1

FRACTIONAL EXPONENTS

❑ *INTRODUCTION*

Let's begin by reviewing the Five Laws of Exponents:

$$x^a x^b = x^{a+b} \qquad \frac{x^a}{x^b} = x^{a-b} \qquad (x^a)^b = x^{ab}$$

$$(xy)^a = x^a x^b \qquad \left(\frac{x}{y}\right)^a = \frac{x^a}{y^a}$$

Homework

1. Simplify each expression:

a. x^3x^7	b. $\dfrac{a^{10}}{a^5}$	c. $(z^3)^5$	d. $\left(\dfrac{x}{y}\right)^9$
e. $(mn)^6$	f. r^4t^5	g. $a^2 + a^4$	h. $g^6 + g^6$
i. $(x + y)^2$	j. x^4x^{-3}	k. $(c^{-3})^{-5}$	l. $(ab)^{-4}$
m. $\dfrac{x^{-8}}{x^{-6}}$	n. $\dfrac{a^{-4}}{a^4}$	o. $\left(\dfrac{u}{w}\right)^{-3}$	p. $(a - b)^2$

❑ THE MEANING OF A FRACTIONAL EXPONENT

Here's what you've probably learned about exponents so far in this course:

$$x^3 = xxx \qquad y^1 = y \qquad z^0 = 1 \qquad w^{-4} = \frac{1}{w^4}$$

(where we assume that neither z nor w is 0).

Now for a new kind of exponent: <u>fractional</u>. For example, is there any reasonable meaning for the expression "9 to the 1/2 power": $9^{1/2}$? To determine the meaning of this number, we can proceed like this:

	$9^{1/2}$	(the number we're trying to analyze)
=	$(3^2)^{1/2}$	(9 can certainly be written as the square of 3)
=	$3^{2\cdot\frac{1}{2}}$	(one of the laws of exponents: $(x^a)^b = x^{ab}$)
=	3^1	(since the product of 2 and $\frac{1}{2}$ is 1)
=	3	(any number to the first power is itself)

We started with the unknown quantity $9^{1/2}$. Then, using just properties we know very well, we turned this mystery number into a 3. In short,

$$\mathbf{9^{1/2} = 3}$$

Now let's calculate 100 to the $\frac{1}{2}$ power:

$$\mathbf{100^{1/2}} = (10^2)^{1/2} = 10^{2\cdot\frac{1}{2}} = 10^1 = \mathbf{10}$$

For our third example, we'll try a different exponent and find the value of $64^{1/3}$:

$$\mathbf{64^{1/3}} = (4^3)^{1/3} = 4^{3\cdot\frac{1}{3}} = 4^1 = \mathbf{4}$$

And one more, using an exponent of $\frac{1}{4}$:

$$\mathbf{16^{1/4}} = (2^4)^{1/4} = 2^{4\cdot\frac{1}{4}} = 2^1 = \mathbf{2}$$

Homework

2. At the top of the chapter it states that w cannot be 0 in the statement $w^{-4} = \frac{1}{w^4}$. Why the restriction?

3. Using the methods described above, calculate each quantity:

a. $25^{1/2}$ b. $81^{1/2}$ c. $144^{1/2}$ d. $49^{1/2}$ e. $8^{1/3}$

f. $125^{1/3}$ g. $27^{1/3}$ h. $216^{1/3}$ i. $81^{1/4}$ j. $256^{1/4}$

❑ *Fractional Exponents and Roots*

It's time for a recap and a conclusion as to the meaning of a fractional exponent. Here's what we know from the examples and the homework:

$9^{1/2} = 3$ $100^{1/2} = 10$ $25^{1/2} = 5$

$64^{1/3} = 4$ $8^{1/3} = 2$ $125^{1/3} = 5$

$16^{1/4} = 2$ $81^{1/4} = 3$ $256^{1/4} = 4$

Now, what's really going on here? It appears that an exponent of $\frac{1}{2}$ indicates square root, an exponent of $\frac{1}{3}$ indicates cube root, and an exponent of $\frac{1}{4}$ indicates fourth root. That is,

$$x^{1/2} = \sqrt{x} \qquad x^{1/3} = \sqrt[3]{x} \qquad x^{1/4} = \sqrt[4]{x}$$

Summary: Assuming n is a natural number bigger than 1:

