Patterning the Powers of 10 Learning Strategies

What should students be able to do?

Students should be able to correctly order base 10 exponents using patterns and understand the meaning of a positive and a negative exponent.

Common mistakes made by students:

Students may:

- Think that $10^3$ is $10 \times 3$ instead of $10 \times 10 \times 10$.
- Think that a negative exponent makes the number negative.
- Struggle with the idea that each negative exponent defines a number between 0 and 1.

Curriculum Connections:

- Please note all of the following correlations match outcomes in the new Mathematics Kindergarten to Grade 9 Program of Studies (2007).

Grade 5 Number SO8: Describe and represent decimals (tenths, hundredths, thousandths), concretely, pictorially and symbolically.

Grade 5 Number SO9: Relate decimals to fractions and fractions to decimals (to thousandths).

Grade 7 Number SO4: Demonstrate an understanding of the relationship between positive terminating decimals and positive fractions and between positive repeating decimals and positive fractions.

Grade 7 Number SO7: Compare and order positive fractions, positive decimals (to thousandths) and whole numbers by using:
  - benchmarks
  - place value
  - equivalent fractions and/or decimals.

Grade 8 Number SO5: Solve problems that involve rates, ratios and proportional reasoning.

Grade 9 Number SO1: Demonstrate an understanding of powers with integral bases (excluding base 0) and whole number exponents by:
  - representing repeated multiplication, using powers
  - using patterns to show that a power with an exponent of zero is equal to one
  - solving problems involving powers.
Assessment notes:
*Note: The Print Activity is not intended to be an assessment piece

In the print activity, it is recommended that students use the Table and Viewer screens in the “Explore It” mode to check their solutions. Students will be asked to demonstrate, explain, and order base 10 positive and negative exponents using patterns. If only a portion of the print activity is sought for assessment purposes, or if you want to manipulate the questions, open the activity in Word format instead of PDF and make the changes yourself.

Solutions to the Print Activity:

1. a.

<table>
<thead>
<tr>
<th>Power</th>
<th>Numeric Value</th>
<th>Expanded</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^1$</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>$10^0$</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>$10^{-1}$</td>
<td>0.1</td>
<td>$\frac{1}{10}$</td>
</tr>
<tr>
<td>$10^{-2}$</td>
<td>0.01</td>
<td>$\frac{1}{10\times10}$</td>
</tr>
</tbody>
</table>

b.

<table>
<thead>
<tr>
<th>Power</th>
<th>Numeric Value</th>
<th>Expanded</th>
<th>Lowest Value Fraction</th>
<th>Fractional Exponent</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^{-2}$</td>
<td>0.01</td>
<td>$\frac{1}{10\times10}$</td>
<td>$\frac{1}{100}$</td>
<td>$\frac{1}{10^2}$</td>
</tr>
<tr>
<td>$10^{0}$</td>
<td>1</td>
<td>1</td>
<td>$\frac{1}{1}$</td>
<td>$\frac{10^0}{1}$</td>
</tr>
<tr>
<td>$10^{5}$</td>
<td>100 000</td>
<td>$10\times10\times10\times10\times10$</td>
<td>$\frac{100000}{1}$</td>
<td>$\frac{10^5}{1}$</td>
</tr>
<tr>
<td>$10^{2}$</td>
<td>100</td>
<td>$10\times10$</td>
<td>$\frac{100}{1}$</td>
<td>$\frac{10^2}{1}$</td>
</tr>
</tbody>
</table>
2. a. No.
   b. \(10^0 = 1, \ 10^1 = 10\)

3. a. No.
   b. \(10^{-8} = 0.000 \ 000 \ 01, \ 10^8 = 100 \ 000 \ 000\)

4. a. \(1,000,000,000 \ m = 10^9 \ m\)
   b. 1 micrometer = \(0.000 \ 001 \ m = 10^{-6} \ m\)

5. a. Fill in the blanks in the following table:

<table>
<thead>
<tr>
<th>Power</th>
<th>Expanded</th>
<th>Lowest Value Fraction</th>
<th>Numeric Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10^4)</td>
<td>(10 \times 10 \times 10 \times 10)</td>
<td>(\frac{10000}{1})</td>
<td>10 000</td>
</tr>
<tr>
<td>(10^{-5})</td>
<td>(\frac{1}{10 \times 10 \times 10 \times 10 \times 10})</td>
<td>(\frac{1}{100000})</td>
<td>0.000 01</td>
</tr>
<tr>
<td>(10^{-3})</td>
<td>(\frac{1}{10 \times 10 \times 10})</td>
<td>(\frac{1}{1000})</td>
<td>0.001</td>
</tr>
<tr>
<td>(10^5)</td>
<td>(10 \times 10 \times 10 \times 10 \times 10)</td>
<td>(\frac{100000}{1})</td>
<td>100 000</td>
</tr>
</tbody>
</table>

b. Nucleus of the cell.

<table>
<thead>
<tr>
<th>Exponent</th>
<th>Base</th>
<th>Power</th>
<th>Numeric Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
<td>$10^0$</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>$10^1$</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>$10^2$</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>$10^3$</td>
<td>1 000</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>$10^4$</td>
<td>10 000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Difference in the Numerical Values:</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
</tr>
<tr>
<td>90</td>
</tr>
<tr>
<td>900</td>
</tr>
<tr>
<td>9 000</td>
</tr>
</tbody>
</table>

The difference in the exponents is always 1.

The difference in the numeric values forms a sequence. The next term in the sequence can be found by multiplying the previous term by 10. The sequence is 9, 90, 900, 9 000, …

c. The difference in the numeric values:

<table>
<thead>
<tr>
<th>Power</th>
<th>Numeric Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^5$</td>
<td>100 000</td>
</tr>
<tr>
<td>$10^6$</td>
<td>1 000 000</td>
</tr>
<tr>
<td>$10^7$</td>
<td>10 000 000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Difference in the Numerical Values:</th>
</tr>
</thead>
<tbody>
<tr>
<td>900 000</td>
</tr>
<tr>
<td>9 000 000</td>
</tr>
</tbody>
</table>
d. The difference in the numeric values between $10^7$ and $10^8$ is larger. To find the next term in the sequence representing the difference in numeric values, you multiply the previous term by 10. So the difference between $10^6$ and $10^7$ is 9,000,000, but the difference between $10^7$ and $10^8$ is 90,000,000, which is larger.