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SOLUTIONS BOOK

CLASS 8

Mathematics · Ganita Prakash

CHAPTER 2

Power Play

Complete Exercise Solutions

Figure it Out (Section 2.2) | End-of-Chapter Exercises | In-Text Questions (2.1–2.5) | Puzzle Time

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FIO

CLASS 8 MATHS · GANITA PRAKASH · CHAPTER 2

Figure it Out

Section 2.2 · pp. 22–23 · 3 questions

QUESTION 1

Express the following in exponential form:

(i) $6 \times 6 \times 6 \times 6$
(ii) $y \times y$
(iii) $b \times b \times b \times b$
(iv) $5 \times 5 \times 7 \times 7 \times 7$
(v) $2 \times 2 \times a \times a$
(vi) $a \times a \times a \times c \times c \times c \times c \times d$

ANSWER

In general, n multiplied by itself a times is written n^a. So for every base we count how many times it occurs in the product; that count is its exponent. A letter that occurs only once has exponent 1 ($d = d^1$).

(i) **$6 \times 6 \times 6 \times 6$**

The base 6 occurs 4 times, so $6 \times 6 \times 6 \times 6 = 6^4$.

(ii) **$y \times y$**

y occurs 2 times, so $y \times y = y^2$.

(iii) **$b \times b \times b \times b$**

b occurs 4 times, so the product is b^4.

(iv) **$5 \times 5 \times 7 \times 7 \times 7$**

5 occurs 2 times and 7 occurs 3 times, so $5 \times 5 \times 7 \times 7 \times 7 = 5^2 \times 7^3$.

(v) **$2 \times 2 \times a \times a$**

2 occurs 2 times and a occurs 2 times, so the product is $2^2 \times a^2$.

(vi) **$a \times a \times a \times c \times c \times c \times c \times d$**

a occurs 3 times, c occurs 4 times and d occurs once, so the product is $a^3 \times c^4 \times d$.

(i) 6^4 (ii) y^2 (iii) b^4 (iv) $5^2 \times 7^3$ (v) $2^2 \times a^2$ (vi) $a^3 \times c^4 \times d$

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QUESTION 2

Express each of the following as a product of powers of their prime factors in exponential form.

(i) 648 (ii) 405 (iii) 540 (iv) 3600

ANSWER

Divide repeatedly by the smallest prime that divides the number (2, then 3, then 5, …) until 1 is reached, then collect equal primes as powers.

(i) 648

$648 \div 2 = 324$; $324 \div 2 = 162$; $162 \div 2 = 81$
$81 \div 3 = 27$; $27 \div 3 = 9$; $9 \div 3 = 3$; $3 \div 3 = 1$
$648 = 2 \times 2 \times 2 \times 3 \times 3 \times 3 \times 3 = 2^3 \times 3^4$

(ii) 405

$405 \div 3 = 135$; $135 \div 3 = 45$; $45 \div 3 = 15$; $15 \div 3 = 5$; $5 \div 5 = 1$
$405 = 3 \times 3 \times 3 \times 3 \times 5 = 3^4 \times 5$

(iii) 540

$540 \div 2 = 270$; $270 \div 2 = 135$
$135 \div 3 = 45$; $45 \div 3 = 15$; $15 \div 3 = 5$; $5 \div 5 = 1$
$540 = 2 \times 2 \times 3 \times 3 \times 3 \times 5 = 2^2 \times 3^3 \times 5$

(iv) 3600

$3600 \div 2 = 1800$; $1800 \div 2 = 900$; $900 \div 2 = 450$; $450 \div 2 = 225$
$225 \div 3 = 75$; $75 \div 3 = 25$; $25 \div 5 = 5$; $5 \div 5 = 1$
$3600 = 2^4 \times 3^2 \times 5^2$

Check: $2^3 \times 3^4 = 8 \times 81 = 648$; $3^4 \times 5 = 81 \times 5 = 405$; $2^2 \times 3^3 \times 5 = 4 \times 27 \times 5 = 540$; $2^4 \times 3^2 \times 5^2 = 16 \times 9 \times 25 = 3600$.

(i) $648 = 2^3 \times 3^4$ (ii) $405 = 3^4 \times 5$ (iii) $540 = 2^2 \times 3^3 \times 5$ (iv) $3600 = 2^4 \times 3^2 \times 5^2$

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QUESTION 3

Write the numerical value of each of the following:

(i) 2×10^3 **(ii) $7^2 \times 2^3$** **(iii) 3×4^4**
(iv) $(-3)^2 \times (-5)^2$ **(v) $3^2 \times 10^4$** **(vi) $(-2)^5 \times (-10)^6$**

ANSWER

Evaluate each power first, then multiply. A negative base raised to an even power is positive; raised to an odd power it is negative.

(i) $2 \times 10^3 = 2 \times 1000 = 2000$
(ii) $7^2 \times 2^3 = 49 \times 8 = 392$
(iii) $3 \times 4^4 = 3 \times 256 = 768$
(iv) $(-3)^2 \times (-5)^2 = 9 \times 25 = 225$
(v) $3^2 \times 10^4 = 9 \times 10000 = 90000$
(vi) $(-2)^5 \times (-10)^6 = (-32) \times 1000000 = -32000000$

Here $4^4 = 4 \times 4 \times 4 \times 4 = 256$, $(-2)^5 = -32$ (odd power) and $(-10)^6 = 1000000$ (even power).

(i) 2000 (ii) 392 (iii) 768 (iv) 225 (v) 90000 (vi) – 32000000 (– 3,20,00,000)

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EOC

CLASS 8 MATHS · GANITA PRAKASH · CHAPTER 2

End-of-Chapter Exercises

Figure it Out · pp. 44–45 · 14 questions

QUESTION 1

Find out the units digit in the value of $2^{224} \div 4^{32}$? [Hint: $4 = 2^2$]

ANSWER

Write 4^{32} as a power of 2: since $4 = 2^2$, $4^{32} = (2^2)^{32} = 2^{2 \times 32} = 2^{64}$.

$$2^{224} \div 4^{32} = 2^{224} \div 2^{64} = 2^{224 - 64} = 2^{160}$$

The units digits of the powers of 2 repeat in a cycle of length 4:

Power	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8
Value	2	4	8	16	32	64	128	256
Units digit	2	4	8	6	2	4	8	6

Since $160 = 4 \times 40$ leaves remainder 0 when divided by 4, 2^{160} has the same units digit as 2^4, i.e. 6.

$2^{224} \div 4^{32} = 2^{160}$, and its units digit is 6.

QUESTION 2

There are 5 bottles in a container. Every day, a new container is brought in. How many bottles would be there after 40 days?

ANSWER

Each day one container (5 bottles) is added, so the number of bottles increases by the same amount 5 every day. This is **linear (additive) growth**.

Day	1	2	3	4	...	40
Bottles	5	10	15	20	...	5×40

$$\text{Number of bottles after 40 days} = 40 \times 5 = 200 = 2 \times 10^2$$

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After 40 days there would be 200 bottles (= 2×10^2).

QUESTION 3

Write the given number as the product of two or more powers in three different ways. The powers can be any integers.

(i) 64^3 **(ii) 192^8** **(iii) 32^{-5}**

ANSWER

First write the number with prime bases, then split the exponent using $n^a \times n^b = n^{a+b}$, $m^a \times n^a = (mn)^a$ and $(n^a)^b = n^{ab}$.

(i) 64^3

$64 = 2^6$, so $64^3 = (2^6)^3 = 2^{18}$. Three ways:

(a) $2^{10} \times 2^8$ $(10 + 8 = 18)$
(b) $4^5 \times 4^4 = 4^9 = (2^2)^9 = 2^{18}$
(c) $8^3 \times 8^3 = 8^6 = (2^3)^6 = 2^{18}$

(ii) 192^8

$192 = 2^6 \times 3$ (since $64 \times 3 = 192$), so $192^8 = (2^6)^8 \times 3^8 = 2^{48} \times 3^8$. Three ways:

(a) $2^{48} \times 3^8$
(b) $2^{40} \times 2^8 \times 3^8$
(c) $2^{40} \times 6^8$ $(2^8 \times 3^8 = (2 \times 3)^8 = 6^8)$

(iii) 32^{-5}

$32 = 2^5$, so $32^{-5} = (2^5)^{-5} = 2^{-25}$. Three ways:

(a) $2^{-10} \times 2^{-15}$ $(-10 - 15 = -25)$
(b) $2^{-5} \times 2^{-20}$
(c) $4^{-12} \times 2^{-1} = (2^2)^{-12} \times 2^{-1} = 2^{-24} \times 2^{-1} = 2^{-25}$

(i) $2^{10} \times 2^8$, $4^5 \times 4^4$, $8^3 \times 8^3$ (ii) $2^{48} \times 3^8$, $2^{40} \times 2^8 \times 3^8$, $2^{40} \times 6^8$ (iii) $2^{-10} \times 2^{-15}$, $2^{-5} \times 2^{-20}$, $4^{-12} \times 2^{-1}$

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QUESTION 4

Examine each statement below and find out if it is 'Always True', 'Only Sometimes True', or 'Never True'. Explain your reasoning.

(i) Cube numbers are also square numbers.

(ii) Fourth powers are also square numbers.

(iii) The fifth power of a number is divisible by the cube of that number.

(iv) The product of two cube numbers is a cube number.

