

Warm Up

Simplify (leave solutions with positive exponents)

$$\begin{aligned}
 \text{a) } & (4x^3 b^{-2})^{-3} \\
 & = 4^{-3} x^{-9} b^6 \\
 & = \frac{b^6}{4^3 x^9} \\
 & = \frac{b^6}{64 x^9}
 \end{aligned}$$

$$\begin{aligned}
 \text{b) } & \left(\frac{m^7}{m^{-4} 3m^5} \right)^{-2} \\
 & = \left(\frac{m^7}{3m^{-4+5}} \right)^{-2} \quad \text{applied product law to denominator} \\
 & = \left(\frac{m^7}{3m^1} \right)^{-2} \quad \text{quotient law to the "m"} \\
 & = \left(\frac{m^6}{3^1} \right)^{-2} \quad \text{power of a quotient} \\
 & = \frac{m^{-12}}{3^{-2}} \quad \text{negative exp. (switch positions)} \\
 & = \frac{3^2}{m^{12}} \\
 & = \frac{9}{m^{12}}
 \end{aligned}$$

L



Warm Up

Simplify (leave solutions with positive exponents)

a) $(4x^3 b^{-2})^{-3}$

x exponents

$$= \frac{4^3 x^9 b^6}{4^3 x^9}$$

$$= \frac{b^6}{64 x^9}$$

b) $\left(\frac{m^7}{m^{-4} 3m^5}\right)^{-2}$

product law on denominator (add ex)

quotient in law in bracket (subtract ex)

$$= \left(\frac{m^7}{3m^1}\right)^{-2}$$

$$= \left(\frac{m^6}{3}\right)^{-2}$$

$$= \frac{m^{-12}}{3^{-2}}$$

$$= \frac{3^2}{m^{12}}$$

$$= \frac{9}{m^{12}}$$

Homework

Worksheet Solutions

Laws of exponents Practice Worksheet

Simplify. Your answer should contain only positive exponents.

$$1) \frac{2u^3v^3 \cdot (3u^2)^2}{2u^2}$$

$9u^5v^3$

$$2) \frac{(4xy^2)^3}{(4y^3)^4 \cdot 2y^3} \cdot \frac{x^2}{8y^9}$$

$$3) \frac{(4uv^2)^2}{3u^2v^4 \cdot 3v^2} \cdot \frac{16}{9v^2}$$

$$4) \left(\frac{4a^4b^3}{3a^4b^3 \cdot 4a^3b^4} \right)^3 \cdot \frac{27a^3}{4b^3}$$

$$5) \left(\frac{3y^3 \cdot 3x^3y^4}{4x^4y^2} \right)^4 \cdot \frac{6561y^{20}}{256x^4}$$

$$6) \left(\frac{3xy^4 \cdot 3x^3y^2}{yx^4} \right)^3$$

$729y^{15}$

$$7) \frac{2ba^2}{4a(2a^3b^4)^3} \cdot \frac{1}{16a^8b^{11}}$$

$$8) \frac{(2x^2y^2)^4}{(2x^2 \cdot (yx^2)^3)^2} \cdot \frac{4y^2}{x^8}$$

$$9) \frac{(m^2n^2)^2}{3m^4n^2 \cdot 2m^3n^2} \cdot \frac{1}{6m^3}$$

$$10) \frac{x^2}{4x^4y^2 \cdot (3x^4y^2)^2}$$

$$11) \left(\frac{n}{m \cdot 2m^4n^4} \right)^4 \cdot \frac{1}{16m^{20}n^{12}}$$

$$12) \left(\frac{3x^2y^3 \cdot 4x^3y^2}{3xy^3} \right)^4$$

$256x^{16}y^8$

$$13) \left(\frac{3x^2y^4 \cdot x^3y^3}{(2x^2y^3)^4} \right)^2 \cdot \frac{9}{256x^6y^{10}}$$

$$14) \left(\frac{2u^4v^3 \cdot 2uv^3}{4u^3} \right)^4$$

$4^8 \sqrt[4]{9}$

$$15) \frac{3uv^2}{2u^3v^2 \cdot (2v^2)^2} \cdot \frac{3}{8u^2v^4}$$

$$16) \frac{(4y)^3}{4y \cdot 3y^2} \cdot \frac{16}{3}$$

Test Review Sheet


1) $\sqrt[3]{\frac{125}{8}} = \frac{\sqrt[3]{125}}{\sqrt[3]{8}} = \frac{5}{2}$

2) $\sqrt[3]{100}$ $\sqrt[4]{16}$ $\sqrt[3]{130}$ $\sqrt{81}$
 $\sqrt[3]{64} \sqrt[3]{125}$ \downarrow $\sqrt[3]{125} \sqrt[3]{216}$ $\sqrt[3]{81} \sqrt[3]{100}$
 \downarrow \downarrow \downarrow \downarrow
 4 No 5 No 5 Yes 9 No

