

USE **BIDMAS** and **SIMPLIFY** when necessary.  
write with **positive powers**

Ex 1 D

Qn 1 a)  $(3a^2b^2)^3 \times 2a^4b^3$

$= 3^3 a^6 b^6 \times 2a^4 b^3$

$= 3^3 \times 2 \times a^{6+4} \times b^{6+3}$

$3^3 \times 2 = 6$

$= 54 \times a^{10} \times b^9$

$= 54 a^{10} b^9$

Bracket is simplified already  
Index Law  $(a^m b^n)^r = a^{mr} b^{nr}$

Multiply numbers and powers with the same base.  
 $a^m \times a^n = a^{m+n}$

Simplify the powers

b)  $(4ab^5)^2 \times 3a^3b^6$

$= 4^2 a^2 b^{10} \times 3a^3 b^6$

$= 4^2 \times 3 \times a^{2+3} \times b^{10+6}$

$= 48 a^5 b^{16}$

Bracket simplified ✓  
Index:  $(a^m b^n)^r = a^{mr} b^{nr}$

Multiply numbers and powers with the p

Simplify by the powers.

c)  $2m^3 n^{-5} \times (m^2 n^3)^{-6}$

$= 2m^3 n^{-5} \times m^{-12} n^{+18}$

$= 2 \times m^{3+(12)} n^{-5+(18)}$

$= 2 \times m^9 \times n^{13}$

$= 2 \times \frac{1}{m^9} \times n^{13}$

$= \frac{2n^{13}}{m^9}$

Bracket simplified ✓  
Index  $(a^m)^n = a^{mn}$

Multiply numbers and  $a^m \times a^n = a^{m+n}$

Write with positive powers  
 $a^{-n} = \frac{1}{a^n}$

Simplify  $2 \times \frac{1}{m^9} \times n^{13} = \frac{2}{1} \times \frac{1}{m^9} \times \frac{n^{13}}{1}$

Qn 1 d)  $(2pq^3)^2 \times (5p^2q^4)^3$

$$= 2^2 p^2 q^6 \times 5^3 p^6 q^{12}$$

$$= 2^2 \times 5^3 \times p^{2+6} \times q^{6+12}$$

$$= 4 \times 125 \times p^8 \times q^{18}$$

$$= 500 p^8 q^{18}$$

{ Brackets simplified ✓  
 Index  $(a^m)^n = a^{mn}$   
 { Multiply numbers and powers with same base  
 { simplify the power →

e)  $(2a^7b^2)^2 \times (3a^3b^3)^2$

$$= 2^2 a^{14} b^4 \times 3^2 a^6 b^6$$

$$= 2^2 \times 3^2 \times a^{14+6} \times b^{4+6}$$

$$= 4 \times 9 \times a^{20} \times b^{10}$$

$$= 36 a^{20} b^{10}$$

{ Brackets simplified ✓  
 Index  $(a^m)^n = a^{mn}$   
 { Multiply  
 { Simplify the power →

f)  $5(b^2c^{-2})^3 \times 3(bc^5)^{-4}$

$$= 5 \times b^6 c^{-6} \times 3 \times b^{-4} c^{-20}$$

$$= 15 \times b^{6+(-4)} \times c^{-6+(-20)}$$

$$= 15 \times b^2 \times c^{-26}$$

$$= 15 \times b^2 \times \frac{1}{c^{26}}$$

$$= \frac{15b^2}{c^{26}}$$

{ Bracket simplified ✓  
 Index  $(a^m)^n = a^{mn}$   
 { Multiply  
 { simplify  
 {  $a^{-n} = \frac{1}{a^n}$ , write with positive power  
 $15 \times b^2 \times \frac{1}{c^{26}} = \frac{15}{1} \times \frac{b^2}{1} \times \frac{1}{c^{26}}$

2a) g)  $6x^{\frac{1}{2}}y^{\frac{1}{3}} \times (4x^{\frac{3}{4}}y^{\frac{4}{5}})^{\frac{1}{2}}$

Brackets simplified ✓  
Index  $(a^m)^n = a^{mn}$

$$= 6x^{\frac{1}{2}}y^{\frac{1}{3}} \times 4^{\frac{1}{2}} \times x^{\frac{3}{4} \times \frac{1}{2}} \times y^{\frac{4}{5} \times \frac{1}{2}}$$

Simplify powers by multiplying fractions.

$$= 6x^{\frac{1}{2}}y^{\frac{1}{3}} \times 4^{\frac{1}{2}} \times x^{\frac{3}{8}} \times y^{\frac{4}{10}}$$