(v) q^{46} is both a 4th power and a 6th power (q is a prime number).

ANSWER

(i) Cube numbers are also square numbers — Only Sometimes True

A cube n^3 is a square only for some n. For example $64 = 4^3 = 8^2$ is both a cube and a square, but $8 = 2^3$ is a cube that is not a square (there is no whole number whose square is 8). A cube is also a square exactly when it is a 6th power: $n^6 = (n^3)^2 = (n^2)^3$.

(ii) Fourth powers are also square numbers — Always True

For every number n, $n^4 = (n^2)^2$, which is the square of n^2. For example $3^4 = 81 = 9^2$.

(iii) The fifth power of a number is divisible by its cube — Always True

$n^5 = n^3 \times n^2$, so $n^5 \div n^3 = n^2$ (for $n \neq 0$). For example $2^5 \div 2^3 = 32 \div 8 = 4 = 2^2$.

(iv) The product of two cube numbers is a cube number — Always True

$a^3 \times b^3 = (ab)^3$, which is again a cube. For example $8 \times 27 = 216 = 6^3$.

(v) q^{46} is both a 4th power and a 6th power — Never True

If q is prime, q^{46} is a kth power only when k divides 46, because the exponent of the prime q must be divisible by k. The divisors of 46 are 1, 2, 23 and 46. Neither 4 nor 6 divides 46, so q^{46} is neither a 4th power nor a 6th power.

(i) Only Sometimes True (ii) Always True (iii) Always True (iv) Always True (v) Never True

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QUESTION 5

Simplify and write these in the exponential form.

(i) $10^{-2} \times 10^{-5}$ **(ii)** $5^7 \div 5^4$ **(iii)** $9^{-7} \div 9^4$

(iv) $(13^{-2})^{-3}$ **(v)** $m^5n^{12}(mn)^9$

ANSWER

Use $n^a \times n^b = n^{a+b}$, $n^a \div n^b = n^{a-b}$ and $(n^a)^b = n^{ab}$, which hold for all integer exponents.

(i) $10^{-2} \times 10^{-5} = 10^{-2+(-5)} = 10^{-7}$

(ii) $5^7 \div 5^4 = 5^{7-4} = 5^3$

(iii) $9^{-7} \div 9^4 = 9^{-7-4} = 9^{-11}$

(iv) $(13^{-2})^{-3} = 13^{(-2)\times(-3)} = 13^6$

(v) $m^5n^{12}(mn)^9 = m^5n^{12} \times m^9n^9 = m^{5+9}\, n^{12+9} = m^{14}n^{21}$

(i) 10^{-7} **(= 1/10⁷)** **(ii)** 5^3 **(iii)** 9^{-11} **(= 1/9¹¹)** **(iv)** 13^6 **(v)** $m^{14}n^{21}$

QUESTION 6

If $12^2 = 144$ what is

(i) $(1.2)^2$ **(ii)** $(0.12)^2$

(iii) $(0.012)^2$ **(iv)** 120^2

ANSWER

Write each number as 12 divided or multiplied by a power of 10, and use $(a \div b)^2 = a^2 \div b^2$ and $(a \times b)^2 = a^2 \times b^2$.

(i) $(1.2)^2 = (12 \div 10)^2 = 144 \div 100 = 1.44$

(ii) $(0.12)^2 = (12 \div 100)^2 = 144 \div 10000 = 0.0144$

(iii) $(0.012)^2 = (12 \div 1000)^2 = 144 \div 1000000 = 0.000144$

(iv) $120^2 = (12 \times 10)^2 = 144 \times 100 = 14400$

(i) 1.44 (ii) 0.0144 (iii) 0.000144 (iv) 14400

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QUESTION 7

Circle the numbers that are the same —

$2^4 \times 3^6$ **$6^4 \times 3^2$** **6^{10}** **$18^2 \times 6^2$** **6^{24}**

ANSWER

Write every number as a product of powers of the primes 2 and 3 (using $6 = 2 \times 3$ and $18 = 2 \times 3^2$) and compare.

$2^4 \times 3^6$ (already in prime form)

$6^4 \times 3^2 = (2 \times 3)^4 \times 3^2 = 2^4 \times 3^4 \times 3^2 = 2^4 \times 3^6$

$6^{10} = (2 \times 3)^{10} = 2^{10} \times 3^{10}$

$18^2 \times 6^2 = (2 \times 3^2)^2 \times (2 \times 3)^2 = 2^2 \times 3^4 \times 2^2 \times 3^2 = 2^4 \times 3^6$

$6^{24} = 2^{24} \times 3^{24}$

Check with values: $2^4 \times 3^6 = 16 \times 729 = 11664$, $6^4 \times 3^2 = 1296 \times 9 = 11664$ and $18^2 \times 6^2 = 324 \times 36 = 11664$, whereas 6^{10} and 6^{24} are much larger.

$2^4 \times 3^6$, $6^4 \times 3^2$ and $18^2 \times 6^2$ are the same number (11664); 6^{10} and 6^{24} are different.

QUESTION 8

Identify the greater number in each of the following —

(i) 4^3 or 3^4 **(ii) 2^8 or 8^2** **(iii) 100^2 or 2^{100}**

ANSWER

(i) **4^3 or 3^4**

$4^3 = 4 \times 4 \times 4 = 64$ and $3^4 = 3 \times 3 \times 3 \times 3 = 81$. Since $81 > 64$, 3^4 is greater.

(ii) **2^8 or 8^2**

$2^8 = 256$ and $8^2 = 64$. Since $256 > 64$, 2^8 is greater.

(iii) **100^2 or 2^{100}**

$100^2 = (10^2)^2 = 10^4 = 10000$. For 2^{100}, use $2^{10} = 1024 > 1000 = 10^3$:

$2^{100} = (2^{10})^{10} > (10^3)^{10} = 10^{30}$

$10^{30} > 10^4$, so $2^{100} > 100^2$

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(i) 3^4 is greater (ii) 2^8 is greater (iii) 2^{100} is greater

QUESTION 9

A dairy plans to produce 8.5 billion packets of milk in a year. They want a unique ID (identifier) code for each packet. If they choose to use the digits 0–9, how many digits should the code consist of?

ANSWER

A code of n digits (each digit has 10 choices) gives 10^n different codes. We need 10^n to be at least the number of packets.

$8.5 \text{ billion} = 8{,}500{,}000{,}000 = 8.5 \times 10^9$

$10^9 = 1{,}000{,}000{,}000 < 8{,}500{,}000{,}000$ (9 digits are not enough)

$10^{10} = 10{,}000{,}000{,}000 > 8{,}500{,}000{,}000$ (10 digits are enough)

The code must have at least 10 digits.

QUESTION 10

64 is a square number (8^2) and a cube number (4^3). Are there other numbers that are both squares and cubes? Is there a way to describe such numbers in general?

ANSWER

Yes. Look at $64 = 2^6$: the exponent 6 is divisible by 2 (so it is a square, $(2^3)^2$) and by 3 (so it is a cube, $(2^2)^3$).

In general, $n^6 = (n^3)^2 = (n^2)^3$, so every 6th power is both a square and a cube. Conversely, in the prime factorisation of a number that is both a square and a cube, every exponent is divisible by 2 and by 3, hence by 6; so the number is a 6th power.

n	1	2	3	4	5
n^6	1	64	729	4096	15625
As a square	1^2	8^2	27^2	64^2	125^2
As a cube	1^3	4^3	9^3	16^3	25^3

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Yes — infinitely many. The numbers that are both squares and cubes are exactly the 6th powers n^6: 1, 64, 729, 4096, 15625, …

QUESTION 11

A digital locker has an alphanumeric (it can have both digits and letters) passcode of length 5. Some example codes are G89P0, 38098, BRJKW, and 003AZ. How many such codes are possible?

ANSWER

Each of the 5 positions can hold any one of the 26 capital letters or any one of the 10 digits (as in the example codes), i.e. 26 + 10 = 36 choices per position.

$$\text{Number of codes} = 36 \times 36 \times 36 \times 36 \times 36 = 36^5$$

$$36 \times 36 = 1296;\ 1296 \times 36 = 46656;\ 46656 \times 36 = 1679616;\ 1679616 \times 36 = 60466176$$

36^5 = 6,04,66,176 passcodes are possible.

QUESTION 12

The worldwide population of sheep (2024) is about 10^9, and that of goats is also about the same. What is the total population of sheep and goats?

(i) 20^9 **(ii) 10^{11}** **(iii) 10^{10}**
(iv) 10^{18} **(v) 2×10^9** **(vi) $10^9 + 10^9$**

ANSWER

Total = sheep + goats = $10^9 + 10^9$. Adding two equal quantities gives 2 times the quantity:

$$10^9 + 10^9 = 2 \times 10^9 = 2{,}00{,}00{,}000$$

Now check the options. Adding does **not** change the exponent, so 10^{11}, 10^{10} and 10^{18} are wrong ($10^{10} = 10 \times 10^9$ is ten times too big, 10^{11} a hundred times). $20^9 = 2^9 \times 10^9 = 512 \times 10^9$ is also far too large.

(v) 2×10^9 and (vi) $10^9 + 10^9$ — both express the same total, 2×10^9.

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QUESTION 13

Calculate and write the answer in scientific notation:

(i) If each person in the world had 30 pieces of clothing, find the total number of pieces of clothing.

