Name: ________________________________ Points: ______

1. Properties of Exponents

Multiplication/Product Rule	$x^m \cdot x^n =$
Division/Quotient Rule	$\dfrac{x^m}{x^n} =$ where $(x \neq 0)$
Zero Exponent	$x^0 =$ where $(x \neq 0)$
Power of a Power	$(x^m)^n =$
Power of a Product	$(x \cdot y)^n =$
Power of a Quotient	$\left(\dfrac{x}{y}\right)^n =$ where $(y \neq 0)$
Negative Exponent	$x^{-n} =$ where $(x \neq 0)$

Schwartzman (1994) defines **Exponent:** "From the Latin **ex**, meaning 'away, out' and **ponent**, the present participle stem of the word **ponere** meaning 'to put or to place.' When something is **exposed** it is "put out" so it can be seen. Similarly, in mathematical notation the **exponent** is the small number or letter that is "put out" to the right and above the base when that base is being raised to a power, also called a "superscript." An exponent is therefore named after its physical appearance in writing rather than its mathematical significance."

a. Simplify $(-3x^{-3}y^2)(4x^2y^{-5})$

b. Simplify $(mm^2)^3(2m^{-7}n^6)^5$

Instead of writing out long multiplication of the same number, for example, $2\times2\times2$, a symbolic representation of this idea was developed, so that $a \times a \times a = a^3$. Rene Descartes introduced this idea in 1637 in his book "La Geometrie," so that any value multiplied by itself a certain number of times could be represented as a^2, a^3, or a^4. Descartes was both a philosopher and a mathematician, and is famous for, among other things, the line, *Cogito, ergo sum*, which in English is *I think, therefore I am*.

Supported by CUNY OAA-Improving Undergraduate Learning Outcomes in Mathematics, BMI, NSF STEP #0622493, Perkins and DOE MSEIP Grant #120A150063

Schwartzman (1994) defines **Power:** "From old French word **poier**, from the Vulgar Latin **potere** a variant of classic Latin **posse** meaning 'to be able.' The Indo-European root is **poti,** meaning 'powerful [as in]: Lord.' If one is able to do many things one is considered powerful. A powerful person typically has a large number of possessions (a word derived from 'posse') and a large amount of money. In algebra when even a small number like 2 (two) is multiplied by itself a number of times, the result becomes very large quickly; metaphorically speaking, the result is powerful. If the term 'power' is used precisely, it refers to the result of multiplying a number by itself a certain number of times."

c. Simplify $\left(\frac{1}{9}\right)^{-1}+\left(-\frac{2}{3}\right)^{2}-\left(\frac{3}{6}\right)^{0}$

d. Simplify $\left(\frac{7x^{3}y^{-4}}{x^{-3}y^{9}}\right)^{3}$

e. Simplify $\left(\frac{-6a^{-4}b^{6}}{a^{-2}b^{-5}c}\right)^{-3}$

Figure 1

The first known reasoning behind mathematical exponents started with the Egyptians of the Middle Empire, 2040-1630 B.C. (Cajori, 2007). The ancient symbol for squaring a number was found in a hieratic Egyptian papyrus of that period. In part of the ancient Papyrus containing the computation of the volume of a pyramid of a square base occurs a hieratic term containing a pair of walking legs (see Figure 1) signifying "make in going," which means squaring the number.

References:

Cajori, F. (2007). *A history of mathematical notations*. Volume 1, 2, 335-339. Chicago, IL: Open Court Publishing Co.

Swartzman, S. (1994). *The words of mathematics: An etymological dictionary of mathematical terms used in English*. USA: The Mathematical Association of America.

Supported by CUNY OAA-Improving Undergraduate Learning Outcomes in Mathematics, BMI, NSF STEP #0622493, Perkins and DOE MSEIP Grant #120A150063