3) $\sqrt{50}$, $\sqrt[3]{-125}$, $\sqrt{4.9} = \sqrt{\frac{49}{10}}$, $\sqrt{\frac{81}{36}}$
 Not in perfect square list, so irrational = -5 Rational = $\frac{\sqrt{49}}{\sqrt{10}}$ so irrational = $\frac{\sqrt{81}}{\sqrt{36}} = \frac{9}{6}$ Rational

4) $\sqrt{28}$, $\sqrt[3]{40}$, $\sqrt[5]{301}$, $\sqrt[3]{-83}$
 5.2915 3.419 3.1310 -4.36 least

- 5) a) integer but not whole? any negative (Ex -1)
 ±1, ±2, ±3 0, 1, 2, 3
 b) is a whole but not integer? 0
 0, 1, 2, 3 ±1, ±2, ±3
 c) whole but not natural? 0
 0, 1, 2, 3, 4 1, 2, 3, 4

6)  $c^2 = a^2 + b^2$
 $= 4^2 + 9^2$
 $= 16 + 81$
 $c^2 = 97$
 $c = \sqrt{97}$

7) $\sqrt[3]{648}$ $\sqrt[3]{216 \times 3}$ $\sqrt[3]{216} \sqrt[3]{3}$
 6 $\sqrt[3]{3}$ (look in perfect cube list)
 8) $\sqrt{605}$ $\sqrt{121 \times 5}$ $11 \sqrt{5}$
 (look in perfect square list, find largest perfect square that divides into 605)

9) a) $4 \sqrt[3]{7}$ $\sqrt[3]{4^3 \times 7}$ $\sqrt[3]{64 \times 7}$ $= \sqrt[3]{448}$
 b) $5 \sqrt{10}$ $= \sqrt{5^2 \times 10}$ $= \sqrt{25 \times 10}$ $= \sqrt{250}$

10) $71^{3/4} = (\sqrt[4]{71})^3$ Remember $x^{m/n} = \sqrt[n]{x^m}$
 11) a) $(\sqrt[3]{6})^2 = 6^{2/3}$ b) $(\sqrt[5]{11})^3 = 11^{3/5}$ c) $(\sqrt[3]{9})^2 = (\frac{3}{9})^{3/2}$ d) $(\sqrt[5]{\frac{5}{6}})^2 = (\frac{5}{6})^{2/5}$

Review for test sheet continued

12) $8.4^{0.75}$ as radical $\rightarrow 8.4^{3/4} = \sqrt[4]{8.4^3}$ or $(\sqrt[4]{8.4})^3$

b) $7.5^{1.25} = (7.5)^{5/4} = \sqrt[4]{7.5^5}$ *change 1.25 to fraction 5/4*

13) Evaluate $(\frac{343}{216})^{2/3}$ $\rightarrow \frac{(\sqrt[3]{343})^2}{(\sqrt[3]{216})^2} = \frac{7^2}{6^2} = \frac{49}{36}$

b) $(\frac{1024}{1600})^{-3/5}$ $\rightarrow \frac{1024^{-3/5}}{1600^{-3/5}} = \frac{(\sqrt[5]{1024})^{-3}}{(\sqrt[5]{1600})^{-3}} = \frac{(\sqrt[5]{1024})^3}{(\sqrt[5]{1600})^3} = \frac{8^3}{20^3} = \frac{512}{8000} = \frac{16}{250} = \frac{8}{125}$

