Learning Outcome: This lesson explores properties of exponents, use of the properties to generate equivalent expressions, and (at an advanced level) solving problems using relations.

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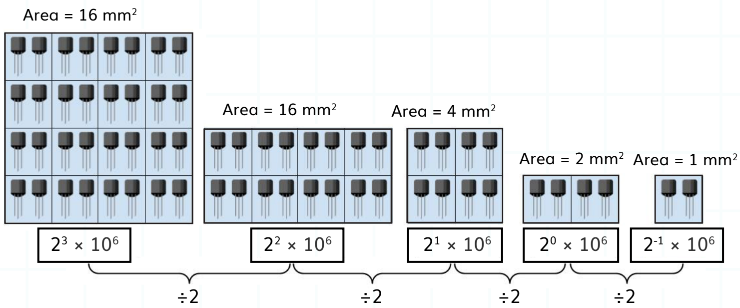
Q:01

If ProChips' latest chip consists of 8×10^6 transistors spread across an area of 16 mm^2, find the number of transistors present per mm^2.

a) $2^{-1} \times 10^6$ b) 20×10^6

c) 2×10^6 d) 2×10^8

SOLUTION



Q:02

Match the following with their equivalent expressions.

(a*a*a*a)/(a*a*a*a*a)	b^0
a*a*a*b*b*b	a^6
(b*b*b)/(b*b*b)	a^{-1}
a*a*a*a*a*a	b^{-4}
1/(b*b*b*b)	$(ab)^3$

SOLUTION

(a*a*a*a)/(a*a*a*a*a)	$= (a^4 / a^5)$ $= (a^4\ a^{-5})$ $= a^{4-5}$ $= a^{-1}$	a^{-1}
a*a*a*b*b*b	a^3b^3	$(ab)^3$
(a*a*a*a)/(a*a*a*a*a)	$= b^3 / b^3$ $= b^3\ b^{-3}$ $= b^{3-3}$ $= b^0$	b^0
a*a*a*a*a*a	a^6	a^6
1/(b*b*b*b)	$1/b^4$	b^{-4}

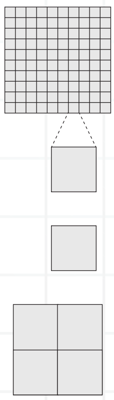
Q:03

For a particular design of the chip, a scientist needed to convert 4 cm into m. Which of the following show(s) the correct conversion?

a) 4 cm = 400 m b) 4 cm = 4 x 10-2 m

c) 4 cm = 1/40 m d) 4 cm = 0.04 m

SOLUTION



100 cm = 1 meter

1 cm = 1 ÷ 100 meter

1 cm = 10^{-2} meter = 0.01 meter

4 cm = 4×10^{-2} meter = 0.04 meter

Q:04

Which of the following statements are true?

a) (-6)/5 = 6/(-5) b) 6/5 = (-6)/(-5)

c) -(-6)/5 = 6/5 d) None of these

SOLUTION

Option A: $(-6)/5 = (-1 \times 6)/5 = (-6/5)$; $6/(-5) = 6/(-1 \times 5) = -(6/5)$ } Equal

Option B: $(-6)/(-5) = (-1 \times 6)/(-1 \times 5) = [\underbrace{(-1)/(-1)}_{+1}] \times [6/5] = 6/5$; $6/5$ } Equal

Option C: $-(-6)/5 = -1\ (-1 \times 6)/5 = (\underbrace{-1 \times -1}_{+1})(6/5) = 6/5$; $6/5$ } Equal

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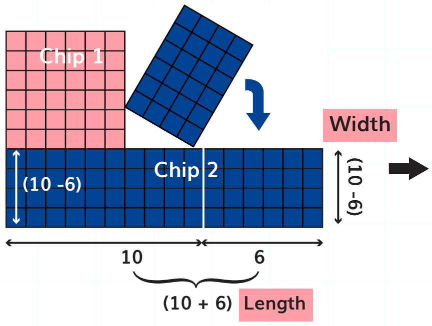
Q:05

