

KEY

Practice

Check

1

Write each product as a single power.

- a)  $5^5 \times 5^4 = 5^9$
- b)  $10^2 \times 10^{11} = 10^{13}$
- c)  $(-3)^3 \times (-3)^3 = (-3)^6$
- d)  $21^6 \times 21^4 = 21^{10}$
- e)  $(-4)^1 \times (-4)^3 = (-4)^4$
- f)  $6^{12} \times 6^3 = 6^{15}$
- g)  $2^0 \times 2^4 = 2^4$
- h)  $(-7)^3 \times (-7)^0 = (-7)^3$

2

Write each quotient as a power.

- a)  $4^5 \div 4^3 = 4^2$
- b)  $8^9 \div 8^6 = 8^3$
- c)  $15^{10} \div 15^0 = 15^{10}$
- d)  $(-6)^8 \div (-6)^3 = (-6)^5$
- e)  $\frac{2^{12}}{2^{10}} = 2^2$
- f)  $\frac{(-10)^{12}}{(-10)^6} = (-10)^6$
- g)  $\frac{6^5}{6^1} = 6^4$
- h)  $\frac{(-1)^5}{(-1)^4} = (-1)^1$

Apply

3

a) Evaluate.

- i)  $3^4 \div 3^4 = 1$
- ii)  $(-4)^6 \div (-4)^6 = 1$
- iii)  $\frac{5^8}{5^8} = 1$
- iv)  $\frac{(-6)^3}{(-6)^3} = 1$

b) Use the results of part a. Explain how the exponent law for the quotient of powers can be used to verify that a power with exponent 0 is 1.

ie:  $8-8=0$

4

a) Compare these products.

- i)  $3^4 \times 3^9$
- ii)  $3^9 \times 3^4$

b) Explain the results in part a.

i =  $13^{13} = 1594323$   
 ii = Same

5

Express as a single power.

- a)  $3^4 \times 3^9 \div 3^{11} = 3^2$
- b)  $(-4)^3 \div (-4)^2 \times (-4)^{10} = 4^{11}$
- c)  $6^0 \times 6^3 \div 6^2 = 6^1$
- d)  $\frac{4^3 \times 4^5}{4^2 \times 4^6} = 4^0$
- e)  $\frac{(-3)^4 \times (-3)^4}{(-3)^4} = (-3)^4$

6

a) Express as a single power, then evaluate.

- i)  $(-6)^1 \times (-6)^7 \div (-6)^7 = (-6)^1 = -6$
- ii)  $(-6)^7 \div (-6)^7 \times (-6)^1 = (-6)^1 = -6$

b) Explain why changing the order of the terms in the expressions in part a does not affect the answer.

7

Simplify, then evaluate.

- a)  $10^2 \times 10^2 + 10^4$
- b)  $10^3 \times 10^3 - 10^3$
- c)  $10^{11} - 10^3 \times 10^6$
- d)  $10^1 + 10^5 \times 10^2$
- e)  $10^6 \div 10^2 \times 10^2$
- f)  $10^9 \div 10^9$
- g)  $\frac{10^{12}}{10^6}$
- h)  $\frac{10^4 \times 10^3}{10^2}$
- i)  $\frac{10^{11}}{10^4 \times 10^2}$
- j)  $\frac{10^5}{10^3} + 10^2$

over

8

Evaluate.

- a)  $2^3 \times 2^2 - 2^5 \times 2 = -32$
- b)  $3^2 \times 3 + 2^2 \times 2^4 = 91$
- c)  $4^2 - 3^0 \times 3 + 2^3 = 21$
- d)  $(-3)^6 \div (-3)^5 - (-3)^5 \div (-3)^3 = -12$
- e)  $(-2)^4 [(-2)^5 \div (-2)^3] + (-2)^4 = 80$
- f)  $-2^4(2^6 \div 2^2) - 2^4 = -272$
- g)  $(-5)^3 \div (-5)^2 \times (-5)^0 + (-5)^2 \div (-5) = -10$

