

10. [Exponents]

Skill 10.1 Evaluating whole numbers in exponential form.

MMMaive 1 1 2 2 3 3 4 4
MMLime 1 1 2 2 3 3 4 4

- Observe the exponent. The exponent tells you how many times to multiply the base by itself.

5 to the power of 4
Base 5⁴ Exponent

5⁴ = 5 · 5 · 5 · 5
5 multiplied by itself 4 times

6⁰ = 1
number to the power of 0 = 1

3¹ = 3
number to the power of 1 = itself

4² = 4 · 4 = 16
4 squared

2³ = 2 · 2 · 2 = 8
2 cubed

Q. 2⁵ =

A. 2⁵ =

= 2 · 2 · 2 · 2 · 2
= 32

2 multiplied by itself 5 times

a) 3⁴ =

= 3 · 3 · 3 · 3

= 81

b) 2³ =

= 2 · 2 · 2

=

c) 2⁶ =

=

=

d) 5² =

=

=

e) 1⁷ =

=

=

f) 4² =

=

=

g) 7² =

=

=

h) 6³ =

=

=

i) 10³ =

=

=

j) 3⁵ =

=

=

k) 7³ =

=

=

l) 9² =

=

=

m) 8¹ =

=

=

n) 9⁰ =

=

=

o) 0⁷ =

=

=

Skill 10.2 Evaluating powers with fraction bases.

MMMaube 1 1 2 2 3 3 4 4
MMLime 1 1 2 2 3 3 4 4

- Observe the exponent. The exponent tells you how many times to multiply the numerator by itself and the denominator by itself.

numerator, 2 to the power of 3

Base $\left(\frac{2}{5}\right)^3$ Exponent

denominator, 5 to the power of 3

2 multiplied by itself 3 times

$$\left(\frac{2}{5}\right)^3 = \frac{2 \cdot 2 \cdot 2}{5 \cdot 5 \cdot 5} = \frac{8}{125}$$

5 multiplied by itself 3 times

Q. $\left(\frac{3}{7}\right)^2 =$

A. $\left(\frac{3}{7}\right)^2 =$

$= \frac{3 \cdot 3}{7 \cdot 7}$ (3 multiplied by itself 2 times)

$= \frac{9}{49}$ (7 multiplied by itself 2 times)

a) $\left(\frac{3}{10}\right)^3 =$

$= \frac{3 \cdot 3 \cdot 3}{10 \cdot 10 \cdot 10} = \frac{27}{1000}$

b) $\left(\frac{1}{5}\right)^3 =$

$=$

c) $\left(\frac{2}{7}\right)^2 =$

$=$

d) $\left(\frac{1}{10}\right)^2 =$

$=$

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

$=$

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

$=$

g) $\left(\frac{6}{11}\right)^2 =$

$=$

h) $\left(\frac{4}{9}\right)^2 =$

$=$

i) $\left(\frac{1}{4}\right)^4 =$

$=$

j) $\left(\frac{2}{3}\right)^5 =$

$=$

k) $\left(\frac{4}{5}\right)^3 =$

$=$

l) $\left(\frac{7}{10}\right)^3 =$

$=$

Skill 10.3 Raising a negative number to a power.

- Observe the exponent.

$$\begin{aligned}
 &\text{even exponent} \\
 (-5)^2 &= -5 \cdot (-5) \\
 &= +25 \\
 &\text{positive result}
 \end{aligned}$$

$$\begin{aligned}
 &\text{odd exponent} \\
 (-5)^3 &= -5 \cdot (-5) \cdot (-5) \\
 &= +25 \cdot (-5) \\
 &= -125 \\
 &\text{negative result}
 \end{aligned}$$