Multiply numbers and powers with the same base  
 $a^m \times a^n = a^{m+n}$

$$= 6 \times 4^{\frac{1}{2}} \times x^{\frac{1}{2} + \frac{3}{8}} \times y^{\frac{1}{3} + \frac{4}{10}}$$

Simplify powers by adding fractions...

$$= 6 \times (2^2)^{\frac{1}{2}} \times x^{\frac{4}{8} + \frac{3}{8}} \times y^{\frac{10}{30} + \frac{12}{30}}$$

$$\frac{1}{2} + \frac{3}{8} = \frac{1 \times 4}{2 \times 4} + \frac{3}{8}$$

$$= \frac{4}{8} + \frac{3}{8}$$

$$= 6 \times 2^{2 \times \frac{1}{2}} \times x^{\frac{7}{8}} \times y^{\frac{22}{30}}$$

simplify.

$$= 12 \times 2^1 \times x^{\frac{7}{8}} \times y^{\frac{11}{15}}$$

$$\frac{22}{30} = \frac{11 \times 2}{15 \times 2}$$

h)  $(16m^3n^4)^{\frac{3}{4}} \times (m^{\frac{1}{2}}n^{\frac{1}{4}})^3$

Brackets simplified ✓  
Index  $(a^m)^n = a^{mn}$

$$= (2^4)^{\frac{3}{4}} \times m^{\frac{3 \times 3}{4}} \times n^{\frac{4 \times 3}{4}} \times m^{\frac{1 \times 3}{2}} \times n^{\frac{1 \times 3}{4}}$$

Simplify powers by multiplying fractions

$$= 2^{4 \times \frac{3}{4}} \times m^{\frac{9}{4}} \times n^3 \times m^{\frac{3}{2}} \times n^{\frac{3}{4}}$$

Multiply numbers and powers with the same base  $a^m \times a^n = a^{m+n}$

$$= 2^3 \times m^{\frac{9}{4} + \frac{3}{2}} \times n^{3 + \frac{3}{4}}$$

Simplify powers by adding fractions... write with same denominator to add.

$$= 8 \times m^{\frac{9}{4} + \frac{6}{4}} \times n^{\frac{12}{4} + \frac{3}{4}}$$

$$= 8 \times m^{\frac{15}{4}} \times n^{\frac{15}{4}}$$

$$= 8m^{\frac{15}{4}}n^{\frac{15}{4}}$$

Qnl i).  $2(pq)^{\frac{2}{3} \times \frac{1}{2}} \times 3(pq)^{\frac{1}{4} \times \frac{3}{4}}^{-\frac{1}{3}}$

$= 2 \times p^{\frac{2}{3} \times \frac{1}{2}} q^{\frac{1}{3} \times \frac{3}{4}} \times 3 \times p^{\frac{1}{4} \times \frac{3}{4}} q^{-\frac{3}{4} \times \frac{1}{3}}$

$= 2 \times p^{-\frac{6}{12}} q^{-\frac{3}{12}} \times 3 \times p^{-\frac{1}{4}} q^{\frac{3}{12}}$

$= 2 \times 3 \times p^{-\frac{6}{12} + (-\frac{1}{12})} \times q^{-\frac{3}{12} + \frac{3}{12}}$

$= 6 \times p^{-\frac{7}{12}} \times q^0$

$= 6 \times \frac{1}{p^{\frac{7}{12}}} \times 1$

$= \frac{6}{p^{\frac{7}{12}}}$

Annotations:

- Brackets simplified.
- Index  $(a^m)^n = a^{mn}$
- Simplify powers by multiplying fractions.
- Multiply numbers and powers with the same base.
- Simplify powers by adding fractions.
- Simplify  $q^0 = 1$
- Write with positive powers.

j)  $(8p^{\frac{1}{3}}q^{\frac{2}{3}})^{-\frac{1}{2}} \times (64p^{\frac{1}{3}}q^{\frac{3}{4}})^{\frac{1}{2}}$

$= (2^3)^{-\frac{1}{3}} \times p^{\frac{1}{3} \times -\frac{1}{2}} \times q^{\frac{2}{3} \times -\frac{1}{2}} \times (2^6)^{\frac{1}{4}} \times p^{\frac{1}{3} \times \frac{1}{2}} \times q^{\frac{3}{4} \times \frac{1}{2}}$