$$x^{1/n} = \sqrt[n]{x}$$

$n = 2, 3, 4, \ldots$

EXAMPLE 1: **Evaluate each expression with a fractional exponent:**

A. $225^{1/2} = \sqrt{225} = \mathbf{15}$

B. $125^{1/3} = \sqrt[3]{125} = \mathbf{5}$

C. $81^{1/4} = \sqrt[4]{81} = \mathbf{3}$

D. $(-32)^{1/5} = \sqrt[5]{-32} = \mathbf{-2}$

E. $-16^{1/2} = -\sqrt{16} = \mathbf{-4}$

F. $(-16)^{1/2} = \sqrt{-16}$ = **Not a real number**

G. $-81^{1/4} = -\sqrt[4]{81} = \mathbf{-3}$

H. $(-81)^{1/4} = \sqrt[4]{-81}$ = **Not a real number**

Homework

4. Explain why $25^{1/2}$ is a real number, but $(-25)^{1/2}$ is not.

5. Evaluate each expression:

a. $36^{1/2}$ b. $8^{1/3}$ c. $16^{1/4}$ d. $32^{1/5}$

e. $625^{1/2}$ f. $1^{1/3}$ g. $0^{1/4}$ h. $243^{1/5}$

i. $-25^{1/2}$ j. $-49^{1/2}$ k. $(-64)^{1/2}$ l. $(-16)^{1/4}$

m. $(-64)^{1/3}$ n. $(-1)^{1/5}$ o. $(-32)^{1/5}$ p. $(-1)^{1/4}$

6. Convert each expression to radical form:

a. $x^{1/2}$ b. $y^{1/3}$ c. $z^{1/4}$ d. $w^{1/5}$

e. $(ab)^{1/2}$ f. $ab^{1/2}$ g. $xy^{1/3}$ h. $(xy)^{1/3}$

i. $y+z^{1/2}$ j. $(y+z)^{1/2}$ k. $(a-b)^{1/3}$ l. $(Q+R-T)^{1/4}$

7. Convert each expression to exponent form:

a. $\sqrt{x}$ b. $\sqrt[4]{y}$ c. $\sqrt[3]{z}$ d. $\sqrt[5]{n}$

e. $a\sqrt{b}$ f. $\sqrt{ab}$ g. $x\sqrt[4]{y}$ h. $\sqrt[3]{tw}$

i. $\sqrt{x+y}$ j. $\sqrt[3]{p-q}$ k. $\sqrt[4]{a+n}$ l. $\sqrt[6]{x-x}$

8. True/False:

a. The expression $x^{1/2}$ is always defined.

b. The expression $x^{1/3}$ is always defined.

❑ *MORE FRACTIONAL EXPONENTS*

The previous problems each had a numerator of 1 in the fractional exponent. What about an expression like $27^{2/3}$? What could this mean? Let's dissect $27^{2/3}$ using our laws of exponents to determine the value of this number.

	$27^{2/3}$	(the power of 27 we're analyzing)
=	$27^{\frac{1}{3}\cdot 2}$	(certainly $\frac{1}{3}\cdot 2 = \frac{2}{3}$)

$$= \left(27^{1/3}\right)^2 \qquad \text{(law of exponents: } (x^a)^b = x^{ab}\text{)}$$

$$= \left(\sqrt[3]{27}\right)^2 \qquad \text{(a 1/3 exponent indicates cube root)}$$

$$= 3^2 \qquad \text{(the cube root of 27 is 3)}$$

$$= \mathbf{9} \qquad \text{(3 squared is 9)}$$

Here's another example. Let's calculate $16^{5/4}$:

$$\mathbf{16^{5/4}} = 16^{\frac{1}{4}\cdot 5} = \left(16^{1/4}\right)^5 = \left(\sqrt[4]{16}\right)^5 = 2^5 = \mathbf{32}$$

And a third example:

$$\mathbf{243^{2/5}} = 243^{\frac{1}{5}\cdot 2} = \left(243^{1/5}\right)^2 = \left(\sqrt[5]{243}\right)^2 = 3^2 = \mathbf{9}$$

Homework

9. Using the three examples above as a guide, find the value of each fractional power:

a. $8^{2/3}$ b. $4^{3/2}$ c. $9^{3/2}$ d. $16^{5/2}$

e. $27^{4/3}$ f. $27^{2/3}$ g. $16^{3/4}$ h. $32^{7/5}$

What's really going on here? There must be a simpler way to view a fractional exponent, and thus a simpler way to calculate one. If you look at the above examples and homework you just completed, you may have noticed that the denominator of the fractional exponent indicated a root, while the numerator indicated a power. For example, in the first example above, we showed that $27^{2/3}$ was calculated by first taking the cube root of 27, and then squaring that result to get **9**.

