

Exponents and Scientific Notation: practice solutions, Grade 8 – download the PDF

Written solutions to the chapter problems. Check each step, then correct yourself.

1 Parts of a power



a. The base is **6** and the exponent is **4**.

b. $6^4 = 6 \times 6 \times 6 \times 6$.

c. $6 \times 6 = 36$, $36 \times 6 = 216$, $216 \times 6 = 1,296$. So $6^4 = 1,296$.

2 Evaluating powers



$2^6 = 64$; $10^3 = 1,000$; $(-2)^3 = -8$ (odd exponent, negative result) ; $(-4)^2 = 16$ (the base -4 is squared) ; $-4^2 = -(4 \times 4) = -16$ (only the 4 is squared) ; $3^4 = 81$.

3 Using the product rule



Same base, so add the exponents. $4^3 \times 4^5 = 4^8$; $9 \times 9^6 = 9^1 \times 9^6 = 9^7$; $x^2 \times x^7 = x^9$; $y^5 \times y = y^{5+1} = y^6$.

4 Using the quotient rule



Same base, so subtract the exponents. $\frac{6^9}{6^4} = 6^5$; $\frac{10^8}{10^3} = 10^5$; $\frac{z^{12}}{z^5} = z^7$; $\frac{2^7}{2^7} = 2^0 = 1$, which matches the fact that any nonzero number divided by itself is 1.

5 Powers of powers



Multiply the exponents. $(3^2)^4 = 3^8$; $(5^3)^3 = 5^9$; $(y^6)^2 = y^{12}$; $(10^2)^5 = 10^{10}$.

6 Zero and negative exponents



$7^0 = 1$; $3^{-2} = \frac{1}{3^2} = \frac{1}{9}$; $10^{-3} = \frac{1}{1,000} = 0.001$; $2^{-4} = \frac{1}{16}$; $(-5)^0 = 1$ (any nonzero base to the power 0).

7 Standard form



$3.2 \times 10^4 = 32,000$ (4 places right); $7 \times 10^6 = 7,000,000$; $5.1 \times 10^{-3} = 0.0051$ (3 places left); $9.04 \times 10^2 = 904$.

8 True or false?



- a. False. Add the exponents: $2^3 \times 2^4 = 2^7 = 128$, not 2^{12} .
- b. True. Multiply the exponents: $(3^2)^3 = 3^{2 \times 3} = 3^6 = 729$.
- c. False. A negative exponent gives a reciprocal: $5^{-1} = \frac{1}{5}$.
- d. False. Any nonzero base to the power 0 equals 1, so $4^0 = 1$.

9 Which is bigger?



- (a) $2^5 = 32$ and $5^2 = 25$, so 2^5 is greater.
- (b) $3^4 = 81$ and $4^3 = 64$, so 3^4 is greater.
- (c) $2^{10} = 1,024$ and $10^2 = 100$, so 2^{10} is greater. Swapping base and exponent does not give the same value!

10 Simplifying with variables



- (a) Multiply the numbers and add the exponents: $4 \times 5 = 20$, so $20x^{3+4} = 20x^7$.
- (b) $\frac{18}{6} = 3$ and $m^{9-4} = m^5$, so the result is $3m^5$.
- (c) $(2a^2)^3 = 2^3 \times (a^2)^3 = 8a^6$.

11 To scientific notation



$58,000,000 = 5.8 \times 10^7$ (7 places left) ; $0.00071 = 7.1 \times 10^{-4}$ (4 places right) ;
 $640,000,000,000 = 6.4 \times 10^{11}$ (11 places left) ; $0.0000093 = 9.3 \times 10^{-6}$ (6 places right).

12 Ordering numbers



- a. Compare exponents first, then decimal parts: 8.1×10^4 (exponent 4) is least. Next, with exponent 5: $4.2 \times 10^5 < 6 \times 10^5$. Greatest is 3.9×10^6 . Order:
 $8.1 \times 10^4 < 4.2 \times 10^5 < 6 \times 10^5 < 3.9 \times 10^6$.
- b. The values are 0.0072, 0.0009 and 0.0011. Order:
 $9 \times 10^{-4} < 1.1 \times 10^{-3} < 7.2 \times 10^{-3}$.

13 Multiplying in scientific notation



- (a) $2.5 \times 4 = 10$ and $10^3 \times 10^5 = 10^8$, so the product is $10 \times 10^8 = 1 \times 10^9$.
- (b) $6 \times 3 = 18$ and $10^{-2} \times 10^7 = 10^5$, so the product is $18 \times 10^5 = 1.8 \times 10^6$.

14 Phone storage



- a. $256 \times 10^9 = 2.56 \times 10^2 \times 10^9 = 2.56 \times 10^{11}$ bytes.
- b. $\frac{2.56 \times 10^{11}}{2 \times 10^3} = 1.28 \times 10^8$. About 128,000,000 text files would fit.

15 Simplifying with negative exponents



- a. Add the exponents on top: $x^{3-7} = x^{-4}$. Then subtract: $x^{-4-(-2)} = x^{-2} = \frac{1}{x^2}$.
- b. Top: $2^{-3+5} = 2^2$. Then $2^{2-(-1)} = 2^3 = 8$.
- c. $(5^2)^{-2} = 5^{-4}$, then $5^{-4} \times 5^3 = 5^{-1} = \frac{1}{5}$.

16 Reading an exponential curve



- a. $2^2 = 4$, so $y = 4$. And $2^{-1} = \frac{1}{2}$, so $y = 0.5$.
- b. $2^3 = 8$, so $x = 3$. $2^{-1} = \frac{1}{2}$, so $x = -1$.
- c. A power of 2 is never zero and never negative: $2^{-n} = \frac{1}{2^n}$ gets smaller and smaller but stays positive. The curve gets closer to the axis without reaching it.

17 Doubling bacteria



a. $500 \times 2^6 = 500 \times 64 = 32,000$ bacteria.

b. We need $500 \times 2^n > 10^6$, that is $2^n > 2,000$. Since $2^{10} = 1,024$ is too small and $2^{11} = 2,048$ works, the answer is $n = 11$. Check: after 10 hours there are 512,000; after 11 hours there are 1,024,000. The population first exceeds one million after 11 hours.

18 Adding and subtracting



(a) Rewrite $8.5 \times 10^4 = 0.85 \times 10^5$. Then $6.2 \times 10^5 + 0.85 \times 10^5 = 7.05 \times 10^5$.

(b) Rewrite $2.6 \times 10^{-4} = 0.26 \times 10^{-3}$. Then $4.1 \times 10^{-3} - 0.26 \times 10^{-3} = 3.84 \times 10^{-3}$.

19 How long does light take?



Time = distance $\div$ speed.

Sun: $\frac{1.5 \times 10^{11}}{3 \times 10^8} = 0.5 \times 10^3 = 5 \times 10^2 = 500$ s, which is 8 min 20 s.

Moon: $\frac{3.84 \times 10^8}{3 \times 10^8} = 1.28$ s.

Sunlight takes about 8 minutes 20 seconds to reach Earth; moonlight takes about 1.28 seconds.

20 How many times larger?



Since $8 > 6$, the country is larger. Divide: $\frac{3.3 \times 10^8}{2.4 \times 10^6} = \frac{3.3}{2.4} \times 10^2 = 1.375 \times 10^2$.

Rounded: 1.4×10^2 . The country has about 140 times as many residents as the city.



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