

EXPONENTS

A POSITIVE EXPONENTS

A.1 WRITING REPEATED MULTIPLICATION IN EXPONENT FORM

Ex 1: Write in exponent form:

$$2 \times 2 \times 2 = \boxed{2^3}$$

Answer: $\overbrace{2 \times 2 \times 2}^{3 \text{ factors}} = 2^3$

Ex 2: Write in exponent form:

$$3 \times 3 \times 3 \times 3 = \boxed{3^4}$$

Answer: $\overbrace{3 \times 3 \times 3 \times 3}^{4 \text{ factors}} = 3^4$

Ex 3: Write in exponent form:

$$5 \times 5 = \boxed{5^2}$$

Answer: $\overbrace{5 \times 5}^{2 \text{ factors}} = 5^2$

Ex 4: Write in exponent form:

$$7 \times 7 \times 7 = \boxed{7^3}$$

Answer: $\overbrace{7 \times 7 \times 7}^{3 \text{ factors}} = 7^3$

Ex 5: Write in exponent form:

$$10 \times 10 \times 10 \times 10 \times 10 = \boxed{10^5}$$

Answer: $\overbrace{10 \times 10 \times 10 \times 10 \times 10}^{5 \text{ factors}} = 10^5$

A.2 WRITING IN EXPONENT FORM FROM VERBAL EXPRESSIONS

Ex 6: Write in exponent form:

$$2 \text{ raised to the power } 3 = \boxed{2^3}$$

Answer: 2 raised to the power of 3 = 2^3

Ex 7: Write in exponent form:

$$5 \text{ raised to the power } 2 = \boxed{5^2}$$

Answer: 5 raised to the power of 2 = 5^2

Ex 8: Write in exponent form:

$$7 \text{ raised to the power } 4 = \boxed{7^4}$$

Answer: 7 raised to the power of 4 = 7^4

Ex 9: Write in exponent form:

$$10 \text{ raised to the power } 5 = \boxed{10^5}$$

Answer: 10 raised to the power of 5 = 10^5

A.3 CALCULATING POWERS

Ex 10: Evaluate the power:

$$2^3 = \boxed{8}$$

Answer:

$$2^3 = 2 \times 2 \times 2 \\ = 8$$

Ex 11: Evaluate the power:

$$5^2 = \boxed{25}$$

Answer:

$$5^2 = 5 \times 5 \\ = 25$$

Ex 12: Evaluate the power:

$$3^4 = \boxed{81}$$

Answer:

$$3^4 = 3 \times 3 \times 3 \times 3 \\ = 81$$

Ex 13: Evaluate the power:

$$10^3 = \boxed{1000}$$

Answer:

$$10^3 = 10 \times 10 \times 10 \\ = 1000$$

A.4 EXPRESSING NUMBERS IN EXPONENT FORM

Ex 14: Write in exponent form:

$$8 = \boxed{2^3}$$

Answer:

$$8 = 2 \times 2 \times 2 \\ = 2^3$$

Ex 15: Write in exponent form:

$$27 = \boxed{3^3}$$

Answer:

$$27 = 3 \times 3 \times 3 \\ = 3^3$$

Ex 16: Write in exponent form:

$$16 = \boxed{2^4}$$

Answer:

$$16 = 2 \times 2 \times 2 \times 2 \\ = 2^4$$

Ex 17: Write in exponent form:

$$100 = \boxed{10^2}$$

Answer:

$$100 = 10 \times 10 \\ = 10^2$$

A.5 INTERPRETING POWERS

MCQ 18: Determine if the following statement is True or False:

$$2^3 = 2 + 2 + 2$$

- ☐ True
☒ False

Answer:

- The expression 2^3 represents $2 \times 2 \times 2$, not $2 + 2 + 2$.
- Therefore, the statement $2^3 = 2 + 2 + 2$ is **False**.

MCQ 19: Determine if the following statement is True or False:

$$3^2 = 2 \times 2 \times 2$$

- ☐ True
☒ False

Answer:

- The expression 3^2 represents 3×3 , not $2 \times 2 \times 2$.
- Therefore, the statement $3^2 = 2 \times 2 \times 2$ is **False**.

MCQ 20: Determine if the following statement is True or False:

$$4^3 = 4 \times 4 \times 4$$

- ☒ True
☐ False

Answer:

- The expression 4^3 represents $4 \times 4 \times 4$.
- Therefore, the statement $4^3 = 4 \times 4 \times 4$ is **True**.

MCQ 21: Determine if the following statement is True or False:

$$3 \times 4 = 4 + 4 + 4$$

- ☒ True
☐ False

Answer:

- The expression 3×4 represents 3 groups of 4, which is $4 + 4 + 4$.
- Therefore, the statement $3 \times 4 = 4 + 4 + 4$ is **True**.

MCQ 22: Determine if the following statement is True or False:

$$3^2 = 2 \times 2 \times 2$$

- ☐ True
☒ False

Answer:

- The expression 3^2 means 3×3 , which equals 9.
- The expression $2 \times 2 \times 2$ means multiplying 2 three times, which equals 8.
- Therefore, the statement $3^2 = 2 \times 2 \times 2$ is **False**.