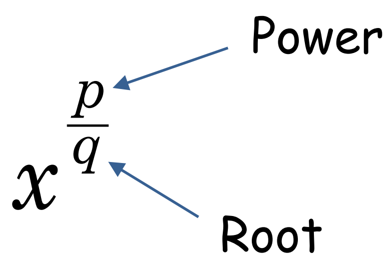
Thus, a problem like $16^{5/2}$ is calculated quickly as the square root of 16, raised to the fifth power, which is 4^5, which is **1,024**.

In summary,

$$x^{p/q} = \left(\sqrt[q]{x}\right)^p$$

EXAMPLE:

$$8^{5/3}$$
$$= \left(\sqrt[3]{8}\right)^5$$
$$= 2^5$$
$$= 32$$



One more example for this section: To calculate $\mathbf{64^{2/3}}$, think cube root of 64, raised to the second power, which is 4^2, which is **16**.

Homework

10. Using the power-root idea, find the value of each fractional power:

a. $8^{4/3}$	b. $4^{1/2}$	c. $9^{5/2}$	d. $16^{3/2}$
e. $27^{2/3}$	f. $27^{4/3}$	g. $16^{5/4}$	h. $32^{6/5}$
i. $8^{2/3}$	j. $4^{3/2}$	k. $9^{3/2}$	l. $16^{5/2}$
m. $27^{4/3}$	n. $125^{2/3}$	o. $16^{3/4}$	p. $32^{7/5}$

❑ NEGATIVE FRACTIONAL EXPONENTS

Since a negative exponent indicates reciprocal, we can combine negative exponents (assuming you've studied them) with the fractional exponents we're learning now. Recalling that $x^{-n} = \dfrac{1}{x^n}$, we can work the following examples.

EXAMPLE 2: **Evaluate each expression:**

A. $9^{-1/2} = \dfrac{1}{9^{1/2}} = \dfrac{1}{\sqrt{9}} = \mathbf{\dfrac{1}{3}}$

B. $-27^{-1/3} = -\dfrac{1}{27^{1/3}} = -\dfrac{1}{\sqrt[3]{27}} = -\mathbf{\dfrac{1}{3}}$

C. $8^{-2/3} = \dfrac{1}{8^{2/3}} = \dfrac{1}{\left(\sqrt[3]{8}\right)^2} = \dfrac{1}{2^2} = \mathbf{\dfrac{1}{4}}$

D. $9^{-5/2} = \dfrac{1}{9^{5/2}} = \dfrac{1}{\left(\sqrt{9}\right)^5} = \dfrac{1}{3^5} = \mathbf{\dfrac{1}{243}}$

E. $-16^{-3/4} = -\dfrac{1}{16^{3/4}} = -\dfrac{1}{\left(\sqrt[4]{16}\right)^3} = -\dfrac{1}{2^3} = -\mathbf{\dfrac{1}{8}}$

F. $(-16)^{-3/2} = \dfrac{1}{(-16)^{3/2}} = \dfrac{1}{\left(\sqrt{-16}\right)^3} =$ **Not a real number**

G. $(-8)^{-2/3} = \dfrac{1}{(-8)^{2/3}} = \dfrac{1}{\left(\sqrt[3]{-8}\right)^2} = \dfrac{1}{(-2)^2} = \mathbf{\dfrac{1}{4}}$

Homework

11. Evaluate each expression:

a. $9^{-3/2}$ b. $27^{-2/3}$ c. $8^{-4/3}$ d. $8^{-1/3}$

e. $16^{-5/4}$ f. $81^{-1/4}$ g. $81^{-3/4}$ h. $32^{-1/5}$

i. $-8^{-4/3}$ j. $(-25)^{-3/2}$ k. $(-64)^{-2/3}$ l. $(-32)^{-6/5}$

12. Convert each expression to radical form:

a. $x^{2/3}$ b. $y^{5/4}$ c. $z^{1/7}$

d. $(a+b)^{3/2}$ e. $(x-y)^{4/3}$ f. $(xy)^{4/5}$

g. $uw^{2/3}$ h. $x+y^{4/5}$ i. $(ab+c)^{5/6}$

13. Convert each expression to exponent form:

a. $\sqrt[3]{t}$ b. $\sqrt[5]{z}$ c. $\sqrt[4]{ab}$

d. $x\sqrt[3]{y}$ e. $\left(\sqrt{a}\right)^3$ f. $\left(\sqrt[3]{p}\right)^2$

g. $\left(\sqrt[4]{w}\right)^5$ h. $\left(\sqrt[7]{a+b}\right)^3$ i. $\left(\sqrt{x-y}\right)^{10}$

❑ *THE LAWS OF EXPONENTS*

The same five laws of exponents we've used with all the previous exponents still work just fine with fractional exponents.