(ii) There are about 100 million bee colonies in the world. Find the number of honeybees if each colony has about 50,000 bees.

(iii) The human body has about 38 trillion bacterial cells. Find the bacterial population residing in all humans in the world.

(iv) Total time spent eating in a lifetime in seconds.

ANSWER

World population is taken as 8.2×10^9 (Section 2.5 of the chapter).

(i) Pieces of clothing

Total $= 8.2 \times 10^9 \times 30 = 8.2 \times 3 \times 10^9 \times 10 = 24.6 \times 10^{10}$
$= 2.46 \times 10^{11}$ pieces

(ii) Honeybees

100 million $= 10^8$; $50{,}000 = 5 \times 10^4$
Total bees $= 5 \times 10^4 \times 10^8 = 5 \times 10^{12}$ bees

(iii) Bacterial cells in all humans

38 trillion $= 38 \times 10^{12} = 3.8 \times 10^{13}$
Total $= 3.8 \times 10^{13} \times 8.2 \times 10^9 = 31.16 \times 10^{22}$
$= 3.116 \times 10^{23}$ bacterial cells

(iv) Time spent eating in a lifetime

This needs assumptions: a lifetime of 70 years and 1 hour of eating per day (1 hour = 3600 seconds), ignoring leap days.

Seconds per year spent eating $= 3600 \times 365 = 13{,}14{,}000$
In 70 years: $13{,}14{,}000 \times 70 = 9{,}19{,}80{,}000$ seconds
$= 9.198 \times 10^7$ seconds

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(i) 2.46×10^{11} (ii) 5×10^{12} (iii) 3.116×10^{23} (iv) $\approx 9.2 \times 10^{7}$ seconds (with the stated assumptions)

QUESTION 14

What was the date 1 arab/1 billion seconds ago?

ANSWER

1 arab = 1 billion = 10^9. Convert 10^9 seconds into days (1 day = 24 × 60 × 60 = 86,400 seconds):

$10^9 \div 86400 \approx 11{,}574.07$ days

11,574 days ÷ 365.25 ≈ 31.7 years (about 31 years 8 months)

The answer depends on today's date, so we show the method with an example. Take today as **22 November 2026**:

22 Nov 1995 to 22 Nov 2026 = 31 × 365 + 8 leap days = 11,323 days

Remaining days to go back: 11,574 – 11,323 = 251 days

22 Nov 1995 minus 251 days = 16 March 1995

10^9 seconds ≈ 11,574 days ≈ 31.7 years, so 1 billion seconds before 22 November 2026 was around 16 March 1995. (Subtract the same number of days from the date on which you work.)

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2.1

CLASS 8 MATHS · GANITA PRAKASH · CHAPTER 2

In-Text Questions

Section 2.1 · Experiencing the Power Play · 6 questions

IN-TEXT · P. 19 · T1

Take a sheet of paper, as large a sheet as you can find. Fold it once. Fold it again, and again.

How many times can you fold it over and over?

Try it with different types of paper and see what happens.

ANSWER

This is a hands-on activity. When you try it with an ordinary sheet (notebook or printer paper) you will find that it can be folded only about **6 to 7 times**, which is what Estu heard. A newspaper or tissue paper, or a much larger sheet, may allow one or two more folds, but not many more.

The reason is that **every fold doubles the number of layers**, so the thickness doubles, while the folded packet becomes smaller and smaller. After 7 folds there are already 128 layers:

Fold	1	2	3	4	5	6	7
Layers (2^n)	2	4	8	16	32	64	128
Thickness (0.001 cm sheet)	0.002 cm	0.004 cm	0.008 cm	0.016 cm	0.032 cm	0.064 cm	0.128 cm

An ordinary sheet can be folded about 6–7 times in practice; thinner or larger paper allows a few more, because the thickness doubles with every fold.

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IN-TEXT · P. 19 · T2

Say you can fold a sheet of paper as many times as you wish. What would its thickness be after 30 folds? Make a guess.

Let us find out how thick a sheet of paper will be after 46 folds. Assume that the thickness of the sheet is 0.001 cm.

ANSWER

Most people guess a few metres, but the thickness doubles at every fold. Starting with 0.001 cm, the thickness after n folds is 0.001×2^n cm.

After 10 folds: $0.001 \times 2^{10} = 0.001 \times 1024 = 1.024$ cm
After 20 folds: $0.001 \times 2^{20} = 0.001 \times 1048576 \approx 1049$ cm ≈ 10.5 m
After 30 folds: $0.001 \times 2^{30} = 0.001 \times 1073741824 = 1073741.824$ cm
$= 10737.4$ m ≈ 10.7 km

For 46 folds: $2^{46} = 7,03,68,74,41,77,664$ so the thickness is 0.001×2^{46} cm $\approx 7.04 \times 10^{10}$ cm $\approx$ 7,03,687 km, which is more than 7,00,000 km.

After 30 folds the sheet would be about 10.7 km thick (the height at which planes fly); after 46 folds it would be about 7,03,687 km thick.

IN-TEXT · P. 20 · T3

Now, what do you think the thickness would be after 30 folds? 45 folds? Make a guess.

ANSWER

Use thickness = 0.001×2^n cm.

30 folds: 0.001×2^{30} cm $\approx 10.7 \times 10^5$ cm ≈ 10.7 km
45 folds: 0.001×2^{45} cm $= 0.001 \times 3,51,84,37,20,88,832$ cm $\approx 3.52 \times 10^{10}$ cm
$= 3,51,844$ km (approximately)

The Moon is about 3,84,400 km away. After 45 folds the paper would already be about 3.5 lakh km thick, almost the distance to the Moon, and the 46th fold doubles this to about 7 lakh km, which is beyond the Moon.

30 folds ≈ 10.7 km; 45 folds ≈ 3,51,844 km (nearly the Earth–Moon distance).

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IN-TEXT · P. 20 · T4

Fill the table below.

ANSWER

Folds 18–20 and 27 are already given in the book; folds 21–26, 28–30 and 31–45 are to be filled. The thickness after n folds is 0.001×2^n cm; equivalently, each fold doubles the thickness of the previous row. The entries below are computed this way and converted to metres (1 m = 100 cm) or kilometres (1 km = 1,00,000 cm).

Fold	Thickness	Fold	Thickness	Fold	Thickness
18	≈ 262 cm	28	≈ 2.68 km	38	≈ 2,749 km
19	≈ 524 cm	29	≈ 5.37 km	39	≈ 5,498 km
20	≈ 10.5 m	30	≈ 10.74 km	40	≈ 10,995 km
21	≈ 21.0 m	31	≈ 21.47 km	41	≈ 21,990 km
22	≈ 41.9 m	32	≈ 42.95 km	42	≈ 43,980 km
23	≈ 83.9 m	33	≈ 85.90 km	43	≈ 87,961 km
24	≈ 167.8 m	34	≈ 171.80 km	44	≈ 1,75,922 km
25	≈ 335.5 m	35	≈ 343.60 km	45	≈ 3,51,844 km
26	≈ 671 m	36	≈ 687.19 km	46	≈ 7,03,687 km
27	≈ 1.34 km	37	≈ 1,374 km		

Check against the book: fold 26 ≈ 671 m (the book says approximately 670 m; the Burj Khalifa is 830 m tall), fold 30 ≈ 10.7 km, and fold 40 ≈ 10,995 km. Fold 46 is included to show that it crosses 7,00,000 km.

Thickness after n folds = 0.001×2^n cm; it doubles every time (see the filled table).

IN-TEXT · P. 21 · T5

Notice the change in thickness after two folds. By how much does it increase?

ANSWER

Compare two entries that are 2 folds apart, for example fold 4 and fold 6:

Fold 4: 0.016 cm Fold 6: 0.064 cm

$0.064 \div 0.016 = 4$

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Each fold multiplies the thickness by 2, so two folds multiply it by $2 \times 2 = 2^2 = 4$. The same happens for any two folds (fold 9 → fold 11: 0.512 cm → 2.048 cm, and $2.048 \div 0.512 = 4$).

After any two folds the thickness increases 4 times (= 2 × 2).

IN-TEXT · P. 21 · T6

After any 3 folds, the thickness increases 8 times (= 2 × 2 × 2). Check if that is true.

ANSWER

Pick entries from the table that are 3 folds apart:

From fold	To fold	Thickness	Ratio
4	7	0.016 cm → 0.128 cm	$0.128 \div 0.016 = 8$
9	12	0.512 cm → 4.096 cm	$4.096 \div 0.512 = 8$
10	13	1.024 cm → 8.192 cm	$8.192 \div 1.024 = 8$

In general three folds multiply the thickness by $2 \times 2 \times 2 = 2^3 = 8$, and ten folds by $2^{10} = 1024$.

Yes, it is true: after any 3 folds the thickness becomes 8 times as much.

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2.2

CLASS 8 MATHS · GANITA PRAKASH · CHAPTER 2

In-Text Questions

Section 2.2 · Exponential Notation and Operations · 25 questions

IN-TEXT · P. 22 · T1

Which expression describes the thickness of a sheet of paper after it is folded 10 times? The initial thickness is represented by the letter-number *v*.