A.6 EVALUATING EXPRESSIONS WITH POWERS

Ex 23: Evaluate the expression:

$$2^3 \times 3^2 = \boxed{72}$$

Answer:

$$\begin{aligned} 2^3 \times 3^2 &= (2 \times 2 \times 2) \times (3 \times 3) \\ &= 8 \times 9 \\ &= 72 \end{aligned}$$

Ex 24: Evaluate the expression:

$$3^2 \times 10^2 = \boxed{900}$$

Answer:

$$\begin{aligned} 3^2 \times 10^2 &= (3 \times 3) \times (10 \times 10) \\ &= 9 \times 100 \\ &= 900 \end{aligned}$$

Ex 25: Evaluate the expression:

$$6 \times 10^3 = \boxed{6000}$$

Answer:

$$\begin{aligned} 6 \times 10^3 &= 6 \times (10 \times 10 \times 10) \\ &= 6 \times 1000 \\ &= 6000 \end{aligned}$$

Ex 26: Evaluate the expression:

$$2.5 \times 10^2 = \boxed{250}$$

Answer:

$$\begin{aligned} 2.5 \times 10^2 &= 2.5 \times (10 \times 10) \\ &= 2.5 \times 100 \\ &= 250 \end{aligned}$$

A.7 CHECKING EQUALITY BETWEEN PRODUCTS AND POWERS

MCQ 27: Determine if the following statement is True or False:

$$2 \times 2 \times 3 \times 3 = 2^4$$

- ☐ True
☒ False

Answer:

- The expression $2 \times 2 \times 3 \times 3$ is equal to $2^2 \times 3^2 = 4 \times 9 = 36$.
- The expression $2^4 = 2 \times 2 \times 2 \times 2 = 16$.
- Therefore, the statement $2 \times 2 \times 3 \times 3 = 2^4$ is **False**.

MCQ 28: Determine if the following statement is True or False:

$$2 \times 2 \times 2 = 3^2$$

- ☐ True
☒ False

Answer:

- $2 \times 2 \times 2 = 8$
- $3^2 = 3 \times 3 = 9$
- Therefore, the statement $2 \times 2 \times 2 = 3^2$ is **False**.

MCQ 29: Determine if the following statement is True or False:

$$2 \times 3 \times 2 \times 3 = 2^2 \times 3^2$$

- ☒ True
☐ False

Answer:

$$\begin{aligned} 2 \times 3 \times 2 \times 3 &= (2 \times 2) \times (3 \times 3) \\ &= 2^2 \times 3^2 \end{aligned}$$

Therefore, the statement $2 \times 3 \times 2 \times 3 = 2^2 \times 3^2$ is **True**.

MCQ 30: Determine if the following statement is True or False:

$$5 \times 5 \times 5 \times 4 = 5^3 \times 2^2$$

- ☒ True
☐ False

Answer:

$$\begin{aligned} 5 \times 5 \times 5 \times 4 &= (5 \times 5 \times 5) \times 4 \\ &= 5^3 \times 4 \\ &= 5^3 \times (2 \times 2) \\ &= 5^3 \times 2^2 \end{aligned}$$

Therefore, the statement $5 \times 5 \times 5 \times 4 = 5^3 \times 2^2$ is **True**.

A.8 WRITING REPEATED MULTIPLICATION OF AN ALGEBRAIC EXPRESSION IN EXPONENT FORM

Ex 31: Write in exponent form:

$$x \times x \times x = \boxed{x^3}$$

Answer: $\overbrace{x \times x \times x}^{3 \text{ factors}} = x^3$

Ex 32: Write in exponent form:

$$x \times x = \boxed{x^2}$$

Answer: $\overbrace{x \times x}^{2 \text{ factors}} = x^2$

MCQ 33: Which expressions are equal to x ?

Choose all answers that apply:

- ☐ x^2
☒ x^1
☐ 1

Answer:

- x^2 means $x \times x$, which is not equal to x (unless $x = 1$ or $x = 0$).

- $x^1 = x$: (correct)

- 1 is only equal to x if $x = 1$, but in general, $x \neq 1$.

Ex 34: Write in exponent form:

$$x \times x \times x \times x = \boxed{x^4}$$

Answer: $\overbrace{x \times x \times x \times x}^{4 \text{ factors}} = x^4$

A.9 WRITING ALGEBRAIC EXPRESSIONS IN EXPONENT FORM FROM VERBAL DESCRIPTIONS

Ex 35: Write in exponent form:

$$x \text{ squared} = \boxed{x^2}$$

Answer: $x \text{ squared} = x^2$

Ex 36: Write in exponent form:

$$x \text{ to the power of } 4 = \boxed{x^4}$$

Answer: $x \text{ to the power of } 4 = x^4$

Ex 37: Write in exponent form:

$$x \text{ cubed} = \boxed{x^3}$$

Answer: $x \text{ cubed} = x^3$

Ex 38: Write in exponent form:

$$x \text{ to the power of } 5 = \boxed{x^5}$$

Answer: $x \text{ to the power of } 5 = x^5$

B NEGATIVE EXPONENTS

B.1 WRITING NEGATIVE EXPONENTS AS FRACTIONS

Ex 39: Write as a fraction:

$$3^{-2} = \boxed{\frac{1}{9}}$$

Answer:

$$\begin{aligned} 3^{-2} &= \frac{1}{3 \times 3} \\ &= \frac{1}{9} \end{aligned}$$

Ex 40: Write as a fraction:

$$10^{-3} = \boxed{\frac{1}{1000}}$$

Answer:

$$\begin{aligned} 10^{-3} &= \frac{1}{10 \times 10 \times 10} \\ &= \frac{1}{1000} \end{aligned}$$

Ex 41: Write as a fraction:

$$2^{-1} = \boxed{\frac{1}{2}}$$

Answer:

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

Ex 42: Write as a fraction:

$$5^{-2} = \boxed{\frac{1}{25}}$$

Answer:

$$\begin{aligned} 5^{-2} &= \frac{1}{5 \times 5} \\ &= \frac{1}{25} \end{aligned}$$

B.2 WRITING FRACTIONS AS NEGATIVE EXPONENTS

Ex 43: Write using a negative exponent:

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

Answer:

$$\begin{aligned} \frac{1}{4} &= \frac{1}{2 \times 2} \\ &= 2^{-2} \end{aligned}$$

Ex 44: Write using a negative exponent:

$$\frac{1}{27} = \boxed{3^{-3}}$$

Answer:

$$\begin{aligned} \frac{1}{27} &= \frac{1}{3 \times 3 \times 3} \\ &= 3^{-3} \end{aligned}$$

Ex 45: Write using a negative exponent:

$$\frac{1}{1000} = \boxed{10^{-3}}$$

Answer:

$$\begin{aligned} \frac{1}{1000} &= \frac{1}{10 \times 10 \times 10} \\ &= 10^{-3} \end{aligned}$$

