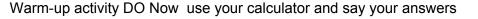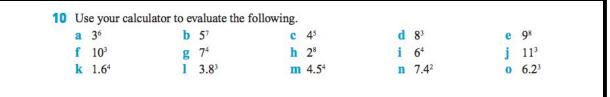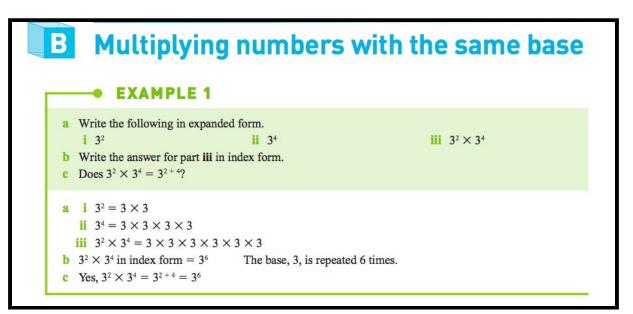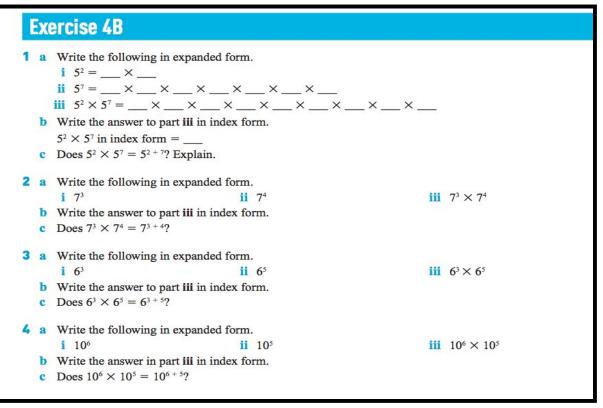Week two-session 1
WALT multiplying numbers with exponents
Success criteria I know I can add powers when multiplying numbers with powers
Algebra In Action
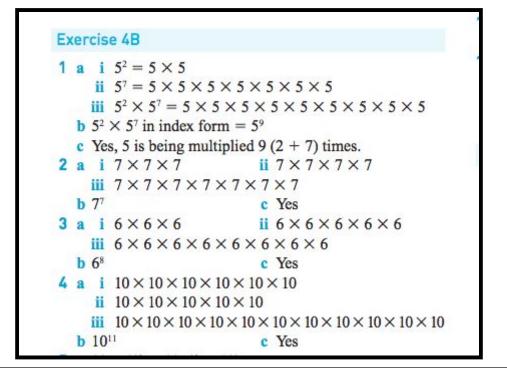Multiplying numbers with exponents

Warm-up activity DO Now use your calculator and say your answers

10 Use your calculator to evaluate the following.

a 3^6	**b** 5^7	**c** 4^5	**d** 8^3	**e** 9^8
f 10^3	**g** 7^4	**h** 2^8	**i** 6^4	**j** 11^3
k 1.6^4	**l** 3.8^3	**m** 4.5^4	**n** 7.4^2	**o** 6.2^3

B Multiplying numbers with the same base

● EXAMPLE 1

a Write the following in expanded form.
  i 3^2 **ii** 3^4 **iii** $3^2 \times 3^4$
b Write the answer for part **iii** in index form.
c Does $3^2 \times 3^4 = 3^{2+4}$?

a **i** $3^2 = 3 \times 3$
  ii $3^4 = 3 \times 3 \times 3 \times 3$
  iii $3^2 \times 3^4 = 3 \times 3 \times 3 \times 3 \times 3 \times 3$
b $3^2 \times 3^4$ in index form $= 3^6$ The base, 3, is repeated 6 times.
c Yes, $3^2 \times 3^4 = 3^{2+4} = 3^6$

Discuss and then work in your books

Exercise 4B

1 a Write the following in expanded form.
   i $5^2 = $ ___ $\times$ ___
   ii $5^7 = $ ___ $\times$ ___ $\times$ ___ $\times$ ___ $\times$ ___ $\times$ ___ $\times$ ___
   iii $5^2 \times 5^7 = $ ___ $\times$ ___ $\times$ ___ $\times$ ___ $\times$ ___ $\times$ ___ $\times$ ___ $\times$ ___ $\times$ ___
b Write the answer to part **iii** in index form.
   $5^2 \times 5^7$ in index form $= $ ___
c Does $5^2 \times 5^7 = 5^{2+7}$? Explain.