Q. Evaluate $(-4)^3$

$$\begin{aligned}
 \text{A. } (-4)^3 &\text{ odd exponent} \\
 &= -4 \cdot (-4) \cdot (-4) \\
 &= -64 \\
 &\text{negative result}
 \end{aligned}$$

a) Evaluate $(-9)^2$ *even exponent*

$$\begin{aligned}
 &= -9 \cdot (-9) = \boxed{81} \\
 &\text{positive result}
 \end{aligned}$$

b) Evaluate $(-2)^2$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

c) Evaluate $(-1)^5$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

d) Evaluate $(-4)^3$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

e) Evaluate $(-8)^2$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

f) Evaluate $(-2)^4$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

g) Evaluate $(-1)^7$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

h) Evaluate $(-2)^6$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

i) Evaluate $(-3)^3$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

j) Evaluate $(-6)^3$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

k) Evaluate $(-7)^2$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

l) Evaluate $(-5)^4$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

m) Evaluate $(-10)^3$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

n) Evaluate $(-12)^2$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

o) Evaluate $(-1)^{123}$

$$\begin{aligned}
 &= \dots = \boxed{}
 \end{aligned}$$

Skill 10.4 Multiplying powers with the same base.

MMMaive 1 1 2 3 3 4 4
MMLime 1 1 2 2 3 3 4 4

- Add the exponents of like numbers or like variables (letters).

$$\begin{aligned} \text{Example: } 8^3 \cdot 8^4 &= \underbrace{8 \cdot 8 \cdot 8} \cdot \underbrace{8 \cdot 8 \cdot 8 \cdot 8} \\ &= 8^{3+4} \\ &= 8^7 \end{aligned}$$

$$\text{In general: } a^m \cdot a^n = a^{m+n}$$

- The size of the new exponent tells you how many times to multiply the base by itself.

Q. Simplify and evaluate $6 \cdot 6^2$ **A.** $6 \cdot 6^2$
 $= 6^{1+2}$ *add the exponents*
 $= 6^3$
 $= 6 \cdot 6 \cdot 6$
 $= 216$

a) Simplify $b^2 \cdot b^2$ **b)** Simplify $z \cdot z^3$ **c)** Simplify $y^3 \cdot y^2$
 $= b^{2+2} = \boxed{b^4}$ $= \dots = \boxed{}$ $= \dots = \boxed{}$

d) Simplify $x^3 \cdot x^6$ **e)** Simplify $f \cdot f^4$ **f)** Simplify $m^3 \cdot m^4$
 $= \dots = \boxed{}$ $= \dots = \boxed{}$ $= \dots = \boxed{}$

g) Simplify and evaluate $2^3 \cdot 2$ **h)** Simplify and evaluate $3^2 \cdot 3^3$ **i)** Simplify and evaluate $5 \cdot 5^2$
 $= 2^{3+1} = 2^4$ $= \dots$ $= \dots$
 $= 2 \cdot 2 \cdot 2 \cdot 2 = \boxed{}$ $= \dots = \boxed{}$ $= \dots = \boxed{}$

j) Simplify and evaluate $5^3 \cdot 5$ **k)** Simplify and evaluate $4 \cdot 4^2$ **l)** Simplify and evaluate $3^2 \cdot 3^2$
 $= \dots$ $= \dots$ $= \dots$
 $= \dots = \boxed{}$ $= \dots = \boxed{}$ $= \dots = \boxed{}$

m) Simplify $ab^2 \cdot a^4b^2$ **n)** Simplify $l^2m^3 \cdot lm^4$ **o)** Simplify $g^5h^3 \cdot gh^2$
 $= a^{1+4} \cdot b^{2+2} = \boxed{a^5b^4}$ $= \dots = \boxed{}$ $= \dots = \boxed{}$

Skill 10.5 Dividing powers with the same base.

- Subtract the exponents of like numbers or like variables.

$$\begin{aligned} \text{Example: } 8^5 \div 8^3 &= \frac{8^5}{8^3} = \frac{8 \cdot 8 \cdot \cancel{8} \cdot \cancel{8} \cdot \cancel{8}}{\cancel{8} \cdot \cancel{8} \cdot \cancel{8}} \\ &= 8^{5-3} = 8^2 = 64 \end{aligned}$$

$$\text{In general: } a^m \div a^n = a^{m-n}$$

- The size of the new exponent tells you how many times to multiply the base by itself.