Ex 46: Write using a negative exponent:

$$\frac{1}{25} = \boxed{5^{-2}}$$

Answer:

$$\begin{aligned} \frac{1}{25} &= \frac{1}{5 \times 5} \\ &= 5^{-2} \end{aligned}$$

C EXPONENT LAW 1

C.1 SIMPLIFYING PRODUCTS OF POWERS

Ex 47: Simplify:

$$7^3 \times 7^2 = \boxed{7^5}$$

Answer:

$$\begin{aligned} 7^3 \times 7^2 &= \overbrace{7 \times 7 \times 7}^{3 \text{ factors}} \times \overbrace{7 \times 7}^{2 \text{ factors}} \\ &= \overbrace{7 \times 7 \times 7 \times 7 \times 7}^{3+2 \text{ factors}} \\ &= 7^{3+2} \\ &= 7^5 \end{aligned}$$

Ex 48: Simplify:

$$2^4 \times 2^3 = \boxed{2^7}$$

Answer:

$$\begin{aligned} 2^4 \times 2^3 &= \overbrace{2 \times 2 \times 2 \times 2}^{4 \text{ factors}} \times \overbrace{2 \times 2 \times 2}^{3 \text{ factors}} \\ &= \overbrace{2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2}^{4+3 \text{ factors}} \\ &= 2^{4+3} \\ &= 2^7 \end{aligned}$$

Ex 49: Simplify:

$$3^5 \times 3^2 = \boxed{3^7}$$

Answer:

$$\begin{aligned} 3^5 \times 3^2 &= \overbrace{3 \times 3 \times 3 \times 3 \times 3}^{5 \text{ factors}} \times \overbrace{3 \times 3}^{2 \text{ factors}} \\ &= \overbrace{3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3}^{5+2 \text{ factors}} \\ &= 3^{5+2} \\ &= 3^7 \end{aligned}$$

Ex 50: Simplify:

$$10^6 \times 10^2 = \boxed{10^8}$$

Answer:

$$\begin{aligned} 10^6 \times 10^2 &= \overbrace{10 \times \cdots \times 10}^{6 \text{ factors}} \times \overbrace{10 \times 10}^{2 \text{ factors}} \\ &= \overbrace{10 \times \cdots \times 10}^{6+2 \text{ factors}} \\ &= 10^{6+2} \\ &= 10^8 \end{aligned}$$

Ex 51: Simplify:

$$2^3 \times 2 = \boxed{2^4}$$

Answer:

$$\begin{aligned}
 2^3 \times 2 &= 2^3 \times 2^1 \\
 &= \overbrace{2 \times 2 \times 2}^{3 \text{ factors}} \times \overbrace{2}^{1 \text{ factor}} \\
 &= \overbrace{2 \times 2 \times 2 \times 2}^{3+1 \text{ factors}} \\
 &= 2^{3+1} \\
 &= 2^4
 \end{aligned}$$

Ex 52: Simplify:

$$3 \times 3^4 = \boxed{3^5}$$

Answer:

$$\begin{aligned}
 3 \times 3^4 &= 3^1 \times 3^4 \\
 &= \overbrace{3}^{1 \text{ factor}} \times \overbrace{3 \times 3 \times 3 \times 3}^{4 \text{ factors}} \\
 &= \overbrace{3 \times 3 \times 3 \times 3 \times 3}^{1+4 \text{ factors}} \\
 &= 3^{1+4} \\
 &= 3^5
 \end{aligned}$$

C.2 SIMPLIFYING PRODUCTS OF ALGEBRAIC POWERS

Ex 53: Simplify:

$$x^2 \times x^3 = \boxed{x^5}$$

Answer:

$$\begin{aligned}
 x^2 \times x^3 &= \overbrace{x \times x}^{2 \text{ factors}} \times \overbrace{x \times x \times x}^{3 \text{ factors}} \\
 &= \overbrace{x \times x \times x \times x \times x}^{2+3 \text{ factors}} \\
 &= x^{2+3} \\
 &= x^5
 \end{aligned}$$

Ex 54: Simplify:

$$x \times x^2 = \boxed{x^3}$$

Answer:

$$\begin{aligned}
 x \times x^2 &= x^1 \times x^2 \\
 &= \overbrace{x}^{1 \text{ factor}} \times \overbrace{x \times x}^{2 \text{ factors}} \\
 &= \overbrace{x \times x \times x}^{1+2 \text{ factors}} \\
 &= x^{1+2} \\
 &= x^3
 \end{aligned}$$

Ex 55: Simplify:

$$x^2 \times x^2 = \boxed{x^4}$$

Answer:

$$\begin{aligned}
 x^2 \times x^2 &= \overbrace{x \times x}^{2 \text{ factors}} \times \overbrace{x \times x}^{2 \text{ factors}} \\
 &= \overbrace{x \times x \times x \times x}^{2+2 \text{ factors}} \\
 &= x^{2+2} \\
 &= x^4
 \end{aligned}$$

Ex 56: Simplify:

$$x^3 \times x = \boxed{x^4}$$

Answer:

$$\begin{aligned}
 x^3 \times x &= x^3 \times x^1 \\
 &= \overbrace{x \times x \times x}^{3 \text{ factors}} \times \overbrace{x}^{1 \text{ factor}} \\
 &= \overbrace{x \times x \times x \times x}^{3+1 \text{ factors}} \\
 &= x^{3+1} \\
 &= x^4
 \end{aligned}$$

C.3 IDENTIFYING CORRECT EXPONENTIAL EXPRESSIONS

MCQ 57: Which expressions are equal to $2^2 + 2^1$?

Choose all answers that apply:

- ☐ 6
☐ 2^3
☒ 4^3

Answer:

- $2^3 = 8$ which is not equal to $2^2 + 2^1 = 6$.
- $4^3 = 64$ which is not equal to $2^2 + 2^1 = 6$.
- $2^2 + 2^1 = 4 + 2 = 6$: **(correct)**

MCQ 58: Which expressions are equal to $5^2 \times 5^1$?