You want to redesign a single chip of size 10x10 into 2 chips with the same area. If one of them is 6x6, what should be the size of the other?

a) (10 + 6) (10 - 6) b) (10 + 6) (6 + 10)

c) (10 + 10) (6 + 6) d) (10 - 6) (10 - 6)

SOLUTION



Dimensions of Chip 2:
= length × width
= (10+6) × (10-6)

Therefore, **option a** is the correct answer.

Q:06

Sort the numbers in ascending order

$+5^3$

2^2

5^1

1^{21}

5^{-1}

SOLUTION

$+5^3$

2^2

5^1

1^{21}

5^{-1}

Let's simplify all the numbers first.

$-5^3 = -125$
$2^2 = 4$
$5^1 = 5$
$1^{21} = 1$
$5^{-1} = \frac{1}{5}$

Arrange the RHS in ascending order: $-125 < \frac{1}{5} < 1 < 4 < 5$

Now, arrange LHS in ascending order:

-53 < 5-1 < 121 < 22 < 51

Q:07

Which of the following is the simplified form of $\frac{(p - q)^4}{(p^2 - q^2)^2}$?

a) $\frac{(p - q)^2}{p + q}$ b) $\frac{(p - q)^2}{(p + q)^2}$

c) $\frac{(p - q)}{(p + q)}$ d) $\frac{(p + q)^2}{(p - q)^2}$

SOLUTION

(a2-b2) = (a+ b)(a-b)

Substituting this in the denominator of the equation we get,

$$\frac{(p - q)^4}{(p^2 - q^2)^2} = \frac{(p - q)(p - q)(p - q)(p - q)}{(p^2 - q^2)(p^2 - q^2)^2}$$

$$= \frac{(p - q)(p - q)(p - q)(p - q)}{(p + q)(p - q)(p + q)(p - q)}$$ [As, a2 - b2 = (a + b)(a - b)]

$$= \frac{(p - q)(p - q)}{(p + q)(p + q)}$$

$$= \frac{(p - q)^4}{(p + q)^2}$$

Hence, option b is the simplified form of the given equation.

Q:08

x is a non-zero rational number. Product of the square of x with the cube of x is equal to the ____.

a) Second power of x b) Third power of x

c) Fifth power of x d) Sixth power of x

SOLUTION

Let the number be 'X'
Square of X : X^2
Cube of X : X^3

Product = $(X^2)(X^3) = X^{(2+3)} = X^5$

Given: X⟶A non-zero rational number.
Hence, option c - fifth power of X is the right answer.

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Q:09

A number with negative exponent in the numerator is equal to the same number with ______ exponent in the ___________.

a) Positive, numerator **b) Negative, numerator**

c) Positive, denominator **d) Negative, denominator**

SOLUTION

$X^{-a} = (X^{-1})^a$ $\boxed{(X^{-1}) = 1/X}$

$X^{-a} = 1/X^{a}$

Numerator

Positive exponent

Denominator

Negative exponent

If we observe, we can see that the sign of the exponent has been changed from negative to **positive** and 'X' in the numerator is brought down to the **denominator**.
So, **Option c** is the correct answer.

Q:10

a^n is the ________ of a^{-n}.

a) Additive inverse **b) Additive identity**

c) Multiplicative identity **d) Multiplicative inverse**

SOLUTION

d) Multiplicative inverse

We've seen that, 1/X is nothing but the multiplicative inverse of X. Here, the multiplicative inverse of a^n can be written as $1/a^n$ which in turn can be written as a^{-n}.
So, a^n is the **multiplicative inverse** of a^{-n}. **Option d** is the right answer.

Q:11

Which of the following expressions are equivalent to $\frac{3^{-8}}{3^{-4}}$?

