15. [Indices / Square Roots]

Skill 15.1 Expressing powers as products and products as powers.

To write a product as a power
- Write the factor as the base.
- Count how many times the factor is multiplied by itself and make the result the index.

To write a power as a product
- Multiply the base by itself the same number of times as indicated by the index.

power — 5^4 — Read as: 5 to the power of 4 $\Rightarrow$ base — 5^4 — exponent $\Rightarrow$ $5^4 = 5 \times 5 \times 5 \times 5$ (5 multiplied by itself 4 times)

Q. Write the power as a product:
$7^4 =$

A. $7^4 =$
$= 7 \times 7 \times 7 \times 7$ (7 multiplied by itself 4 times)

a) Write the product as a power:
$6 \times 6 \times 6 \times 6 \times 6 =$
6^5
(5 factors of 6 $\Rightarrow$ 6 is the base, 5 the exponent)

b) Write the product as a power:
$2 \times 2 \times 2 =$

c) Write the product as a power:
$5 \times 5 =$

d) Write the product as a power:
$4 \times 4 \times 4 \times 4 \times 4 \times 4 =$

e) Write the power as a product:
$8^3 =$

f) Write the power as a product:
$3^4 =$

g) Write the power as a product:
$2^5 =$

h) Write the power as a product:
$9^3 =$

i) Write the product as a power:
$1 \times 1 \times 1 \times 1 \times 1 \times 1 \times 1 =$

j) Write the product as a power:
$7 \times 7 \times 7 =$

k) Write the power as a product:
$6^4 =$

l) Write the product as a power:
$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 =$

Skill 15.2 Squaring whole numbers.

- Multiply the number by itself.

1^2	2^2	3^2	4^2
= one squared	= two squared	= three squared	= four squared
= 1 square	= 4 squares	= 9 squares	= 16 squares
$= 1 \times 1$	$= 2 \times 2$	$= 3 \times 3$	$= 4 \times 4$
$= \mathbf{1}$	$= \mathbf{4}$	$= \mathbf{9}$	$= \mathbf{16}$

Q. $90^2 =$

A. $90^2 =$ (*90 multiplied by itself 2 times*)

$= 90 \times 90$

$= \mathbf{8100}$

$$\begin{array}{r} {\scriptstyle 8}\ 90 \\ \times\ 90 \\ \hline 8100 \end{array}$$

a) $7^2 =$ (*7 multiplied by itself 2 times*)

$= 7 \times 7$ $= 49$

b) $3^2 =$

$=$ ..... $=$ ☐

c) $2^2 =$

$=$ ..... $=$ ☐

d) $10^2 =$

$=$ ..... $=$ ☐

e) $5^2 =$

$=$ ..... $=$ ☐

f) $1^2 =$

$=$ ..... $=$ ☐

g) $12^2 =$

$=$ ..... $=$ ☐

h) $11^2 =$

$=$ ..... $=$ ☐

i) $0^2 =$

$=$ ..... $=$ ☐

j) $4^2 =$

$=$ ..... $=$ ☐

k) $9^2 =$

$=$ ..... $=$ ☐

l) $20^2 =$

$=$ ..... $=$ ☐

m) $50^2 =$

$=$ ..... $=$ ☐

n) $30^2 =$

$=$ ..... $=$ ☐

o) $70^2 =$

$=$ ..... $=$ ☐

p) $80^2 =$

$=$ ..... $=$ ☐

q) $40^2 =$

$=$ ..... $=$ ☐

r) $60^2 =$

$=$ ..... $=$ ☐

Skill 15.3 Calculating powers of 10.

- Put the same number of zeros in the answer as the index shows.
  Example: $10^4 \Rightarrow$ index is 4 so the answer ends in 4 zeros
  $10^4 = 10\,000$

Q. $10^5 =$

A. $10^5 =$ *Index is 5*
$= 10 \times 10 \times 10 \times 10 \times 10$
$= \mathbf{100\,000}$ *Answer ends in 5 zeros*

a) $10^9 =$ *10 multiplied by itself 9 times*

$= 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$

$=$ 1 000 000 000

b) $10^2 =$

$=$ .....

$=$

c) $10^7 =$

$=$ .....

$=$

d) $10^4 =$

$=$ .....

$=$

e) $10^1 =$

$=$ .....

$=$

f) $10^5 =$

$=$ .....