Choose all answers that apply:

- ☐ 25
☒ 125
☒ 5^3

Answer:

- $5^2 \times 5^1 = 5^{2+1} = 5^3 = 125$: **(correct)**
- 25 is just 5^2 , not $5^2 \times 5^1$.
- 5^3 is the same as $5^2 \times 5^1$ by the law of exponents : **(correct)**

MCQ 59: Which expressions are equal to $3^2 + 3^1$?

Choose all answers that apply:

- ☒ 12
☐ 3^3
☐ 9^3

Answer:

- $3^2 + 3^1 = 9 + 3 = 12$: **(correct)**
- $3^3 = 27$ which is not equal to $3^2 + 3^1 = 12$.
- $9^3 = 729$ which is not equal to $3^2 + 3^1 = 12$.
- "None of the above" is incorrect because 12 is a correct answer.



MCQ 60: Which expressions are equal to $4^3 \times 4^2$?

Choose all answers that apply:

- ☒ 4^5
- ☐ 64
- ☒ 1024

Answer:

- $4^3 \times 4^2 = 4^{3+2} = 4^5$: (correct)
- 64 is 4^3 , not $4^3 \times 4^2$.
- 1024 is 4^5 , and thus equal to $4^3 \times 4^2$: (correct)

C.4 SIMPLIFYING EXPRESSIONS OF POWERS

Ex 61: Simplify:

$$x^{-2} x^3 = \boxed{x}$$

Answer:

$$\begin{aligned} x^{-2} x^3 &= x^{(-2)+3} \\ &= x^1 \\ &= x \end{aligned}$$

Ex 62: Simplify:

$$2^2 2^{-3} 2^{-3} = \boxed{2^{-4}}$$

Answer:

$$\begin{aligned} 2^2 2^{-3} 2^{-3} &= 2^{2+(-3)+(-3)} \\ &= 2^{(-1)+(-3)} \\ &= 2^{-4} \end{aligned}$$

Ex 63: Simplify:

$$x x^3 x^{-2} = \boxed{x^2}$$

Answer:

$$\begin{aligned} x x^3 x^{-2} &= x^{1+3+(-2)} \\ &= x^{4+(-2)} \\ &= x^2 \end{aligned}$$

Ex 64: Simplify:

$$x^3 \times x^{-3} = \boxed{1}$$

Answer:

$$\begin{aligned} x^3 \times x^{-3} &= x^{3+(-3)} \\ &= x^0 \\ &= 1 \end{aligned}$$

D EXPONENT LAW 2

D.1 SIMPLIFYING FRACTIONS OF POWERS

Ex 65: Simplify:

$$\frac{7^5}{7^2} = \boxed{7^3}$$

Answer:

$$\begin{aligned} \frac{7^5}{7^2} &= \frac{\overbrace{7 \times 7 \times 7 \times 7 \times 7}^{5 \text{ factors}}}{\underbrace{7 \times 7}_{2 \text{ factors}}} \\ &= \overbrace{7 \times 7 \times 7}^{5-2 \text{ factors}} \\ &= 7^{5-2} \\ &= 7^3 \end{aligned}$$

Ex 66: Simplify:

$$\frac{5^6}{5^4} = \boxed{5^2}$$

Answer:

$$\begin{aligned} \frac{5^6}{5^4} &= \frac{\overbrace{5 \times 5 \times 5 \times 5 \times 5 \times 5}^{6 \text{ factors}}}{\underbrace{5 \times 5 \times 5 \times 5}_{4 \text{ factors}}} \\ &= \overbrace{5 \times 5}^{6-4 \text{ factors}} \\ &= 5^{6-4} \\ &= 5^2 \end{aligned}$$

Ex 67: Simplify:

$$\frac{2^3}{2^5} = \boxed{2^{-2}}$$

Answer:

$$\begin{aligned} \frac{2^3}{2^5} &= \frac{\overbrace{2 \times 2 \times 2}^{3 \text{ facteurs}}}{\underbrace{2 \times 2 \times 2 \times 2 \times 2}_{5 \text{ facteurs}}} \\ &= \frac{1}{2 \times 2} \\ &= 2^{-2} \quad (= 2^{3-5}) \end{aligned}$$

Ex 68: Simplify:

$$\frac{3}{3^5} = \boxed{3^{-4}}$$

Answer:

$$\begin{aligned} \frac{3}{3^5} &= \frac{\overbrace{3}^{1 \text{ facteur}}}{\underbrace{3 \times 3 \times 3 \times 3 \times 3}_{5 \text{ facteurs}}} \\ &= \frac{1}{3 \times 3 \times 3 \times 3} \\ &= 3^{-4} \quad (= 3^{1-5}) \end{aligned}$$

Ex 69: Simplify:

$$\frac{7^2}{7^6} = \boxed{7^{-4}}$$

Answer:

$$\begin{aligned} \frac{7^2}{7^6} &= \frac{\overbrace{7 \times 7}^{2 \text{ facteurs}}}{\underbrace{7 \times 7 \times 7 \times 7 \times 7 \times 7}_{6 \text{ facteurs}}} \\ &= \frac{1}{\overbrace{7 \times 7 \times 7 \times 7}^{4 \text{ facteurs}}} \\ &= 7^{-4} \quad (= 7^{2-6}) \end{aligned}$$

D.2 SIMPLIFYING FRACTIONS OF ALGEBRAIC POWERS

Ex 70: Simplify:

$$\frac{x^5}{x^2} = \boxed{x^3}$$

Answer:

$$\begin{aligned} \frac{x^5}{x^2} &= \frac{\overbrace{x \times x \times x \times x \times x}^{5 \text{ factors}}}{\underbrace{x \times x}_{2 \text{ factors}}} \\ &= \overbrace{x \times x \times x}^{5-2 \text{ factors}} \\ &= x^{5-2} \\ &= x^3 \end{aligned}$$

Ex 71: Simplify:

$$\frac{x^6}{x^4} = \boxed{x^2}$$

Answer:

$$\begin{aligned} \frac{x^6}{x^4} &= \frac{\overbrace{x \times x \times x \times x \times x \times x}^{6 \text{ factors}}}{\underbrace{x \times x \times x \times x}_{4 \text{ factors}}} \\ &= \overbrace{x \times x}^{6-4 \text{ factors}} \\ &= x^{6-4} \\ &= x^2 \end{aligned}$$