14) $\frac{1}{9} = \frac{1}{3^2} = 3^{-2}$

15) $[(-3x^4y^2)(7xy^3)]^{-2}$

simplify inside bracket first since like terms

$(-21x^5y^5)^{-2}$

$= (-21)^{-2} (x^5)^{-2} (y^5)^{-2}$

$= \frac{1}{(-21)^2 x^{10} y^{10}} = \frac{1}{441 x^{10} y^{10}}$

b) $(\frac{x^3y^3z}{x^4y^2z})^2$

simplify inside bracket first

$(\frac{x^3y^3z^1}{x^4y^2z^1})^2$

$(x^{-1}y^1z^0)^2$

$= x^{-2}y^2z^0 = \frac{y^2}{x^2}$

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

$\frac{3^5 x^{20}}{z^{10}} = \frac{243 x^{20}}{z^{10}}$

OR $(\frac{3x^4}{z^2})^{-20}$

$\frac{3^{-20} x^{-80}}{z^{-40}} = \frac{z^{40}}{3^{20} x^{80}}$

d) $(\frac{4xy^2}{12x^4y^3})(\frac{3x^2y^3}{4})^2$

$= \frac{4xy^2}{12x^4y^3} \cdot \frac{9x^4y^6}{16}$

$= \frac{4 \cdot 9 \cdot x^1 \cdot x^4 \cdot y^2 \cdot y^6}{12 \cdot 16 \cdot x^4 \cdot y^3}$

$= \frac{36x^5y^8}{192x^4y^3} = \frac{3x^1y^5}{16}$

$= \frac{3 \cdot 27 x^{1+3} y^{5+1}}{16} = \frac{81x^4y^6}{16}$

e) $(\frac{3}{4} a^{-1} b^2)^{-2}$

$= (\frac{3 \cdot a^{-1} \cdot b^2}{4})^{-2} = \frac{3^{-2} a^{2} b^{-4}}{4^{-2}} = \frac{1}{9} \frac{a^2 b^{-4}}{16} = \frac{a^2}{144 b^4}$

$$e) \left(\frac{3 a^{-7} b^5}{4} \right)^{-2} =$$

$$\frac{3^{-2} a^{14} b^{-10}}{4^{-2}}$$

$$= \frac{4^2 a^{14}}{3^2 b^{10}} = \frac{16 a^{14}}{9 b^{10}}$$

$$\begin{aligned} & \frac{125^{-\frac{2}{5}}}{1} \\ &= \frac{1}{125^{\frac{2}{5}}} \\ &= \frac{1}{(\sqrt[5]{125})^2} \quad \text{leave it} \end{aligned}$$

Example 3**Simplifying Algebraic Expressions with Rational Exponents**

Simplify. Explain the reasoning.

a) $(8a^3b^6)^{\frac{1}{3}}$

b) $(x^{\frac{3}{2}}y^2)(x^{\frac{1}{2}}y^{-1})$

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

**CHECK YOUR UNDERSTANDING**

$$\text{c) } \frac{4a^{-2}b^{\frac{2}{3}}}{2a^2b^{\frac{1}{3}}}$$

Homework

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9(b,d,f,h), #10(b,d), 11, 12, 15(a,b,c,d),
16(a,b,c,d), 17(a,) 19(a), 21(a,b), #22(a,b)

$$a) (8a^3b^6)^{\frac{1}{3}}$$

$$= 8^{\frac{1}{3}} a^1 b^2$$

$$= \sqrt[3]{8} a^1 b^2$$

$$= 2 a b^2$$

Example 1**Simplifying Numerical Expressions with Rational Number Bases**

Simplify by writing as a single power. Explain the reasoning.

a) $0.3^{-3} \cdot 0.3^5$ b) $\left[\left(-\frac{3}{2} \right)^{-4} \right]^2 \cdot \left[\left(-\frac{3}{2} \right)^2 \right]^3$

c) $\frac{(1.4^3)(1.4^4)}{1.4^{-2}}$ d) $\left(\frac{7^{\frac{2}{3}}}{7^{\frac{1}{3}} \cdot 7^{\frac{5}{3}}} \right)^6$

SOLUTION

a) $0.3^{-3} \cdot 0.3^5$

Use the product of powers law:

When the bases are the same, add the exponents.

$$\begin{aligned} 0.3^{-3} \cdot 0.3^5 &= 0.3^{(-3) + 5} \\ &= 0.3^2 \end{aligned}$$

(Solution continues.)