Hint: A number or a variable without an exponent actually is to the power of 1.

Q. Simplify and evaluate $2^9 \div 2^3$ **A.** $2^9 \div 2^3$
 $= 2^{9-3}$ *subtract the exponents*
 $= 2^6$
 $= 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$
 $= 64$

a) Simplify $t^4 \div t^3$

$$= \dots = \boxed{t}$$

b) Simplify $p^8 \div p^2$

$$= \dots = \boxed{}$$

c) Simplify $r^9 \div r^2$

$$= \dots = \boxed{}$$

d) Simplify $\frac{j^8}{j^3}$

$$= \dots = \boxed{}$$

e) Simplify $\frac{q^9}{q^4}$

$$= \dots = \boxed{}$$

f) Simplify $\frac{y^7}{y^5}$

$$= \dots = \boxed{}$$

g) Simplify and evaluate $4^3 \div 4$

$$\begin{aligned} &= 4^{3-1} = 4^2 \\ &= 4 \cdot 4 = \boxed{} \end{aligned}$$

h) Simplify and evaluate $9^6 \div 9^4$

$$\begin{aligned} &= \dots = \dots \\ &= \dots = \boxed{} \end{aligned}$$

i) Simplify and evaluate $5^8 \div 5^5$

$$\begin{aligned} &= \dots = \dots \\ &= \dots = \boxed{} \end{aligned}$$

j) Simplify and evaluate $\frac{8^8}{8^5}$

$$\begin{aligned} &= 8^{8-5} = 8^3 \\ &= \dots = \boxed{} \end{aligned}$$

k) Simplify and evaluate $\frac{7^4}{7^2}$

$$\begin{aligned} &= \dots = \dots \\ &= \dots = \boxed{} \end{aligned}$$

l) Simplify and evaluate $\frac{10^9}{10^6}$

$$\begin{aligned} &= \dots = \dots \\ &= \dots = \boxed{} \end{aligned}$$

m) Simplify $\frac{p^6 q^4}{p^3 q^2}$

$$\begin{aligned} &= (p^6 \div p^3) \cdot (q^4 \div q^2) \\ &= p^{6-3} \cdot q^{4-2} = \boxed{p^3 q^2} \end{aligned}$$

n) Simplify $\frac{a^5 b^3}{ab}$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

o) Simplify $\frac{t^4 u^6}{tu^2}$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

Skill 10.6 Multiplying powers with coefficients and with the same base.

MMMaive 11 22 3 44
MMLime 11 22 3 44

- Multiply the coefficients.
- Add the exponents of the like variables.

$$\begin{aligned} \text{Example: } 2a^3 \cdot 3a^2 &= (2 \cdot 3) \cdot (a \cdot a \cdot a) \cdot (a \cdot a) \\ &= 6a^{3+2} = 6a^5 \end{aligned}$$

Hint: A number or a variable without an exponent actually is to the power of 1.

Q. Simplify $7a^7b \cdot a^3b^6$ **A.** $7a^7b \cdot a^3b^6$

$$\begin{aligned} &= (7 \cdot 1)(a^7 \cdot a^3)(b \cdot b^6) \\ &= 7 \cdot a^{7+3} \cdot b^{1+6} \\ &= 7a^{10}b^7 \end{aligned}$$

multiply the coefficients *add the exponents*

a) Simplify $3t^4 \cdot 3t$

$$\begin{aligned} &= (3 \cdot 3)(t^4 \cdot t^1) \\ &= 9 \cdot t^{4+1} = \boxed{9t^5} \end{aligned}$$