(i) $10v$ **(ii) $10 + v$** **(iii) $2 \times 10 \times v$**

(iv) 2^{10} **(v) $2^{10}v$** **(vi) 10^2v**

ANSWER

Each fold doubles the thickness, so after 10 folds the initial thickness v has been multiplied by 2 ten times:

$$v \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = v \times 2^{10} = 2^{10}v$$

Option (iv) 2^{10} forgets the initial thickness v; (i), (ii), (iii) and (vi) do not multiply by 2 ten times (for example $10 + v$ would only add 10).

(v) $2^{10}v$

IN-TEXT · P. 22 · T2

Express the number 32400 as a product of its prime factors and represent the prime factors in their exponential form.

ANSWER

Divide 32400 repeatedly by prime numbers:

$32400 \div 2 = 16200;\ 16200 \div 2 = 8100;\ 8100 \div 2 = 4050;\ 4050 \div 2 = 2025$

$2025 \div 5 = 405;\ 405 \div 5 = 81$

$81 \div 3 = 27;\ 27 \div 3 = 9;\ 9 \div 3 = 3;\ 3 \div 3 = 1$

$$32400 = 2 \times 2 \times 2 \times 2 \times 5 \times 5 \times 3 \times 3 \times 3 \times 3 = 2^4 \times 5^2 \times 3^4$$

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Check: $2^4 \times 5^2 \times 3^4 = 16 \times 25 \times 81 = 400 \times 81 = 32400$.

$32400 = 2^4 \times 5^2 \times 3^4$

IN-TEXT · P. 22 · T3

What is $(-1)^5$? Is it positive or negative? What about $(-1)^{56}$?

ANSWER

Multiplying two negative numbers gives a positive number, so $(-1) \times (-1) = 1$. Pair up the factors:

$(-1)^5 = [(-1) \times (-1)] \times [(-1) \times (-1)] \times (-1) = 1 \times 1 \times (-1) = -1$

$(-1)^{56} = 28$ pairs of $[(-1) \times (-1)] = 1 \times 1 \times \ldots \times 1$ (28 times) $= 1$

An odd number of negative factors gives a negative result, and an even number of negative factors gives a positive result.

$(-1)^5 = -1$ (negative); $(-1)^{56} = 1$ (positive).

IN-TEXT · P. 22 · T4

Is $(-2)^4 = 16$? Verify.

ANSWER

$(-2)^4 = (-2) \times (-2) \times (-2) \times (-2)$

$= [(-2) \times (-2)] \times [(-2) \times (-2)] = 4 \times 4 = 16$

The exponent 4 is even, so the four negative signs cancel in pairs. Note that $2^4 = 16$ as well.

Yes, $(-2)^4 = 16$.

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IN-TEXT · P. 22 · T5

What is 0^2, 0^5? What is 0^n?

ANSWER

$0^2 = 0 \times 0 = 0$

$0^5 = 0 \times 0 \times 0 \times 0 \times 0 = 0$

In 0^n (n a counting number) zero is multiplied by itself n times; any product with a factor 0 is 0.

$0^2 = 0$, $0^5 = 0$ and $0^n = 0$ for every counting number n.

IN-TEXT · P. 23 · T6

Three daughters with curious eyes, / Each got three baskets — a kingly prize. / Each basket had three silver keys, / Each opens three big rooms with ease. / Each room had tables — one, two, three, / With three bright necklaces on each, you see. / Each necklace had three diamonds so fine… / Can you count these stones that shine?

Hint: Find out the number of baskets and rooms.

How many rooms were there altogether?

ANSWER

At every stage the number is multiplied by 3, so we keep multiplying by 3:

Stage	Working	Number	As a power of 3
Daughters	3	3	3^1
Baskets	3 × 3	9	3^2
Keys	9 × 3	27	3^3
Rooms	27 × 3	81	3^4

Hint answer: there are 9 baskets (3^2) and 81 rooms (3^4).

There were $3^4 = 81$ rooms altogether.

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IN-TEXT · P. 23 · T7

How many diamonds were there in total? Can we find out by just one multiplication using the products above?

ANSWER

Continue the table: each room has 3 tables, each table has 3 necklaces and each necklace has 3 diamonds.

Stage	Working	Number	As a power of 3
Rooms	3^4	81	3^4
Tables	81×3	243	3^5
Necklaces	243×3	729	3^6
Diamonds	729×3	2187	3^7

By one multiplication: the number of diamonds is $3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^7$. Using the earlier products, $3^7 = 3^4 \times 3^3 = 81 \times 27 = 2187$.

There were $3^7 = 2187$ diamonds, and $3^4 \times 3^3 = 81 \times 27 = 2187$ gives it in a single multiplication.

IN-TEXT · P. 24 · T8

3^7 can also be written as $3^2 \times 3^5$. Can you reason out why?

ANSWER

$$3^7 = 3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3$$
$$= (3 \times 3) \times (3 \times 3 \times 3 \times 3 \times 3)$$
$$= 3^2 \times 3^5$$

The 7 factors of 3 can be grouped as 2 factors and 5 factors ($2 + 5 = 7$). Check: $3^2 \times 3^5 = 9 \times 243 = 2187 = 3^7$.

$3^7 = 3^2 \times 3^5$ because $2 + 5 = 7$ factors of 3 are multiplied.

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IN-TEXT · P. 24 · T9

Write the product $p^4 \times p^6$ in exponential form.

ANSWER

$p^4 \times p^6 = (p \times p \times p \times p) \times (p \times p \times p \times p \times p \times p)$
$= p$ multiplied $4 + 6 = 10$ times $= p^{10}$

This is the general rule $n^a \times n^b = n^{a+b}$, where a and b are counting numbers.

$p^4 \times p^6 = p^{10}$

IN-TEXT · P. 24 · T10

Use this observation to compute the following.

(i) 2^9 **(ii) 5^7** **(iii) 4^6**

ANSWER

Split each exponent into two smaller ones, use $n^a \times n^b = n^{a+b}$, and multiply the smaller powers.

(i) **2^9**

$2^9 = 2^4 \times 2^5 = 16 \times 32 = 512$

(ii) **5^7**

$5^7 = 5^3 \times 5^4 = 125 \times 625 = 78125$

(iii) **4^6**

$4^6 = 4^3 \times 4^3 = 64 \times 64 = 4096$

Other splits give the same values, e.g. $4^6 = 4^2 \times 4^2 \times 4^2 = 16 \times 16 \times 16 = 4096$.

(i) $2^9 = 512$ (ii) $5^7 = 78125$ (iii) $4^6 = 4096$

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IN-TEXT · P. 24 · T11

Is 2^{10} also equal to $(2^5)^2$? Write it as a product.

ANSWER

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

Check with numbers: $2^5 = 32$ and $32^2 = 1024 = 2^{10}$.

Yes, $2^{10} = 2^5 \times 2^5 = (2^5)^2$.

IN-TEXT · P. 24 · T12

Write the following expressions as a power of a power in at least two different ways:

(i) 8^6 **(ii) 7^{15}** **(iii) 9^{14}** **(iv) 5^8**

ANSWER

Use $(n^a)^b = (n^b)^a = n^{ab}$: split the exponent into a product of two numbers.

(i) $8^6 = (8^2)^3 = (8^3)^2$; also $8^6 = (2^3)^6 = 2^{18}$
(ii) $7^{15} = (7^3)^5 = (7^5)^3$
(iii) $9^{14} = (9^2)^7 = (9^7)^2$; also $9^{14} = (3^2)^{14} = 3^{28}$
(iv) $5^8 = (5^2)^4 = (5^4)^2$

In each case the product of the two exponents equals the original exponent: $2 \times 3 = 6$, $3 \times 5 = 15$, $2 \times 7 = 14$ and $2 \times 4 = 8$.

(i) $(8^2)^3$, $(8^3)^2$ (ii) $(7^3)^5$, $(7^5)^3$ (iii) $(9^2)^7$, $(9^7)^2$ (iv) $(5^2)^4$, $(5^4)^2$

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IN-TEXT · P. 25 · T13

In the middle of a beautiful, magical pond lies a bright pink lotus. The number of lotuses doubles every day in this pond. After 30 days, the pond is completely covered with lotuses. On which day was the pond half full?

If the pond is completely covered by lotuses on the 30th day, how much of it is covered by lotuses on the 29th day?

ANSWER

The number of lotuses doubles every day. So the number on any day is double the number on the previous day, and the number on the previous day is **half** of the number on that day.

Day 30: pond completely covered (full)
Day 29: half of the lotuses on day 30 → pond half covered

The pond was half full on the 29th day, and on the 29th day half (1/2) of the pond is covered.

IN-TEXT · P. 25 · T14

Write the number of lotuses (in exponential form) when the pond was —

(i) fully covered (ii) half covered

ANSWER

Start with 1 lotus. After each day the number is multiplied by 2, so after d days there are 2^d lotuses.

(i) Fully covered (day 30): 2^{30} lotuses
(ii) Half covered (day 29): 2^{29} lotuses

Check: $2^{30} = 2 \times 2^{29}$, i.e. the full pond has double the lotuses of the half-covered pond.

(i) 2^{30} (ii) 2^{29}

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IN-TEXT · P. 25 · T15

There is another pond in which the number of lotuses triples every day. When both the ponds had no flowers, Damayanti placed a lotus in the doubling pond. After 4 days, she took all the lotuses from there and put them in the tripling pond. How many lotuses will be in the tripling pond after 4 more days?