Ex 72: Simplify:

$$\frac{x^3}{x^5} = \boxed{x^{-2}}$$

Answer:

$$\begin{aligned} \frac{x^3}{x^5} &= \frac{\overbrace{x \times x \times x}^{3 \text{ facteurs}}}{\underbrace{x \times x \times x \times x \times x}_{5 \text{ facteurs}}} \\ &= \frac{1}{\overbrace{x \times x}^{2 \text{ facteurs}}} \\ &= x^{-2} \quad (= x^{3-5}) \end{aligned}$$

Ex 73: Simplify:

$$\frac{x}{x^5} = \boxed{x^{-4}}$$

Answer:

$$\begin{aligned} \frac{x}{x^5} &= \frac{\overbrace{x}^{1 \text{ facteur}}}{\underbrace{x \times x \times x \times x \times x}_{5 \text{ facteurs}}} \\ &= \frac{1}{\overbrace{x \times x \times x \times x \times x}^{5 \text{ facteurs}}} \\ &= x^{-4} \quad (= x^{1-5}) \end{aligned}$$

Ex 74: Simplify:

$$\frac{x^2}{x^6} = \boxed{x^{-4}}$$

Answer:

$$\begin{aligned} \frac{x^2}{x^6} &= \frac{\overbrace{x \times x}^{2 \text{ facteurs}}}{\underbrace{x \times x \times x \times x \times x \times x}_{6 \text{ facteurs}}} \\ &= \frac{1}{\overbrace{x \times x \times x \times x \times x \times x}^{6 \text{ facteurs}}} \\ &= x^{-4} \quad (= x^{2-6}) \end{aligned}$$

E EXPONENT LAW 3

E.1 SIMPLIFYING POWERS OF POWERS

Ex 75: Simplify:

$$(5^2)^3 = \boxed{5^6}$$

Answer:

$$\begin{aligned} (5^2)^3 &= (5 \times 5)^3 \\ &= (5 \times 5) \times (5 \times 5) \times (5 \times 5) \\ &= 5^6 \quad (= 5^{2 \times 3}) \end{aligned}$$

Ex 76: Simplify:

$$(7^3)^2 = \boxed{7^6}$$

Answer:

$$\begin{aligned} (7^3)^2 &= (7 \times 7 \times 7)^2 \\ &= (7 \times 7 \times 7) \times (7 \times 7 \times 7) \\ &= 7^6 \quad (= 7^{3 \times 2}) \end{aligned}$$

Ex 77: Simplify:

$$(3^2)^4 = \boxed{3^8}$$

Answer:

$$\begin{aligned} (3^2)^4 &= (3 \times 3)^4 \\ &= (3 \times 3) \times (3 \times 3) \times (3 \times 3) \times (3 \times 3) \\ &= 3^8 \quad (= 3^{2 \times 4}) \end{aligned}$$

Ex 78: Simplify:

$$(2^5)^2 = \boxed{2^{10}}$$

Answer:

$$\begin{aligned} (2^5)^2 &= (2 \times 2 \times 2 \times 2 \times 2)^2 \\ &= (2 \times 2 \times 2 \times 2 \times 2) \times (2 \times 2 \times 2 \times 2 \times 2) \\ &= 2^{10} \quad (= 2^{5 \times 2}) \end{aligned}$$

E.2 SIMPLIFYING POWERS OF POWERS

Ex 79: Simplify:

$$(x^2)^3 = \boxed{x^6}$$

Answer:

$$\begin{aligned}(x^2)^3 &= (x \times x)^3 \\ &= (x \times x) \times (x \times x) \times (x \times x) \\ &= x^6 \quad (= x^{2 \times 3})\end{aligned}$$

Ex 80: Simplify:

$$(x^3)^2 = \boxed{x^6}$$

Answer:

$$\begin{aligned}(x^3)^2 &= (x \times x \times x)^2 \\ &= (x \times x \times x) \times (x \times x \times x) \\ &= x^6 \quad (= x^{3 \times 2})\end{aligned}$$

Ex 81: Simplify:

$$(x^2)^4 = \boxed{x^8}$$

Answer:

$$\begin{aligned}(x^2)^4 &= (x \times x)^4 \\ &= (x \times x) \times (x \times x) \times (x \times x) \times (x \times x) \\ &= x^8 \quad (= x^{2 \times 4})\end{aligned}$$

Ex 82: Simplify:

$$(x^5)^2 = \boxed{x^{10}}$$

Answer:

$$\begin{aligned}(x^5)^2 &= (x \times x \times x \times x \times x)^2 \\ &= (x \times x \times x \times x \times x) \times (x \times x \times x \times x \times x) \\ &= x^{10} \quad (= x^{5 \times 2})\end{aligned}$$

F EXPONENT LAW 4

F.1 SIMPLIFYING POWERS OF PRODUCTS

Ex 83: Simplify:

$$(3 \times 5)^2 = \boxed{3^2 \times 5^2}$$

Answer:

$$\begin{aligned}(3 \times 5)^2 &= (3 \times 5) \times (3 \times 5) \\ &= (3 \times 3) \times (5 \times 5) \\ &= 3^2 \times 5^2\end{aligned}$$

Ex 84: Simplify:

$$(2 \times 3)^4 = \boxed{2^4 \times 3^4}$$

Answer:

$$\begin{aligned}(2 \times 3)^4 &= (2 \times 3) \times (2 \times 3) \times (2 \times 3) \times (2 \times 3) \\ &= (2 \times 2 \times 2 \times 2) \times (3 \times 3 \times 3 \times 3) \\ &= 2^4 \times 3^4\end{aligned}$$

Ex 85: Simplify:

$$(3 \times 7)^3 = \boxed{3^3 \times 7^3}$$

Answer:

$$\begin{aligned}(3 \times 7)^3 &= (3 \times 7) \times (3 \times 7) \times (3 \times 7) \\ &= (3 \times 3 \times 3) \times (7 \times 7 \times 7) \\ &= 3^3 \times 7^3\end{aligned}$$