$= 2^{-1} \times p^{-\frac{1}{6}} \times q^{-\frac{1}{3}} \times 2^{\frac{3}{2}} \times p^{\frac{1}{6}} \times q^{\frac{3}{8}}$

$= 2^{-1+4} \times p^{-\frac{1}{6} + \frac{1}{6}} \times q^{-\frac{1}{3} + \frac{3}{8}}$

$= 2^3 \times p^0 \times q^{-\frac{4}{24} + \frac{9}{24}}$

$= 8 \times p^0 \times q^{\frac{5}{24}}$

$= 8p^0q^{\frac{5}{24}}$

Annotations:

- Brackets
- Index  $(a^m)^n = a^{mn}$
- Simplify powers by multiplying fractions.
- Multiply:  $a^m \times a^n = a^{m+n}$
- Simplify powers by adding fractions (write fractions with the same denominator)
- Simplify.

Qn 2. a)  $\frac{5a^2b^3}{(2a^3b)^3}$

$$= \frac{5a^2b^3}{2^3a^9b^3}$$

$$= \frac{5}{8} \times a^{2-9} \times b^{3-3}$$

$$= \frac{5}{8} \times a^{-7} \times b^0$$

$$= \frac{5}{8} \times \frac{1}{a^7} \times 1$$

$$= \frac{5}{8a^7}$$

Brackets already simplified  
Index  $(a^m)^n = a^{mn}$

Divide terms.  
 $\frac{a^m}{a^n} = a^{m-n}$

Simplify powers

Write with positive powers

Simplify

b)  $\frac{4x^5y^6}{(2xy^3)^4}$

$$= \frac{4x^5y^6}{2^4x^4y^{12}}$$

$$= \frac{2^2}{2^4} \times x^{5-4} \times y^{6-12}$$

$$= 2^{2-4} \times x^1 \times y^{-6}$$

$$= 2^{-2} \times x \times y^{-6}$$

$$= \frac{1}{2^2} \times x \times \frac{1}{y^6}$$

$$= \frac{x}{4y^6}$$

Brackets already simplified  
Index:  $(a^m)^n = a^{mn}$

Divide terms.  
 $\frac{a^m}{a^n} = a^{m-n}$

Simplify powers.

Write with positive powers.

2 c)

$$\frac{(3m^2n^3)^3}{(2m^5n^5)^7}$$

$$= \frac{3^3 m^6 n^9}{2^7 m^{35} n^{35}}$$

$$= \frac{27}{128} \times m^{6-35} \times n^{9-35}$$

$$= \frac{27}{128} \times m^{-29} \times n^{-26}$$

$$= \frac{27}{128} \times \frac{1}{m^{29}} \times \frac{1}{n^{26}}$$

$$= \frac{27}{128m^{29}n^{26}}$$

Both Brackets simplified.  
Index:  $(a^m)^n = a^{mn}$

Divide terms:  $\frac{a^m}{a^n} = a^{m-n}$

Simplify powers

Write as positive powers.

d)  $\left(\frac{4x^3y^{10}}{2x^7y^4}\right)^6$

$$= \left(2x^{3-7}y^{10-4}\right)^6$$

$$= \left(2x^{-4}y^6\right)^6$$

$$= \left(2 \times \frac{1}{x^4} \times y^6\right)^6$$

$$= \left(\frac{2y^6}{x^4}\right)^6$$

$$= \frac{2^6 y^{36}}{x^{24}}$$

$$= \frac{64y^{36}}{x^{24}}$$

Bracket can be simplified by using  $\frac{a^m}{a^n} = a^{m-n}$

Simplify powers.

Write with positive powers.

Simplify.

Indices:  $(a^m)^n = a^{mn}$

Note: you could also do indices first!

Qn 2e)

$$\frac{3a^3b^{-5}}{(2a^7b^4)^{-3}}$$

$$= \frac{3a^3b^{-5}}{2^{-3}a^{-21}b^{-12}}$$

$$= 3 \times \frac{1}{2^{-3}} \times a^{3-(-21)} \times b^{-5-(-12)}$$

$$= 3 \times (2^{-3})^{-1} \times a^{24} \times b^7$$

$$= 3 \times 2^3 \times a^{24} \times b^7$$

$$= 24a^{24}b^7$$

Brackets simplified ✓  
Index  $(a^m)^n = a^{mn}$

Divide terms

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

Simplify powers  
and write with positive powers

f).  $\left(\frac{3g^2h^5}{2g^4h}\right)^3$

$$= \left(\frac{3 \times g^{2-4} \times h^{5-1}}{2}\right)^3$$

$$= \left(\frac{3 \times g^{-2} \times h^4}{2}\right)^3$$

$$= \left(\frac{3}{2} \times \frac{1}{g^2} \times h^4\right)^3$$

$$= \left(\frac{3h^4}{2g^2}\right)^3$$

$$= \frac{3^3 h^{12}}{2^3 g^6}$$

$$= \frac{27h^{12}}{8g^6}$$

Bracket needs simplifying  
using index laws

$$\left(\frac{a^m}{a^n}\right)^p = a^{m \cdot p - n \cdot p}$$

Simplify powers

write with positive powers

Simplify

Index:  $(a^m)^n = a^{mn}$

Qn 2g).

