**SM 2**

**Date:** **Section: 3.1**

**Objective: Exponent rules**

The following properties are true for all real numbers *a* and *b* and all integers *m* and *n*, provided that no denominators are 0 and that $0^0$ is not considered.

| | | |
|---|---|---|
| 1 as an exponent: | $a^1 = a$ | e.g.) $7^1 = 7,\ \pi^1 = \pi,\ (-10)^1 = -10$ |
| 0 as an exponent: | $a^0 = 1$ | e.g.) $2^0 = 1,\ 27^0 = 1,\ \left(-\frac{5}{8}\right)^0 = 1$ |
| The Product Rule: | $a^m \cdot a^n = a^{m+n}$ | e.g.) $x^2 \cdot x^5 = x^{2+5} = x^7$ |
| The Quotient Rule: | $\frac{a^m}{a^n} = a^{m-n}$ | e.g.) $\frac{x^5}{x^2} = x^{5-2} = x^3$ |
| The Power Rule: | $(a^m)^n = a^{mn}$ | e.g.) $(x^2)^5 = x^{(2)(5)} = x^{10}$ |
| Raising a product to a power: | $(ab)^n = a^n b^n$ | e.g.) $(2k)^4 = 2^4 \cdot k^4 = 16k^4$ |
| Raising a quotient to a power: | $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$ | e.g.) $\left(\frac{p}{q^2}\right)^3 = \frac{p^3}{(q^2)^3} = \frac{p^3}{q^6}$ |
| Negative exponents: | $a^{-n} = \frac{1}{a^n}$ | e.g.) $2^{-3} = \frac{1}{2^3},\ 7x^3y^{-4} = \frac{7x^3}{y^4}$ |
| | $\frac{1}{a^{-n}} = a^n$ | e.g.) $\frac{1}{x^{-9}} = x^9,\ \frac{b}{c^{-3}d} = \frac{bc^3}{d}$ |
| | $\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n = \frac{b^n}{a^n}$ | e.g.) $\left(\frac{2}{v}\right)^{-3} = \left(\frac{v}{2}\right)^3 = \frac{v^3}{2^3} = \frac{v^3}{8}$ |

**To *simplify* an expression containing powers means to rewrite the expression without parentheses or negative exponents.**

**Examples:** Simplify the following expressions.

a) $m^5 \cdot m^7$

b) $\left(5a^2b^3\right)\left(3a^4b^5\right)$

c) $\frac{r^9}{r^3}$

d) $\frac{p^3}{p^7}$

e) $\frac{10x^{11}y^5}{2x^4y^7}$

f) $\frac{4x^3y^2}{6x^7y}$

g) $(-2)^4$

h) $-2^4$

i) $5x^{-4}y^3 \cdot x^2y^{-1}$

j) $\frac{1}{6^{-2}}$

k) $9^{-3} \cdot 9^8$

l) $\frac{3x^2}{15x^{-3}y^{-4}}$

m) $\left(3^5\right)^4$

n) $\frac{y^{-5}}{y^{-4}}$

o) $\left(y^{-5}\right)^7$

p) $\left(a^{-3}\right)^{-7}$

q) $(-2x)^3$

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

s) $\left(3x^5y^{-1}\right)^{-2}$

t) $\left(\frac{y^2z^3}{5}\right)^{-3}$