Ex 86: Simplify:

$$(3 \times 5 \times 7)^2 = \boxed{3^2 \times 5^2 \times 7^2}$$

Answer:

$$\begin{aligned}(3 \times 5 \times 7)^2 &= (3 \times 5 \times 7) \times (3 \times 5 \times 7) \\ &= (3 \times 3) \times (5 \times 5) \times (7 \times 7) \\ &= 3^2 \times 5^2 \times 7^2\end{aligned}$$

F.2 SIMPLIFYING POWERS OF PRODUCTS

Ex 87: Simplify:

$$(2 \times x)^3 = \boxed{2^3 \times x^3}$$

Answer:

$$\begin{aligned}(2 \times x)^3 &= (2 \times x) \times (2 \times x) \times (2 \times x) \\ &= (2 \times 2 \times 2) \times (x \times x \times x) \\ &= 2^3 \times x^3\end{aligned}$$

Ex 88: Simplify:

$$(x \times 3)^2 = \boxed{x^2 \times 3^2}$$

Answer:

$$\begin{aligned}(x \times 3)^2 &= (x \times 3) \times (x \times 3) \\ &= (x \times x) \times (3 \times 3) \\ &= x^2 \times 3^2\end{aligned}$$

Ex 89: Simplify:

$$(5 \times x)^4 = \boxed{5^4 \times x^4}$$

Answer:

$$\begin{aligned}(5 \times x)^4 &= (5 \times x) \times (5 \times x) \times (5 \times x) \times (5 \times x) \\ &= (5 \times 5 \times 5 \times 5) \times (x \times x \times x \times x) \\ &= 5^4 \times x^4\end{aligned}$$

Ex 90: Simplify:

$$(x \times 2)^5 = \boxed{x^5 \times 2^5}$$

Answer:

$$\begin{aligned}(x \times 2)^5 &= (x \times 2) \times (x \times 2) \times (x \times 2) \times (x \times 2) \times (x \times 2) \\ &= (x \times x \times x \times x \times x) \times (2 \times 2 \times 2 \times 2 \times 2) \\ &= x^5 \times 2^5\end{aligned}$$

G EXPONENT LAW 5

G.1 SIMPLIFYING POWERS OF FRACTIONS

Ex 91: Simplify:

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

Answer:

$$\begin{aligned}\left(\frac{5}{3}\right)^2 &= \frac{5}{3} \times \frac{5}{3} \\ &= \frac{5 \times 5}{3 \times 3} \\ &= \frac{5^2}{3^2}\end{aligned}$$

Ex 92: Simplify:

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

Answer:

$$\begin{aligned}\left(\frac{2}{7}\right)^3 &= \frac{2}{7} \times \frac{2}{7} \times \frac{2}{7} \\ &= \frac{2 \times 2 \times 2}{7 \times 7 \times 7} \\ &= \frac{2^3}{7^3}\end{aligned}$$

Ex 93: Simplify:

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

Answer:

$$\begin{aligned}\left(\frac{1}{2}\right)^2 &= \frac{1}{2} \times \frac{1}{2} \\ &= \frac{1 \times 1}{2 \times 2} \\ &= \frac{1^2}{2^2} \\ &= \frac{1}{4}\end{aligned}$$

Ex 94: Simplify:

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

Answer:

$$\begin{aligned}\left(\frac{1}{3}\right)^3 &= \frac{1}{3} \times \frac{1}{3} \times \frac{1}{3} \\ &= \frac{1 \times 1 \times 1}{3 \times 3 \times 3} \\ &= \frac{1^3}{3^3} \\ &= \frac{1}{27}\end{aligned}$$

G.2 SIMPLIFYING POWERS OF ALGEBRAIC FRACTIONS

Ex 95: Simplify:

$$\left(\frac{x}{2}\right)^4 = \boxed{\frac{x^4}{2^4}}$$

Answer:

$$\begin{aligned}\left(\frac{x}{2}\right)^4 &= \frac{x}{2} \times \frac{x}{2} \times \frac{x}{2} \times \frac{x}{2} \\ &= \frac{x \times x \times x \times x}{2 \times 2 \times 2 \times 2} \\ &= \frac{x^4}{2^4}\end{aligned}$$

Ex 96: Simplify:

$$\left(\frac{1}{x}\right)^3 = \boxed{\frac{1^3}{x^3}}$$

Answer:

$$\begin{aligned}\left(\frac{1}{x}\right)^3 &= \frac{1}{x} \times \frac{1}{x} \times \frac{1}{x} \\ &= \frac{1 \times 1 \times 1}{x \times x \times x} \\ &= \frac{1^3}{x^3} \\ &= \frac{1}{x^3}\end{aligned}$$

Ex 97: Simplify:

$$\left(\frac{2}{x}\right)^4 = \boxed{\frac{2^4}{x^4}}$$

Answer:

$$\begin{aligned}\left(\frac{2}{x}\right)^4 &= \frac{2}{x} \times \frac{2}{x} \times \frac{2}{x} \times \frac{2}{x} \\ &= \frac{2 \times 2 \times 2 \times 2}{x \times x \times x \times x} \\ &= \frac{2^4}{x^4} \\ &= \frac{16}{x^4}\end{aligned}$$

Ex 98: Simplify:

$$\left(\frac{x}{10}\right)^2 = \boxed{\frac{x^2}{10^2}}$$

Answer:

$$\begin{aligned}\left(\frac{x}{10}\right)^2 &= \frac{x}{10} \times \frac{x}{10} \\ &= \frac{x \times x}{10 \times 10} \\ &= \frac{x^2}{10^2} \\ &= \frac{x^2}{100}\end{aligned}$$