b) Simplify $x^3 \cdot 2x$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

c) Simplify $2p^2 \cdot 2p$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

d) Simplify $2b \cdot 3b^2$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

e) Simplify $2d^2 \cdot 4d^4$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

f) Simplify $3m^3 \cdot 5m^5$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

g) Simplify $4s^2t \cdot 6st^3$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

h) Simplify $5a^4b \cdot 2ab^6$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

i) Simplify $7j^2k^2 \cdot jk^7$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

j) Simplify $6c^6d \cdot 3c^5d$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

k) Simplify $2xy \cdot 9x^3y^7$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

l) Simplify $4uv^4 \cdot u^3v^2$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

m) Simplify $2j^2k \cdot 4j^3k^4$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

n) Simplify $y^2z^3 \cdot 7y^3z^4$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

o) Simplify $3v^3w \cdot 2v^2w^5$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

Skill 10.7 Dividing powers with coefficients and with the same base.

MMMaive 11 2 2 3 3 4 4
MMLime 11 2 2 3 3 4 4

- Divide the coefficients.
- Subtract the exponents of the like variables.

$$\begin{aligned} \text{Example: } (12a^5) \div (4a^2) &= (12 \div 4)(a^5 \div a^2) \\ &= 3 \cdot a^{5-2} \\ &= 3a^3 \end{aligned}$$

OR

$$\begin{aligned} \frac{12a^5}{4a^2} &= \frac{12 \cdot a \cdot a \cdot a \cdot a \cdot a}{4 \cdot a \cdot a} \\ &= \frac{12a^3}{4} = 3a^3 \end{aligned}$$

Hint: A number or a variable without an exponent actually is to the power of 1.

Q. Simplify $(10j^6) \div (5j^3)$

A. $(10j^6) \div (5j^3) =$
 $= (10 \div 5)(j^6 \div j^3)$
 $= 2 \cdot j^{6-3}$
 $= 2j^3$

subtract the exponents

a) Simplify $(8c^4) \div (2c^3)$

$$\begin{aligned} &= (8 \div 2)(c^4 \div c^3) \\ &= 4 \cdot c = \boxed{4c} \end{aligned}$$

b) Simplify $(6a^5) \div (2a^2)$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

c) Simplify $(8h^7) \div (2h^3)$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

d) Simplify $(10m^9) \div (2m)$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

e) Simplify $(5z^8) \div (5z^4)$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

f) Simplify $(12f^7) \div (2f^2)$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

g) Simplify $\frac{8u^{11}}{4u^7}$

$$\begin{aligned} &= (8 \div 4)(u^{11} \div u^7) \\ &= 2 \cdot u^{11-7} = \boxed{2u^4} \end{aligned}$$

h) Simplify $\frac{12b^3}{6b}$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

i) Simplify $\frac{6w^5}{2w^2}$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

j) Simplify $\frac{7e^{10}}{e^6}$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

k) Simplify $\frac{14q^6}{7q^6}$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

l) Simplify $\frac{9w^6}{3w^2}$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

m) Simplify $\frac{15j^3k^2}{45j^2k^2}$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

n) Simplify $\frac{6c^3d^4}{60c^5d}$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

o) Simplify $\frac{32g^2h^3}{8g^3h}$

$$\begin{aligned} &= \dots \\ &= \dots = \boxed{} \end{aligned}$$

Skill 10.8 Raising a product or a quotient to a power.

MMMaive 11 22 3 44
MMLime 11 22 3 44

- Raise each number or variable in the product or the quotient to the exponent.

Example: $(ab)^3 = a^3 \cdot b^3 = a^3b^3$

In general: $(ab)^m = a^m \cdot b^m$

- Multiply from left to right.

Hint: A number or a variable without an exponent actually is to the power of 1.