2 a Write the following in expanded form.
   i 7^3 **ii** 7^4 **iii** $7^3 \times 7^4$
b Write the answer to part **iii** in index form.
c Does $7^3 \times 7^4 = 7^{3+4}$?

3 a Write the following in expanded form.
   i 6^3 **ii** 6^5 **iii** $6^3 \times 6^5$
b Write the answer to part **iii** in index form.
c Does $6^3 \times 6^5 = 6^{3+5}$?

4 a Write the following in expanded form.
   i 10^6 **ii** 10^5 **iii** $10^6 \times 10^5$
b Write the answer in part **iii** in index form.
c Does $10^6 \times 10^5 = 10^{6+5}$?

Exercise 4B

1 a **i** $5^2 = 5 \times 5$

    ii $5^7 = 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5$

    iii $5^2 \times 5^7 = 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5$

  b $5^2 \times 5^7$ in index form $= 5^9$

  c Yes, 5 is being multiplied 9 (2 + 7) times.

2 a **i** $7 \times 7 \times 7$ **ii** $7 \times 7 \times 7 \times 7$

    iii $7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7$

  b 7^7 **c** Yes

3 a **i** $6 \times 6 \times 6$ **ii** $6 \times 6 \times 6 \times 6 \times 6$

    iii $6 \times 6 \times 6 \times 6 \times 6 \times 6 \times 6 \times 6$

  b 6^8 **c** Yes

4 a **i** $10 \times 10 \times 10 \times 10 \times 10 \times 10$

    ii $10 \times 10 \times 10 \times 10 \times 10$

    iii $10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$

  b 10^{11} **c** Yes

EXAMPLE 2

Write the following in index form.

a $5^2 \times 5^4$ **b** $2^3 \times 2^7$

a $5^2 \times$ 5^4

    $5 \times 5 \times 5 \times 5 \times 5 \times 5 = 5^{2+4} = 5^6$ *Count the number of 5s.* ❗

b 2^3 $\times$ 2^7

    $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^{3+7} = 2^{10}$ *Count the number of 2s.* ❗

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5 Simplify the following by writing in index form.

  a $8^4 \times 8^{10} = 8^{\square+10} = 8^{\square}$ **b** $7^7 \times 7^2 = 7^{7+\square} = 7^{\square}$

  c $9^7 \times 9^3 = 9^{\square+\square} = 9^{\square}$ **d** $5^6 \times 5^{11} = 5^{\square+\square} = 5^{\square}$

6 Simplify the following by writing in index form.

  a $3^5 \times 3^4$ **b** $2^7 \times 2^5$ **c** $7^2 \times 7^8$ **d** $5^7 \times 5^2$ **e** $4^{10} \times 4^6$

  f $6^9 \times 6^4$ **g** $10^5 \times 10^4$ **h** $2^{10} \times 2^{10}$ **i** $5^{20} \times 5^{10}$ **j** $3^{11} \times 3^7$

  k $3^4 \times 3^6$ **l** $7^5 \times 7^8$ **m** $2^4 \times 2^4$ **n** $8^9 \times 8^{12}$ **o** $3^{14} \times 3^3$

7 Can you see a rule emerging? Complete the following statement.

Choose from these words: base, add, indices, multiplying.

When _____ numbers with the same _____, _____ the _____.

Construct your own example to explain the rule.

Look at question 6 to determine the rule. ❗

8 a Write 4^3 in expanded form.

  b Write $4^3 \times 4$ in expanded form.

  c Write your answer for part **b** in index form.

  d Is $4^3 \times 4 = 4^3 \times 4^1$? Explain.

  e Hence, is 4 the same as 4^1?

9 Simplify by writing the following in index form.

  a $5^4 \times 5$ **b** $3^7 \times 3$ **c** $2^9 \times 2$ **d** 5×5^8 **e** 7×7^{11}

Check your answers

1 a i $5^2 = 5 \times 5$

ii $5^7 = 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5$

iii $5^2 \times 5^7 = 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5$

b $5^2 \times 5^7$ in index form $= 5^9$

c Yes, 5 is being multiplied 9 (2 + 7) times.

