**SEPTEMBER 19, 2019**

**UNIT 1: ROOTS AND POWERS**

**SECTION 4.6:**
**APPLYING THE EXPONENT LAWS**


**K. Sears**
*NUMBERS, RELATIONS AND FUNCTIONS 10*

#2

## WHAT'S THE POINT OF TODAY'S LESSON?

**We will continue working on the NRF 10 Specific Curriculum Outcome (SCO) "Algebra and Numbers 3" OR "AN3" which states:**

**"Demonstrate an understanding of powers with integral and rational exponents."**

#3

# What does THAT mean???

**SCO AN3 means that we will:**

* **apply the 6 exponent laws you learned in grade 9:**
  $a^0 = 1$
  $(a^m)(a^n) = a^{m+n}$
  $a^m \div a^n = a^{m-n}$
  $(a^m)^n = a^{mn}$
  $(ab)^m = a^m b^m$
  $(a \div b)^n = a^n \div b^n$
* **use patterns to explain $a^{-n} = \frac{1}{a^n}$ and $a^{\frac{1}{n}} = \sqrt[n]{a}$**
* **apply all exponent laws to evaluate a variety of expressions**
* **express powers with rational exponents as radicals and vice versa**
* **identify and correct errors in work that involves powers**

#4

## EXPONENT LAWS (separate sheet):

1. **Zero Exponent Law:** $a^0 = 1$
2. **Product of Powers:** $(a^m)(a^n) = a^{m+n}$
3. **Quotient of Powers:** $a^m \div a^n = a^{m-n}$
4. **Power of a Power:** $(a^m)^n = a^{mn}$
5. **Power of a Product:** $(ab)^m = a^m b^m$
6. **Power of a Quotient:** $(a \div b)^n = a^n \div b^n$

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## 7. MULTIPLICATION PROPERTY OF RADICALS:

$\sqrt[n]{ab} = \sqrt[n]{a} \cdot \sqrt[n]{b}$

**EX.:** $\sqrt{24}$ (Factors: 1, 2, 3, 4, 6, 8, 12, 24)

$= \sqrt{4 \cdot 6}$

$= \sqrt{4} \cdot \sqrt{6}$

$= 2 \cdot \sqrt{6}$

$= 2\sqrt{6}$ (MIXED RADICAL)

**EX.:** $\sqrt[3]{24}$ (ENTIRE RADICAL)

$= \sqrt[3]{8 \cdot 3}$

$= \sqrt[3]{8} \cdot \sqrt[3]{3}$

$= 2 \cdot \sqrt[3]{3}$

$= 2\sqrt[3]{3}$

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## 8. POWERS WITH RATIONAL EXPONENTS WITH A NUMERATOR OF 1:

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

**EX.:**

$$8^{\frac{1}{3}}$$

$$= \sqrt[3]{8}$$

$$= 2$$

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## 9. POWERS WITH RATIONAL EXPONENTS:

EXPONENT

$$x^{\frac{m}{n}} = \left(x^{\frac{1}{n}}\right)^m = \left(\sqrt[n]{x}\right)^m$$

INDEX

AND

EXPONENT

$$x^{\frac{m}{n}} = \left(x^m\right)^{\frac{1}{n}} = \sqrt[n]{x^m}$$

INDEX

**EX.:** Evaluate $16^{\frac{3}{2}}$.

$\frac{3}{2}$ (EXPONENT) / (INDEX)

$$16^{\frac{3}{2}} = \left(\sqrt[2]{16}\right)^3 = 4^3 = 64$$

OR

$\frac{3}{2}$ (EXP.) / (INDEX)

$$16^{\frac{3}{2}} = \sqrt[2]{16^3} = \sqrt{4096} = 64$$

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## 10. POWERS WITH NEGATIVE EXPONENTS:

$$x^{-n} = \frac{1}{x^n} \quad AND \quad \frac{1}{x^{-n}} = x^n$$

**EX.:** $4^{-2} = \frac{1}{4^2} = \frac{1}{16}$

**EX.:** $\frac{1}{5^{-2}} = 5^2 = 25$

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**Basically, remember to take the reciprocal of the ENTIRE base and change the negative exponent to a positive exponent.**

**EX.:** $\left(-\frac{3}{4}\right)^{-3}$

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# LAST MINUTE QUESTIONS???
# (page 236, #1 to #8)

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# QUIZ TIME!
# (Sections 4.4 and 4.5 - 10 to 15 min.)