<u>EXAMPLE 3:</u> **Simplify each expression:**

A. $a^{1/2}a^{1/3} = a^{1/2+1/3} = a^{3/6+2/6} = \boldsymbol{a^{5/6}}$
(add the exponents)

B. $y^{1/2}y^{1/2} = y^{1/2+1/2} = y^1 = \boldsymbol{y}$
(add the exponents)

C. $\left(x^{3/4}\right)^{7/2} = x^{(3/4)(7/2)} = \boldsymbol{x^{21/8}}$

(multiply the exponents)

D. $\dfrac{n^{5/6}}{n^{2/3}} = n^{5/6 - 2/3} = n^{5/6 - 4/6} = \boldsymbol{n^{1/6}}$

(subtract the exponents)

E. $(ab)^{4/5} = \boldsymbol{a^{4/5}b^{4/5}}$

(raise each factor to the 4/5 power)

F. $\left(\dfrac{a}{b}\right)^{5/3} = \dfrac{\boldsymbol{a^{5/3}}}{\boldsymbol{b^{5/3}}}$

(raise top and bottom to the 5/3 power)

G. $\dfrac{w^{1/2}}{w^{4/5}} = w^{1/2 - 4/5} = w^{5/10 - 8/10} = w^{-3/10} = \dfrac{\boldsymbol{1}}{\boldsymbol{w^{3/10}}}$

(subtract the exponents) (LCD) (a negative exponent means reciprocal)

Homework

14. Simplify each expression:

a. $x^{1/2}x^{2/3}$ b. $\dfrac{y^{4/5}}{y^{1/5}}$ c. $\dfrac{w^{1/2}}{w^{2/3}}$ d. $\left(a^{2/7}\right)^{7}$

e. $\left(\dfrac{p}{q}\right)^{3/8}$ f. $t^{4/5}t^{1/3}$ g. $\left(k^{5/2}\right)^{2/5}$ h. $(wz)^{2/3}$

<u>EXAMPLE 4:</u> **Simplify each expression:**

A. $x^{-1/2}x^{-2/3} = x^{-1/2 - 2/3} = x^{-3/6 - 4/6} = x^{-7/6} = \dfrac{\boldsymbol{1}}{\boldsymbol{x^{7/6}}}$

B. $\dfrac{n^{1/2}}{n^{-4/5}} = n^{1/2-(-4/5)} = n^{1/2+4/5} = n^{5/10+8/10} = \boldsymbol{n^{13/10}}$

C. $\left(x^{2/3}\right)^{-1/4} = x^{(2/3)(-1/4)} = x^{-1/6} = \boldsymbol{\dfrac{1}{x^{1/6}}}$

D. $(xy)^{-2/3} = x^{-2/3}y^{-2/3} = \dfrac{1}{x^{2/3}} \cdot \dfrac{1}{y^{2/3}} = \boldsymbol{\dfrac{1}{x^{2/3}y^{2/3}}}$

E. $\left(\dfrac{g}{h}\right)^{-4/3} = \dfrac{g^{-4/3}}{h^{-4/3}} = \dfrac{\frac{1}{g^{4/3}}}{\frac{1}{h^{4/3}}} = \dfrac{1}{g^{4/3}} \times \dfrac{h^{4/3}}{1} = \boldsymbol{\dfrac{h^{4/3}}{g^{4/3}}}$

Homework

15. Simplify each expression:

a. $x^{4/5}x^{-3/5}$ b. $y^{1/3}y^{-5/3}$ c. $\left(a^{-1/2}\right)^{-2/3}$

d. $(abc)^{-3/4}$ e. $\left(\dfrac{w}{z}\right)^{-2/5}$ f. $\dfrac{n^{-1/2}}{n^{-2/3}}$

g. $\dfrac{a^{-3}}{a^{5/2}}$ h. $\dfrac{x}{x^{-2/3}}$ i. $\left(\left(c^{1/2}\right)^{-4/3}\right)^{-3/2}$

