

b) $(0.6^4)^5 \div (0.6^{-2})^{-5} \div (0.6^2)^3$

c) $\frac{(5^2 \cdot 5^8)(4^{-2})}{(4^{-1})^3(5^3)^3}$

d) $\frac{[(-2)^{0.75}]^{24}}{[(-2)^{0.6}]^{24}}$

e) $\frac{(5^{-6} \times 5)^{-4}}{(5^5 \div 5^{-3})^2}$

f) $\frac{-7(7^3)^5(7^{-8})^2}{(7^{-1})^2}$

3. Simplify using the exponent laws.

a) $(v^2)^2(-v)$ b) $\frac{(k^5)^3}{k^2}$ c) $\frac{(x^2x^3)^4}{(x^5x)^3}$

d) $(n^4)^3(n^2)^{-3}$ e) $\frac{-24j(j^8)^2}{(j^5)^2(3j^{-2})}$ f) $\left(\frac{5x^3y^8y^{-2}}{\sqrt{16+9} \cdot x^3y^4}\right)^3$

4. Simplify using the exponent laws, and then evaluate.

a) $\frac{(x^5)^2(x^7)^3}{(x^4)^6}$ when $x = -1$ b) $\frac{m^{11}}{(m^4)^2} + \frac{n^{11}}{(n^2)^3}$ when $m = 3$ and $n = -2$

5. Express each of the following as a single power with the base indicated.

a) 16^2 ; base of 4 b) 16^2 ; base of -2 c) $(-27)^3$; base of -3 d) $625^{\frac{1}{2}}$; base of 5

6. The length of each side of a cube is 3^5 units. Express its **surface area** (SA) and **volume** (V) using powers and simplify.

7. Scientists estimate that there are $50 \times (10^6)^2$ cells in the average human. There are approximately $6 \times (10^3)^3$ humans in the world. Approximately how many cells do all the humans on Earth have? Write your answer in scientific notation.

8. The annual worldwide production of all grains is about $9 \times (10^3)^4$ kg. How much grain is produced per person if there are approximately $6 \times (10^{0.9})^{10}$ people worldwide?

Answers

1. a) 7^{15} b) 3^6 c) $(-2)^{21}$ d) 10^{36} e) $\left(\frac{2}{5}\right)^9$ f) 6^5 g) $(-3)^{15}$ h) 5^{11}

2. a) $3^3 = 27$ b) $0.6^4 = 0.1296$ or $\left(\frac{3}{5}\right)^4 = \frac{81}{625}$ c) $(4^1)(5^1) = 20$ d) $(-2)^2 = 4$ e) $5^4 = 625$ f) $-7^2 = -49$

3. a) $-v^5$ b) k^{13} c) x^2 d) n^6 e) $-8j^9$ f) y^6 4. a) $x^7; -1$ b) $m^3 + n^5; -5$ 5. a) 4^4 b) $(-2)^8$ c) $(-3)^9$ d) 5^2

6. $SA = 6 \times 3^{10} \text{ unit}^2$; $V = 3^{15} \text{ units}^3$ 7. $3 \times 10^{23} \text{ cells}$ 8. $1.5 \times 10^3 \text{ kg}$ or 1500 kg

3.3 Exponent Laws for Power of a Product and Quotient

Warm-up: i) $a^m \times a^n =$ ii) $\frac{a^m}{a^n} =$ iii) $(a^m)^n =$

1. Simplify to a single power, and then evaluate. 2. Express as a power of the base indicated.

a) $\left(\frac{3^{\frac{1}{3}} \times 3^{\frac{1}{2}}}{3^{-\frac{5}{6}}}\right)^3$

b) $\left[(4^2)^3\right]^4 - (4^{-3})^{-8}$

a) 16^5 with base 2

b) 27^3 with base 3

Power	Long Expansion	Short Expansion
$(xy)^6$	$xy \cdot xy \cdot xy \cdot xy \cdot xy \cdot xy$	
$\left(\frac{x}{y}\right)^4$	$\frac{x}{y} \cdot \frac{x}{y} \cdot \frac{x}{y} \cdot \frac{x}{y}$	
$\left(\frac{x^2 y^3}{z^4}\right)^3$	$\frac{x^2 y^3}{z^4} \cdot \frac{x^2 y^3}{z^4} \cdot \frac{x^2 y^3}{z^4}$	

$(a^m b)^n =$ _____ To simplify a **power of a product**, _____ the exponent with **each** factor of the base.