ANSWER

After 4 days in the doubling pond: $1 \times 2 \times 2 \times 2 \times 2 = 2^4 = 16$ lotuses

After 4 more days in the tripling pond: $2^4 \times 3 \times 3 \times 3 \times 3 = 2^4 \times 3^4$

$= 16 \times 81 = 1296$

There will be $2^4 \times 3^4 = 1296$ lotuses.

IN-TEXT · P. 25 · T16

What if Damayanti had changed the order in which she placed the flowers in the lakes? How many lotuses would there be?

ANSWER

Now the lotus first grows 4 days in the tripling pond and is then moved to the doubling pond for 4 days:

$1 \times 3^4 \times 2^4 = (3 \times 3 \times 3 \times 3) \times (2 \times 2 \times 2 \times 2) = 81 \times 16 = 1296$

Multiplication can be done in any order, so $3^4 \times 2^4 = 2^4 \times 3^4$.

The number of lotuses is the same: $3^4 \times 2^4 = 1296$.

IN-TEXT · P. 25 · T17

Can this product be expressed as an exponent m^n, where m and n are some counting numbers?

ANSWER

The product is $3^4 \times 2^4$. Both factors have the same exponent 4, so regroup the eight factors in pairs:

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$(3 \times 3 \times 3 \times 3) \times (2 \times 2 \times 2 \times 2) = (3 \times 2) \times (3 \times 2) \times (3 \times 2) \times (3 \times 2)$
$= (3 \times 2)^4 = 6^4$

In general $m^a \times n^a = (mn)^a$, where a is a counting number. Check: $6^4 = 1296$.

Yes, $3^4 \times 2^4 = 6^4$ (here $m = 6$, $n = 4$).

IN-TEXT · P. 25 · T18

Use this observation to compute the value of $2^5 \times 5^5$.

ANSWER

$2^5 \times 5^5 = (2 \times 5)^5 = 10^5 = 1{,}00{,}000$

Check: $2^5 \times 5^5 = 32 \times 3125 = 1{,}00{,}000$.

$2^5 \times 5^5 = 10^5 = 1{,}00{,}000$

IN-TEXT · P. 25 · T19

Simplify $10^4/5^4$ and write it in exponential form.

ANSWER

Both numerator and denominator have the same exponent, so use $m^a/n^a = (m/n)^a$:

$10^4/5^4 = (10/5)^4 = 2^4 = 16$

Check: $10^4 = 10000$, $5^4 = 625$ and $10000 \div 625 = 16$.

$10^4/5^4 = 2^4 = 16$

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IN-TEXT · P. 26 · T20

Estu has 4 dresses and 3 caps. How many different ways can Estu combine the dresses and caps?

ANSWER

Each cap can be worn with any of the 4 dresses, so 3 caps give 4 + 4 + 4 = 4 × 3 combinations. Looking at it the other way, each dress can be worn with any of the 3 caps: 3 + 3 + 3 + 3 = 3 × 4.

$4 \times 3 = 12$

Estu can combine the dresses and caps in 4 × 3 = 12 different ways.

IN-TEXT · P. 26 · T21

Roxie has 7 dresses, 2 hats, and 3 pairs of shoes. How many different ways can Roxie dress up?

Hint: Try drawing a diagram like the one above.

ANSWER

Choose a dress, then a hat, then a pair of shoes; every choice can be combined with every choice of the others.

Dress + hat: $7 \times 2 = 14$ combinations

Each of these 14 can be worn with any of the 3 pairs of shoes: $14 \times 3 = 42$

Roxie can dress up in 7 × 2 × 3 = 42 different ways.

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IN-TEXT · P. 26 · T22

Estu and Roxie came across a safe containing old stamps and coins that their great-grandfather had collected. It was secured with a 5-digit password. Since nobody knew the password, they had no option except to try every password until it opened. They were unlucky and the lock only opened with the last password, after they had tried all possible combinations. How many passwords did they end up checking?

ANSWER

Try a simpler version first, as the book suggests. Each digit has 10 options (0 to 9).

Lock	Working	Passwords
1-digit	10	10
2-digit	10 × 10	100
3-digit	100 × 10	1000
4-digit	1000 × 10	10,000
5-digit	10,000 × 10 = 10^5	1,00,000

The passwords run from 00000 to 99999, and since the lock opened only with the last one, all of them were tried.

They checked 10 × 10 × 10 × 10 × 10 = 10^5 = 1,00,000 passwords.

IN-TEXT · P. 27 · T23

How many 5-digit passwords are possible?

ANSWER

Each of the 5 digits has 10 choices, and the choices are independent:

$$10 \times 10 \times 10 \times 10 \times 10 = 10^5 = 1,00,000$$

This is the same as writing all the numbers 00000, 00001, ..., 99999 using 5 digits.

1,00,000 (= 10^5) different 5-digit passwords are possible.

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IN-TEXT · P. 27 · T24

Estu says, “Next time, I will buy a lock that has 6 slots with the letters A to Z. I feel it is safer.”

How many passwords are possible with such a lock?

ANSWER

Each of the 6 slots can show any of the 26 letters A to Z:

$$26 \times 26 \times 26 \times 26 \times 26 \times 26 = 26^6$$

$26^2 = 676$; $26^3 = 17{,}576$; $26^4 = 4{,}56{,}976$; $26^5 = 1{,}18{,}81{,}376$

$26^6 = 1{,}18{,}81{,}376 \times 26 = 30{,}89{,}15{,}776$

This is about 3,089 times as many as the 1,00,000 passwords of the 5-digit lock, so Estu’s lock is indeed much harder to open by trial.

$26^6 = 30{,}89{,}15{,}776$ passwords (about 3.09×10^8) are possible.

IN-TEXT · P. 27 · T25

Think about how many combinations are possible in different contexts. Some examples are —

(i) Pincodes of places in India — The Pincode of Vidisha in Madhya Pradesh is 464001. The Pincode of Zemabawk in Mizoram is 796017.

(ii) Mobile numbers.

(iii) Vehicle registration numbers.

Try to find out how these numbers or codes are allotted/generated.

ANSWER

This is an exploration question; the answers below describe the usual structure of each code and use the multiplication principle to count the possibilities.

(i) Pincodes

A Pincode has 6 digits, so at most $10^6 = 10{,}00{,}000$ strings are possible (9×10^5 if the first digit cannot be 0). The digits are not random: the **first digit** stands for a postal zone, the **first two digits** for a sub-zone (postal circle), the **first three digits** for a sorting district, and the **last three digits** for a particular post office. In 464001, 4 is the zone, 46 the sub-zone, 464 the sorting district and 001 the post office; 796017 is read the same way.

(ii) Mobile numbers

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Mobile numbers in India have 10 digits and begin with 6, 7, 8 or 9. By the multiplication principle there can be $4 \times 10^9 = 400$ crore such numbers (first digit: 4 choices; each of the other 9 digits: 10 choices). They are allotted to telecom operators in blocks (series).

(iii) Vehicle registration numbers

A typical number has the form **XX 00 YY 0000**: two letters for the State/UT, two digits for the registering office (RTO) district, one to three letters for the series and a 4-digit running number (0001 to 9999). For one office and one 2-letter series the count is $26 \times 26 \times 9999 = 67{,}59{,}324 \approx 6.8 \times 10^6$ numbers. When a series is used up, the next series of letters is started.

> **Each code is built from separate parts (zone, district, series, serial number); multiplying the number of choices for each part gives the number of possible codes.**

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2.3

CLASS 8 MATHS · GANITA PRAKASH · CHAPTER 2

In-Text Questions

Section 2.3 · The Other Side of Powers · 10 questions

IN-TEXT · P. 27 · T1

What is $2^{100} \div 2^{25}$ in powers of 2?

ANSWER

Use $n^a \div n^b = n^{a-b}$ ($n \neq 0$, $a > b$):

$$2^{100} \div 2^{25} = 2^{100-25} = 2^{75}$$

$2^{100} \div 2^{25} = 2^{75}$

IN-TEXT · P. 28 · T2

Why can't *n* be 0?

ANSWER

In $n^a \div n^b$ the divisor is n^b. If $n = 0$, then $0^b = 0$ and we would have to divide by 0, which is not defined. For example $0^4 \div 0^3 = 0 \div 0$ has no meaning, so the rule $0^{4-3} = 0^1$ cannot be applied.

***n* cannot be 0 because the division would be by $0^b = 0$, and division by zero is not defined.**

IN-TEXT · P. 28 · T3

We have not covered the case when the exponent is 0; for example, what is 2^0?

ANSWER

Define 2^0 so that the rule $n^a \div n^b = n^{a-b}$ still works. Take $a = b = 4$:

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$2^0 = 2^{4-4} = 2^4 \div 2^4 = (2 \times 2 \times 2 \times 2) \div (2 \times 2 \times 2 \times 2) = 1$

The same happens for any exponent a: $2^0 = 2^{a-a} = 2^a \div 2^a = 1$. In general $x^0 = 1$ for $x \neq 0$.

$2^0 = 1$

IN-TEXT · P. 29 · T4

Can we write $10^3 = 1/10^{-3}$?

ANSWER

$1/10^{-3} = 1 \div (1/10^3) = 1 \times 10^3 = 10^3$

because $10^{-3} = 1/10^3$, and dividing 1 by a fraction means multiplying by its reciprocal. Similarly $7^2 = 1/7^{-2}$ and $4^a = 1/4^{-a}$.