H ORDER OF OPERATIONS

H.1 EVALUATING EXPRESSIONS WITH EXPONENTS IN 2 STEPS

Ex 99: Evaluate this expression:

$$2 \times 5^2 = \boxed{50}$$

Answer:

$$\begin{aligned} 2 \times 5^2 &= 2 \times 5^2 \quad (\text{exponent: } 5^2 = 25) \\ &= 2 \times 25 \quad (\text{multiplication: } 2 \times 25 = 50) \\ &= 50 \end{aligned}$$

Ex 100: Evaluate this expression:

$$2^3 - 1 = \boxed{7}$$

Answer:

$$\begin{aligned} 2^3 - 1 &= 2^3 - 1 \quad (\text{exponent: } 2^3 = 8) \\ &= 8 - 1 \quad (\text{subtraction: } 8 - 1 = 7) \\ &= 7 \end{aligned}$$

Ex 101: Evaluate this expression:

$$(2 + 1)^2 = \boxed{9}$$

Answer:

$$\begin{aligned} (2 + 1)^2 &= (2 + 1)^2 \quad (\text{parentheses: } 2 + 1 = 3) \\ &= 3^2 \quad (\text{exponent: } 3^2 = 9) \\ &= 9 \end{aligned}$$

Ex 102: Evaluate this expression:

$$2^3 \div 4 = \boxed{2}$$

Answer:

$$\begin{aligned} 2^3 \div 4 &= 2^3 \div 4 \quad (\text{exponent: } 2^3 = 8) \\ &= 8 \div 4 \quad (\text{division: } 8 \div 4 = 2) \\ &= 2 \end{aligned}$$

Ex 103: Evaluate this expression:

$$(5 - 2)^2 = \boxed{9}$$

Answer:

$$\begin{aligned} (5 - 2)^2 &= (5 - 2)^2 \quad (\text{parentheses: } 5 - 2 = 3) \\ &= 3^2 \quad (\text{exponent: } 3^2 = 9) \\ &= 9 \end{aligned}$$

H.2 EVALUATING EXPRESSIONS WITH EXPONENTS IN 3 STEPS

Ex 104: Evaluate this expression:

$$2^3 \times (8 - 6) = \boxed{16}$$

Answer:

$$\begin{aligned} 2^3 \times (8 - 6) &= 2^3 \times (8 - 6) \quad (\text{parentheses: } 8 - 6 = 2) \\ &= 2^3 \times 2 \quad (\text{exponent: } 2^3 = 8) \\ &= 8 \times 2 \quad (\text{multiplication: } 8 \times 2 = 16) \\ &= 16 \end{aligned}$$

Ex 105: Evaluate this expression:

$$(2 + 1)^2 - 1 = \boxed{8}$$

Answer:

$$\begin{aligned} (2 + 1)^2 - 1 &= (2 + 1)^2 - 1 \quad (\text{parentheses: } 2 + 1 = 3) \\ &= 3^2 - 1 \quad (\text{exponent: } 3^2 = 9) \\ &= 9 - 1 \quad (\text{subtraction: } 9 - 1 = 8) \\ &= 8 \end{aligned}$$

Ex 106: Evaluate this expression:

$$(3^2 - 1) \times 4 = \boxed{32}$$

Answer:

$$\begin{aligned} (3^2 - 1) \times 4 &= (3^2 - 1) \times 4 \quad (\text{eval parenthesis: } 3^2 = 9) \\ &= (9 - 1) \times 4 \quad (\text{eval parenthesis: } 9 - 1 = 8) \\ &= 8 \times 4 \quad (\text{multiplication: } 8 \times 4 = 32) \\ &= 32 \end{aligned}$$

Ex 107: Evaluate this expression:

$$\frac{3^2 - 1}{2} = \boxed{4}$$

Answer:

$$\begin{aligned} \frac{3^2 - 1}{2} &= \frac{3^2 - 1}{2} \quad (\text{eval numerator: } 3^2 = 9) \\ &= \frac{9 - 1}{2} \quad (\text{eval numerator: } 9 - 1 = 8) \\ &= \frac{8}{2} \quad (\text{division: } 8 \div 2 = 4) \\ &= 4 \end{aligned}$$

H.3 FINDING THE OPERATORS

Ex 108:



$$3^3 \boxed{-} 2^2 = 23$$

Answer:

- $3^3 + 2^2 = 27 + 4 = 31$, so it's not true.
- $3^3 - 2^2 = 27 - 4 = 23$, so it's true.

- $3^3 \times 2^2 = 27 \times 4 = 108$, so it's not true.
- $3^3 \div 2^2 = 27 \div 4 = 6.75$, so it's not true.

Ex 109: 

$$2^4 \boxed{\times} 3^2 = 144$$

Answer:


- $2^4 + 3^2 = 16 + 9 = 25$, so it's not true.
- $2^4 - 3^2 = 16 - 9 = 7$, so it's not true.
- $2^4 \times 3^2 = 16 \times 9 = 144$, so it's true.
- $2^4 \div 3^2 = 16 \div 9 \approx 1.78$, so it's not true.

Ex 110: 

$$2^3 \boxed{\div} 4 = 2$$

Answer:

- $2^3 + 4 = 8 + 4 = 12$, so it's not true.
- $2^3 - 4 = 8 - 4 = 4$, so it's not true.
- $2^3 \times 4 = 8 \times 4 = 32$, so it's not true.
- $2^3 \div 4 = 8 \div 4 = 2$, so it's true.

Ex 111: 

$$(2 + 1)^2 \boxed{+} 1 = 10$$

Answer:

- $(2 + 1)^2 + 1 = 9 + 1 = 10$, so it's true.
- $(2 + 1)^2 - 1 = 9 - 1 = 8$, so it's not true.
- $(2 + 1)^2 \times 1 = 9 \times 1 = 9$, so it's not true.
- $(2 + 1)^2 \div 1 = 9 \div 1 = 9$, so it's not true.