$\left(\frac{a b^m}{c^m d}\right)^n =$ _____ To simplify a **power of a quotient**, _____ the exponent with **each** factor in the numerator and denominator.

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

Ex. 1. Simplify the following algebraic expressions using the exponent laws.

a) $(-2a^3)^5$ b) $(2^2 m^4 n)^3$ c) $(4a^2 \times 3b^4)^2$ d) $\frac{(3^6 \times 4^5)^3}{(4^7 \times 3^8)^2}$

e) $(5x^5)^3(-3x^7)^2$ f) $\frac{-24x^{-4}y^5}{8x^{-5}y^3}$ g) $\left(\frac{10x^3y^2}{-5xy^{-1}}\right)^4$ h) $\left(\frac{-a^3b}{3c^5}\right)^3$

Ex. 2. Simplify using the exponent laws, and then evaluate for $a = 3$ and $b = -2$.

a) $\frac{\left(\frac{2}{3}a^2b^4\right)^4}{\left(\frac{2}{3}a^2b^5\right)^3}$ b) $(-3a^{-11}b^{-3})(-a^2b)^6$

3.3 Power of a Product and Quotient Homework

1. Simplify the following expressions using the exponent laws.

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

b) $(5x^5)^2$

c) $(-a^{0.5}b)^6$

d) $(2^3 x^3 y^4 z^2)^2$

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

f) $\left(\frac{3p}{2q}\right)^3$

g) $\left(\frac{-s^2}{t^3}\right)^5$

h) $\left(\frac{-4ab^2}{5c^3}\right)^2$

i) $\frac{(6^3 a^4)^5}{(6^7 a^3)^2}$

j) $\frac{(-5a^3b)^5}{(-5a^5b^2)^2}$

k) $\left(\frac{-144a^{18}b^{-13}}{72a^{16}b^{-15}}\right)^3$

l) $(5a^2 \times 2b^3)^2$

$$\text{m) } (2t^{-4} \times 2t^9)^2 (t^{-4})^3 \left(-\frac{1}{2}t\right)^5$$

$$\text{n) } (-2a^8b)(3a^{-3}b^3)^2$$

$$\text{o) } (a^4b^{16}c^{12})^{\frac{1}{4}}(b^6c^3)^{-\frac{1}{3}}$$

2. Simplify using the exponent laws, and then evaluate for $x = -1\frac{1}{2}$ and $y = \frac{2}{3}$.

$$\text{a) } \frac{(-3x^4y^5)(-4x^5y)}{(6x^3y^2)^2}$$

$$\text{b) } \frac{(x^{-5}y^{-4})^{-2}}{(y^4x^3)^2}$$

Answers

1. a) $-27a^6$ b) $25x^{10}$ c) a^3b^6 d) $64x^6y^8z^4$ e) $\frac{x^2}{16}$ f) $\frac{27p^3}{8q^3}$ g) $-\frac{s^{10}}{t^{15}}$ h) $\frac{16a^2b^4}{25c^6}$ i) $6a^{14}$ j) $-125a^5b$ k) $-8a^6b^6$ l) $100a^4b^6$
 m) $-\frac{1}{2}t^3$ n) $-18a^2b^7$ o) ab^2c^2 2. a) $-\frac{1}{3}x^3y^2; -\frac{1}{2}$ b) $x^4; \frac{81}{16}$