3^{-12}	3^{-4}	3^2	3^{-4}
$\frac{1}{3^2}$	3^{-12}	$\frac{1}{3^4}$	$\frac{1}{3^4}$
$\frac{1}{3^{12}}$	$\frac{1}{81}$	$\frac{1}{27}$	$\frac{1}{81}$

SOLUTION

$\frac{3^{-8}}{3^{-4}} = 3^{-8+4}$

$= 3\text{-}4$

$1/3^2 = 3^{-2} \rightarrow 1/3^2$ is not equivalent to 3^{-4}.

$1/3^4 = 3^{-4} \rightarrow$ So, $1/3^4$ is equivalent to 3^{-4}.

$1/3^{12} = 3^{-12} \rightarrow 1/3^{12}$ is not equivalent to 3^{-4}.

$1 / 81 = 1/3^4 \rightarrow$ So, $1 / 81$ is equivalent to 3^{-4}.

$1/27 = 1/3^3 \rightarrow 1/27$ is not equivalent to 3^{-4}.

We can write 3^{-4} as $\frac{1}{3^4}$ and $\frac{1}{81}$

Q:12

A garden is 12 yards long. Assuming that the snail is moving at a constant speed of 5-2foot per second. How many minutes will the snail take to travel the length of the garden?

a) 10 **b) 15**

c) 20 **d) 25**

SOLUTION

Distance covered by the snail		Time taken
5^{-2} foot	$\longrightarrow$	1 second
$5^{-2} \times 5^{-2}$ foot	$\longrightarrow$	1×5^2 second
1 foot	$\longrightarrow$	25 seconds
1 × 3 feet	$\longrightarrow$	25 × 3 seconds
1 yard	$\longrightarrow$	75 seconds
1 × 12 yards	$\longrightarrow$	75 × 12 seconds
12 yards	$\longrightarrow$	900 seconds
12 yards	$\longrightarrow$	60 × 15 seconds
12 yards	$\longrightarrow$	**15 minutes**

The snail travels 12 yards in 15 minutes. **Option b** is the correct answer.

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Q:13

Evaluate and choose the correct value:

7^{-2}	49 -49 1/49
$\frac{r^8\, r^{-8}}{4}$	0 1 1/4
$\frac{1}{5^{-3}} \times \frac{1}{5^6}$	125 1/125 25
$\frac{1}{3^{-4}}$	27 81 1/81

SOLUTION

$7^{-2} = 1/72 = \mathbf{1/49}$

$\frac{r^8\, r^{-8}}{4} = \frac{r^{8-8}}{4} = \frac{r^0}{4} = \frac{1}{4}$ [Since $x^0 = 1$, x being any number.]

$\frac{1}{5^{-3}} = \frac{1}{5^6} = \frac{r^{8-8}}{5^{-3+6}} = \frac{1}{5^3} = \frac{1}{125}$

$\frac{1}{3^{-4}} = 3^4 = \mathbf{81}$

Q:14

Place true and false in front of the statements.

a) $10^{-2} = \frac{1}{100}$

b) $3^5 > \frac{1}{(3^{-5})}$

c) $2 - \frac{1}{(2^{-1})}$

d) $5^0 = 5$

SOLUTION

2 can also be written as $\frac{1}{2^{-1}}$.

Hence, the given expression is **true**.

Q:15

If $\frac{5^m \times 5^3 \times 5^{-2}}{5^{-5}} = 5^{12}$, then m = ____

Complete the steps to find the value of m.

Step 1: $\frac{5^m \times 5^{\_\_}}{5^{-5}} = 5$

Step 2: $5^m \times 5^{\_\_} = 5$

Step 3: m + ____ = 12

SOLUTION

Step 1: $\frac{5^m \times 5^1}{5^{-5}} = 5$

Step 2: $5^m \times 5^6 = 5$

Step 3: m + 6 = 12

So, the value of m = 6