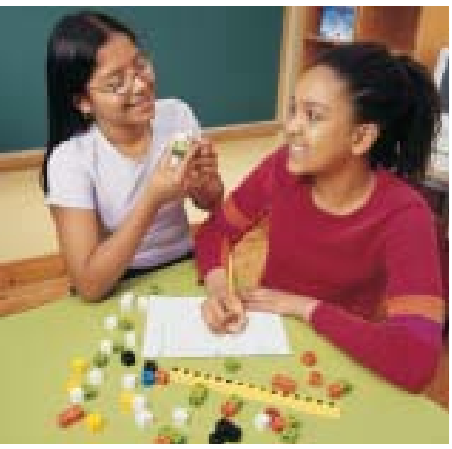
1.4 Exponents

Focus Use exponents to represent repeated multiplication.

Explore

Work with a small group.
You will need 65 interlocking cubes.
The edge length of each cube is 1 unit.
The volume of each cube is 1 cubic unit.



- How many different ways can you make a larger cube?
- What is the volume of each larger cube you make?
  What is its edge length?
- Use factors to write the volume of each cube.
- Record your results in a table.

Number of Cubes	Volume (cubic units)	Edge Length (units)	Volume As a Product
1	1	1	$1 \times 1 \times 1$

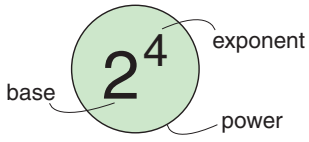
Reflect & Share

Observe how the volume grows. Describe the growth using pictures or numbers. What other patterns do you see in the table?
Use these patterns to help you write the volumes of the next 3 cubes in the pattern.

Connect

When numbers are repeated in multiplication, we can write them in **exponent form**.

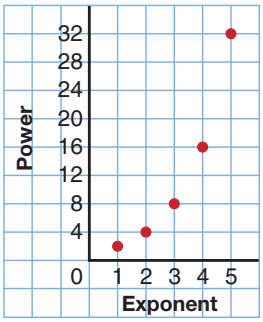
For example, we can write $2 \times 2 \times 2 \times 2$ as 2^4.
2 is the **base**.
4 is the **exponent**.
2^4 is the **power**.



We say: 2 to the power of 4, or
2 to the 4th
2^4 is a power of 2.

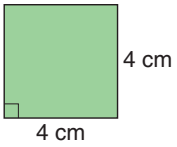
If we graph the power against the exponent, we see how quickly the power gets very large.

Exponent	Power
1	$2^1 = 2$
2	$2^2 = 4$
3	$2^3 = 8$
4	$2^4 = 16$
5	$2^5 = 32$



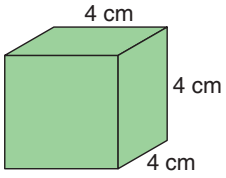
Square numbers and cube numbers are special powers.

➢ A power with exponent 2 is a **square number**.
The area of a square is side length × side length.
This square has side length 4 cm.
Area = 4 cm × 4 cm
= 16 cm^2



Here are 3 ways to write 16:
Standard form: 16
Expanded form: 4 × 4
Exponent form: 4^2
4^2 is a power of 4.
16 is called a **perfect square**.

➢ A power with exponent 3 is a **cube number**.
The volume of a cube is edge length × edge length × edge length.
This cube has edge length 4 cm.
Volume = 4 cm × 4 cm × 4 cm
= 64 cm^3



Here are 3 ways to write 64:
Standard form: 64
Expanded form: 4 × 4 × 4
Exponent form: 4^3
4^3 is a power of 4.
64 is called a **perfect cube**.

Example 1

Write in exponent form.

a) 6×6 **b)** $5 \times 5 \times 5$ **c)** 32

Solution

a) $6 \times 6 = 6^2$ **b)** $5 \times 5 \times 5 = 5^3$

c) $32 = 2 \times 2 \times 2 \times 2 \times 2 = 2^5$

Example 2

Write in expanded form and standard form.

a) 3^5 **b)** 7^4

Solution

a) 3^5
$= 3 \times 3 \times 3 \times 3 \times 3$
$= 243$

b) 7^4
$= 7 \times 7 \times 7 \times 7$
$= 2401$

A calculator can be used to simplify a power such as 3^5.
For a scientific calculator, the keystrokes are:

[3] [^] [5] [ENTER] or [3] [y^x] [5] [ENTER] to display 243

For a non-scientific calculator, use repeated multiplication.
The keystrokes are:

[3] [×] [=] [=] [=] [=] to display 243

Practice

1. Write the base of each power.

a) 2^4 **b)** 3^2 **c)** 7^3 **d)** 10^5 **e)** 6^9 **f)** 8^3

2. Write the exponent of each power.

a) 2^5 **b)** 3^2 **c)** 7^1 **d)** 9^5 **e)** 8^{10} **f)** 10^4

3. Write in expanded form.

a) 2^4 **b)** 10^3 **c)** 6^5 **d)** 4^2 **e)** 2^1 **f)** 5^4

4. Write in exponent form.

a) $3 \times 3 \times 3 \times 3$ **b)** $2 \times 2 \times 2$ **c)** $5 \times 5 \times 5 \times 5 \times 5 \times 5$

d) $10 \times 10 \times 10$ **e)** 79×79 **f)** $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$

Calculator Skills

A case of 24 cans of pop costs $7.49 at a local grocery store. A variety store charges customers $1.25 for 1 can. How much more money is the variety store making?

5. Write in exponent form, then in standard form.

a) 5×5 **b)** $3 \times 3 \times 3 \times 3$

c) $10 \times 10 \times 10 \times 10 \times 10$ **d)** $2 \times 2 \times 2$

e) $9 \times 9 \times 9$ **f)** $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$

6. Write in standard form.

a) 2^4 **b)** 10^3 **c)** 3^5 **d)** 7^3 **e)** 2^8 **f)** 4^1

7. Write as a power of 10. How did you do it?

a) 100 **b)** 10 000 **c)** 100 000

d) 10 **e)** 1000 **f)** 1 000 000

8. Write as a power of 2. Explain your method.

a) 4 **b)** 16 **c)** 64 **d)** 256 **e)** 32 **f)** 2

9. What patterns do you see in the pairs of numbers? Which is the greater number in each pair? Explain how you know.

a) 2^3 or 3^2 **b)** 2^5 or 5^2 **c)** 3^4 or 4^3 **d)** 5^4 or 4^5

10. Write these numbers in order from least to greatest:
3^5, 5^2, 3^4, 6^3. How did you do this?

11. Simplify.

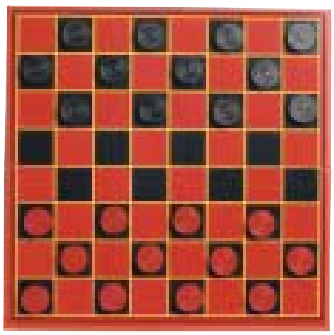
a) 3^{12} **b)** 7^3 **c)** 5^6 **d)** 4^8 **e)** 9^8 **f)** 2^{23}

12. **Assessment Focus**

a) Express each number in exponent form in as many different ways as you can.

i) 16 **ii)** 81 **iii)** 64

b) Find other numbers that can be written in exponent form, in more than one way. Show your work.



13. Write in exponent form:

a) the number of small squares on a checkerboard

b) the area of a square with side length 5 units

c) the volume of a cube with edge length 9 units

Reflect

When you see a number, how can you find out if it is a perfect square, or a perfect cube, or neither? Give examples.