2 a i $7 \times 7 \times 7$ **ii** $7 \times 7 \times 7 \times 7$

iii $7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7$

b 7^7 **c** Yes

3 a i $6 \times 6 \times 6$ **ii** $6 \times 6 \times 6 \times 6 \times 6$

iii $6 \times 6 \times 6 \times 6 \times 6 \times 6 \times 6 \times 6$

b 6^8 **c** Yes

4 a i $10 \times 10 \times 10 \times 10 \times 10 \times 10$

ii $10 \times 10 \times 10 \times 10 \times 10$

iii $10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$

b 10^{11} **c** Yes

5 a $8^4 \times 8^{10} = 8^{4+10} = 8^{14}$

b $7^7 \times 7^2 = 7^{7+2} = 7^9$

c $9^7 \times 9^3 = 9^{7+3} = 9^{10}$

d $5^6 \times 5^{11} = 5^{6+11} = 5^{17}$

6 a 3^9 **b** 2^{12} **c** 7^{10} **d** 5^9

e 4^{16} **f** 6^{13} **g** 10^9 **h** 2^{20}

i 5^{30} **j** 3^{18} **k** 3^{10} **l** 7^{13}

m 2^8 **n** 8^{21} **o** 3^{17}

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7 Rule: When multiplying numbers with the same base, add the indices.

8 a $4 \times 4 \times 4$

b $4 \times 4 \times 4 \times 4$

c 4^4

d Yes, 4 is being multiplied 4 times.

e Yes

9 a 5^5 **b** 3^8 **c** 2^{10} **d** 5^9 **e** 7^{12}

Now working with variables Day 2

WALT use indices rules for multiplication and raising powers

Success Criteria: I know how to apply the rule when multiplying add the powers and when raising the powers then multiply powers inside the bracket

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Simplify the following by writing in index form.

a $2^3 \times 2^5 \times 2^4$

b $3^5 \times 3^6 \times 3^3$

> *Remember: You can add indices if the bases are the same.* ❗

a $2^3 \times 2^5 \times 2^4 = 2^{3+5+4} = 2^{12}$

b $3^5 \times 3^6 \times 3^3 = 3^{5+6+3} = 3^{14}$

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16 Complete the following to write the answer in index form.

a $4^2 \times 4 \times 4^5 = 4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 = 4^{2+1+5} = 4^\square$

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

c $10^5 \times 10^2 \times 10^8$

d $2^7 \times 2^{13} \times 2 \times 2^3$

e $p^3 \times p^6 \times p^2$

f $m^7 \times m^4 \times m^2 \times m^5$

> *Letters can also be a base.* ❗

17 Simplify the following by writing in index form.

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

b $3^8 \times 3^3 \times 3^7$

c $5^3 \times 5^7 \times 5^4$

d $9^2 \times 9^5 \times 9^4$

e $4^6 \times 4^3 \times 4$

f $a^4 \times a^5 \times a^2$

g $y^7 \times y^3 \times y^2$

h $n^9 \times n^8 \times n^2$

i $p^6 \times p^3 \times p^{11}$

j $t^4 \times t^1 \times t^2$

18 Summary of findings: Complete each statement and copy it into your exercise book.
Choose from these words: 1, index, letters, bases, add.

a Only _____ indices if the _____ are the same.

b Indices is the plural of the word _____.

c Bases can be numbers or _____.

d A single digit or letter has an index value of _____.

Check your answers

16 a $4^{2+1+5} = 4^8$

b $6^{2+4+3} = 6^9$

c 10^{15} **d** 2^{24} **e** p^{11} **f** m^{18}

17 a 2^{13} **b** 3^{18} **c** 5^{14} **d** 9^{11} **e** 4^{10}

f a^{11} **g** y^{12} **h** n^{19} **i** p^{20} **j** t^7

18 a Only add indices if the bases are the same.

b Indices is the plural of the word index.

c Bases can be numbers or letters.

d A single digit or letter has an index value of 1.

C Raising a number to a power

EXAMPLE 1

Simplify each of the following by writing it in expanded form. Record your findings in index form.

a $(3^2)^3$ **b** $(7^3)^5$

a $(3^2)^3 = (3 \times 3)^3$
$= (3 \times 3) \times (3 \times 3) \times (3 \times 3) = 3 \times 3 \times 3 \times 3 \times 3 \times 3$
$= 3^6$

b $(7^3)^5 = (7 \times 7 \times 7)^5$
$= (7 \times 7 \times 7) \times (7 \times 7 \times 7) \times (7 \times 7 \times 7) \times (7 \times 7 \times 7) \times (7 \times 7 \times 7)$
$= 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 7$
$= 7^{15}$

