Warm-up

Simplify

① $x^3 \cdot x^{12}$

$x^{3+12} = x^{15}$

$7^3 \cdot 7^{12} = 7^{15}$

② $a^6 c^2 \cdot a^4$

$a^{10} c^2$

③ $(f^3 u^2 n^5)^5$

$f^{3 \cdot 5} u^{2 \cdot 5} n^{1.5}$

$f^{15} u^{10} n^5$

④ $\dfrac{x^4 y^1 z^7}{x^1 y^2 z^7} = \dfrac{x^3}{y^1} = \dfrac{x^3}{y}$

5.1 Properties of Exponents

① Products of Powers

$2^3 \cdot 2^4 = (2\cdot2\cdot2)(2\cdot2\cdot2\cdot2) = 2^7$ or 2^{3+4}

add exponents

$4^3 \cdot 12^7$ → can't combine base not same

So $a^m \cdot a^n = a^{m+n}$

② Power of a Power

$(5^3)^2 = 5^3 \cdot 5^3 = 5^6$ or $5^{3\cdot2}$

multiply exponents

So $(a^m)^n = a^{mn}$

③ Power of a Product

$(2^3 \cdot 4)^3 = (2^3 \cdot 4)(2^3 \cdot 4)(2^3 \cdot 4) = 2^9 \cdot 4^3$

So $(a^n \cdot b)^m = a^{m\cdot n} \cdot b^m$

④ Quotient of Powers

$\frac{4^5}{4^2} = 4^{5-2} = 4^3$

$\frac{4^3}{4^7} = \frac{1}{4^{7-3}} = \frac{1}{4^4}$

$\frac{a^m}{a^n} =$ or

⑤ Power of a Quotient

$\left(\frac{5}{3}\right)^4 = \frac{5^{1\cdot4}}{3^{1\cdot4}} = \frac{5^4}{3^4}$

So $\left(\frac{a}{b}\right)^m =$

⑥ Zero Exponent

$4^0 = 4^{3-3} = \frac{4^3}{4^3}$ $\frac{64}{64} = 1$ Same # on top & bottom

$(-8)^0 =$ ← subtract same # on top & bottom $= 1$

So $a^0 = 1$, $a \neq 0$ except 0^0 = undefined

⑦ Negative Exponent

$\frac{4^3}{4^7} = \frac{4^{3-7}}{1} = 4^{-4}$ To be happy → $\frac{1}{4^{7-3}} = \frac{1}{4^4}$

So $\frac{4^{-4}}{1} = \frac{1}{4^4}$

$\frac{8^5}{8^2} = \frac{1}{8^{2-5}} \cdot \frac{1}{8^{-3}}$ To be happy → $\frac{8^{5-2}}{1} = 8^3$

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

$\frac{1}{9^{-2}} =$ Move upstairs to make happy $\frac{9^2}{1} = 9^2$

So $a^{-m} =$ or $\frac{1}{a^{-m}} =$

Examples

Simplify

① $\dfrac{-4\ \ b^{4}}{2a^{-1}b^{4}}$

② $\dfrac{3^{-2}x^{4}y^{-5}}{x^{2}y^{-4}z}$

③ $(x^{-2}y^{6})(x^{3}y^{-8})$

④ $\left(\dfrac{4c^{2}d}{6cd^{5}}\right)^{2}$

⑤ $\left(\dfrac{23\cdot\pi-1}{(76\div4)^{2}}\right)^{0}$

Homework

(3) $3^3 \cdot 3^2$

(6) $(2^4)^2$

(9) $9^3 \cdot 9^{-1}$

(12) $\left(\frac{2}{3}\right)^{-5}\left(\frac{2}{3}\right)^4$

(15) $(4.2 \times 10^3)(1.5 \times 10^6)$

(18) $(7.2 \times 10^9)(9.4 \times 10^8)$

(21) $\frac{8.1 \times 10^{12}}{5.4 \times 10^9}$

(24) $\frac{w^{-2}}{w^6}$

(27) $(w^3 x^{-2})(w^6 x^{-1})$

(30) $\frac{x^{-1} y^2}{x^2 y^{-1}}$

(33) $\frac{2a^3 b^{-4}}{3a^5 b^{-2}}$