3.4 Zero and Negative Exponents

Warm-up: i) $a^m \times a^n =$ ii) $\frac{a^m}{a^n} =$ iii) $(a^m)^n =$ iv) $\left(\frac{ab^m}{c^m d}\right)^n =$ _____

1. Simplify using the exponent laws, and then evaluate.

a) $\left(\frac{3^8 \times 2^4}{6^2}\right)^{\frac{1}{2}}$

b) $\frac{(5^3)^{-3}(5^{-4})}{(5^4)^{-4}}$

2. Simplify to a single power of base 2, and then evaluate.

$$\frac{32^5}{4^2 \times 16^4}$$

Power	Value	Power with a positive exponent
3^3		
3^2		
3^1		
3^0		
3^{-1}		
3^{-2}		
3^{-3}		

More Exponent Laws

i) $a^0 =$

ii) $a^{-n} =$

iii) $\left(\frac{a}{b}\right)^{-n} =$

To evaluate a **power** with a **negative exponent**, take the _____ of the base in brackets and raise it to the _____ exponent.

Zero and Negative Exponent Laws

i) $a^0 =$ $(-a)^0 =$ $-a^0 =$

ii) $a^{-n} =$ $\left(\frac{a}{b}\right)^{-n} =$ $\frac{1}{a^{-n}} =$

Ex. 1. Evaluate each of the following using the exponent laws.

a) 2^{-4}

b) $\left(\frac{1}{3}\right)^{-4}$

c) $3^0 - \frac{1}{4^{-2}}$

d) $-3^0 + 5^{-1}$

e) $(-3)^{-3} - 9^{-1}$

f) $\left(1 - \frac{2}{5}\right)^{-3}$

g) $\frac{2^{-3} - 2^{-1}}{4^{-1} + 4^{-2}}$

Ex. 2. Simplify to a single power, and then evaluate.

a) $2^{-4} \div 2 \div 2^{-11}$

b) $\left(-\frac{2}{5}\right)^8 \times \left(-\frac{2}{5}\right)^0 \div \left(-\frac{2}{5}\right)^{11}$

3.4 Zero and Negative Exponents Homework

For **A** and **B** show all work in the space provided.

A - What is the title of this picture?

1. 3^{-1}

2. 2^{-3}

3. 4^{-2}

4. $(-5)^{-1}$

5. $(-6)^{-2}$

4	AL
2	AR
$\frac{1}{36}$	RE
$\frac{1}{3}$	LE
0.01	US
$\frac{4}{9}$	ED
$\frac{1}{8}$	SE
22	FI
$\frac{1}{16}$	FO
10	AL
6	PO
$-\frac{1}{5}$	MS
$\frac{3}{2}$	RF



13	5	8	1	12	9	3
6	11	2	7	10	4	

6. $2^{-1} + 2^0$

7. $\frac{1}{4^{-1}}$

8. $\frac{2}{3^{-1}}$

9. $3^{-1} + 3^{-2}$

10. $4^{-2} \times 2^5$

11. $\frac{2^0 + 2^{-2}}{2^{-3}}$

12. $(6^2 - 5^2 - 7^0)^{-2}$

13. $6^2(3^{-2} + 2^{-1})$

B – Evaluating Expressions with Zero and Negative Exponents

Evaluate the following:

1. $3^0 + 5^0$

2. $2^4 \times 2^{-2}$

3. $3^4 \div 3$

4. $2^0 - 4^2$

5. $2^3 + 2^{-2}$

6. $2^4 \times 2^0 \div 2^3$

7. $(6+5)^0 - 2^3$

8. $\left(\frac{2}{3}\right)^{-1} + 4^{-1}$

9. $16 \div (13-11)^{-2} + 2^3$

10. $-3(-4)^0$

11. $2(3^0) - 5(3^{-1})$

12. $2^0 + 2^{-1} + 2^{-2}$

13. $8^{-1} \times \left(1\frac{1}{2}\right)^{-3}$

14. $\frac{4}{4^{-1} + 4^0}$

15. $\frac{2^{-3} + 2^{-1}}{2^{-4} - 2^{-2}}$

16. $\frac{27^3 \times 9^2}{81^3 \times 3^5}$

Answers (Not in Order)