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## 4.6 - APPLYING EXPONENT LAWS:

**Let's build gradually on what we knew in grade 9...**

**For example:**

$$(2^2)(2^6)$$
$$= 2^8$$
$$= 256$$

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# APPLYING EXPONENT LAWS:

## Let's build gradually on what we knew in grade 9...

**For example:**

$$(2^2)(2^{-6})$$
$$= 2^{-4}$$
$$= \frac{1}{2^4}$$
$$= \frac{1}{16}$$

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APPLYING EXPONENT LAWS:

Let's build gradually on what we knew in grade 9...

For example:

$$\left[\left(2^2\right)\left(2^{-6}\right)\right]^{\frac{-3}{2}}$$
$$= \left(2^{-4}\right)^{\frac{-3}{2}}$$
$$= \left(\frac{1}{2^4}\right)^{\frac{-3}{2}}$$
$$= \left(\frac{1}{16}\right)^{\frac{-3}{2}}$$
$$= 16^{\frac{3}{2}}$$
$$= \left(\sqrt{16}\right)^3$$
$$= 4^3$$
$$= 64$$

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## EXAMPLE:

**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)** $\left(\frac{7^{\frac{2}{3}}}{7^{\frac{1}{3}} \cdot 7^{\frac{5}{3}}}\right)^{6}$

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## SOLUTIONS:

**a)** $0.3^{-3} \cdot 0.3^{5} = 0.3^{(-3)+5}$

$= 0.3^{2}$

**b)** $\left[\left(-\frac{3}{2}\right)^{-4}\right]^{2} \cdot \left[\left(-\frac{3}{2}\right)^{2}\right]^{3} = \left(-\frac{3}{2}\right)^{-8} \cdot \left(-\frac{3}{2}\right)^{6}$

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

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

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**c)** $\dfrac{(1.4^3)(1.4^4)}{1.4^{-2}}$