Yes, $10^3 = 1/10^{-3}$.

IN-TEXT · P. 29 · T5

We had required *a* and *b* to be counting numbers. Can *a* and *b* be any integers? Will the generalised forms still hold true?

ANSWER

Test the three rules with negative and zero exponents:

$n^a \times n^b$: $5^{-2} \times 5^7 = (1/25) \times 78125 = 3125 = 5^5 = 5^{-2+7}$

$(n^a)^b$: $(2^{-3})^2 = (1/8)^2 = 1/64 = 2^{-6} = 2^{(-3)\times 2}$

$n^a \div n^b$: $3^2 \div 3^5 = 9/243 = 1/27 = 3^{-3} = 3^{2-5}$

The meaning $n^{-a} = 1/n^a$ and $n^0 = 1$ was chosen precisely so that the rules continue to hold (for $n \neq 0$).

Yes, *a* and *b* can be any integers (with $n \neq 0$) and the three rules still hold.

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IN-TEXT · P. 29 · T6

Write equivalent forms of the following.

(i) 2^{-4} **(ii) 10^{-5}** **(iii) $(-7)^{-2}$**

(iv) $(-5)^{-3}$ **(v) 10^{-100}**

ANSWER

Use $n^{-a} = 1/n^a$.

(i) $2^{-4} = 1/2^4 = 1/16$

(ii) $10^{-5} = 1/10^5 = 1/1{,}00{,}000 = 0.00001$

(iii) $(-7)^{-2} = 1/(-7)^2 = 1/49$

(iv) $(-5)^{-3} = 1/(-5)^3 = 1/(-125) = -1/125$

(v) $10^{-100} = 1/10^{100}$

(i) $1/2^4$ (ii) $1/10^5$ (iii) $1/(-7)^2$ (iv) $1/(-5)^3$ (v) $1/10^{100}$

IN-TEXT · P. 29 · T7

Simplify and write the answers in exponential form.

(i) $2^{-4} \times 2^7$ **(ii) $3^2 \times 3^{-5} \times 3^6$** **(iii) $p^3 \times p^{-10}$**

(iv) $2^4 \times (-4)^{-2}$ **(v) $8^p \times 8^q$**

ANSWER

(i) $2^{-4} \times 2^7 = 2^{-4+7} = 2^3$

(ii) $3^2 \times 3^{-5} \times 3^6 = 3^{2-5+6} = 3^3$

(iii) $p^3 \times p^{-10} = p^{3-10} = p^{-7}$

(iv) $2^4 \times (-4)^{-2} = 2^4 \times 1/(-4)^2 = 2^4 \times 1/16 = 16 \times 1/16 = 1$

or: $(-4)^2 = 4^2 = 2^4$, so $2^4 \times 2^{-4} = 2^0 = 1$

(v) $8^p \times 8^q = 8^{p+q}$

(i) 2^3 (ii) 3^3 (iii) p^{-7} (iv) $1\ (= 2^0)$ (v) 8^{p+q}

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IN-TEXT · P. 30 · T8

Can we say that 16384 (4^7) is 16 (4^2) times larger than 1,024 (4^5)?

ANSWER

$4^7 \div 4^5 = 4^{7-5} = 4^2 = 16$

$16384 \div 1024 = 16$

Yes, since $4^7 \div 4^5 = 4^2 = 16$.

IN-TEXT · P. 30 · T9

How many times larger than 4^{-2} is 4^2?

ANSWER

Divide the larger by the smaller:

$4^2 \div 4^{-2} = 4^{2-(-2)} = 4^4 = 256$

Check: $16 \div (1/16) = 16 \times 16 = 256$

4^2 is $4^4 = 256$ times larger than 4^{-2}.

IN-TEXT · P. 30 · T10

Use the power line for 7 to answer the following questions.

2,401 × 49 =

343 × 2,401 =

7/343 =

1,17,649 × 1/343 =

49^3 =

16,807/49 =

16,807/8,23,543 =

1/343 × 1/343 =

ANSWER

Power line of 7: $7^{-4} = 1/2401$, $7^{-3} = 1/343$, $7^{-2} = 1/49$, $7^{-1} = 1/7$, $7^0 = 1$, $7^1 = 7$, $7^2 = 49$, $7^3 = 343$, $7^4 = 2401$, $7^5 = 16807$, $7^6 = 1,17,649$, $7^7 = 8,23,543$.

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Expression	In powers of 7	Value
2,401 × 49	$7^4 \times 7^2 = 7^6$	1,17,649
49^3	$(7^2)^3 = 7^6$	1,17,649
343 × 2,401	$7^3 \times 7^4 = 7^7$	8,23,543
16,807/49	$7^5 \div 7^2 = 7^3$	343
7/343	$7^1 \div 7^3 = 7^{-2}$	1/49
16,807/8,23,543	$7^5 \div 7^7 = 7^{-2}$	1/49
1,17,649 × 1/343	$7^6 \times 7^{-3} = 7^3$	343
1/343 × 1/343	$7^{-3} \times 7^{-3} = 7^{-6}$	1/1,17,649

$2,401 \times 49 = 7^6$; $49^3 = 7^6$; $343 \times 2,401 = 7^7$; $16,807/49 = 7^3$; $7/343 = 7^{-2}$; $16,807/8,23,543 = 7^{-2}$; $1,17,649 \times 1/343 = 7^3$; $1/343 \times 1/343 = 7^{-6}$

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2.4

CLASS 8 MATHS · GANITA PRAKASH · CHAPTER 2

In-Text Questions

Section 2.4 · Powers of 10 (incl. Scientific Notation) · 6 questions

IN-TEXT · P. 30 · T1

Write these numbers in the same way: (i) 172, (ii) 5642, (iii) 6374.

ANSWER

Write each digit with its place value as a power of 10 (units = 10^0, tens = 10^1, hundreds = 10^2, thousands = 10^3).

(i) $172 = (1 \times 10^2) + (7 \times 10^1) + (2 \times 10^0)$

(ii) $5642 = (5 \times 10^3) + (6 \times 10^2) + (4 \times 10^1) + (2 \times 10^0)$

(iii) $6374 = (6 \times 10^3) + (3 \times 10^2) + (7 \times 10^1) + (4 \times 10^0)$

Each number is written as a sum of digit × power of 10 as shown above.

IN-TEXT · P. 30 · T2

How can we write 561.903?

ANSWER

The digits after the decimal point have place values 1/10, 1/100, 1/1000, i.e. 10^{-1}, 10^{-2}, 10^{-3}:

$561.903 = (5 \times 100) + (6 \times 10) + 1 + (9 \times 1/10) + (0 \times 1/100) + (3 \times 1/1000)$

$= (5 \times 10^2) + (6 \times 10^1) + (1 \times 10^0) + (9 \times 10^{-1}) + (0 \times 10^{-2}) + (3 \times 10^{-3})$

$561.903 = 5 \times 10^2 + 6 \times 10^1 + 1 \times 10^0 + 9 \times 10^{-1} + 0 \times 10^{-2} + 3 \times 10^{-3}$

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IN-TEXT · P. 31 · T3

Write the large-number facts we read just before in this form.

(i) The Sun is located 30,00,00,00,00,00,00,00,00,000 m from the centre of our Milky Way galaxy.

(ii) The number of stars in our galaxy is 1,00,00,00,00,000.

(iii) The mass of the Earth is 59,76,00,00,00,00,00,00,00,00,00,000 kg.

ANSWER

Write the number as $x \times 10^y$ with $1 \le x < 10$. If the number has d digits, the exponent is $y = d - 1$.

(i) 30,00,00,00,00,00,00,00,00,000 has 21 digits → 3×10^{20} m
(ii) 1,00,00,00,00,000 has 12 digits → 1×10^{11} stars
(iii) 59,76,00,00,00,00,00,00,00,00,00,000 has 25 digits → 5.976×10^{24} kg

(i) 3×10^{20} m (ii) 1×10^{11} (iii) 5.976×10^{24} kg

IN-TEXT · P. 32 · T4

The distance between the Sun and Saturn is 14,33,50,00,00,000 m = 1.4335×10^{12} m. The distance between Saturn and Uranus is 14,39,00,00,00,000 m = 1.439×10^{12} m. The distance between the Sun and Earth is 1,49,60,00,00,000 m = 1.496×10^{11} m.

Can you say which of the three distances is the smallest?

ANSWER

Compare the exponents first: the Sun–Earth distance has exponent 11, the other two have exponent 12. A smaller exponent means a smaller number (it has one digit fewer).

Sun–Earth: 1.496×10^{11} m (12 digits)
Sun–Saturn: 1.4335×10^{12} m (13 digits)
Saturn–Uranus: 1.439×10^{12} m (13 digits)

(For the other two, same exponent, so compare coefficients: 1.4335 < 1.439.)

The Sun–Earth distance, 1.496×10^{11} m, is the smallest (order: Sun–Earth < Sun–Saturn < Saturn–Uranus).

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IN-TEXT · P. 32 · T5

The number line below shows the distance between the Sun and Saturn (1.4335×10^{12} m). On the number line below, mark the relative position of the Earth. The distance between the Sun and the Earth is 1.496×10^{11} m.