$$\frac{(5p^6 q^{\frac{1}{3}})^2}{25(p^{\frac{1}{2}} q^{\frac{1}{4}})^{\frac{2}{3}}}$$

Brackets simplified  
Index  $(a^m)^n = a^{mn}$

$$= \frac{5^2 p^{12} q^{\frac{2}{3}}}{25 p^{\frac{1}{2} \times \frac{2}{3}} q^{\frac{1}{4} \times \frac{2}{3}}}$$

Simplify powers by multiplying fractions.

$$= \frac{25 p^{12} q^{\frac{2}{3}}}{25 p^{\frac{1}{3}} q^{\frac{1}{6}}}$$

Divide terms.  $\frac{a^m}{a^n} = a^{m-n}$

$$= \frac{25}{25} \times p^{12 - \frac{1}{3}} q^{\frac{2}{3} - \frac{1}{6}}$$

Simplify powers by subtracting fractions  
→ write with same denominator

$$= 1 \times p^{\frac{36}{3} - \frac{1}{3}} \times q^{\frac{4}{6} - \frac{1}{6}}$$

$$= p^{\frac{35}{3}} \times q^{\frac{3}{6}}$$

$$\frac{1}{2} \times \frac{3}{3} = \frac{3}{6}$$

$$= p^{\frac{35}{3}} q^{\frac{1}{2}}$$



Qn 2h).

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

Bracket needs simplifying...

$$\text{use } \frac{a^m}{a^n} = a^{m-n}$$

$$= \left( \frac{3}{5} \times b^{2-(-3)} \times c^{3-(-4)} \right)^{-4}$$

Simplify power.

$$= \left( \frac{3}{5} \times b^5 \times c^7 \right)^{-4}$$

Simplify

$$= \left( \frac{3b^5c^7}{5} \right)^{-4}$$

Index:  $(a^m)^n = a^{mn}$

$$= \frac{3^{-4} b^{-20} c^{-28}}{5^{-4}}$$

Simplify by writing as separate terms

$$= 3^{-4} \times \frac{1}{5^{-4}} \times b^{-20} \times c^{-28}$$

Write with positive powers

$$= \frac{1}{3^4} \times (5^{-4})^{-1} \times \frac{1}{b^{20}} \times \frac{1}{c^{28}}$$

Simplify.

$$= \frac{5^4}{3^4 b^{20} c^{28}}$$

$$= \frac{625}{81 b^{20} c^{28}}$$

Qn 2 i)

$$\frac{(x^{\frac{1}{3}} y^{\frac{1}{4}} z^{\frac{1}{2}})^2}{(x^{\frac{2}{3}} y^{-\frac{1}{4}} z^{\frac{1}{3}})^{-\frac{1}{2}}}$$

Brackets simplified  
Index:  $(a^m)^n = a^{mn}$

$$= \frac{x^{\frac{1}{3} \times 2} y^{\frac{1}{4} \times 2} z^{\frac{1}{2} \times 2}}{x^{\frac{2}{3} \times -\frac{1}{2}} y^{-\frac{1}{4} \times -\frac{1}{2}} z^{\frac{1}{3} \times -\frac{1}{2}}}$$

Simplify powers by multiplying fractions.

$$= \frac{x^{\frac{2}{3}} y^{\frac{1}{2}} z^1}{x^{-1} y^{\frac{1}{8}} z^{-\frac{1}{2}}}$$

Divide terms.  $\left[ \frac{a^m}{a^n} = a^{m-n} \right]$

$$= x^{\frac{2}{3} - (-1)} \times y^{\frac{1}{2} - \frac{1}{8}} \times z^{1 - (-\frac{1}{2})}$$

Simplify powers by adding fractions (with same denominator)

$$= x^{\frac{5}{3}} \times y^{\frac{3}{4}} \times z^{\frac{3}{2}}$$