Q. Simplify $(2x)^3$

A. $(2x)^3$
 $= 2^3 \cdot x^3$
 $= 8 \cdot x^3$
 $= 8x^3$

a) Simplify $(-2x)^4$ even exponent

$= (-2)^4 \cdot x^4$
 $= 16 \cdot x^4 = 16x^4$
positive result

b) Simplify $(fg)^2$

$= \dots = \boxed{}$

c) Simplify $(de)^f$

$= \dots = \boxed{}$

d) Simplify $(6m)^3$

$= \dots$
 $= \dots = \boxed{}$

e) Simplify $(7r)^2$

$= \dots$
 $= \dots = \boxed{}$

f) Simplify $(3p)^4$

$= \dots$
 $= \dots = \boxed{}$

g) Simplify $(-5t)^3$

$= (-5)^3 \cdot t^3$
 $= -125 \cdot t^3 = -125t^3$

h) Simplify $(-4j)^4$

$= \dots$
 $= \dots = \boxed{}$

i) Simplify $(-2m)^6$

$= \dots$
 $= \dots = \boxed{}$

j) Simplify $6(2y)^3$

$= 6 \cdot 2^3 \cdot y^3$
 $= \dots = \boxed{}$

k) Simplify $2(2q)^2$

$= \dots$
 $= \dots = \boxed{}$

l) Simplify $8(3h)^2$

$= \dots$
 $= \dots = \boxed{}$

m) Simplify $\left(\frac{4u}{3}\right)^2$

$= \dots$
 $= \dots = \boxed{}$

n) Simplify $\left(\frac{lm}{5n}\right)^2$

$= \dots$
 $= \dots = \boxed{}$

o) Simplify $\left(\frac{cd}{3e}\right)^4$

$= \dots$
 $= \dots = \boxed{}$

Skill 10.9 Raising a power to another power.

- Multiply the exponents of the number or variable.

$$\begin{aligned} \text{Example: } (a^2)^4 &= a^2 \cdot a^2 \cdot a^2 \cdot a^2 = a^{2+2+2+2} \\ &= a^{2 \cdot 4} \\ &= a^8 \end{aligned}$$

$$\text{In general: } (a^m)^n = a^{m \cdot n}$$

Hint: A number or a variable without an exponent actually is to the power of 1.

Q. Simplify $(m^y)^z$

A. $(m^y)^z$
 $= m^{y \cdot z}$ *multiply the exponents*
 $= m^{yz}$

a) Simplify $(y^4)^2$

$$= y^4 \cdot y^4 = y^{4+4}$$

$$= y^{4 \cdot 2} = \boxed{y^8}$$

b) Simplify $(r^4)^4$

$$=$$

$$= \boxed{}$$

c) Simplify $(x^2)^5$

$$=$$

$$= \boxed{}$$

d) Simplify $(a^e)^f$

$$= \boxed{}$$

e) Simplify $(p^q)^r$

$$= \boxed{}$$

f) Simplify $(t^u)^v$

$$= \boxed{}$$

g) Simplify $(d^2)^2$

$$= \boxed{}$$

h) Simplify $(h^3)^2$

$$= \boxed{}$$

i) Simplify $(n^4)^3$

$$= \boxed{}$$

j) Simplify $(v^5)^0$

$$= \boxed{}$$

k) Simplify $(a^4)^5$

$$= \boxed{}$$

l) Simplify $(g^2)^5$

$$= \boxed{}$$

m) Simplify $2(b^3)^2$

$$= 2 \cdot b^3 \cdot b^3 = 2 \cdot b^{3+3}$$

$$= 2 \cdot b^{3 \cdot 2} = \boxed{2b^6}$$

n) Simplify $4(q^3)^3$

$$= \boxed{}$$

o) Simplify $5(z^3)^2$

$$= \boxed{}$$

p) Simplify $6(c^4)^3$

$$= \boxed{}$$

q) Simplify $8(w^4)^2$

$$= \boxed{}$$

r) Simplify $7(k^3)^5$

$$= \boxed{}$$

Skill 10.10 Simplifying exponential expressions.