ANSWER

Find what fraction of the Sun–Saturn distance the Earth's distance is:

$$(1.496 \times 10^{11}) \div (1.4335 \times 10^{12}) = (1.496 \div 1.4335) \times 10^{-1} \approx 1.044 \times 0.1 \approx 0.104$$

So the Earth is a little more than one-tenth of the way from the Sun to Saturn. Dividing the line into 10 equal parts, mark the Earth just after the first division from the Sun.



Figure: the Earth lies at about 0.104 of the Sun–Saturn distance

Mark the Earth at about 1/10 (≈ 0.104) of the length from the Sun towards Saturn.

IN-TEXT · P. 32 · T6

Express the following numbers in standard form.

(i) 59,853
(ii) 65,950
(iii) 34,30,000
(iv) 70,04,00,00,000

ANSWER

Place the decimal point after the first digit and count how many places it moved; that count is the exponent.

(i) $59{,}853 = 5.9853 \times 10^4$ (5 digits)
(ii) $65{,}950 = 6.595 \times 10^4$ (5 digits)
(iii) $34{,}30{,}000 = 3.43 \times 10^6$ (7 digits)
(iv) $70{,}04{,}00{,}00{,}000 = 7.004 \times 10^{10}$ (11 digits)

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(i) 5.9853×10^4 (ii) 6.595×10^4 (iii) 3.43×10^6 (iv) 7.004×10^{10}

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2.5

CLASS 8 MATHS · GANITA PRAKASH · CHAPTER 2

In-Text Questions

Section 2.5 · Did You Ever Wonder? · 22 questions

IN-TEXT · P. 33 · T1

What would be the worth (in rupees) of the donated jaggery? What would be the worth (in rupees) of the donated wheat?

Make necessary and reasonable assumptions for the unknowns and find the answers. Remember, Roxie is 13 years old and Estu is 11 years old.

ANSWER

Relationships: worth of jaggery = Roxie's weight in kg × cost of 1 kg jaggery; worth of wheat = Estu's weight in kg × cost of 1 kg wheat. The weights and prices are unknown, so we assume them (values may differ from place to place and over time).

Assume Roxie's weight = 45 kg, jaggery = ₹70 per kg

Worth of jaggery = 45 × 70 = ₹3150

Assume Estu's weight = 50 kg, wheat = ₹50 per kg

Worth of wheat = 50 × 50 = ₹2500

With these assumptions: jaggery ≈ ₹3150 and wheat ≈ ₹2500.

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IN-TEXT · P. 33 · T2

Roxie wonders, “Instead of jaggery if we use 1-rupee coins, how many coins are needed to equal my weight?”. How can we find out?

Would the number of coins be in hundreds, thousands, lakhs, crores, or even more? Make an instinctive guess.

Find the answer by making necessary and reasonable assumptions and approximations for the unknowns. Remember, we are not looking for an exact answer but a reasonably close estimate.

ANSWER

Guess: a reasonable instinctive guess is “thousands” or “tens of thousands”.

Relationship: number of coins = Roxie’s weight ÷ weight of one coin (in the same unit).

Assumptions: Roxie weighs 45 kg = 45,000 g; one 1-rupee coin weighs about 4 g (weigh a coin on a kitchen scale to check).

$$\text{Number of coins} \approx 45{,}000 \div 4 = 11{,}250 \approx 1.1 \times 10^4$$

About 11,000 (≈ 1.1×10^4) one-rupee coins are needed — the number is in thousands (about eleven thousand).

IN-TEXT · P. 34 · T3

Estu asks, “What if we use 5-rupee coins or 10-rupee notes instead? How much money could it be?”

Make an instinctive guess first. Then find out (make necessary and reasonable assumptions about the unknown details and find the answers).

ANSWER

Assumptions: weight to be balanced = Roxie’s 45 kg = 45,000 g; a 5-rupee coin ≈ 6 g; a 10-rupee note ≈ 1 g (these can be checked by weighing).

5-rupee coins: $45{,}000 \div 6 = 7{,}500$ coins → $7{,}500 \times ₹5 = ₹37{,}500$

10-rupee notes: $45{,}000 \div 1 = 45{,}000$ notes → $45{,}000 \times ₹10 = ₹4{,}50{,}000$

(1-rupee coins, for comparison: $11{,}250 \times ₹1 = ₹11{,}250$)

Notes are very light for their value, so the same weight in notes is worth far more money than in coins.

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Roughly ₹37,500 in 5-rupee coins and ₹4.5 lakh (4.5×10^5 rupees) in 10-rupee notes.

IN-TEXT · P. 34 · T4

Estu says, "When I become an adult, I would like to donate notebooks worth my weight every year". Roxie says, "When I grow up, I would like to do annadāna (offering grains or meals) worth my weight every year".

How many people might benefit from each of these offerings in a year? Again, guess first before finding out.

ANSWER

Assumptions: an adult weighs about 60 kg = 60,000 g. A notebook weighs about 250 g and a student uses about 6 notebooks in a year. A person is given about 150 g of uncooked grain per meal.

Notebooks: 60,000 ÷ 250 = 240 notebooks

Students supplied for a year: 240 ÷ 6 = 40

Annadāna: 60,000 ÷ 150 = 400 meals → about 400 people for one meal

About 40 students for a whole year ($\approx 4 \times 10^1$) from the notebooks, and about 400 people (4×10^2) for a meal from the annadāna — under these assumptions.

IN-TEXT · P. 34 · T5

Roxie and Estu overheard someone saying — "We did pādayātra for about 400 km to reach this place! We arrived early this morning."

How long ago would they have started their journey?

Find answers by making necessary assumptions and approximations. Do guess first before calculating to check how close your guess was!

ANSWER

Assumptions: pilgrims walk about 4 km per hour for about 8 hours a day.

Distance per day ≈ 4 × 8 = 32 km

Days needed ≈ 400 ÷ 32 = 12.5 days ≈ 13 days

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They would have started about 12–13 days ago (roughly two weeks), with these assumptions.

IN-TEXT · P. 35 · T6

How many times can a person circumnavigate (go around the world) the Earth in their lifetime if they walk non-stop? Consider the distance around the Earth as 40,000 km.

ANSWER

Assumptions: walking speed 5 km/h, non-stop (24 hours a day), for a lifetime of 70 years (365 days a year).

Distance per day = $5 \times 24 = 120$ km

Distance in a year = $120 \times 365 = 43{,}800$ km

Distance in 70 years = $43{,}800 \times 70 = 30{,}66{,}000$ km $\approx 3.07 \times 10^6$ km

Number of rounds = $30{,}66{,}000 \div 40{,}000 \approx 76.7$

About 77 times ($\approx 8 \times 10^1$). With a speed of 4 km/h it would be about 61 times.

IN-TEXT · P. 35 · T7

Roxie tells Estu about a science-fiction novel she is reading where they build a ladder to reach the moon, "... I wonder if we actually had a ladder like that, how many steps would it have?".

What do you think? Make an instinctive guess first.

Would the number of steps be in thousands, lakhs, crores, or even more?

ANSWER

Most guesses are far too small. With a gap of 20 cm between steps and the Moon 3,84,400 km away (next question) the ladder needs 1,92,20,00,000 steps, i.e. 192 crore 20 lakh steps.

The number of steps would be in crores — in fact hundreds of crores ($\approx 1.9 \times 10^9$), which is "even more" than crores.

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IN-TEXT · P. 36 · T8

We have to find out how many 20 cm make 3,84,400 km.

ANSWER

Convert the distance to centimetres (1 km = 1000 m = 1,00,000 cm = 10^5 cm):

$3{,}84{,}400 \text{ km} = 3.844 \times 10^5 \text{ km} = 3.844 \times 10^5 \times 10^5 \text{ cm} = 3.844 \times 10^{10} \text{ cm}$

$\text{Number of steps} = 3.844 \times 10^{10} \div 20 = 1.922 \times 10^9$

$= 1{,}92{,}20{,}00{,}000$

1,92,20,00,000 steps (192 crore 20 lakh = 1 billion 922 million).

IN-TEXT · P. 36 · T9

Can you come up with some examples of linear growth and of exponential growth?

ANSWER

Linear growth adds the same amount each time (additive):

- saving ₹100 every week;
- reading 5 pages every day;
- a ladder rising 20 cm with every step;
- the 5 bottles added every day (EOC Q2).

Exponential growth multiplies by the same factor each time (multiplicative):

- the paper-folding thickness (doubles each fold);
- the lotuses in the magical pond (double each day);
- a message forwarded to 2 new people by each receiver;
- bacteria dividing into two every few minutes.

Linear growth is additive (same amount added each step); exponential growth is multiplicative (same factor each step).

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IN-TEXT · P. 37 · T10

The estimated global population of starlings is around 1.3 arab/1.3 billion (_____).

ANSWER

1.3 arab = 1.3 billion = 1.3 × 1,00,00,00,000 = 1.3×10^9

The blank is 1.3×10^9.

IN-TEXT · P. 38 · T11

With a global human population of about 8×10^9 and about 4×10^5 African elephants, can we say that there are nearly 20,000 people for every African elephant?

ANSWER

People per elephant = $(8 \times 10^9) \div (4 \times 10^5) = (8 \div 4) \times 10^{9-5} = 2 \times 10^4 = 20{,}000$

Yes, there are nearly 20,000 people for every African elephant.

IN-TEXT · P. 38 · T12

The estimated mosquito population worldwide (2023) is 11 neel/110 trillion (_____).

