EXPONENT RULES

Learning Goals

- use the power rules to simplify and evaluate

Exponent Rules

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

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

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

Power of a Quotient $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

Power of a Product $(ab)^n = a^n b^n$

Simplify

$a^5 \times a^6 = a^{11}$

$\left(\frac{a}{b}\right)^2 = \frac{a^2}{b^2}$

$\frac{a^9}{a^6} = a^3$

$\left(\frac{a^7}{a^2}\right)^3 = \frac{(a^7)^3}{(a^2)^3} = \frac{a^{21}}{a^6} = a^{15}$

$\to (a^5)^3 = a^{15}$

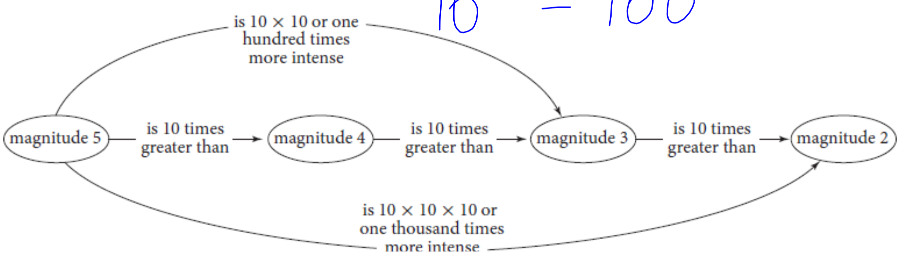
$(a^5)^6 = a^{30}$

$\left(\frac{a^2}{b^3}\right)^4 = \frac{(a^2)^4}{(b^3)^4} = \frac{a^8}{b^{12}}$

Earthquakes

The intensity of an earthquake can range from 1 to 10 000 000. The Richter scale is a base-10 exponential scale used to classify the magnitude of an earthquake. An earthquake with an intensity of 100 000 or 10^5, has a magnitude of 5 as measured on the Richter scale. The chart shows how magnitudes are related.

$10^2 = 100$



Intensity	Magnitude	Earthquake Effects
Up to $10^{2.5}$	2.5 or less	Usually not felt, but can be recorded by seismograph.
$10^{2.5}$ to $10^{5.4}$	2.5 to 5.4	Often felt, but only causes minor damage.
$10^{5.5}$ to $10^{6.0}$	5.5 to 6.0	Slight damage to buildings and other structures.
$10^{6.1}$ to $10^{6.9}$	6.1 to 6.9	May cause heavy damage in very populated areas.
$10^{7.0}$ to $10^{7.9}$	7.0 to 7.9	Major earthquake. Serious damage.
$10^{8.0}$ and greater	8.0 or greater	Great earthquake. Can totally destroy communities near the epicentre.

An earthquake measuring 2 on the Richter scale can barely be felt, but one measuring 6 often causes damage. An earthquake with magnitude 7 is considered a major earthquake.

a) How much more intense is an earthquake with magnitude 6 than one with magnitude 2?

b) How much more intense is an earthquake with magnitude 7 than one with magnitude 6?

a) magnitude 6 $\Rightarrow 10^6$
magnitude 2 $\Rightarrow 10^2$

$$\frac{10^6}{10^2} = 10^4 = 10000$$

$\therefore$ 10000 times stronger

b) magnitude 7 $\Rightarrow 10^7$
magnitude 6 $\Rightarrow 10^6$

$$\frac{10^7}{10^6} = 10^1 = 10$$

$\therefore$ 10 times stronger

On the Boards...

1. Write each expression as a single power, then evaluate.

a) $5^2 \times 5^2$

b) $2^4 \times 2^3 = 2^7$

c) $(-3)^2 \times (-3)^4$

d) $(-4)^3 \times (-4)^3$
$= (-4)^6$
$= 4096$

e) $\left(\frac{1}{4}\right)^2 \times \left(\frac{1}{4}\right)^3$
$= \left(\frac{1}{4}\right)^5$
$= \frac{1}{1024}$

f) $\left(-\frac{1}{2}\right)^2 \times \left(-\frac{1}{2}\right)^1$
$= \left(-\frac{1}{2}\right)^3 = \frac{-1}{8}$

2. Write each expression as a single power, then evaluate.

a) $6^5 \div 6^4 = 6^1 = 6$

b) $8^7 \div 8^5$

c) $12^8 \div 12^7 = 12$

d) $\frac{2^{10}}{2^6} = 2^4 =$

e) $\frac{(-2)^9}{(-2)^6}$

f) $\frac{(-3)^6}{(-3)^4} = (-3)^2$
$= 9$

3. Write the single powers, then evaluate.

a) $(5^2)^3 = 5^6 = 15625$

b) $(2^3)^3 = 2^9 = 512$

c) $[(-4)^3]^2$

d) $\left(\frac{1}{7^2}\right)^2 = \frac{1^2}{7^4} = \frac{1}{\quad}$

e) $\left(\frac{1}{3^3}\right)^2 = \frac{1^2}{3^6} = \frac{1}{\quad}$

f) $\left(-\frac{1}{10^2}\right)^4 = \frac{1^4}{10^8} = \frac{1}{100000000}$

5. Write each expression as a single power, then evaluate.

a) $9^4 \times 9^5 = 9^9$

b) $(7^2)^4 = 7^8$

c) $(-6) \times (-6)^5 = (-6)^6$

d) $24^6 \div 24^5 = 24^2$

e) $\frac{9^7}{9^5} = 9^2$

f) $\left(\frac{3}{4}\right)^5 \times \left(\frac{3}{4}\right)^2 = \left(\frac{3}{4}\right)^3 = \frac{3^3}{4^3}$

g) $(4^3)^5 = 4^{15}$

h) $\frac{(-8)^9}{(-8)^6} = (-8)^3$

i) $\left(-\frac{5}{7}\right)^8 \div \left(-\frac{5}{7}\right)^4 = \left(\frac{-5}{7}\right)^4$

6. Canada's greatest earthquake was recorded in 1949 at the Queen Charlotte Islands in British Columbia. It had a magnitude of about 8. The magnitude of the greatest recorded earthquake in Ontario was about 6. It occurred at the Ontario—Quebec border north of Mattawa in 1935. How much more intense was the earthquake in British Columbia compared to the one in Ontario?

$\frac{10^8}{10^6}$

$= 10^2$

$= 100$

∴ 100 times more intense

11. The probability of rolling a 5 using a single die is $\frac{1}{6}$. The probability of rolling two 5s using two dice is $\left(\frac{1}{6}\right) \times \left(\frac{1}{6}\right)$ or $\left(\frac{1}{6}\right)^2$.

a) Evaluate the probability of rolling two 5s. Leave your answer in fraction form.

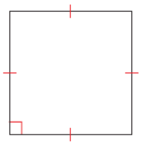
$\left(\frac{1}{6}\right)^2 = \frac{1}{36}$

b) What would be the probability of rolling three 5s using three dice?

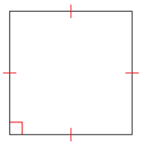
$\left(\frac{1}{6}\right)^3 = \frac{1}{6^3} = \frac{1}{216}$

12. The area of a square can be calculated using the formula $A = s^2$, where s is the length of a side. Calculate the area of a square with each side length. Express your answer as a fraction.

a)



b)



a)
$A = lw$
$= \left(\frac{1}{2}\right)^2$
$= \frac{1}{4}$
$\therefore \frac{1}{4}\ in^2$

b)
$A = lw$
$= \left(\frac{1}{4}\right)^2$
$= \frac{1}{16}$
$\therefore \frac{1}{16}\ in^2$

Seatwork

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