Exercise 4C

1 Simplify each of the following by writing in expanded form. Record your findings in index form.

a $(4^4)^3 = (4 \times \underline{\hspace{1em}} \times \underline{\hspace{1em}} \times 4)^3$
$= (4 \times \underline{\hspace{1em}} \times \underline{\hspace{1em}} \times 4) \times (4 \times \underline{\hspace{1em}} \times \underline{\hspace{1em}} \times 4) \times (4 \times \underline{\hspace{1em}} \times \underline{\hspace{1em}} \times 4)$
$= 4^\square$

b $(8^3)^2 = (8 \times \underline{\hspace{1em}} \times \underline{\hspace{1em}})^2$
$= (8 \times \underline{\hspace{1em}} \times \underline{\hspace{1em}}) \times (8 \times \underline{\hspace{1em}} \times \underline{\hspace{1em}})$
$= 8^\square$

c $(2^5)^3 = (2 \times 2 \times 2 \times \underline{\hspace{1em}} \times \underline{\hspace{1em}})^3$
$= (2 \times 2 \times 2 \times \underline{\hspace{1em}} \times \underline{\hspace{1em}}) \times (2 \times 2 \times 2 \times \underline{\hspace{1em}} \times \underline{\hspace{1em}}) \times (2 \times 2 \times 2 \times \underline{\hspace{1em}} \times \underline{\hspace{1em}})$
$= 2^\square$

d $(7^3)^5 = (7 \times 7 \times \underline{\hspace{1em}})^5$
$= (7 \times 7 \times \underline{\hspace{1em}}) \times (7 \times 7 \times \underline{\hspace{1em}}) \times (7 \times 7 \times \underline{\hspace{1em}}) \times (7 \times 7 \times \underline{\hspace{1em}}) \times (7 \times 7 \times \underline{\hspace{1em}})$
$= 7^\square$

2 Can you see a rule emerging?
  a Review your answers for question 1.
  $(4^4)^3 = 4^\square$ $(8^3)^2 = 8^\square$ $(2^5)^3 = 2^\square$ $(7^3)^5 = 7^\square$
  Write the rule in your own words.
  b Complete the rule below based on your findings from part a. Copy it into your exercise book.
  When raising a number to a higher power, _____ the indices.

3 Write each of the following in index form by applying the rule.
  a $(3^2)^3$ **b** $(5^3)^2$ **c** $(2^3)^4$ **d** $(3^5)^3$ **e** $(7^4)^5$
  f $(10^2)^5$ **g** $(4^2)^6$ **h** $(6^5)^7$ **i** $(3^8)^3$ **j** $(2^7)^{10}$
  k $(3^4)^5$ **l** $(3^5)^4$ **m** $(5^2)^4$ **n** $(5^6)^2$ **o** $(9^{15})^2$

4 Write each of the following in index form by applying the rule.
  a $(a^3)^2$ **b** $(b^6)^9$ **c** $(c^7)^6$ **d** $(d^5)^{11}$ **e** $(e^4)^{10}$
  f $(f^2)^7$ **g** $(g^9)^4$ **h** $(h^{11})^3$ **i** $(i^6)^5$ **j** $(j^6)^2$
  k $(k^7)^8$ **l** $(l^5)^8$ **m** $(m^6)^6$ **n** $(n^9)^3$ **o** $(o^9)^7$

Check your answers

1 a $(4 \times 4 \times 4 \times 4)^3 = (4 \times 4 \times 4 \times 4) \times (4 \times 4 \times 4 \times 4)$
$\times (4 \times 4 \times 4 \times 4)$
$= 4^{12}$

  b $(8 \times 8 \times 8)^2 = (8 \times 8 \times 8) \times (8 \times 8 \times 8) = 8^6$

  c $(2 \times 2 \times 2 \times 2 \times 2)^3$
$= (2 \times 2 \times 2 \times 2 \times 2) \times (2 \times 2 \times 2 \times 2 \times 2) \times$
$(2 \times 2 \times 2 \times 2 \times 2) = 2^{15}$

  d $(7 \times 7 \times 7)^5$
$= (7 \times 7 \times 7) \times (7 \times 7 \times 7) \times (7 \times 7 \times 7) \times$
$(7 \times 7 \times 7) \times (7 \times 7 \times 7) = 7^{15}$

2 a $(4^4)^3 = 4^{12}$ $(8^3)^2 = 8^6$ $(2^5)^3 = 2^{15}$ $(7^3)^5 = 7^{15}$

  b When raising a number to a higher power, multiply the indices.

3 a 3^8 b 5^6 c 2^{12} d 3^{15}
  e 7^{20} f 10^{10} g 4^{12} h 6^{21}
  i 3^{24} j 2^{70} k 3^{20} l 3^{20}
  m 5^8 n 5^8 o 9^{30}

4 a a^8 b b^{54} c c^{42} d d^{55}
  e e^{40} f f^{14} g g^{36} h h^{33}
  i i^{20} j j^8 k k^{56} l l^{49}
  m m^{36} n n^{27} o o^{63}