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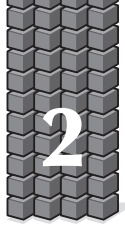
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2 Algebraic Expressions

2.1 Laws of Exponents

Example

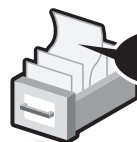
Write each expression as a single power with a positive exponent.

1. $2^8 \times 2^5 = 2^{8+5}$ ← Keep the base and add the exponents.
 $\underbrace{\hspace{1.5cm}}_{\text{same base}} = 2^{13}$

2. $2^8 \div 2^5 = 2^{8-5}$ ← Keep the base and subtract the exponents.
 $\underbrace{\hspace{1.5cm}}_{\text{same base}} = 2^3$

3. $(2^8)^5 = 2^{8 \times 5}$ ← Keep the base and multiply the exponents.
 $= 2^{40}$

4. $2^{-8} = \frac{1}{2^8}$



HINT

Laws of Exponents ($a \neq 0$)

$$a^0 = 1$$

$$a^1 = a$$

$$a^{-p} = \frac{1}{a^p}$$

(p is an integer.)

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = a^{m-n}$$

$$(a^m)^n = a^{m \times n}$$

(m and n are natural numbers.)

Try This

① $6^5 \times 6^2 = 6^{\square + \square} = \underline{6^{\square}}$

② $6^5 \div 6^2 = 6^{\square - \square} = \underline{6^{\square}}$

③ $(6^5)^2 = 6^{\square \times \square} = \underline{6^{\square}}$

④ $6^{-5} = \frac{1}{\underline{6^{\square}}}$

Write each expression as a single power with a positive exponent.

① $10^8 \div 10^5 = \underline{\hspace{2cm}}$

② $4^3 \times 4^2 = \underline{\hspace{2cm}}$

③ $5^{-8} = \underline{\hspace{2cm}}$

④ $3^7 \times 3^3 = \underline{\hspace{2cm}}$

⑤ $5^6 \div 5 = \underline{\hspace{2cm}}$

⑥ $(6^3)^3 = \underline{\hspace{2cm}}$

⑦ $4^{-2} = \underline{\hspace{2cm}}$

⑧ $(7^2)^4 = \underline{\hspace{2cm}}$

⑨ $(8^{-3})^2 = \underline{\hspace{2cm}}$

⑩ $8^3 \times 8^4 = \underline{\hspace{2cm}}$

⑪ $(6^{-1})^2 = \underline{\hspace{2cm}}$

⑫ $3^4 \div 3 = \underline{\hspace{2cm}}$

⑬ $5^2 \div 5^0 \times 5^3 = \underline{\hspace{2cm}}$

⑭ $9^3 \times 9 \div 9^2 = \underline{\hspace{2cm}}$

⑮ $(7^2)^3 \times 7^2 = \underline{\hspace{2cm}}$

⑯ $(8^2)^3 \div (8^2)^2 = \underline{\hspace{2cm}}$

⑰ $(3^{-2})^3 \times 3^5 = \underline{\hspace{2cm}}$

⑱ $(10^{-2})^4 \times (10^3)^2 = \underline{\hspace{2cm}}$

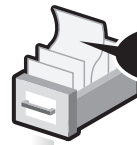
Write each expression as a base of 2 or 3 with a positive exponent.

⑲ $8^3 = \underline{\hspace{2cm}}$ ⑳ $81^4 = \underline{\hspace{2cm}}$

㉑ $9^5 = \underline{\hspace{2cm}}$ ㉒ $64^{-2} = \underline{\hspace{2cm}}$

㉓ $243^2 = \underline{\hspace{2cm}}$ ㉔ $4^7 = \underline{\hspace{2cm}}$

㉕ $1024^3 = \underline{\hspace{2cm}}$ ㉖ $27^{-4} = \underline{\hspace{2cm}}$



HINT

$$\begin{aligned}
 &9^5 \\
 &= (3^2)^5 \quad \leftarrow \text{Think: } 9 = 3^2 \\
 &= 3^{10} \quad \leftarrow \text{Replace } 9 \text{ by } 3^2. \\
 &\quad \leftarrow \text{Keep the base} \\
 &\quad \quad \text{and multiply the} \\
 &\quad \quad \text{exponents.}
 \end{aligned}$$

$$(a^m)^n = a^{m \times n}$$

Write each expression as a single power. Then evaluate each power.

⑲ $\frac{4^3 \div 2^2}{2^0 \times (2^3)^3}$

⑳ $\frac{5^2 \times 5^4 \div 5^3}{5^0 + 2^2}$

㉑ $\frac{(7^2)^3 \times 7^4 \div 7}{(49)^3 \div 7^0}$

⑳ $5^{-3} \times \frac{(5^2)^2}{25^3}$

㉒ $9^8 \div 3^2 \times \frac{3^{-6}}{2^3 + 2^0}$

㉓ $\frac{512^3 \times 2^{-9} \div 2^8}{9^2 \div 9 - 5^0}$

㉔ $\frac{64^4 \div (2^7 \times 2^6)}{5^2 - 3^2} = \underline{\hspace{2cm}}$

㉕ $216^{-4} \times \frac{(6^{13} \div 6)}{5^2 - 5^0 + 2^3} = \underline{\hspace{2cm}}$