$\frac{7}{4}$, 4, $\frac{1}{27}$, $3\frac{1}{5}$, 72, 27, 2, -15, $\frac{1}{81}$, $1\frac{3}{4}$, -7, $\frac{1}{3}$, -3, $8\frac{1}{4}$, 2, $-3\frac{1}{3}$

3.5 Negative Exponents and Scientific Notation

Scientific Notation: is a way of writing an extremely large or extremely small number as a decimal between 1 and 10, multiplied by a power of 10.

speed of light

300 000 000 *m/s*

mass of a proton

0.000 000 000 000 000 000 000 001 76 *grams*

Ex. 1. Express in standard form.

a) 1.6×10^5

b) 3.85×10^{-2}

c) 2.1×10^{-8}

Ex. 2. Express in scientific notation.

a) 5 300 000

b) 0.000 000 802

c) 54.1×10^{-5}

d) 0.282×10^9

Ex. 3. Express each number in scientific notation, simplify using the exponent laws, and then evaluate. Leave your final answer in scientific notation.

a) $(40\,000\,000\,000)(0.000\,032)$

b) $(0.000\,032) \div (40\,000\,000\,000)$

Ex. 4. According to the U.S. National Debt Clock, the outstanding Public Debt is about 16 trillion dollars. If the estimated population of the United States is 320 million, determine each citizen's share of the debt.

3.5 Negative Exponents and Scientific Notation Homework

1. Express in standard form.

a) 3.46×10^{-6}

b) 8.4×10^8

2. Express in scientific notation.

distance that light travels in one year

a) 5 900 000 000 000 *mi*

mass of the earth

b) 6 020 000 000 000 000 000 000 *kg*

wavelength of one type of X ray

c) 0.000 000 000 128 *m*

mass of an electron

d) 0.000 000 000 000 000 000 000 000 91 *g*

e) 72.5×10^5

f) 0.725×10^5

g) 38.3×10^{-4}

h) 0.383×10^{-4}

3. Express each factor in scientific notation, then multiply. Express the product in scientific notation.

a) (15 000 000 000)(400 000)

b) (3 800 000 000)(0.000 005)

d) (0.000 000 022)(0.0045)

e) (0.000 000 000 076)(90 000 000)

4. Express each number in scientific notation, then divide. Express the quotient in scientific notation.

a) $\frac{91\,000\,000\,000\,000}{700\,000}$

b) $\frac{16\,000}{2\,500\,000\,000}$

c) $(630\,000\,000) \div (0.000\,18)$

d) $(0.002\,32) \div (0.000\,000\,58)$

5. Fill in the blank in each statement comparing these four numbers. Show all work.

$$a = 3.3 \times 10^4 \quad b = 3.3 \times 10^5 \quad c = 3.3 \times 10^8 \quad d = 6.6 \times 10^4$$

i) b is _____ times larger than a .

ii) c is _____ times larger than b .

iii) c is _____ times larger than a .

iv) d is _____ times larger than a .

Answers

1. a) 0.00000346 b) 840000000

2. a) $5.9 \times 10^{12} \text{ mi}$ b) $6.02 \times 10^{24} \text{ kg}$ c) $1.28 \times 10^{-10} \text{ m}$ d) $9.1 \times 10^{-28} \text{ g}$ e) 7.25×10^6 f) 7.25×10^4 g) 3.83×10^{-3} h) 3.83×10^{-5}

3. a) 6×10^{15} b) 1.9×10^4 c) 9.9×10^{-11} d) 6.84×10^{-3}

4. a) 1.3×10^8 b) 6.4×10^{-6} c) 3.5×10^{12} d) 4×10^3

5. i) 10 ii) 1000 iii) 10000 iv) 2

3.6 Negative Exponents and Algebraic Expressions

Simplifying Algebraic Expressions:

