**Chapter P**
**Section P.2**

**Problem 1.** Evaluate the following expressions without using a calculator. Assume that all variables represent nonzero real numbers.

(a) $(-2)^2 3^3$ $= 108$

(b) $\left(\frac{2}{5}\right)^2 = \frac{4}{25}$

(c) $-(3^2 \cdot 5)^0 = -1$

(d) $30^0 = 1$

(e) $-30^0 = -1$

use same notation i.e. $-(30)$

(f) $(-30)^0 = 1$

(g) $20^0 + 30^0 = 2$

(h) $(x^3 y^{-7} k^5 4)^0 = 1$

**Problem 2.** Write each expression with only positive exponents. Assume that all variables represent nonzero real numbers

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

(b) $3^{-3} = \frac{1}{3^3} = \left(\frac{1}{3}\right)^3$

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

(d) $-5r^{-2} = \frac{-5}{r^2}$

(e) $3^{-3} + 9^{-2} = \frac{1}{3^3} + \frac{1}{(3^2)^2} = \frac{1}{3^3} + \frac{1}{3^4} = \frac{3+1}{3^4} = \frac{4}{3^4}$

(f) $3^{-1} - 6^{-1} = \frac{1}{3} - \frac{1}{6} = \frac{2-1}{6} = \frac{1}{6}$

(g) $\left(\frac{1}{5}\right)^{-2} = 5^2$

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

(i) $\left(\frac{3z}{4}\right)^{-3} = \frac{4^3}{3^3 z^3}$

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

**Problem 3.** Apply the quotient rule for exponents, if possible, and write each result with only positive exponents. Assume that all variables represent nonzero real numbers.

(a) $\frac{r^9}{r^{12}} = r^{9-12} = r^{-3} = \frac{1}{r^3}$

(b) $\frac{k^7}{k^3} = k^{7-3} = k^4$

(c) $\frac{c^7}{b^3} = \frac{c^7}{b^3}$

(d) $\frac{12^{-7}}{12^{-6}} = 12^{-7+6} = 12^{-1} = \frac{1}{12}$

(e) $\frac{3}{3^{-4}} = 3^{1+4} = 3^5$

(f) $\frac{a^5}{b^3} = \frac{a^5}{b^3}$

**Problem 4.** Simplify using the power rules. Assume that all variables represent nonzero real numbers.

(a) $\left(\frac{-4x}{5}\right)^3 = \frac{-4^3x^3}{5^3}$

(b) $(3x^4)^2 = 3^2x^8$

(c) $\left(\frac{-2y^3}{z^4}\right)^6 = \frac{2^6y^{18}}{z^{24}}$

**Problem 5.** Write each of the following expressions with a single exponent.

(a) $3^3 \cdot 3^n = 3^{3+n}$

(b) $\frac{2^a 3^a}{6^b} = \frac{6^a}{6^b} = 6^{a-b}$

(c) $\frac{x^7 y}{(x^2)^3}$ (assuming $x \neq 0$)

$= xy$

(d) $(x^2+y)^3(x^2+y)^2$

$= (x^2+y)^5$

This has 2 exponents... Could be needlessly confusing for students

**Problem 6.** Simplify each expression so that no negative exponents appear in the final result. Assume that all variables represent nonzero real numbers.

(a) $(3a^{-2}b^{-4})$

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

(b) $\frac{9^{-3}}{9^7 9^{-2}} = 9^{-3-7+2} = 9^{-8} = \frac{1}{9^8}$

(c) $\frac{12w^7w^{-3}}{20w^{-1}w^5} = \frac{3}{5}w^{7-3+1-5}$ ($12 = 3\cdot 2^2$, $20 = 2^2\cdot 5$)

$= \frac{3}{5}$

(d) $(-2p^2)(3q)^0(5r^2)$

$= -10p^2r^2$

(e) $(-5r^{-2}s^5t^{-3})^2(sr^2s^{-3}t)^{-2}$

$= 5^2r^{-4}s^{10}t^{-6}s^{-2}r^{-4}s^6t^{-2}$

$= 5^2r^{-4-4}s^{10-2+6}t^{-6-2}$

$= \frac{5^2s^{14}}{r^8t^8}$

(f) $\frac{3^{-2}x^{-4}(x^2)^{-3}}{2(x^2)^{-1}} = \frac{1}{6}x^{-4-6+2} = \frac{1}{6x^8}$

(g) $(3x^2y^{-2})^{-2}(2x^{-2}y)^{-3}$

$= \frac{1}{3^2 2^3}\cdot x^{-4+6}y^{4-3}$

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

(h) $\left(\frac{a^6b^{-2}}{2a^{-2}}\right)^{-1}\cdot\left(\frac{6a^{-2}}{5b^{-4}}\right)^2\cdot\left(\frac{2b^{-1}a^2}{3b^{-2}}\right)^{-1}$

$= \left(\frac{1}{2}a^{-6+2}b^2\right)\left(\frac{36}{25}a^{-4}b^{-8}\right)\left(\frac{3}{2}b^3a^{-2}\right)$

$= \frac{27}{25}a^{-10}b^{-3} = \frac{27}{25a^{10}b^3}$