Check

4. Write each expression as a product of powers.

a) $(6 \times 4)^3$ b) $(2 \times 5)^4$ c) $[(-2) \times 3]^5$
d) $(25 \times 4)^2$ e) $(11 \times 3)^1$ f) $[(-3) \times (-2)]^3$

5. Write each expression as a quotient of powers.

a) $(8 \div 5)^3$ b) $(21 \div 5)^4$ c) $[(-12) \div (-7)]^5$
d) $\left(\frac{10}{3}\right)^3$ e) $\left(\frac{1}{3}\right)^2$ f) $\left(\frac{27}{100}\right)^4$

6. Write as a power.

a) $(3^2)^4$ b) $(6^3)^3$ c) $(5^3)^1$
d) $(7^0)^6$ e) $-(8^2)^2$ f) $[(-3)^4]^2$

7. Simplify $(2^4)^2$ and $(2^2)^4$. What do you notice? Explain the results.

8. Write each expression as a product or quotient of powers.

a) $[3 \times (-5)]^3$ b) $-(2 \times 4)^5$
c) $\left(\frac{2}{3}\right)^4$ d) $\left(\frac{-7}{-2}\right)^2$
e) $-[(-10) \times 3]^3$ f) $(16 \div 9)^2$

Apply

9. Why is the value of $(-5^2)^3$ negative?

10. Simplify each expression, then evaluate it. For each expression, state the strategy you used and why.

a) $(3 \times 2)^3$ b) $[(-2) \times 4]^2$ c) $\left(\frac{9}{-3}\right)^3$
d) $\left(\frac{8}{2}\right)^2$ e) $(12^8)^0$ f) $[(-4)^2]^2$

11. Why is the value of $[(-2)^3]^4$ positive but the value of $[(-2)^3]^5$ is negative?

12. Compare the values of $-(4^2)^3$, $(-4^2)^3$, and $[(-4)^2]^3$.
What do you notice? Explain the results.

13. Assessment Focus   For each expression below:

i) Evaluate it in two different ways:
  • do the operation in brackets first
  • use the exponent laws
ii) Compare the results.
  Which method do you prefer? Was it always the same method each time? Explain.

a) $(4 \times 3)^3$ b) $[(-2) \times (-5)]^2$ c) $\left(\frac{6}{2}\right)^4$
d) $\left(\frac{14}{2}\right)^0$ e) $[(-5)^2]^2$ f) $(2^5)^3$

14. Simplify, then evaluate. Show your work.

a) $(3^2 \times 3^1)^2$ b) $(4^6 \div 4^4)^2$
c) $[(-2)^0 \times (-2)^3]^2$ d) $(10^6 \div 10^4)^3$
e) $(10^3)^2 \times (10^2)^3$ f) $(12^2)^4 \div (12^3)^2$
g) $(5^2)^6 \div (5^3)^4$ h) $[(-2)^2]^3 \times (-2)^3$

15. Find any errors in this student's work. Copy the solution and correct the errors.

a) $(3^2 \times 2^2)^3 = (6^4)^3$
  $= 6^{12}$
  $= 2\,176\,782\,336$

b) $[(-3)^2]^3 = (-3)^5$
  $= -243$

c) $\left(\frac{6^2}{6^1}\right)^2 = 6^4$
  $= 1296$

d) $(2^6 \times 2^2 \div 2^4)^3 = (2^3)^3$
  $= 2^9$
  $= 512$

e) $(10^2 + 10^3)^2 = (10^5)^2$
  $= 10^{10}$
  $= 10\,000\,000\,000$

16. Simplify, then evaluate each expression.

a) $(4^2 \times 4^3)^2 - (5^4 \div 5^2)^2$

b) $(3^3 \div 3^2)^3 + (8^4 \times 8^3)^0$

c) $(2^3)^4 + (2^4 \div 2^3)^2$

d) $(6^2 \times 6^0)^3 + (2^6 \div 2^4)^3$

e) $(5^3 \times 5^3)^0 - (4^2)^2$

f) $(10^5 \div 10^2)^2 + (3^3 \div 3^1)^4$

17. Simplify, then evaluate each expression.

a) $[(-2)^3 \times (-2)^2]^2 - [(-3)^3 \div (-3)^2]^2$

b) $[(-2)^3 \div (-2)^2]^2 - [(-3)^3 \times (-3)^2]^2$

c) $[(-2)^3 \times (-2)^2]^2 + [(-3)^3 \div (-3)^2]^2$

d) $[(-2)^3 \div (-2)^2]^2 + [(-3)^3 \times (-3)^2]^2$

e) $[(-2)^3 \div (-2)^2]^2 - [(-3)^3 \div (-3)^2]^2$

f) $[(-2)^3 \times (-2)^2]^2 + [(-3)^3 \times (-3)^2]^2$

18. Use grid paper. For each expression below:

i) Draw a rectangle to represent the expression.

ii) Use the exponent laws to write the expression as a product of squares.

iii) Draw a rectangle to represent the new form of the expression.

iv) Compare the two rectangles for each expression.
How are the rectangles the same? How are they different?
Use these rectangles to explain how the square of a product and the product of squares are related.

a) $(2 \times 3)^2$ **b)** $(2 \times 4)^2$

c) $(3 \times 4)^2$ **d)** $(1 \times 4)^2$

19. Simplify, then evaluate each expression.

a) $(2^3 \times 2^6)^2 - (3^7 \div 3^5)^4$

b) $(6 \times 8)^5 + (5^3)^2$

c) $[(-4)^3 \times (-4)^2]^2 + (4^3 \times 4^2)^2$

d) $[(-2)^4]^3 + [(-4)^3]^2 - [(-3)^2]^4$

e) $[(-3)^4]^2 \times [(-4)^0]^2 - [(-3)^3]^0$

f) $[(-5) \times (-4)]^3 + [(-6)^3]^2$
$- [(-3)^9 \div (-3)^8]^5$

Take It Further

20. a) Write 81:

    i) as a power of 9

    ii) as a power of a product

    iii) as a power of 3

b) Write 64:

    i) as a power of 8

    ii) as a power of a product

    iii) as a power of 2

c) Find other numbers for which you can follow steps similar to those in parts a and b.

21. a) List the powers of 2 from 2^0 to 2^{12} in standard form.

b) Use your list from part a to write each number in the expressions below as a power of 2. Evaluate each expression using the exponent laws and the list in part a.

    i) 32×64 **ii)** $16 \times 8 \times 32$

    iii) $1024 \div 128$ **iv)** $\dfrac{16 \times 256}{1024}$

    v) $(8 \times 4)^3$ **vi)** $\left(\dfrac{256}{64}\right)^4$

Reflect

Design and create a poster that summarizes all the exponent laws you have learned.
Provide an example of each law.