Ex. 1. Simplify using the exponent laws, and then express your final answer with only positive exponents, if applicable.

a) $x^2 \cdot x^{-5} \div x$

b) $(-4n)(-3n^3)(-n^{-12})$

c) $(8a^{-3}) \div (12a^{-4})$

d) $(3a^2b^5)(2ab^{-8})$

e) $-36x^3y^4 \div (-9x^{-1}y^4)$

f) $(-2m^{-5}n^{-3})^3$

g) $[2x^2(-3x^4)]^{-2}$

h) $\frac{5c^{-1}d^7}{(-3c^4d^{-2})^2}$

i) $\left(\frac{4m^4n^{-9}}{mn^{-2}}\right)^{-3}$

3.6 Negative Exponents and Algebraic Expressions Homework

Simplify using the exponent laws, and then express your final answer with only positive exponents, if applicable.

1. $5n^{-3} \cdot n^2$

2. $2n^4 \cdot 9n$

3. $-3n^2(8n^{-5})$

4. $(-15n^{-8})(-n^8)$

5. $(9x^7) \div (3x^2)$

6. $\frac{-30x^3}{5x^5}$

7. $(40x^7) \div (8x^{-1})$

8. $\frac{-2x^{-5}}{-6x^{-2}}$

9. $(15a^4b^5) \div (5a^{-2}b^7)$

10. $(4ab^7)(-3a^4b^{-3})$

11. $(5a^6b)(2b^3)(3a^{-2}b^{-9})$

12. $\frac{(12a^2b^5)(-5ab^{-3})}{15a^3b^2}$

13. $\left(\frac{1}{2}a^2b\right)^{-3}$

14. $(3x^{-5})^{-1}(3x^{-2})^3$

15. $(4xy)^2(4xy^2)^{-1}$

16. $(xy)^{-3}(-x^7y^2)(6x^2)$

17. $\left(\frac{-2xy^3}{xy}\right)^5$

18. $\left(\frac{4x^3y^2}{3xy^6}\right)^{-3}$

19. $[(2x^{-7}y)(3x^{-2}y^5)]^{-1}$

20. $\frac{(x^6y^{-5})(x^{-2}y^2)^3}{(xy^2)^{-1}}$

Answers

1. $5n^{-1} = \frac{5}{n}$ 2. $18n^5$ 3. $-24n^{-3} = -\frac{24}{n^3}$ 4. $15n^0 = 15$ 5. $3x^5$ 6. $-6x^{-2} = -\frac{6}{x^2}$ 7. $5x^8$

8. $\frac{1}{3}x^{-3} = \frac{1}{3x^3}$ 9. $3a^6b^{-2} = \frac{3a^6}{b^2}$ 10. $-12a^5b^4$ 11. $30a^4b^{-5} = \frac{30a^4}{b^5}$ 12. -4 13. $8a^{-6}b^{-3} = \frac{8}{a^6b^3}$

14. $9x^{-1} = \frac{9}{x}$ 15. $4x$ 16. $-6x^6y^{-1} = -\frac{6x^6}{y}$ 17. $-32y^{10}$ 18. $\frac{27}{64}x^{-6}y^{12} = \frac{27y^{12}}{64x^6}$ 19. $\frac{1}{6}x^9y^{-6} = \frac{x^9}{6y^6}$ 20. xy^3

Unit 3 Review

PART A – Circle the best answer(s) for each question.

