

$$1) \frac{2u^3v^3 \cdot (3u^2)^2}{2u^2} \quad \text{power to power first}$$

$$= \frac{2u^3v^3 \cdot 3^2u^4}{2u^2}$$

now use product law for top

$$= \frac{2 \cdot 3^2 u^{3+4} v^3}{2u^2}$$

$$= \frac{\cancel{2} \cdot 9 u^7 v^3}{\cancel{2} u^2} \quad \leftarrow \text{divide } \frac{2}{2} = 1$$

$$= \frac{9 u^7 v^3}{u^2}$$

quotient law

$$= 9 u^{7-2} v^3$$

$$= 9 u^5 v^3$$

$$2) \frac{(4xy^2)^3}{(4y^3)^4 \cdot 2y^3}$$

Step 1 → Since nothing in Bracket simplify
apply Power of a Power

$$\frac{4^3 x^3 y^6}{4^4 y^{12} 2y^3}$$

Step 2 → ~~Step~~ Simplify bottom by pulling
like terms together (product law)

$$\frac{4^3 x^3 y^6}{4^4 \cdot 2y^{15}}$$

quotient law

$$\frac{4^{-1} x^3 y^{-9}}{2}$$

$$\frac{x^3}{4 \cdot 2 y^9} \Rightarrow \frac{x^3}{8y^9}$$

$$3) \quad \frac{(4^1 u v^2)^2}{3^1 u^2 v^4 \cdot 3^1 v^2} \quad \leftarrow \begin{array}{l} \text{Collect like terms} \\ \text{product law} \end{array}$$

$$= \frac{(4^1 u v^2)^2}{3^2 u^2 v^6}$$

power to a power

$$= \frac{4^2 u^2 v^4}{3^2 u^2 v^6}$$

quotient law

$$= \frac{16 u^0 v^{-2}}{9} \quad \leftarrow \begin{array}{l} \text{move to bottom} \\ \text{since negative} \\ \text{exponent} \end{array}$$

$$= \frac{16}{9 v^2} \quad \begin{array}{l} \text{this is 1} \\ \text{so doesn't} \\ \text{change} \end{array}$$

4) $\left(\frac{4a^4b^3}{3a^4b^3 \cdot 4a^3b^4} \right)^3$
 Simplify inside bracket first

$\left(\frac{\cancel{4}a^4b^3}{3 \cdot \cancel{4}a^7b^7} \right)^3$ quotient law inside

$\left(\frac{a^{4-7} b^{3-7}}{3} \right)^3$

$\left(\frac{a^{-3} b^{-4}}{3} \right)^3$ power law

$= \frac{a^{-9} b^{-12}}{3^3}$ since neg exponent move to bottom

$= \frac{1}{\underset{\substack{\text{in} \\ \text{evaluate}}}{3^3} a^9 b^{12}}$

$= \frac{1}{27 a^9 b^{12}}$

5) $\left(\frac{3y^3 \cdot 3x^3y^4}{4x^4y^2}\right)^4$ 6)

simplify inside bracket first

$$= \left(\frac{3^2 y^7 x^3}{4 y^2 x^4}\right)^4$$

inside quotient law

$$= \left(\frac{3^2 y^{7-2} x^{3-4}}{4}\right)^4$$

$$= \left(\frac{3^2 y^5 x^{-1}}{4}\right)^4$$

power to power

$$= \frac{3^8 y^{20} x^{-4}}{4^4} \leftarrow \text{move to bottom}$$

$$= \frac{6561 y^{20}}{256 x^4}$$

7) $26x^2$

$$b) \left(\frac{3x y^4 \cdot 3x^3 y^2}{y x^4} \right)^3$$

simplify inside bracket first

$$= \left(\frac{3^3 x^4 y^6}{x^4 y^1} \right)^3$$

quotient law inside bracket

$$= (3^3 x^{4-4} y^{6-1})^3$$

$$= (3^3 x^0 y^5)^3$$

↑
this is 1

$$= (3^2 y^5)^3$$

← power to power

$$= 3^6 y^{15}$$

$$= 729 y^{15}$$

$$7) \frac{2ba^2}{4a(2a^3b^4)^3}$$

power of power
for bracket

$$= \frac{2^1ba^2}{4a^1 2^3a^9b^{12}}$$

← combine like terms
product law

$$= \frac{2^1b^1a^2}{4 \cdot 2^3a^{10}b^{12}}$$

quotient law

$$= \frac{2^{1-3}b^{1-12}a^{2-10}}{4}$$

$$= \frac{2^{-2}b^{-11}a^{-8}}{4}$$

← move all negative
exponents to bottom

$$= \frac{1}{2^2 \cdot 4b^{11}a^8} = \frac{1}{4 \cdot 4b^{11}a^8} = \frac{1}{16b^{11}a^8}$$

$$8) \frac{(2x^2y^2)^4}{(2x^2 \cdot (yx^2)^3)^2}$$

do Bracket first power + power

$$= \frac{(2x^2y^2)^4}{(2x^2 \cdot y^3x^6)^2}$$

combine like terms product law

$$= \frac{(2x^2y^2)^4}{(2x^8y^3)^2}$$

power to power
on top

$$= \frac{2^4 x^8 y^8}{(2x^8 y^3)^2}$$

power to power
bottom

$$= \frac{2^4 x^8 y^8}{2^2 x^{16} y^6}$$

$$= 2^{4-2} x^{8-16} y^{8-6}$$

quotient law

$$= 2^2 x^{-8} y^2$$

$$= \frac{2^2 y^2}{x^8}$$

2 value
moved to bottom

10)

$$9) \frac{(m^2 n^2)^2}{3m^4 n^2 \cdot 2m^3 n^2} \leftarrow \begin{array}{l} \text{combine like terms} \\ \text{product law} \end{array}$$

$$= \frac{(m^2 n^2)^2}{\underbrace{3 \cdot 2}_{\text{evaluate}} m^7 n^4} \leftarrow \text{power to a power}$$

$$= \frac{m^4 n^4}{6 m^7 n^4}$$

quotient law

$$= \frac{m^{4-7} n^{4-4}}{6}$$

$$= \frac{m^{-3} n^0}{6} \leftarrow \begin{array}{l} \text{more neg exp to bot} \\ \text{this is 1} \\ \text{since } n^0 = \end{array}$$

$$= \frac{1}{6 m^3}$$

$$10) \frac{x^2}{4x^4y^2 \cdot (3x^4y^2)^2} \quad \text{do power of power bracket}$$

$$= \frac{x^2}{4x^4y^2 \cdot 3^2x^8y^4} \quad \leftarrow \text{combine like terms product law}$$

$$= \frac{x^2}{4 \cdot 3^2 x^{12} y^6} \quad \left. \vphantom{\frac{x^2}{4 \cdot 3^2 x^{12} y^6}} \right\} \text{quotient law}$$

$$= \frac{x^{2-12}}{4 \cdot 9 y^6}$$

$$= \frac{x^{-10}}{36 y^6} \quad \leftarrow \text{neg exponent move to bottom}$$

$$= \frac{1}{36x^{10}y^6}$$