$=$

g) $10^6 =$

$=$ .....

$=$

h) $10^3 =$

$=$ .....

$=$

i) $10^8 =$

$=$ .....

$=$

j) $10^{10} =$

$=$ .....

$=$

Skill 15.4 Finding square roots of whole numbers.

Hint: Finding the square root of a number is the reverse of the procedure for squaring a number.

EITHER

- Use trial and error to find the number that, when multiplied by itself, equals the original number.

Example: The square root of 25

$\sqrt{25}$ = the number that when multiplied by itself equals 25

$5 \times 5 = 25$ so

$\sqrt{25} = \sqrt{5 \times 5} = 5$

OR

- Arrange that number of tiles in a square.
- Count the number of tiles along one side length.

5

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

Q. $\sqrt{49} =$

A. $\sqrt{49} = \sqrt{7 \times 7} = 7$

The square root of 49 means: "what number multiplied by itself equals 49"

$7 \times 7 = 49$

$7^2 = 49$

7

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	32	33	34	35
36	37	38	39	40	41	42
43	44	45	46	47	48	49

a) $\sqrt{25} =$ *5 multiplied by itself*

$= \sqrt{5 \times 5}$ ..... $= 5$

b) $\sqrt{9} =$

$=$ ..... $=$ ☐

c) $\sqrt{36} =$

$=$ ..... $=$ ☐

d) $\sqrt{4} =$

$=$ ..... $=$ ☐

e) $\sqrt{16} =$

$=$ ..... $=$ ☐

f) $\sqrt{100} =$

$=$ ..... $=$ ☐

g) $\sqrt{144} =$

$=$ ..... $=$ ☐

h) $\sqrt{121} =$

$=$ ..... $=$ ☐

i) $\sqrt{64} =$

$=$ ..... $=$ ☐

j) $\sqrt{900} =$

$=$ ..... $=$ ☐

k) $\sqrt{4900} =$

$=$ ..... $=$ ☐

l) $\sqrt{2500} =$

$=$ ..... $=$ ☐

m) $\sqrt{8100} =$

$=$ ..... $=$ ☐

n) $\sqrt{3600} =$

$=$ ..... $=$ ☐

o) $\sqrt{12\,100} =$

$=$ ..... $=$ ☐

Skill 15.5 Evaluating powers of whole numbers.

- Observe the index.
- Multiply the number (base) the same number of times by itself as the index shows.
  (see skill 15.1, page 123)

Hints: Any number raised to the power of zero (except 0) equals 1. *Example* $6^0 = 1$
Any number raised to the power of one equals the number itself. *Example* $6^1 = 6$

Q. $5^4 =$

A. $5^4 =$ (5 multiplied by itself 4 times)
$= 5 \times 5 \times 5 \times 5$
$= 125 \times 5$
$= \mathbf{625}$

"5 raised to the power of 4" means 4 lots of 5 in the equation.

a) $3^5 =$ (3 multiplied by itself 5 times)
$= 3 \times 3 \times 3 \times 3 \times 3$
$= 9 \times 9 \times 3 \quad =$ 243

b) $2^4 =$
$=$ .....
$=$ ..... $=$ ☐

c) $4^3 =$
$=$ .....
$=$ ..... $=$ ☐

d) $1^4 =$
$=$ .....
$=$ ..... $=$ ☐

e) $2^5 =$
$=$ .....
$=$ ..... $=$ ☐

f) $4^4 =$
$=$ .....
$=$ ..... $=$ ☐

g) $3^4 =$
$=$ .....
$=$ ..... $=$ ☐

h) $0^2 =$
$=$ .....
$=$ ..... $=$ ☐

i) $2^6 =$
$=$ .....
$=$ ..... $=$ ☐

j) $4^0 =$
$=$ .....
$=$ ..... $=$ ☐

k) $3^3 =$
$=$ .....
$=$ ..... $=$ ☐

l) $5^3 =$
$=$ .....
$=$ ..... $=$ ☐

m) $3^6 =$
$=$ .....
$=$ ..... $=$ ☐

n) $8^3 =$
$=$ .....
$=$ ..... $=$ ☐

o) $4^5 =$
$=$ .....
$=$ ..... $=$ ☐

p) $7^0 =$
$=$ .....
$=$ ..... $=$ ☐

q) $2^8 =$
$=$ .....
$=$ ..... $=$ ☐

r) $9^3 =$
$=$ .....
$=$ ..... $=$ ☐

Skill 15.6 Estimating square roots.