- Which is the simplified expression for $\frac{x(x^6)}{x^{-2}}$?
 - x^8
 - x^5
 - x^9
 - x^4
- What goes in the brackets to complete the equation $(8x^3)(\quad) = 24x^{12}$?
 - $3x^4$
 - $3x^9$
 - $16x^9$
 - $16x^4$
- Which of the following is **not** equivalent to 4^9 ?
 - $(2^2)^9$
 - 64^3
 - 2^{11}
 - $(4^{-1})^{-9}$
- The simplified expression for the **volume** of a cube with each side measuring $3x^2$ cm is:
 - $3x^6$ cm³
 - $9x^6$ cm³
 - $9x^4$ cm³
 - $27x^6$ cm³
- Which number is **not** written in scientific notation?
 - 0.3×10^{-6}
 - 2.01×10
 - 8.2×10^5
 - 5×10^0

PART B – Do all questions on lined paper without a calculator:

1. Evaluate.

- a) $(-1)^{90}$ b) -1^{90} c) $(-1)^{91}$ d) $(1000)^0$ e) $\left(-\frac{2}{3}\right)^3$ f) $\left(-2\frac{1}{4}\right)^2$ g) 2^{-4}
 h) $\left(\frac{2}{5}\right)^{-2}$ i) $\frac{1}{4^{-3}}$ j) $(-2)^2 + (-3)^3$ k) $-5(1-8)^0$ l) $\left(\frac{3}{7}\right)^0 - \left(\frac{3}{7}\right)^2$ m) $4^{-1} + 3^{-1} + 6^{-1}$
 n) $\left(\frac{1}{2}\right)^{-1} + \left(\frac{1}{2}\right)^{-2}$ o) $\left(\frac{2}{3}-1\right)^3$ p) $\left(1\frac{1}{2}\right)^2 - 6^{-2}$ q) $\frac{2^{-3} + 2^{-2}}{4^{-2} - 4^0}$ r) $\frac{3^{-2} - 3^{-3}}{3^{-2} + 3^{-3}}$

2. Evaluate each expression when $x = -3$ and $y = 2$.

- a) $2x^2 - y^5 - xy$ b) $(x - y)^x$ c) $(x^{-1} + y^{-1})^y$ d) $(2x)^2 y^{-4}$

3. Simplify to single powers, and then evaluate.

- a) $0.2^3 \times 0.2^4 \div 0.2^5$ b) $\left[\left(\frac{3}{5}\right)^{-2}\right]^{-1}$ c) $4^{-8} \div (4^{-6} \times 4 \times 4^{-2})$ d) $(-6)^5 \div (-6)^{-2} (-6)^{-7}$
 e) $\left(\frac{2}{3}\right)^8 \div \left(\frac{2}{3}\right)^4$ f) $\left(-\frac{1}{4}\right)^2 \div \left(-\frac{1}{4}\right)^{-1}$ g) $\frac{(2^2)^6 \times (2^3)^2}{(2^8)^3}$ h) $\frac{(4^3)^3 (5^{-2})}{(5^2)^{-2} (4^2)^4}$

4. Simplify to a single power of the indicated base, and then evaluate.

- a) $\frac{25^3 \times 5^2}{125^2}$, base 5 b) $\frac{27^3 \times 9^{-2}}{81 \times 3^3}$, base 3

5. Simplify to a single power of base x , and then evaluate for $x = -4$.

a) $\frac{(x^4)^5(x^3)^4}{(x^7)(x^{23})}$ b) $\frac{(3x^{-5})(-2x^{-2})}{-6x^{-4}}$

6. Simplify using exponent laws. Express your final answer with only positive exponents, if applicable.

a) $y^{12} \cdot y^{-13}$ b) $\frac{c^5}{c^{-3}}$ c) $(m^{-3})^{-2}$ d) $\frac{c^5 \times c^8}{c^3 \times c^4}$ e) $x^{-5} \cdot x \div x^2$ f) $(6m^3)^2$ g) $\frac{60x^7y^4}{-12xy^2}$

h) $\frac{(-3k^2)^3}{(3k^3)^2}$ i) $5n^4(-2n^{-8})$ j) $\left(\frac{3x}{y}\right)^3$ k) $\left(\frac{2x^2}{3y^3}\right)^4$ l) $(-21x^{10}y^{-3}) \div (-3x^{12}y^{-4})$

m) $[6x^2(-2x^5)]^2$ n) $\left(\frac{8a^6b^4}{2a^4b^3}\right)^2$ o) $\left(\frac{9a^2b^3}{3a^5b^{-2}}\right)^{-2}$ p) $(2x^4y^{-2}z^{-5})(3xy^3z^4)^3$