Homework

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Exercises

A _____
3 4 5 6 7 8

B _____
9 10 11 12 13 14 15 16
17 18 19

C _____
20 21

1) $2a \cdot 2a^2$

3) $3k \cdot k$

5) $2n \cdot 3n^3 \cdot 2n^2$

7) $(v^0)^5 v^3$

9) $n^{-5}(n^4)^{-3}$

11) $(2m^3 \cdot 2n^{-3})^{-4}$

13) $(x^3 y^3)^{-1}(x^3 y^{-1})^3$

15) $(2uv^3)^{-4}(u^{-4} v^4)^{-1}$

17) $uv(u^4 v^2)^{-4}$

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

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

23) $\frac{3n^{-3}}{3m^4 n^2}$

25) $\frac{m^3 n^{-3}}{3m}$

2) $3n \cdot 2n^3$

4) $3xx^2$

6) $n^3(n^3)^5$

8) $b^5(b^4)^2$

10) $(x^4)^0$

12) $xy^3 \cdot$

14) $(2x^4)^3$

16) $(y^{-2})^2$

18) $(y^2)^{-2} \cdot 2yx^3 \cdot x^3 y^2$

20) $\frac{2m^{-4} \cdot ((2m^{-3})^4(2m)^{-3})^4}{2m^2}$

22) $\left(\frac{(2r^4)^2}{2rr^0}\right)^4$

24) $\frac{x^3}{3x^{-2}}$

26) $\frac{3x^2 y^0}{4x^4 y^3}$

Answers to Assignment (ID: 1)

- 4) $3x^3$
- 8) b^{13}
- 12) $x^9 y^5$
- 16) $\frac{2x^3}{y^4}$
- 20) $\frac{16}{m^{66}}$
- 24) $\frac{x^5}{3}$

- 3) $3k^2$
- 7) y^3
- 11) $\frac{256m^{12}}{n^{12}}$
- 15) $\frac{1}{16y^{16}}$
- 19) $\frac{n^{12}}{16}$
- 23) $\frac{1}{n^5 m^4}$

- 2) $6n^4$
- 6) n^{18}
- 10) x^3
- 14) $16x^{13} y^3$
- 18) $\frac{2x^6}{y}$
- 22) $16r^{28}$
- 26) $\frac{3}{4x^2 y^3}$

- 1) $4a^3$
- 5) $12n^6$
- 9) $\frac{1}{n^{17}}$
- 13) $\frac{x^6}{y}$
- 17) $\frac{1}{4^{15} v^7}$
- 21) x^{68}
- 25) $\frac{m^2}{3n^3}$

Pre-Algebra

Name _____

Assignment

Date _____ P:

Simplify. Your answer should contain only positive exponents.

Wednesday Sheet

1) $\frac{2u^3v^3 \cdot (3u^2)^2}{2u^2}$

2) $\frac{(4xy^2)^3}{(4y^3)^4 \cdot 2y^3}$

3) $\frac{(4uv^2)^2}{3u^2v^4 \cdot 3v^2}$

4) $\left(\frac{4a^4b^3}{3a^4b^3 \cdot 4a^3b^4}\right)^3$

5) $\left(\frac{3y^3 \cdot 3x^3y^4}{4x^4y^2}\right)^4$

6) $\left(\frac{3xy^4 \cdot 3x^3y^2}{yx^4}\right)^3$

7) $\frac{2ba^2}{4a(2a^3b^4)^3}$

8) $\frac{(2x^2y^2)^4}{(2x^2 \cdot (yx^2)^3)^2}$

9) $\frac{(m^2n^2)^2}{3m^4n^2 \cdot 2m^3n^2}$

10) $\frac{x^2}{4x^4y^2 \cdot (3x^4y^2)^2}$

11) $\left(\frac{n}{m \cdot 2m^4n^4}\right)^4$

12) $\left(\frac{3x^2y^3 \cdot 4x^3y^2}{3xy^3}\right)^4$

13) $\left(\frac{3x^2y^4 \cdot x^3y^3}{(2x^2y^3)^4}\right)^2$

14) $\left(\frac{2u^4v^3 \cdot 2uv^3}{4u^3}\right)^4$

15) $\frac{3uv^2}{2u^3v^2 \cdot (2v^2)^2}$

16) $\frac{(4y)^3}{4y \cdot 3y^2}$

ANSWERS TO ASSIGNMENT (WJ. 1)

1) $9u^5v^3$
 5) $\frac{6561y^{20}}{256x^4}$
 9) $\frac{1}{6m^3}$
 13) $\frac{9}{256x^8y^{10}}$

2) $\frac{x^3}{8y^9}$
 6) $729y^{15}$
 10) $\frac{1}{36x^{10}y^6}$
 14) u^8v^{24}

3) $\frac{16}{9v^2}$
 7) $\frac{1}{16a^8b^{11}}$
 11) $\frac{1}{16m^{20}n^{12}}$
 15) $\frac{3}{8u^2v^4}$

4) $\frac{1}{27a^9b^{12}}$
 8) $\frac{1}{4y^2x^3}$
 12) $256x^{16}y^8$
 16) $\frac{16}{3}$