

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 RATIONAL EXPONENTS

C.1 EXPRESSING ROOTS USING EXPONENTS

Ex 47: Write in exponent form:

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

Answer:

$$\sqrt{3} = 3^{\frac{1}{2}}$$

Ex 48: Write in exponent form:

$$\frac{1}{\sqrt{7}} = \boxed{7^{-\frac{1}{2}}}$$

Answer:

$$\frac{1}{\sqrt{7}} = 7^{-\frac{1}{2}}$$

Ex 49: Write in exponent form:

$$\sqrt{7} = \boxed{7^{\frac{1}{2}}}$$

Answer:

$$\sqrt{7} = 7^{\frac{1}{2}}$$

Ex 50: Write in exponent form:

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

Answer:

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

Ex 51: Write in exponent form:

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

Answer:

$$\sqrt{x} = x^{\frac{1}{2}}$$

C.2 CALCULATING POWERS AND ROUNDING

Ex 52:  Calculate:

$$3^{\frac{1}{2}} = \boxed{1.73} \text{ (rounded to 2 decimal places)}$$

Answer: Using a calculator, we find:

$$3^{\frac{1}{2}} \approx 1.73$$

Ex 53:  Calculate:

$$2^{\frac{1}{2}} = \boxed{1.41} \text{ (rounded to 2 decimal places)}$$

Answer: Using a calculator, we find:

$$2^{\frac{1}{2}} \approx 1.41$$

Ex 54:  Calculate:

$$2^{-\frac{1}{2}} = \boxed{0.71} \text{ (rounded to 2 decimal places)}$$

Answer: Using a calculator, we find:

$$2^{-\frac{1}{2}} \approx 0.71$$



Ex 55: Calculate:

$$100^{-\frac{1}{2}} = \boxed{0.10} \text{ (rounded to 2 decimal places)}$$

Answer: Using a calculator, we find:

$$100^{-\frac{1}{2}} \approx 0.10$$

D EXPONENT LAW 1

D.1 SIMPLIFYING PRODUCTS OF POWERS

Ex 56: 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 57: 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 58: 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 59: 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 60: 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 61: Simplify:

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

Answer:

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

D.2 SIMPLIFYING PRODUCTS OF ALGEBRAIC POWERS

Ex 62: 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 63: 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 64: 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 65: Simplify:

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

Answer:

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

D.3 IDENTIFYING CORRECT EXPONENTIAL EXPRESSIONS

MCQ 66: 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 67: 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 68: 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 69:  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)

D.4 SIMPLIFYING EXPRESSIONS OF POWERS

Ex 70: Simplify:

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

Answer:

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

Ex 71: 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 72: 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 73: Simplify:

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

Answer:

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

E EXPONENT LAW 2

E.1 SIMPLIFYING FRACTIONS OF POWERS

Ex 74: 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 75: 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 76: 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 77: 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 78: Simplify:

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

Answer:

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

E.2 SIMPLIFYING FRACTIONS OF ALGEBRAIC POWERS

Ex 79: 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 80: 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 81: Simplify:

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

Answer:

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

Ex 82: Simplify:

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

Answer:

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

Ex 83: Simplify:

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

Answer:

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

F EXPONENT LAW 3

F.1 SIMPLIFYING POWERS OF POWERS

Ex 84: 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 85: 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 86: 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 87: Simplify:

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

Answer:

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

F.2 SIMPLIFYING POWERS OF POWERS

Ex 88: 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 89: 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 90: 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 91: Simplify:

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

Answer:

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

G EXPONENT LAW 4

G.1 SIMPLIFYING POWERS OF PRODUCTS

Ex 92: 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 93: 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 94: 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 95: Simplify:

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

Answer:

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

G.2 SIMPLIFYING POWERS OF PRODUCTS

Ex 96: 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 97: 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 98: 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 99: Simplify:

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

Answer:

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

H EXPONENT LAW 5

H.1 SIMPLIFYING POWERS OF FRACTIONS

Ex 100: 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 101: 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 102: 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 103: Simplify:

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

Answer:

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

H.2 SIMPLIFYING POWERS OF ALGEBRAIC FRACTIONS

Ex 104: 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 105: 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 106: 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 107: Simplify:

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

Answer:

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

I EXPONENT LAW 6

I.1 EXPRESSING NEGATIVE EXPONENTS AS FRACTIONS

Ex 108: Write as a fraction:

$$\left(\frac{4}{7}\right)^{-1} = \boxed{\frac{7}{4}}$$

Answer:

$$\begin{aligned}\left(\frac{4}{7}\right)^{-1} &= \left(\frac{7}{4}\right)^1 \\ &= \frac{7}{4}\end{aligned}$$

Ex 109: Write as a fraction:

$$\left(\frac{5}{3}\right)^{-2} = \boxed{\frac{9}{25}}$$

Answer:

$$\begin{aligned}\left(\frac{5}{3}\right)^{-2} &= \left(\frac{3}{5}\right)^2 \\ &= \frac{3^2}{5^2} \\ &= \frac{9}{25}\end{aligned}$$

