## Foundations of Math & Pre-Calculus 10
## Grade 9 Exponent Laws Review

- **Exponent Law for a Product of Powers:**

$$a^m \times a^n = a^{(m+n)}, \; a \neq 0$$

To multiply powers with the same base, add the exponents. The variable $a$ is any integer, except 0. The variables $m$ and $n$ are any whole numbers.

- **Exponent Law for a Quotient of Powers:**

$$a^m \div a^n = a^{(m-n)}, \; a \neq 0$$

To divide powers with the same base, subtract the exponents. The variable $a$ is any integer, except 0. The variables $m$ and $n$ are any whole numbers.

<u>Example #1</u>: Simplify each expression (write as a single power).

a) $8^5 \times 8^7 = \boxed{8^{12}}$

$5+7$

*another way to write division*

b) $(-4)^{12} \div (-4) = \dfrac{(-4)^{12}}{(-4)^1} = \boxed{(-4)^{11}}$

$* \; a = a^1$

$(-4) = (-4)^1$

*any # has an exponent of 1*

$12-1$

*brackets are essential!*

c) $k^6 \times k^2 = \boxed{k^8}$

$6+2$

d) $\dfrac{h^2 \times h^5}{h^9} = \dfrac{h^7}{h^9} = \boxed{h^{-2}}$

$2+5 \quad 7-9$

*negative exponents are okay (for now)*

<u>Example #2</u>: Simplify and evaluate each expression.

a) $2^2 + 2^3 \times 2^2 = \boxed{2^2 + 2^5}$ ← "Simplify"

*no rules for simplifying addition (or subtraction) of powers*

$= 4 + 32$

$= \boxed{36}$ ← "Evaluate"

| 2 | 4 | 8 | 16 |
|---|---|---|---|
| ×2 | ×2 | ×2 | ×2 |
| 4 | 8 | 16 | 32 |

b) $(-3)^4 [(-3)^6 \div (-3)^4] - 3^2$

*\* Follow BEDMAS*

$= (-3)^4 [(-3)^2] - 3^2$

$= \boxed{(-3)^6 - 3^2}$ ← cannot combine; "Simplified"

$= 729 - 9$

$= \boxed{720}$ ← "Evaluated"

$* \; (-3)^6$ on calc:

$(-3) \boxed{\wedge} 6$ or

$(-3) \boxed{x^y} 6$ or

$(-3) \boxed{y^x} 6$

- **Exponent Law for a Power of a Power:** $\boxed{(a^m)^n = a^{mn},\ a \neq 0}$

  To raise a power to a power, multiply the exponents. The variable $a$ is any integer, except 0. The variables $m$ and $n$ are any whole numbers.

  <u>Example #3</u>: Simplify each expression (write as a single power).

  a) $(8^2)^5\ =\ \boxed{8^{10}}$

  $2 \times 5$

  b) $[(-7)^3]^4\ =\ \boxed{(-7)^{12}}$ ← remember, brackets are essential (they must be there) since $-7^{12} \neq (-7)^{12}$

  $3 \times 4$

- **Exponent Law for a Power of a Product:** $\boxed{(a \times b)^m = a^m \times a^m,\ a, b \neq 0}$

  The variables $a$ and $b$ are any integers, except 0. The variable $m$ is any whole number.

- **Exponent Law for a Power of a Quotient:** $\boxed{(a \div b)^m = a^m \div a^m,\ a, b \neq 0}$

  The variables $a$ and $b$ are any integers, except 0. The variable $m$ is any whole number.

  <u>Example #4</u>: Write each expression as a product or quotient of powers.

  a) $(cd)^2 = \boxed{c^2 d^2}$

  b) $(e^2 f^4 g)^3 = \boxed{e^6 f^{12} g^3}$

  c) $\left(\dfrac{j}{k}\right)^4 = \boxed{\dfrac{j^4}{k^4}}$

  d) $\left(\dfrac{m^2}{n^5}\right)^5 = \boxed{\dfrac{m^{10}}{n^{25}}}$

  <u>Example #5</u>: Simplify the following expression.

  $$\left(\frac{4p^{-2}r^4}{p^0 r^5 \times p^3 r^3}\right)^2 = \left(\frac{4p^{-2}r^4}{p^3 r^8}\right)^2 = \left(4p^{-5}r^{-4}\right)^2$$

  \* do inside brackets first

  \* simplify top, and then bottom, of fraction

  $$= 4^2 p^{-10} r^{-8}$$

  $$= \boxed{16\,p^{-10}\,r^{-8}}$$