H.4 COMBINING NEGATIVE POWERS WITH ARITHMETIC

Ex 112: Write as a fraction:

$$1 + 2^{-1} = \boxed{\frac{3}{2}}$$

Answer:

$$\begin{aligned} 1 + 2^{-1} &= 1 + \frac{1}{2} \\ &= \frac{2}{2} + \frac{1}{2} \\ &= \frac{3}{2} \end{aligned}$$

Ex 113: Write as a fraction:

$$3^{-1} - 1 = \boxed{-\frac{2}{3}}$$

Answer:

$$\begin{aligned} 3^{-1} - 1 &= \frac{1}{3} - 1 \\ &= \frac{1}{3} - \frac{3}{3} \\ &= \frac{1-3}{3} \\ &= -\frac{2}{3} \end{aligned}$$

Ex 114: Write as a fraction:

$$5 \times 3^{-2} = \boxed{\frac{5}{9}}$$

Answer:

$$\begin{aligned} 5 \times 3^{-2} &= 5 \times \frac{1}{3 \times 3} \\ &= 5 \times \frac{1}{9} \\ &= \frac{5}{9} \end{aligned}$$

Ex 115: Write as a fraction:

$$\frac{4}{5} \times 2^{-2} = \boxed{\frac{1}{5}}$$

Answer:

$$\begin{aligned} \frac{4}{5} \times 2^{-2} &= \frac{4}{5} \times \frac{1}{2 \times 2} \\ &= \frac{4}{5} \times \frac{1}{4} \\ &= \frac{4 \times 1}{5 \times 4} \\ &= \frac{4}{20} \\ &= \frac{1}{5} \end{aligned}$$

H.5 SIMPLIFYING ALGEBRAIC EXPRESSIONS

Ex 116: Simplify the expression:

$$2x^2 + 3x^2 = \boxed{5x^2}$$

Answer:

$$\begin{aligned} 2x^2 + 3x^2 &= (2 + 3)x^2 \quad (\text{combine like terms}) \\ &= 5x^2 \end{aligned}$$

Ex 117: Simplify the expression:

$$3x^2 - x^2 = \boxed{2x^2}$$

Answer:

$$\begin{aligned} 3x^2 - x^2 &= (3 - 1)x^2 \quad (\text{combine like terms}) \\ &= 2x^2 \end{aligned}$$

Ex 118: Simplify the expression:

$$2x^2 + 3x + x = \boxed{2x^2 + 4x}$$

Answer:

$$\begin{aligned}
 2x^2 + 3x + x &= 2x^2 + (3+1)x \quad (\text{combine like terms}) \\
 &= 2x^2 + 4x
 \end{aligned}$$

Ex 119: Simplify the expression:

$$x^2 + 2x + x^2 + 5x + 1 = \boxed{2x^2 + 7x + 1}$$

Answer:

$$\begin{aligned}
 x^2 + 2x + x^2 + 5x + 1 &= (x^2 + x^2) + (2x + 5x) + 1 \quad (\text{combine like terms}) \\
 &= 2x^2 + 7x + 1
 \end{aligned}$$

Ex 120: Simplify the expression:

$$3x^2 + 4 + 2x + x^2 + 6x + 1 = \boxed{4x^2 + 8x + 5}$$

Answer:

$$\begin{aligned}
 3x^2 + 4 + 2x + x^2 + 6x + 1 &= (3x^2 + x^2) + (2x + 6x) + (4 + 1) \quad (\text{combine like terms}) \\
 &= 4x^2 + 8x + 5
 \end{aligned}$$

Ex 121: Simplify the expression:

$$(2x - x)^2 = \boxed{x^2}$$

Answer:

$$\begin{aligned}
 (2x - x)^2 &= (x)^2 \quad (\text{combine like terms in the parentheses}) \\
 &= x^2
 \end{aligned}$$

H.6 SIMPLIFYING EXPRESSIONS OF POWERS

Ex 122: Simplify:

$$\frac{2^3}{2} \times 2^3 = \boxed{2^5}$$

Answer:

$$\begin{aligned}
 \frac{2^3}{2} \times 2^3 &= 2^{3-1} \times 2^3 \\
 &= 2^2 \times 2^3 \\
 &= 2^{2+3} \\
 &= 2^5
 \end{aligned}$$

Ex 123: Simplify:

$$x^3 \times \frac{x^4}{x^2} = \boxed{x^5}$$

Answer:

$$\begin{aligned}
 x^3 \times \frac{x^4}{x^2} &= x^3 \times x^{4-2} \\
 &= x^3 \times x^2 \\
 &= x^{3+2} \\
 &= x^5
 \end{aligned}$$

Ex 124: Simplify:

$$\frac{x}{x^2} x^{-1} = \boxed{x^{-2}}$$

Answer:

$$\begin{aligned}
 \frac{x}{x^2} x^{-1} &= x^{1-2} \times x^{-1} \\
 &= x^{-1} \times x^{-1} \\
 &= x^{(-1)+(-1)} \\
 &= x^{-2}
 \end{aligned}$$

Ex 125: Simplify:

$$\frac{2^2}{2 \times 2^3} = \boxed{2^{-2}}$$

$$\begin{aligned}
 \frac{2^2}{2 \times 2^3} &= \frac{2^2}{2^1 \times 2^3} \\
 &= \frac{2^2}{2^{1+3}} \\
 &= \frac{2^2}{2^4} \\
 &= 2^{2-4} \\
 &= 2^{-2}
 \end{aligned}$$

Ex 126: Simplify:

$$\left(\frac{x}{2}\right)^2 \times 4 = \boxed{x^2}$$

Answer:

$$\begin{aligned}
 \left(\frac{x}{2}\right)^2 \times 4 &= \frac{x^2}{2^2} \times 4 \\
 &= \frac{x^2}{4} \times 4 \\
 &= x^2
 \end{aligned}$$

Ex 127: Simplify:

$$\frac{x^3 \times (x^2)^2}{x^4} = \boxed{x^3}$$

Answer:

$$\begin{aligned}
 \frac{x^3 \times (x^2)^2}{x^4} &= \frac{x^3 \times x^{2 \times 2}}{x^4} \\
 &= \frac{x^3 \times x^4}{x^4} \\
 &= \frac{x^{3+4}}{x^4} \\
 &= \frac{x^7}{x^4} \\
 &= x^{7-4} \\
 &= x^3
 \end{aligned}$$