- Use the appropriate operations to simplify the exponential expressions:

Multiplying powers. (see skill 10.4, page 114 and skill 10.6, page 116)

Dividing powers. (see skill 10.5, page 115 and skill 10.7, page 117)

Raising a product to a power. (see skill 10.8, page 118)

Raising a quotient to a power. (see skill 10.8, page 118)

Raising a power to a power. (see skill 10.9, page 119)

Q. Simplify $(6w^5)^2 \cdot w^4$

A. $(6w^5)^2 \cdot w^4$
 $= 6^2 \cdot w^{5 \times 2} \cdot w^4$
 $= 36 \cdot w^{10} \cdot w^4$
 $= 36 \cdot w^{10+4}$
 $= 36w^{14}$

a) Simplify $(4s^3)^2 \cdot s^5$

$$= 4^2 \cdot s^{3 \cdot 2} \cdot s^5$$

$$= 16 \cdot s^6 \cdot s^5$$

$$= 16 \cdot s^{6+5} = \boxed{16s^{11}}$$

b) Simplify $(5x^6)^3 \cdot x^5$

$$=$$

$$=$$

$$= \boxed{}$$

c) Simplify $(3x^2)^4 \cdot x^3$

$$=$$

$$=$$

$$= \boxed{}$$

d) Simplify $mn^6 \cdot (m^2n^3)^3$

$$=$$

$$=$$

$$= \boxed{}$$

e) Simplify $l^5m \cdot (l^3m^3)^3$

$$=$$

$$=$$

$$= \boxed{}$$

f) Simplify $(g^2h^6)^2 \cdot (h^4)^3$

$$=$$

$$=$$

$$= \boxed{}$$

g) Simplify $\left(\frac{d^2}{5}\right)^4$

$$= \frac{(d^2)^4}{5^4}$$

$$= \frac{d^{2 \cdot 4}}{5 \cdot 5 \cdot 5 \cdot 5} = \boxed{\frac{d^8}{625}}$$

h) Simplify $\left(\frac{a^3}{2}\right)^5$

$$=$$

$$= \boxed{}$$

i) Simplify $\left(\frac{h^3}{4}\right)^3$

$$=$$

$$= \boxed{}$$

j) Simplify $\frac{6m \cdot 8m^4}{12m^2}$

$$=$$

$$=$$

$$= \boxed{}$$

k) Simplify $\frac{8r^7 \cdot 3r^6}{6r^3}$

$$=$$

$$=$$

$$= \boxed{}$$

l) Simplify $\frac{15x^3 \cdot 3x^6}{9x^5}$

$$=$$

$$=$$

$$= \boxed{}$$

Skill 10.11 Raising a number or a variable to a negative power.

- Write the reciprocal of the base number.
- Raise the reciprocal of the base number to the corresponding positive exponent.

$$a^{-2} = \left(\frac{1}{a}\right)^2 = \frac{1}{a^2}$$

Labels: Negative exponent (pointing to -2), Base (pointing to a), Positive exponent (pointing to 2), Reciprocal (pointing to $\frac{1}{a}$)