Ex 110: Write as a fraction:

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

Answer:

$$\begin{aligned}\left(\frac{1}{2}\right)^{-3} &= \left(\frac{2}{1}\right)^3 \\ &= 2^3 \\ &= 8\end{aligned}$$

Ex 111: Write as a fraction:

$$\left(\frac{2}{3}\right)^{-3} = \boxed{\frac{27}{8}}$$

Answer:

$$\begin{aligned}\left(\frac{2}{3}\right)^{-3} &= \left(\frac{3}{2}\right)^3 \\ &= \frac{3^3}{2^3} \\ &= \frac{27}{8}\end{aligned}$$

I.2 MULTIPLYING BY THE INVERSE

Ex 112: Simplify:

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

Answer:

$$\begin{aligned}\frac{3}{2} \times \left(\frac{3}{2}\right)^{-1} &= \frac{3}{2} \times \frac{2}{3} \\ &= \frac{3 \times 2}{2 \times 3} \\ &= 1\end{aligned}$$

Ex 113: Simplify:

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

Answer:

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

Ex 114: Simplify:

$$\frac{a}{b} \times \left(\frac{a}{b}\right)^{-1} = \boxed{1}$$

Answer:

$$\begin{aligned}\frac{a}{b} \times \left(\frac{a}{b}\right)^{-1} &= \frac{a}{b} \times \frac{b}{a} \\ &= \frac{a \times b}{b \times a} \\ &= \frac{ab}{ab} \\ &= 1\end{aligned}$$

J ORDER OF OPERATIONS

J.1 EVALUATING EXPRESSIONS WITH EXPONENTS IN 2 STEPS

Ex 115: 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 116: 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 117: 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 118: 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 119: Evaluate this expression:

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

Answer:

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

J.2 EVALUATING EXPRESSIONS WITH EXPONENTS IN 3 STEPS

Ex 120: 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 121: 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 122: 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 123: Evaluate this expression:

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

Answer:

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


J.3 FINDING THE OPERATORS

Ex 124: 

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

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 125: 

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

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 126: 

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

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 127: 

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

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.

J.4 COMBINING NEGATIVE POWERS WITH ARITHMETIC

Ex 128: 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 129: 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 130: 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 131: Write as a fraction:

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

Answer:

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

J.5 SIMPLIFYING ALGEBRAIC EXPRESSIONS

Ex 132: 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 133: 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 134: 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 135: 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 136: 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 137: Simplify the expression:

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

Answer:

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

J.6 SIMPLIFYING EXPRESSIONS OF POWERS

Ex 138: 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 139: 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 140: 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 141: Simplify:

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

Answer:

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

Ex 142: 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 143: Simplify:

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

Answer:

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

J.7 EVALUATING TO AN INTEGER

Ex 144: Express as an integer:

$$\sqrt{2} \times 2^{\frac{1}{2}} = \boxed{2}$$

Answer:

$$\begin{aligned}\sqrt{2} \times 2^{\frac{1}{2}} &= 2^{\frac{1}{2}} \times 2^{\frac{1}{2}} \\ &= 2^{\frac{1}{2} + \frac{1}{2}} \\ &= 2^1 \\ &= 2\end{aligned}$$

Ex 145: Express as an integer:

$$\frac{2^{\frac{3}{2}}}{\sqrt{2}} = \boxed{2}$$

Answer:

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

Ex 146: Express as an integer:

$$(\sqrt{2})^4 = \boxed{4}$$

Answer:

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

Ex 147: Express as an integer:

$$(3\sqrt{2})^2 = \boxed{18}$$

Answer:

$$\begin{aligned}(3\sqrt{2})^2 &= 3^2 \times (\sqrt{2})^2 \\ &= 9 \times 2 \\ &= 18\end{aligned}$$

K SCIENTIFIC NOTATION

K.1 WRITING NUMBERS AS POWERS OF TEN

Ex 148: Write in exponent form:

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

Answer:

$$\begin{aligned}100 &= 10 \times 10 \\ &= 10^2\end{aligned}$$

Ex 149: Write in exponent form:

$$1\,000 = \boxed{10^3}$$

Answer:

$$\begin{aligned}1\,000 &= 10 \times 10 \times 10 \\ &= 10^3\end{aligned}$$

Ex 150: Write in exponent form:

$$0.01 = \boxed{10^{-2}}$$

Answer:

$$\begin{aligned}0.01 &= \frac{1}{100} \\ &= \frac{1}{10^2} \\ &= 10^{-2}\end{aligned}$$

Ex 151: Write in exponent form:

$$0.000\,1 = \boxed{10^{-4}}$$

Answer:

$$\begin{aligned}0.000\,1 &= \frac{1}{10\,000} \\ &= \frac{1}{10^4} \\ &= 10^{-4}\end{aligned}$$