$= \dfrac{1.4^{3+4}}{1.4^{-2}}$

$= \dfrac{1.4^7}{1.4^{-2}}$

$= 1.4^{7-(-2)}$

$= 1.4^9$

**d)** $\left(\dfrac{7^{\frac{2}{3}}}{7^{\frac{1}{3}} \cdot 7^{\frac{5}{3}}}\right)^6$

$= \left(\dfrac{7^{\frac{2}{3}}}{7^{\frac{6}{3}}}\right)^6$

$= \left(7^{\frac{2}{3}-\frac{6}{3}}\right)^6$

$= \left(7^{-\frac{4}{3}}\right)^6$

$= 7^{-\frac{24}{3}}$

$= 7^{-8}$

$= \dfrac{1}{7^8}$ $\left(\frac{1}{7}\right)^8$

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**YOU TRY!**

**a)** $0.8^2 \cdot 0.8^{-7}$ $= 0.8^{-5}$

**b)** $\left[\left(-\dfrac{4}{5}\right)^{2}\right]^{-3} \div \left[\left(-\dfrac{4}{5}\right)^{4}\right]^{-5}$

**c)** $\dfrac{(1.5^{-3})^{-5}}{1.5^5}$

**d)** $\dfrac{9^{\frac{5}{4}} \cdot 9^{-\frac{1}{4}}}{9^{\frac{3}{4}}}$

a) $0.8^{-5} = \left(\frac{8}{10}\right)^{-5}$

$= \left(\frac{10}{8}\right)^{5}$

$= \left(\frac{5}{4}\right)^{5}$

$= \frac{3125}{1024}$

b) $\left(-\frac{4}{5}\right)^{-6} \div \left(-\frac{4}{5}\right)^{-20}$

$\left(-\frac{4}{5}\right)^{-6-(-20)}$

$\left(-\frac{4}{5}\right)^{14}$

c) $\dfrac{(1.5)^{15}}{1.5^5} = 1.5^{10}$

d) $9^{\frac{5}{4}+\frac{-1}{4}-\frac{3}{4}} = 9^{\frac{1}{4}}$

$\doteq 1.7$

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[Answers: a) $\frac{1}{0.8^5}$ b) $\left(-\frac{4}{5}\right)^{14}$

c) $1.5^{10}$ d) $9^{\frac{1}{4}}$]

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**EXAMPLE:**

**a)** $(x^3y^2)(x^2y^{-4}) = x^5y^{-2}$

$= \frac{x^5}{y^2}$

**b)** $\frac{10a^5b^3}{2a^2b^{-2}}$

$= 5a^3b^{3-(-2)}$

$= 5a^3b^5$

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## SOLUTIONS:

**a)** $(x^3y^2)(x^2y^{-4}) = x^3 \cdot y^2 \cdot x^2 \cdot y^{-4}$

$= x^3 \cdot x^2 \cdot y^2 \cdot y^{-4}$

$= x^{3+2} \cdot y^{2+(-4)}$

$= x^5 \cdot y^{-2}$

$= x^5 \cdot \frac{1}{y^2}$

$= \frac{x^5}{y^2}$

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**b)** $\frac{10a^5b^3}{2a^2b^{-2}} = \frac{10}{2} \cdot \frac{a^5}{a^2} \cdot \frac{b^3}{b^{-2}}$

$= 5 \cdot a^{5-2} \cdot b^{3-(-2)}$

$= 5 \cdot a^3 \cdot b^5$

$= 5a^3b^5$

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## HOW I WOULD ACTUALLY SHOW MY WORK:

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

**b)** $\dfrac{10a^5b^3}{2a^2b^{-2}}$

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## YOU TRY!

**a)** $m^4n^{-2} \cdot m^2n^3$

a) $m^6n^1$

**b)** $\dfrac{6x^4y^{-3}}{14xy^2}$

b) $\dfrac{3x^3y^{-3-2}}{7}$

$\dfrac{3x^3y^{-5}}{7}$

$\dfrac{3x^3}{7y^5}$

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[Answers: a) $m^6n$ b) $\frac{3x^3}{7y^5}$]

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**EXAMPLE:** $\frac{3}{1}(\frac{1}{3})$

**a)** $(8a^3b^6)^{\frac{1}{3}} = 2a^1b^2$

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

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

**d)** $\left(\frac{100a^1}{25a^5b^{-\frac{1}{2}}}\right)^{\frac{1}{2}}$ $\left(4a^{-4}b^{\frac{1}{2}}\right)^{\frac{1}{2}}$ $2a^{-2}b^{\frac{1}{4}}$ $\frac{2b^{\frac{1}{4}}}{a^2}$

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**SOLUTIONS:**

**a)** $(8a^3b^6)^{\frac{1}{3}} = 8^{\frac{1}{3}} \cdot a^{3\left(\frac{1}{3}\right)} \cdot b^{6\left(\frac{1}{3}\right)}$