7. Simplify first using the exponent laws, and then evaluate for $x = 2$ and $y = -1$.

a) $\frac{(-6x^5y^2)(8x^3y)}{(8x^2y)^2}$ b) $\left(\frac{4^9x^{-18}}{8^6y^{-15}}\right)^{\frac{1}{3}}$

8. Express in standard form.

a) 3.0×10^5 b) 2.4×10^{-6}
c) 3.05×10^{-3} d) 6.12×10^9

9. Express in scientific notation.

a) 0.000 000 12 b) 21 000 000 000
c) 0.000 231 d) 710 000 000 000 000

10. Evaluate using the exponent laws and express the final answer in scientific notation.

a) $(2 \times 10^{-19})(3 \times 10^8)$ b) $(9 \times 10^{12}) \div (3 \times 10^5)$ c) $(3.2 \times 10^{-6}) \div (6.4 \times 10^2)$
d) $(8 \times 10^5)(3 \times 10^3)$ e) $(72\ 000\ 000) \div (0.000\ 05)$ f) $(120\ 000\ 000\ 000)(0.000\ 003)$

11. The human body contains about 3.2×10^{-2} litres of blood for each pound of body weight.

Each litre of blood contains about 5×10^{12} red blood cells. About how many blood cells are in the body of a 100-pound person?

12. The speed of light in space is 3×10^8 km/s. Sirius A, the brightest star in the heavens, is

8.1×10^{13} km from the earth. How many seconds does it take for light to travel from Sirius A

to the earth? **Note:** $time = \frac{distance}{speed}$

Answers

PART A: 1. c 2. b 3. c 4. d 5. a PART B:

1. a) 1 b) -1 c) -1 d) 1 e) $-\frac{8}{27}$ f) $5\frac{1}{16}$ g) $\frac{1}{16}$ h) $6\frac{1}{4}$ i) 64 j) -23 k) -5 l) $\frac{40}{49}$ m) $\frac{3}{4}$ n) 6 o) $-\frac{1}{27}$ p) $2\frac{2}{9}$ q) $-\frac{2}{5}$ r) $\frac{1}{2}$

2. a) -8 b) $-\frac{1}{125}$ c) $\frac{1}{36}$ d) $2\frac{1}{4}$ 3. a) 0.04 b) $\frac{9}{25}$ c) $\frac{1}{4}$ d) 1 e) $\frac{16}{81}$ f) $-\frac{1}{64}$ g) $\frac{1}{64}$ h) 100 4. a) $5^2, 25$ b) $3^{-2}, \frac{1}{9}$

5. a) $x^2, 16$ b) $x^{-3}, -\frac{1}{64}$ 6. a) $\frac{1}{y}$ b) c^8 c) m^6 d) c^6 e) $\frac{1}{x^6}$ f) $36m^6$ g) $-5x^6y^2$ h) -3

i) $-\frac{10}{n^4}$ j) $\frac{27x^3}{y^3}$ k) $\frac{16x^8}{81y^{12}}$ l) $\frac{7y}{x^2}$ m) $144x^{14}$ n) $16a^4b^2$ o) $\frac{a^6}{9b^{10}}$ p) $54x^7y^7z^7$ 7. a) $-\frac{3}{4}x^4y, 12$ b) $\frac{y^5}{x^6}, -\frac{1}{64}$

8. a) 300 000 b) 0.000 002 4 c) 0.003 05 d) 6 120 000 000 9. a) 1.2×10^{-7} b) 2.1×10^{10} c) 2.31×10^{-4} d) 7.1×10^{14}

10. a) 6×10^{-11} b) 3×10^7 c) 5×10^{-9} d) 2.4×10^9 e) 1.44×10^{12} f) 3.6×10^5 11. 1.6×10^{13} cells 12. 2.7×10^5 s