In general: $a^{-n} = \frac{1}{a^n}$

Q. Evaluate 4^{-2}

A. 4^{-2}

$$= \frac{1}{4^2}$$

Write the reciprocal of 4

$$= \frac{1}{4 \cdot 4}$$

Multiply 4 by itself 2 times

$$= \frac{1}{16}$$

a) Simplify f^{-3}

$$\frac{1}{f^3}$$

b) Evaluate v^{-5}

c) Evaluate b^{-8}

d) Evaluate r^{-6}

e) Evaluate w^{-9}

f) Evaluate z^{-7}

g) Evaluate 10^{-3}

$$= \frac{1}{10 \cdot 10 \cdot 10} = \frac{1}{1000}$$

h) Evaluate 3^{-3}

$$= \frac{1}{3 \cdot 3 \cdot 3} = \frac{1}{27}$$

i) Evaluate 2^{-2}

$$= \frac{1}{2 \cdot 2} = \frac{1}{4}$$

j) Evaluate 4^{-3}

$$= \frac{1}{4 \cdot 4 \cdot 4} = \frac{1}{64}$$

k) Evaluate 7^{-1}

$$= \frac{1}{7} = \frac{1}{7}$$

l) Evaluate 8^{-2}

$$= \frac{1}{8 \cdot 8} = \frac{1}{64}$$

m) Evaluate 9^{-2}

$$= \frac{1}{9 \cdot 9} = \frac{1}{81}$$

n) Evaluate 2^{-4}

$$= \frac{1}{2 \cdot 2 \cdot 2 \cdot 2} = \frac{1}{16}$$

o) Evaluate 5^{-4}

$$= \frac{1}{5 \cdot 5 \cdot 5 \cdot 5} = \frac{1}{625}$$

p) Evaluate 6^{-3}

$$= \frac{1}{6 \cdot 6 \cdot 6} = \frac{1}{216}$$

q) Evaluate 10^{-4}

$$= \frac{1}{10 \cdot 10 \cdot 10 \cdot 10} = \frac{1}{10000}$$

r) Evaluate 3^{-5}

$$= \frac{1}{3 \cdot 3 \cdot 3 \cdot 3 \cdot 3} = \frac{1}{243}$$

Skill 10.12 Simplifying expressions involving negative exponents.

MMMaive 11 22 33 44
MMLime 11 22 33 44

- Simplify the coefficients first.
- Simplify the powers. (see skill 10.6, page 116, skill 10.7, page 117 and skill 10.9, page 119)
- Express the answer using positive exponents.

Q. Simplify $(12a^{-8}) \div (3a^{-2})$ and express the answer using positive exponents.

$$\begin{aligned}
 \text{A. } & (12a^{-8}) \div (3a^{-2}) \quad \text{Simplify: } \div 4 \\
 & = 4(a^{-8} \div a^{-2}) \\
 & = 4 \cdot a^{-8 - (-2)} \quad \text{subtract powers} \\
 & = 4a^{-6} \\
 & = \frac{4}{a^6}
 \end{aligned}$$

a) Simplify $3x^{-3} \cdot 5x^{-2}$ and express the answer using positive exponents.

$$\begin{aligned}
 & 15x^{-3 + (-2)} \\
 & \dots\dots\dots \\
 & = 15x^{-5} \quad = \boxed{}
 \end{aligned}$$

b) Simplify $m^{-8} \cdot m^4$ and express the answer using positive exponents.

$$\begin{aligned}
 & \dots\dots\dots \\
 & = \boxed{}
 \end{aligned}$$

c) Simplify $7z^3 \cdot 2z^{-5}$ and express the answer using positive exponents.

$$\begin{aligned}
 & \dots\dots\dots \\
 & = \boxed{}
 \end{aligned}$$

d) Simplify $4g^{-1} \cdot 7g^{-2}$ and express the answer using positive exponents.

$$\begin{aligned}
 & \dots\dots\dots \\
 & = \boxed{}
 \end{aligned}$$

e) Simplify $(63c^3) \div (7c^{-7})$ and express the answer using positive exponents.

$$\begin{aligned}
 & \dots\dots\dots \\
 & = \boxed{}
 \end{aligned}$$

f) Simplify $(27w^{-9}) \div (3w^3)$ and express the answer using positive exponents.

$$\begin{aligned}
 & \dots\dots\dots \\
 & = \boxed{}
 \end{aligned}$$

g) Simplify $(2t^{-2})^5$ and express the answer using positive exponents.

$$\begin{aligned}
 & \dots\dots\dots \\
 & = \boxed{}
 \end{aligned}$$

h) Simplify $(4t^{-1})^3$ and express the answer using positive exponents.

$$\begin{aligned}
 & \dots\dots\dots \\
 & = \boxed{}
 \end{aligned}$$