- Find the two perfect squares closest to the number under the square root:
  one greater than (>) the number and
  one less than (<) the number.
- Take square root of these two numbers to estimate the size of the square root.

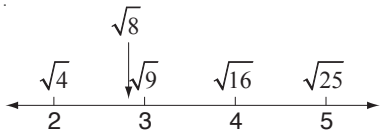
Q. Between which two consecutive whole numbers does $\sqrt{8}$ lie?

A. $4 < 8 < 9$

$\sqrt{4} < \sqrt{8} < \sqrt{9}$

$\sqrt{4} = 2$

$\sqrt{9} = 3$



$2 < \sqrt{8} < 3$

*The answer is **2** and **3***

a) Between which two consecutive whole numbers does $\sqrt{72}$ lie?

$\sqrt{64} = 8$ $\sqrt{81} = 9$ $\Rightarrow$ 8 and 9

b) Between which two consecutive whole numbers does $\sqrt{20}$ lie?

..... $\Rightarrow$ and

c) Between which two consecutive whole numbers does $\sqrt{5}$ lie?

..... $\Rightarrow$ and

d) Between which two consecutive whole numbers does $\sqrt{60}$ lie?

..... $\Rightarrow$ and

e) Between which two consecutive whole numbers does $\sqrt{34}$ lie?

..... $\Rightarrow$ and

f) Between which two consecutive whole numbers does $\sqrt{24}$ lie?

..... $\Rightarrow$ and

g) Between which two consecutive whole numbers does $\sqrt{80}$ lie?

..... $\Rightarrow$ and

h) Between which two consecutive whole numbers does $\sqrt{75}$ lie?

..... $\Rightarrow$ and

i) Between which two consecutive whole numbers does $\sqrt{56}$ lie?

..... $\Rightarrow$ and

j) Between which two consecutive whole numbers does $\sqrt{99}$ lie?

..... $\Rightarrow$ and

k) Between which two consecutive whole numbers does $\sqrt{48}$ lie?

..... $\Rightarrow$ and

l) Between which two consecutive whole numbers does $\sqrt{90}$ lie?

..... $\Rightarrow$ and

Skill 15.7 Finding powers of negative whole numbers.

- Observe the index.
- Multiply the number (base) the same number of times by itself as the index shows. (see skill 15.1, page 123)
- Give the result a sign.

A negative number raised to an **even index** gives a **positive result**

$(-5)^2 = -5 \times (-5)$
$= +25$

A negative number raised to an **odd index** gives a **negative result**

$(-5)^3 = -5 \times (-5) \times (-5)$
$= +25 \times (-5)$
$= -125$

Q. $(-6)^3 =$

A. $(-6^3) =$ (odd index)
$= -6 \times (-6) \times (-6)$
$= 36 \times (-6)$
$= -216$ (negative result)

"–6 raised to the power of 3" means 3 lots of –6 in the equation.

a) $(-3)^4 =$ (even index)

$= -3 \times (-3) \times (-3) \times (-3)$

$= 9 \times 9$ (positive result) $= 81$

b) $(-2)^4 =$

$=$ .....

$=$ ..... $=$ ☐

c) $(-6)^2 =$

$=$ .....

$=$ ..... $=$ ☐

d) $(-1)^7 =$

$=$ .....

$=$ ..... $=$ ☐

e) $(-3)^3 =$

$=$ .....

$=$ ..... $=$ ☐

f) $(-4)^2 =$

$=$ .....

$=$ ..... $=$ ☐

g) $(-2)^3 =$

$=$ .....

$=$ ..... $=$ ☐

h) $(-5)^2 =$

$=$ .....

$=$ ..... $=$ ☐

i) $(-3)^5 =$

$=$ .....

$=$ ..... $=$ ☐

j) $(-4)^4 =$

$=$ .....

$=$ ..... $=$ ☐

k) $(-1)^9 =$

$=$ .....

$=$ ..... $=$ ☐

l) $(-7)^2 =$

$=$ .....

$=$ ..... $=$ ☐

m) $(-2)^6 =$

$=$ .....

$=$ ..... $=$ ☐

n) $(-12)^2 =$

$=$ .....

$=$ ..... $=$ ☐

o) $(-10)^3 =$

$=$ .....

$=$ ..... $=$ ☐