㉖ $\frac{(5^6)^2 \div (5^3 \times 5^2)}{5^3 \div 125} = \underline{\hspace{2cm}}$

㉗ $\frac{243 \times 3^6}{5^4 \div 5^2 + 2^6 \div 2^5} = \underline{\hspace{2cm}}$

㉘ $\frac{8^3 \times (4^3 \div 2^7)}{64 \div 2^3 \div 2} = \underline{\hspace{2cm}}$

㉙ $\frac{54 - 3^3}{9^6 \div 3^9 \times 81} = \underline{\hspace{2cm}}$



Write each expression as powers with positive exponents.

$$\begin{aligned} 39 \quad 5^3 \times \left(\frac{2}{5}\right)^2 & \\ &= 5^3 \times \frac{2^2}{5^2} \\ &= 5^{3-2} \times 2^2 \\ &= \underline{\hspace{2cm}} \end{aligned}$$

$$\begin{aligned} 40 \quad 20^2 \times \frac{1}{4^2} & \\ &= (4 \times \square)^2 \times \frac{1}{4^2} \\ &= 4^{\square} \times \square^{\square} \times \frac{1}{4^2} \\ &= \underline{\hspace{2cm}} \end{aligned}$$



Laws of Exponents

($b \neq 0$, m – integers)

$$(a \times b)^m = a^m \times b^m$$

e.g. $6^5 = (2 \times 3)^5$
 $= 2^5 \times 3^5$

$$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$$

e.g. $\left(\frac{3}{5}\right)^2 = \frac{3^2}{5^2}$

$$41 \quad 6^3 \times \frac{1}{9^2} = \underline{\hspace{2cm}}$$

$$42 \quad 8^{-2} \times 24^3 = \underline{\hspace{2cm}}$$

$$43 \quad \frac{14^2}{2^3} = \underline{\hspace{2cm}}$$

$$44 \quad 4^2 \times 28^{-2} = \underline{\hspace{2cm}}$$

Write each number in scientific notation.

Think: 0.000084

This decimal should be greater than or equal to 1 and less than 10.

Think: 7,600,000

$$45 \quad 0.000084 = \underline{\hspace{1cm}} \times 10^{\square}$$

$$46 \quad 7\,600\,000 = \underline{\hspace{1cm}} \times 10^{\square}$$

$$47 \quad 0.00000864 = \underline{\hspace{2cm}}$$

$$48 \quad 12\,500\,000 = \underline{\hspace{2cm}}$$

$$49 \quad 395 \times 10^3 = \underline{\hspace{2cm}}$$

$$50 \quad 0.017 \times 10^{-6} = \underline{\hspace{2cm}}$$

$$51 \quad 0.00895 \times 10^8 = \underline{\hspace{2cm}}$$

$$52 \quad 2700 \times 10^4 = \underline{\hspace{2cm}}$$

Evaluate each expression without a calculator. Then write the answer in scientific notation.

$$53 \quad 9 \times 10^{-5} \times 8 \times 10^2 = \underline{\hspace{2cm}}$$

$$54 \quad 6 \times 10^8 \times 50 \times 10^{-2} = \underline{\hspace{2cm}}$$

$$55 \quad 70 \times 10^8 \times 200 \times 10^{-5} = \underline{\hspace{2cm}}$$

$$56 \quad 4 \times 10^{-3} \times 5 \times 10^{-6} = \underline{\hspace{2cm}}$$

$$57 \quad \frac{3 \times 10^{-5} \times 10^2}{6 \times 10^3 \times 10} = \underline{\hspace{2cm}}$$

$$58 \quad \frac{2 \times 10^7 \times 10^2}{8 \times 10^3} = \underline{\hspace{2cm}}$$

Solve the problems. Write the answers in scientific notation.

- ⑤9 The surface area of the Earth is about $510\,000\,000\text{ km}^2$. About 71% of the surface is covered by oceans and the rest is covered by land.
- a. What is the surface area of the Earth's oceans? _____
- b. What is the surface area of the Earth's land? _____
- ⑥0 The volume of water flowing over Horseshoe Falls is about $343\,200\,000\text{ L/min}$ in peak flow season.
- a. What is the volume of water in a second? _____
- b. What is the volume of water in an hour? _____
- ⑥1 The distance between the sun and the Earth is about $1.5 \times 10^8\text{ km}$. The speed of light is $3 \times 10^8\text{ m/s}$.
- a. What is the distance between the sun and the Earth in m? _____
- b. How long does it take for light to travel from the sun to the Earth? _____
- ⑥2 The population of Canada in 2005 was about 3.2×10^7 . There were about 77% of Canadians living in cities and towns.
- a. How many Canadians lived in cities and towns in 2005? _____
- b. The population of Canada in 2007 was about 4% more than that in 2005. What was the population in 2007? _____

Challenge

The radius of the Earth is about $6.3 \times 10^3\text{ km}$. Find its volume in terms of π .

Volume of a Sphere

$$= \frac{4}{3} \pi r^3, \text{ where } r = \text{radius}$$