$= (2^3)^{\frac{1}{3}} \cdot a^1 \cdot b^2$

$= 2ab^2$

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

$= x^{\frac{3}{2}+\frac{1}{2}} \cdot y^{2+(-1)}$

$= x^2y$

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

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

$$= 2\cdot a^{-4}\cdot b^{\frac{1}{3}}$$

$$= \frac{2b^{\frac{1}{3}}}{a^{4}}$$

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$$\text{d)}\left(\frac{100a}{25a^{5}b^{-\frac{1}{2}}}\right)^{\frac{1}{2}} = \left(\frac{100}{25}\cdot\frac{a^{1}}{a^{5}}\cdot\frac{1}{b^{-\frac{1}{2}}}\right)^{\frac{1}{2}}$$

$$= \left(4\cdot a^{1-5}\cdot b^{\frac{1}{2}}\right)^{\frac{1}{2}}$$

$$= \left(4\cdot a^{-4}\cdot b^{\frac{1}{2}}\right)^{\frac{1}{2}}$$

$$= 4^{\frac{1}{2}}\cdot a^{(-4)\left(\frac{1}{2}\right)}\cdot b^{\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)}$$

$$= 2\cdot a^{-2}\cdot b^{\frac{1}{4}}$$

$$= \frac{2b^{\frac{1}{4}}}{a^{2}}$$

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## HOW I WOULD ACTUALLY SHOW MY WORK:

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

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

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## HOW I WOULD ACTUALLY SHOW MY WORK:

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

**d)** $\left(\dfrac{100a}{25a^5b^{-\frac{1}{2}}}\right)^{\frac{1}{2}}$

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**YOU TRY!**

**a)** $(25a^4b^2)^{\frac{3}{2}}$

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

**c)** $\dfrac{12x^{-5}y^{\frac{5}{2}}}{3x^{\frac{1}{2}}y^{-\frac{1}{2}}}$

**d)** $\left(\dfrac{50x^2y^4}{2x^4y^7}\right)^{\frac{1}{2}}$

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**a)** $(25a^4b^2)^{\frac{3}{2}}$ $25^{\frac{3}{2}}(a^4)^{\frac{3}{2}}(b^2)^{\frac{3}{2}}$

$125\ a^{\frac{12}{2}}\ b^{\frac{6}{2}}$

$125a^6b^3$

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

$= x^{3-1}\ y^{-\frac{3}{2}+\frac{1}{2}}$

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

$= x^2 y^{-1}$

$= \frac{x^2}{y}$

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**c)** $\frac{12x^{-5}y^{\frac{5}{2}}}{3x^{\frac{1}{2}}y^{-\frac{1}{2}}}$

$= 4x^{-5-\frac{1}{2}}\ y^{\frac{5}{2}+\left(-\frac{1}{2}\right)}$

$= 4x^{-5\frac{1}{2}}\ y^{\frac{6}{2}}$

$= 4x^{-\frac{11}{2}}\ y^{3}$

$= \frac{4y^3}{x^{\frac{11}{2}}}$

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**d)** $\left(\dfrac{50x^2y^4}{2x^4y^7}\right)^{\frac{1}{2}} = \left(\dfrac{25x^2y^4}{x^4y^7}\right)^{\frac{1}{2}}$

$= \left(\dfrac{25}{x^2y^3}\right)^{\frac{1}{2}}$

$= \dfrac{\sqrt{25}}{\sqrt{x^2}\sqrt{y^3}}$

$= \dfrac{5}{xy^{\frac{3}{2}}}$

$(x^2)^{\frac{1}{2}} = x^{\frac{2}{2}} = x$

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[Answers: a) $125a^6b^3$ b) $\dfrac{x^2}{y}$

c) $\dfrac{4y^3}{x^{\frac{11}{2}}}$ d) $\dfrac{5}{xy^{\frac{3}{2}}}$]

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# CONCEPT REINFORCEMENT:

*FPCM 10*:

Page 241: #3 to #6
Page 242: #7 to #11, #14 to #17 & #19
Page 243: #21 & #22

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# UNIT 1 TEST PREPARATION

*FPCM 10*:

Page 197: Skills Summary (3.1 / 3.2)
Page 198: Review Questions (3.1 / 3.2)
Page 201: Practice Test (#1 & #3)

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Page 244: Study Guide
Page 245: Skills Summary
Pages 246 to 248: Review Questions
Page 249: Practice Test

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