ANSWER

110 trillion = $110 \times 10^{12} = 1.1 \times 10^2 \times 10^{12} = 1.1 \times 10^{14}$

Check: 11 neel = $11 \times 10^{13} = 1.1 \times 10^{14}$

The blank is 1.1×10^{14}.

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IN-TEXT · P. 38 · T13

Calculate and write the answer using scientific notation:

(i) How many ants are there for every human in the world?

(ii) If a flock of starlings contains 10,000 birds, how many flocks could there be in the world?

(iii) If each tree had about 10^4 leaves, find the total number of leaves on all the trees in the world.

(iv) If you stacked sheets of paper on top of each other, how many would you need to reach the Moon?

ANSWER

Data from the chapter: ants 2×10^{16}; humans about 8×10^9; starlings 1.3×10^9; trees 3×10^{12}; Earth–Moon distance 3,84,400 km; sheet thickness 0.001 cm.

(i) Ants per human

$(2 \times 10^{16}) \div (8 \times 10^9) = 0.25 \times 10^7 = 2.5 \times 10^6$

(ii) Flocks of starlings

$(1.3 \times 10^9) \div 10^4 = 1.3 \times 10^5$ flocks

(iii) Leaves on all trees

$(3 \times 10^{12}) \times 10^4 = 3 \times 10^{16}$ leaves

(iv) Sheets of paper to the Moon

3,84,400 km = 3.844×10^{10} cm

Number of sheets = $3.844 \times 10^{10} \div 10^{-3} = 3.844 \times 10^{13}$

(i) 2.5×10^6 ants (ii) 1.3×10^5 flocks (iii) 3×10^{16} leaves (iv) 3.844×10^{13} sheets

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IN-TEXT · P. 39 · T14

“I completed 13 years a few weeks ago!” said Roxie. … “I’m 4840 days old today!” said Roxie. “How old are you?” asked Estu again. “I’m _____ hours old!” said Roxie.

Make an estimate before finding this number.

ANSWER

Estimate: 4840 days is about 5000 days, and 5000 × 24 = 1,20,000, so the answer should be about 1.2 lakh hours.

1 day = 24 hours
4840 × 24 = 1,16,160 hours ≈ 1.16×10^5

Roxie is 1,16,160 hours old (≈ 1.16×10^5 hours).

IN-TEXT · P. 39 · T15

Estu: “I am 4070 days old today. Can you find out my date of birth?”

ANSWER

Count 4070 days back from today. Taking today as **22 November 2026** as an example:

22 Nov 2015 to 22 Nov 2026 = 11 × 365 + 3 leap days (2016, 2020, 2024) = 4018 days
Remaining days: 4070 – 4018 = 52 days
22 Nov 2015 minus 52 days = 1 October 2015

If today is 22 November 2026, Estu was born on 1 October 2015 (about 11 years 1½ months ago). For another date, count back the same 4070 days.

IN-TEXT · P. 39 · T16

I am 69,70,710 … old. What could this number mean? Find out!

ANSWER

Roxie is 4840 days old. Try converting to smaller units:

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In hours: $4840 \times 24 = 1{,}16{,}160$

In minutes: $4840 \times 24 \times 60 = 69{,}69{,}600$

In seconds: $4840 \times 24 \times 3600 = 41{,}81{,}76{,}000$

69,70,710 is very close to the number of minutes: 69,70,710 – 69,69,600 = 1,110 minutes = 18 hours 30 minutes, i.e. Roxie is 4840 days 18 h 30 min old.

The number is Roxie's age in minutes (about 69.7 lakh minutes).

IN-TEXT · P. 39 · T17

If you have lived for a million seconds, how old would you be?

ANSWER

1 day = $24 \times 60 \times 60 = 86{,}400$ seconds

$10^6 \div 86{,}400 \approx 11.57$ days

You would be about 11.6 ≈ 12 days old (less than a fortnight).

IN-TEXT · P. 40 · T18

10^5 seconds ≈ 1.16 days and 10^6 seconds ≈ 11.57 days. Think of some events or phenomena whose time is of the order of (i) 10^5 seconds and (ii) 10^6 seconds. Write them in scientific notation.

ANSWER

Convert familiar durations to seconds (1 day = 86,400 s):

Order	Event	Time in seconds
10^5 s	One full day (Earth's rotation)	8.64×10^4
10^5 s	A two-day weekend	1.728×10^5
10^6 s	A fortnight (14 days)	1.2096×10^6
10^6 s	The Moon's orbit around the Earth (about 27.3 days)	2.36×10^6

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(i) one day ≈ 8.64×10^4 s, a weekend ≈ 1.7×10^5 s (ii) a fortnight ≈ 1.2×10^6 s, the Moon's orbit ≈ 2.4×10^6 s

IN-TEXT · P. 41 · T19

A fossil of Kelenken Guillermoi, a type of terror bird, is dated to 15 million years ago (≈ _____ seconds).

ANSWER

1 year ≈ $365 \times 24 \times 3600$ s ≈ 3.15×10^7 s, and 15 million = 1.5×10^7.

15 million years = $1.5 \times 10^7 \times 3.15 \times 10^7$ s
= 4.725×10^{14} s ≈ 4.7×10^{14} s

≈ 4.7×10^{14} seconds (about 5×10^{14}).

IN-TEXT · P. 42 · T20

Plants on land started 47 crore/470 million years ago (≈ _____ seconds).

ANSWER

470 million = 4.7×10^8 years
$4.7 \times 10^8 \times 3.15 \times 10^7$ s = 14.8×10^{15} s ≈ 1.5×10^{16} s

≈ 1.5×10^{16} seconds.

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IN-TEXT · P. 42 · T21

Calculate and write the answer using scientific notation:

(i) If one star is counted every second, how long would it take to count all the stars in the universe? Answer in terms of the number of seconds using scientific notation.

(ii) If one could drink a glass of water (200 ml) every 10 seconds, how long would it take to finish the entire volume of water on Earth?

ANSWER

Data from the chapter: the universe has about 2×10^{23} stars; the Earth has about 2×10^{25} drops of water at 16 drops per millilitre.

(i) **Counting the stars**

Time = 2×10^{23} stars × 1 second per star = 2×10^{23} seconds

(ii) **Drinking all the water**

Volume = $2 \times 10^{25} \div 16$ ml = 0.125×10^{25} ml = 1.25×10^{24} ml

Glasses of 200 ml = $1.25 \times 10^{24} \div (2 \times 10^{2}) = 6.25 \times 10^{21}$

Time = $6.25 \times 10^{21} \times 10$ s = 6.25×10^{22} seconds

(i) 2×10^{23} seconds (ii) 6.25×10^{22} seconds

IN-TEXT · P. 43 · T22

What does the first part of each name denote?

(million, billion, trillion, quadrillion, quintillion, sextillion, septillion, octillion, nonillion, decillion)

ANSWER

Compare the names with the powers of 10 in the chapter. A million is $1000 \times 1000 = 1000^2$. Each of the others is that many more factors of 1000:

Name	First part	Value	Power of 10
bi-llion	bi = 2	$1000 \times 1000^2 = 1000^3$	10^9
tri-llion	tri = 3	1000^4	10^{12}
quad-rillion	quad = 4	1000^5	10^{15}

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Name	First part	Value	Power of 10
quin-tillion	quin = 5	1000^6	10^{18}
sext-illion	sext = 6	1000^7	10^{21}
sept-illion	sept = 7	1000^8	10^{24}
oct-illion	oct = 8	1000^9	10^{27}
non-illion	non = 9	1000^{10}	10^{30}
dec-illion	dec = 10	1000^{11}	10^{33}

The first part (bi, tri, quad, …) tells how many times 1000 is multiplied to 1000: a name with first part k equals $1000^{k+1} = 10^{3k+3}$.

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PT

CLASS 8 MATHS · GANITA PRAKASH · CHAPTER 2

Puzzle Time

Tremendous in Ten! · 2 questions

IN-TEXT · P. PT · T1

In Round 1, Roxie wrote 10000000000000 and Estu wrote 999999 × 999999. Between these two, Roxie's number is greater. Can you see why?

ANSWER

Roxie's number is 1 followed by 13 zeros, i.e. 10^{13}. For Estu's number, 999999 is less than 10^6 (= 1000000), so:

$$999999 \times 999999 < 10^6 \times 10^6 = (10^6)^2 = 10^{12}$$
$$10^{12} < 10^{13}$$

Exactly, 999999 × 999999 = 999,998,000,001, a 12-digit number, whereas 10^{13} has 14 digits.

Roxie's number 10^{13} is greater, because Estu's number is less than 10^{12}, which is 10 times smaller than 10^{13}.

IN-TEXT · P. PT · T2

In Round 2, Roxie wrote $10^{1000} + 10^{1000} + 10^{1000} + 10^{1000}$ and Estu wrote $(10^{1000000}) \times 9000$. Can you say which is greater?

ANSWER

Roxie: $10^{1000} + 10^{1000} + 10^{1000} + 10^{1000} = 4 \times 10^{1000}$

Estu: $10^{1000000} \times 9000 = 10^{1000000} \times 9 \times 10^3 = 9 \times 10^{1000003}$

Both are in scientific notation, so compare exponents first: 1000003 is far larger than 1000. The exponent matters much more than the coefficients 4 and 9.

Estu's number, 9×10^{1000003}, is greater than Roxie's 4×10^{1000}.

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