K.2 EXPRESSING NUMBERS IN SCIENTIFIC NOTATION

Ex 152: Write in scientific notation:

$$123 = \boxed{1.23} \times \boxed{10^2}$$

Answer:

$$\begin{aligned}123 &= 1.23 \times 100 \\ &= 1.23 \times 10^2\end{aligned}$$

Ex 153: Write in scientific notation:

$$1\,200 = \boxed{1.2} \times \boxed{10^3}$$

Answer:

$$\begin{aligned}1\,200 &= 1.2 \times 1\,000 \\ &= 1.2 \times 10^3\end{aligned}$$

Ex 154: Write in scientific notation:

$$5\,000\,000 = \boxed{5} \times \boxed{10^6}$$

Answer:

$$\begin{aligned} 5\,000\,000 &= 5 \times 1\,000\,000 \\ &= 5 \times 10^6 \end{aligned}$$

Ex 155: Write in scientific notation:

$$8\,100\,000\,000 = \boxed{8.1} \times \boxed{10^9}$$

Answer:

$$\begin{aligned} 8\,100\,000\,000 &= 8.1 \times 1\,000\,000\,000 \\ &= 8.1 \times 10^9 \end{aligned}$$

Ex 156: Write in scientific notation:

$$0.05 = \boxed{5} \times \boxed{10^{-2}}$$

Answer:

$$\begin{aligned} 0.05 &= 5 \times \frac{1}{100} \\ &= 5 \times 10^{-2} \end{aligned}$$

Ex 157: Write in scientific notation:

$$0.12 = \boxed{1.2} \times \boxed{10^{-1}}$$

Answer:

$$\begin{aligned} 0.12 &= 1.2 \times \frac{1}{10} \\ &= 1.2 \times 10^{-1} \end{aligned}$$

Ex 158: Write in scientific notation:

$$0.000\,59 = \boxed{5.9} \times \boxed{10^{-4}}$$

Answer:

$$\begin{aligned} 0.000\,59 &= 5.9 \times \frac{1}{10^4} \\ &= 5.9 \times 10^{-4} \end{aligned}$$

K.3 EXPRESSING IN DECIMAL FORM

Ex 159: Write in decimal form:

$$8.2 \times 10^2 = \boxed{820}$$

Answer:

$$\begin{aligned} 8.2 \times 10^2 &= 8.2 \times 100 \\ &= 820 \end{aligned}$$

Ex 160: Write in decimal form:

$$1.25 \times 10^3 = \boxed{1250}$$

Answer:

$$\begin{aligned} 1.25 \times 10^3 &= 1.25 \times 1\,000 \\ &= 1\,250 \end{aligned}$$

Ex 161: Write in decimal form:

$$5 \times 10^6 = \boxed{5\,000\,000}$$

Answer:

$$\begin{aligned} 5 \times 10^6 &= 5 \times 1\,000\,000 \\ &= 5\,000\,000 \end{aligned}$$

Ex 162: Write in decimal form:

$$2 \times 10^{-2} = \boxed{0.02}$$

Answer:

$$\begin{aligned} 2 \times 10^{-2} &= 2 \times \frac{1}{100} \\ &= 0.02 \end{aligned}$$

Ex 163: Write in decimal form:

$$8.5 \times 10^{-1} = \boxed{0.85}$$

Answer:

$$\begin{aligned} 8.5 \times 10^{-1} &= 8.5 \times \frac{1}{10} \\ &= 0.85 \end{aligned}$$

Ex 164: Write in decimal form:

$$9.1 \times 10^{-5} = \boxed{0.000091}$$

Answer:

$$\begin{aligned} 9.1 \times 10^{-5} &= 9.1 \times \frac{1}{100\,000} \\ &= 0.000\,091 \end{aligned}$$

K.4 EXPRESSING REAL-WORLD QUANTITIES IN SCIENTIFIC NOTATION

Ex 165: There are approximately 4 million red blood cells in a drop of blood. Write the quantity in scientific notation:

$$\boxed{4} \times \boxed{10^6} \text{ red blood cells}$$

Answer:

$$\begin{aligned} 4\,000\,000 &= 4 \times 1\,000\,000 \\ &= 4 \times 10^6 \end{aligned}$$

Ex 166: There are approximately 3 billion stars in the galaxy. Write the quantity in scientific notation:

$$\boxed{3} \times \boxed{10^9} \text{ stars}$$

Answer:

$$\begin{aligned} 3\,000\,000\,000 &= 3 \times 1\,000\,000\,000 \\ &= 3 \times 10^9 \end{aligned}$$

Ex 167: There are approximately 7.5 billion people on Earth. Write the quantity in scientific notation:

$$\boxed{7.5} \times \boxed{10^9} \text{ people}$$

Answer:

$$\begin{aligned} 7\,500\,000\,000 &= 7.5 \times 1\,000\,000\,000 \\ &= 7.5 \times 10^9 \end{aligned}$$

Ex 168: The distance from the Earth to the Sun is approximately 150 million kilometers. Write the quantity in scientific notation:

$$\boxed{1.5} \times \boxed{10^8} \text{ kilometers}$$

Answer:

$$\begin{aligned} 150\,000\,000 &= 1.5 \times 100\,000\,000 \\ &= 1.5 \times 10^8 \end{aligned}$$