Practice Problems

16. Convert $\sqrt[4]{x+y}$ to exponent form.

17. Convert $ab^{2/3}$ to radical form.

18. Convert $(a+b)^{5/2}$ to radical form.

19. Convert $\sqrt{a^3 - x^3}$ to exponent form.

20. Evaluate: a. $9^{1/2}$ b. $64^{1/3}$ c. $81^{1/4}$ d. $32^{1/5}$

21. Evaluate: a. $8^{2/3}$ b. $27^{4/3}$ c. $32^{2/5}$ d. $16^{3/4}$

22. Evaluate: a. $-9^{1/2}$ b. $(-9)^{1/2}$ c. $(-8)^{1/3}$ d. $(-16)^{1/4}$

23. Evaluate: a. $9^{-3/2}$ b. $8^{-4/3}$ c. $125^{-4/3}$ d. $-81^{-1/4}$

24. Simplify: a. $x^{1/2}x^{4/5}$ b. $\dfrac{a^{1/3}}{a^{2/5}}$ c. $(ab)^{4/7}$

25. Simplify: a. $\left(\dfrac{a}{b}\right)^{2/7}$ b. $\left(x^{2/3}\right)^{3/5}$ c. $a^{1/2}a^{1/3}a^{1/4}$

26. Simplify: a. $y^{1/2}y^{-1/2}$ b. $\dfrac{n^{1/3}}{n^{-4/3}}$ c. $(PQ)^{-2/3}$

27. Simplify: a. $\left(\dfrac{x}{w}\right)^{-7/10}$ b. $\left(p^{-2/3}\right)^{5/6}$ c. $x^{2/3} + x^{1/3}$

Solutions

1. a. x^{10} b. a^5 c. z^{15} d. $\dfrac{x^9}{y^9}$ e. m^6n^6

f. As is g. As is h. $2g^6$ i. $x^2 + 2xy + y^2$

j. x k. c^{15} l. $\dfrac{1}{a^4b^4}$ m. $\dfrac{1}{x^2}$ n. $\dfrac{1}{a^8}$

o. $\dfrac{w^3}{u^3}$ p. Assuming you've learned how to multiply binomials, the answer is $a^2 - 2ab + b^2$

2. If w were 0, we'd have $0^{-4} = \frac{1}{0^4} = \frac{1}{0} =$ Undefined

3. a. $25^{1/2} = (5^2)^{1/2} = 5^{2\cdot\frac{1}{2}} = 5^1 = 5$ b. same idea; result is 9

c. same idea; result is 12 d. same idea; result is 7

e. $8^{1/3} = (2^3)^{1/3} = 2^{3\cdot\frac{1}{3}} = 2^1 = 2$ f. same idea; result is 5

g. same idea; result is 3 h. same idea; result is 6

i. $81^{1/4} = (3^4)^{1/4} = 3^{4\cdot\frac{1}{4}} = 3^1 = 3$ j. same idea; result is 4

4. $25^{1/2} = \sqrt{25} = 5$, a real number. But $(-25)^{1/2} = \sqrt{-25}$, not a real number.

5. a. 6 b. 2 c. 2 d. 2 e. 25 f. 1 g. 0 h. 3 i. –5
j. –7 k. Not real l. Not real m. –4 n. –1 o. –2
p. Not real

6. a. $\sqrt{x}$ b. $\sqrt[3]{y}$ c. $\sqrt[4]{z}$ d. $\sqrt[5]{w}$ e. $\sqrt{ab}$
f. $a\sqrt{b}$ g. $x\sqrt[3]{y}$ h. $\sqrt[3]{xy}$ i. $y+\sqrt{z}$ j. $\sqrt{y+z}$
k. $\sqrt[3]{a-b}$ l. $\sqrt[4]{Q+R-T}$

7. a. $x^{1/2}$ b. $y^{1/4}$ c. $z^{1/3}$ d. $n^{1/5}$ e. $ab^{1/2}$ f. $(ab)^{1/2}$
g. $xy^{1/4}$ h. $(tw)^{1/3}$ i. $(x+y)^{1/2}$ j. $(p-q)^{1/3}$ k. $(a+n)^{1/4}$ l. 0

8. a. False; if $x = -9$, for instance, then $(-9)^{1/2} = \sqrt{-9}$ which is not a real number, which means that $x^{1/2}$ is undefined in this class when $x = -9$. In fact, $x^{1/2}$ is undefined whenever x is a negative number.

b. True; since $x^{1/3} = \sqrt[3]{x}$, and since the cube root is defined whether x is positive, zero, or negative, $x^{1/3}$ is always defined.