7) a)  $10^4 + 10^4 = 20\ 000$

b)  $10^6 - 10^3 = 999\ 000$

c)  $10^8 - 10^9 = 99\ 000\ 000\ 000$

d)  $10^1 + 10^7 = 10\ 000\ 010$

e)  $10^6 = 1\ 000\ 000$

f)  $10^0 = 1$

g)  $10^6 = 1\ 000\ 000$

h)  $10^5 = 100\ 000$

i)  $10^5 = 100\ 000$

j)  $10^2 + 10^2 = 200$

# Exponent Laws

KEY

① Write as a power.

a)  $(3^2)^4 = 3^8$     b)  $(6^3)^3 = 6^9$     c)  $(5^3)^1 = 5^3$   
 d)  $(7^0)^6 = 7^0$     e)  $-(8^2)^2 = -8^4$     f)  $[(-3)^4]^2 = (-3)^8$

② Simplify  $(2^4)^2$  and  $(2^2)^4$ . What do you notice? Explain the results.

$(2^4)^2 = 2^8$ ;  $(2^2)^4 = 2^8$   
 - product of 8, factor of 2  
 $2 \times 4 = 8$   
 $4 \times 2 = 8$

③ Write each expression as a product or quotient of powers.

a)  $[3 \times (-5)]^3$     b)  $-(2 \times 4)^5$   
 c)  $(\frac{2}{3})^4$     d)  $(\frac{-7}{2})^2$   
 e)  $-[(-10) \times 3]^3$     f)  $(16 \div 9)^2$   
 g)  $-(-10)^3 \times 3^3$     h)  $16^2 \div 9^2$   
 a)  $3^3 \times (-5)^3$   
 b)  $-2^5 \times 4^5$   
 c)  $\frac{2^4}{3^4}$   
 d)  $(\frac{-7}{2})^2$

④ Why is the value of  $(-5^2)^3$  negative?

1)  $5^2 = 25 \rightarrow$  mult. only 5, not -5

⑤ Simplify each expression, then evaluate it. For each expression, state the strategy you used and why.

a)  $(3 \times 2)^3 = 6^3 = 216$     b)  $[(-2) \times 4]^2 = (-8)^2 = 64$     c)  $(\frac{9}{-3})^3 = (-3)^3 = -27$   
 d)  $(\frac{8}{2})^2 = 4^2 = 16$     e)  $(12^8)^0 = 1$     f)  $[(-4)^2]^2 = (-4)^4 = 256$

⑥ Why is the value of  $[(-2)^3]^4$  positive but the value of  $[(-2)^3]^5$  is negative?

$[(-2)^3]^4 = (-2)^{12}$  - even  
 $[(-2)^3]^5 = (-2)^{15}$  - odd

⑦ Compare the values of  $-(4^2)^3$ ,  $(-4^2)^3$ , and  $[(-4)^2]^3$ .

What do you notice? Explain the results.

$-(4^2)^3 = -4096$   
 $(-4^2)^3 = -4096$   
 $[(-4)^2]^3 = 4096 \leftarrow - \times -2 +$

⑧ Assessment Focus: For each expression below:

- i) Evaluate it in two different ways:
- do the operation in brackets first
  - use the exponent laws
- ii) Compare the results. Which method do you prefer? Was it always the same method each time? Explain.

a)  $(4 \times 3)^3 = 1728$     b)  $[(-2) \times (-5)]^2 = 100$     c)  $(\frac{6}{2})^4 = 81$   
 d)  $(\frac{14}{2})^0 = 1$     e)  $[(-5)^2]^2 = 625$     f)  $(2^5)^3 = 32768$

⑨ Simplify, then evaluate. Show your work.

