

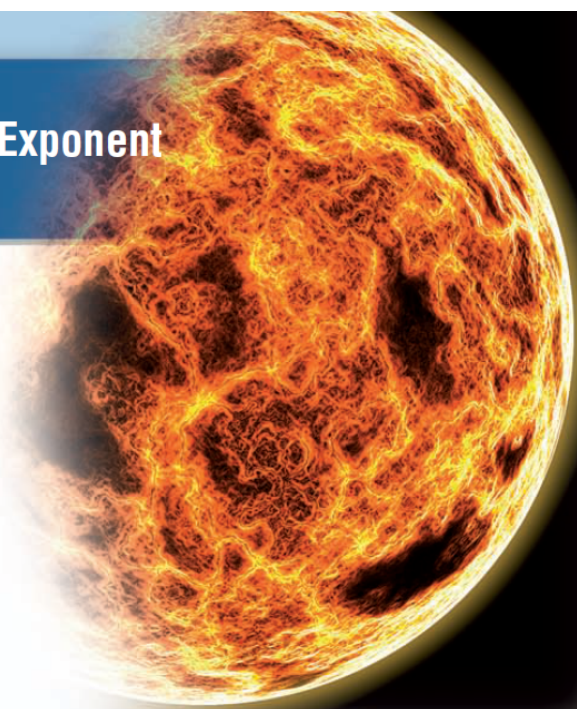
2.2

Powers of Ten and the Zero Exponent

FOCUS

- Explore patterns and powers of 10 to develop a meaning for the exponent 0.

Nuclear reactions in the core of the sun create solar energy. For these reactions to take place, extreme temperature and pressure are needed. The temperature of the sun's core is about 10^7 °C. What is this temperature in millions of degrees Celsius?



Solar System Data

Quantity	Sun	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Distance from Sun	N/A	5.8×10^{10}	1.1×10^{11}	1.5×10^{11}	2.3×10^{11}	7.8×10^{11}	1.4×10^{12}	2.9×10^{12}	4.5×10^{12}
Radius	7.0×10^8	2.5×10^6	6.1×10^6	6.4×10^6	3.4×10^6	7.1×10^7	6.0×10^7	2.6×10^7	2.5×10^7
Mass	2.0×10^{30}	3.3×10^{23}	4.9×10^{24}	6.0×10^{24}	6.4×10^{23}	2.0×10^{27}	5.7×10^{26}	8.7×10^{25}	1.0×10^{26}
Revolution	N/A	88d	225d	365d	1.88y	11.9y	29y	84y	164y
Rotation	Varies	58d	243d	24h	24h	10h	11h	17h	16h

Fundamental Physical Constants

Quantity	Symbol	Accepted value
speed of light in a vacuum	c	2.998×10^8 m/s
gravitational constant	G	6.673×10^{-11} N · m ² /kg ²
Coulomb's constant	k	8.988×10^9 N · m ² /C ²
charge on an electron	e	1.602×10^{-19} C
rest mass of an electron	m_e	9.109×10^{-31} kg
rest mass of a proton	m_p	1.673×10^{-27} kg
rest mass of a neutron	m_n	1.675×10^{-27} kg
Planck's constant	h	6.626×10^{-34} J · s

Investigate

Choose a number between 1 and 10 as the base of a power.

Use the exponents 5, 4, 3, 2, and 1.

Use your base and each exponent to write a power.

Then write the power as repeated multiplication and in standard form.

Record your results in a table.

Exponent	Power	Repeated Multiplication	Standard Form
5	5^5	$5 \times 5 \times 5 \times 5 \times 5$	3125
4	5^4	$5 \times 5 \times 5 \times 5$	625
3	5^3	$5 \times 5 \times 5$	125
2	5^2	5×5	25
1	5^1	5	5
0	5^0		1

Describe any patterns in your table.

Continue the patterns to complete the entries in the last row.

Connect

This table shows decreasing powers of 10.

Number in Words	Standard Form	Power
One billion	1 000 000 000	10^9
One hundred million	100 000 000	10^8
Ten million	10 000 000	10^7
One million	1 000 000	10^6
One hundred thousand	100 000	10^5
Ten thousand	10 000	10^4
One thousand	1 000	10^3
One hundred	100	10^2
Ten	10	10^1
One	1	10^0

Zero Exponent Law

A power with an integer base, other than 0, and an exponent 0 is equal to 1.

$$n^0 = 1, \quad n \neq 0$$

Example 1 Evaluating Powers with Exponent Zero

Evaluate each expression.

a) 4^0

b) -4^0

c) $(-4)^0$

▶ A Solution

A power with exponent 0 is equal to 1.

a) $4^0 = 1$

b) $-4^0 = -1$

c) $(-4)^0 = 1$

We can use the zero exponent and powers of 10 to write a number.

Example 2 Writing Numbers Using Powers of Ten

Write 3452 using powers of 10.

▶ A Solution

Use a place-value chart.

Thousands	Hundreds	Tens	Ones
3	4	5	2

$$\begin{aligned} 3452 &= 3000 + 400 + 50 + 2 \\ &= (3 \times 1000) + (4 \times 100) + (5 \times 10) + (2 \times 1) \quad \text{We use brackets for clarity.} \\ &= (3 \times 10^3) + (4 \times 10^2) + (5 \times 10^1) + (2 \times 10^0) \end{aligned}$$

PRACTICE TIME # 4(a, b) } For
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#6
#8(a, c, e)
#9(a, c, e)
#10(a,c,f), 12