9. a. $8^{2/3} = 8^{\frac{1}{3}\cdot 2} = \left(8^{1/3}\right)^2 = \left(\sqrt[3]{8}\right)^2 = 2^2 = 4$

b. 8 c. 27 d. 1024 e. 81 f. 9 g. 8

h. $32^{7/5} = 32^{\frac{1}{5}\cdot 7} = \left(32^{1/5}\right)^7 = \left(\sqrt[5]{32}\right)^7 = 2^7 = 128$

10. a. $8^{4/3}$ is the cube root of 8, raised to the 4th power: $2^4 = 16$
b. 2
c. $9^{5/2}$ is the square root of 9, raised to the 5th power: $3^5 = 243$
d. 64 e. 9 f. 81 g. 32
h. $32^{6/5}$ is the fifth root of 32, raised to the 6th power: $2^6 = 64$
i. 4 j. 8 k. 27 l. 1024 m. 81 n. 25 o. 8 p. 128

11. a. $\frac{1}{27}$ b. $\frac{1}{9}$ c. $\frac{1}{16}$ d. $\frac{1}{2}$ e. $\frac{1}{32}$ f. $\frac{1}{3}$
g. $\frac{1}{27}$ h. $\frac{1}{2}$ i. $-\frac{1}{16}$ j. Not real k. $\frac{1}{16}$ l. $\frac{1}{64}$

12. a. $\left(\sqrt[3]{x}\right)^2$ b. $\left(\sqrt[4]{y}\right)^5$ c. $\sqrt[7]{z}$ d. $\left(\sqrt{a+b}\right)^3$ e. $\left(\sqrt[3]{x-y}\right)^4$
f. $\left(\sqrt[5]{xy}\right)^4$ g. $u\left(\sqrt[3]{w}\right)^2$ h. $x+\sqrt[5]{y^4}$ i. $\left(\sqrt[6]{ab+c}\right)^5$

13. a. $t^{1/3}$ b. $z^{1/5}$ c. $(ab)^{1/4}$ d. $xy^{1/3}$ e. $a^{3/2}$
f. $p^{2/3}$ g. $w^{5/4}$ h. $(a+b)^{3/7}$ i. $(x-y)^{10/2} = (x-y)^5$

14. a. $x^{7/6}$ b. $y^{3/5}$ c. $\frac{1}{w^{1/6}}$ d. a^2
e. $\frac{p^{3/8}}{q^{3/8}}$ f. $t^{17/15}$ g. k h. $w^{2/3}z^{2/3}$

15. a. $x^{1/5}$ b. $\frac{1}{y^{4/3}}$ c. $a^{1/3}$ d. $\frac{1}{a^{3/4}b^{3/4}c^{3/4}}$
e. $\frac{z^{2/5}}{w^{2/5}}$ f. $n^{1/6}$ g. $\frac{1}{a^{11/2}}$ h. $x^{5/3}$
i. c

16. $(x+y)^{1/4}$ **17**. $a\left(\sqrt[3]{b}\right)^2$

18. $\left(\sqrt{a+b}\right)^5$ or $\sqrt{(a+b)^5}$

19. $(a^3 - x^3)^{1/2}$

20. a. 3 b. 4 c. 3 d. 2

21.	a. 4	b. 81	c. 4	d. 8
22.	a. –3	b. Not real	c. –2	d. Not real
23.	a. $\frac{1}{27}$	b. $\frac{1}{16}$	c. $\frac{1}{625}$	d. $-\frac{1}{3}$
24.	a. $x^{13/10}$	b. $\frac{1}{a^{1/15}}$	c. $a^{4/7}b^{4/7}$	
25.	a. $\frac{a^{2/7}}{b^{2/7}}$	b. $x^{2/5}$	c. $a^{13/12}$	
26.	a. 1	b. $n^{5/3}$	c. $\frac{1}{P^{2/3}Q^{2/3}}$	
27.	a. $\frac{w^{7/10}}{x^{7/10}}$	b. $\frac{1}{p^{5/9}}$	c. As is	

"If you limit your choices only to what seems possible or reasonable, you disconnect yourself from what you truly want, and all that is left is a compromise."

- *Robert Fritz*