a)  $(3^2 \times 3^2)^2 = 6^4 = 1296$     b)  $(4^6 \div 4^4)^2 = 256$   
 c)  $[(-2)^0 \times (-2)^3]^2 = 1$     d)  $(10^6 \div 10^4)^3 = 1000000$   
 e)  $(10^5)^2 \times (10^2)^3 = 10^{17}$     f)  $(12^2)^4 \div (12^3)^2 = 144$   
 g)  $(5^2)^6 \div (5^3)^4 = 5^{12} \div 5^{12} = 1$     h)  $[(-2)^2]^3 \times (-2)^3 = -512$   
 a) 729  
 c) 64  
 e) 1000000000000  
 g) 1

⑩ Find any errors in this student's work. Copy the solution and correct the errors.

a) $(3^2 \times 2^2)^3 = (6^2)^3 = 6^{12} = 2176782336$	b) $[(-3)^2]^3 = (-3)^5 = -243$
c) $(\frac{6^2}{6})^2 = 6^2 = 1296$	d) $(2^6 \times 2^2 + 2^4)^3 = (2^8)^3 = 2^{24} = 512$
e) $(10^2 + 10^5)^2 = (10^5)^2 = 10^{10} = 1000000000$	

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Simplify, then evaluate each expression.

- a)  $(4^2 \times 4^3)^2 - (5^4 \div 5^2)^2 = 1047951$
- b)  $(3^3 \div 3^2)^3 + (8^4 \times 8^3)^0 = 28$
- c)  $(2^3)^4 + (2^4 \div 2^3)^2 = 4100$
- d)  $(6^2 \times 6^0)^3 + (2^6 \div 2^4)^3 = 46720$
- e)  $(5^3 \times 5^3)^0 - (4^2)^2 = -255$
- f)  $(10^5 \div 10^2)^2 + (3^3 \div 3^1)^4 = 1006561$

12

Simplify, then evaluate each expression.

- a)  $[(-2)^3 \times (-2)^2]^2 - [(-3)^3 \div (-3)^2]^2 = 1015$
- b)  $[(-2)^3 \div (-2)^2]^2 - [(-3)^3 \times (-3)^2]^2 = -59045$
- c)  $[(-2)^3 \times (-2)^2]^2 + [(-3)^3 \div (-3)^2]^2 = 1033$
- d)  $[(-2)^3 \div (-2)^2]^2 + [(-3)^3 \times (-3)^2]^2 = 59053$
- e)  $[(-2)^3 \div (-2)^2]^2 - [(-3)^3 \div (-3)^2]^2 = -5$
- f)  $[(-2)^3 \times (-2)^2]^2 + [(-3)^3 \times (-3)^2]^2 = 60073$

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Simplify, then evaluate each expression.

- a)  $(2^3 \times 2^6)^2 - (3^7 \div 3^5)^4$
- b)  $(6 \times 8)^5 + (5^3)^2$
- c)  $[(-4)^3 \times (-4)^2]^2 + (4^3 \times 4^2)^2$
- d)  $[(-2)^4]^3 + [(-4)^3]^2 - [(-3)^2]^4$
- e)  $[(-3)^4]^2 \times [(-4)^0]^2 - [(-3)^3]^0$
- f)  $[(-5) \times (-4)]^3 + [(-6)^3]^2 - [(-3)^9 \div (-3)^8]^5$

### Take It Further

14

a) Write 81:

- i) as a power of 9 =  $9^2$
- ii) as a power of a product =  $(3 \times 3)^2$
- iii) as a power of 3 =  $3^4$

b) Write 64:

- i) as a power of 8
  - ii) as a power of a product
  - iii) as a power of 2
- c) Find other numbers for which you can follow steps similar to those in parts a and b.

15

a) List the powers of 2 from  $2^0$  to  $2^{12}$  in standard form.

b) Use your list from part a to write each number in the expressions below as a power of 2. Evaluate each expression using the exponent laws and the list in part a.

- i)  $32 \times 64$
- ii)  $16 \times 8 \times 32$
- iii)  $1024 \div 128$
- iv)  $\frac{16 \times 256}{1024}$
- v)  $(8 \times 4)^3$
- vi)  $\left(\frac{256}{64}\right)^4$