# Class 8 Maths Chapter 2 Power Play Ganita Prakash NCERT Solutions

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**Concept-1**

The following table lists the thickness after each fold. Observe that the thickness doubles after each fold.

| Fold | Thickness | Fold | Thickness | Fold | Thickness |
|---|---|---|---|---|---|
| 1 | 0.002 cm | 7 | 0.128 cm | 13 | 8.192 cm |
| 2 | 0.004 cm | 8 | 0.256 cm | 14 | 16.384 cm |
| 3 | 0.008 cm | 9 | 0.512 cm | 15 | 32.768 cm |
| 4 | 0.016 cm | 10 | 1.024 cm | 16 | 65.536 cm |
| 5 | 0.032 cm | 11 | 2.048 cm | 17 | ≈ 131 cm |
| 6 | 0.064 cm | 12 | 4.096 cm | | |

(We use the sign '≈' to indicate 'approximately equal to'.)
After 10 folds, the thickness is just above 1 cm (1.024 cm).

After 17 folds, the thickness is about 131 cm (a little more than 4 feet).

**Concept-2**

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

**Solution:**

I think that the thickness after 30 folds would be 10 km, and after 45 folds it would be 20,000 km.

**Concept-3**

Fill the table below.

| Fold | Thickness | Fold | Thickness | Fold | Thickness |
|---|---|---|---|---|---|
| 18 | ≈ 262 cm | 21 | | 24 | |
| 19 | ≈ 524 cm | 22 | | 25 | |
| 20 | ≈ 10.4 m | 23 | | 26 | |

**Solution:**

| Fold | Thickness | Fold | Thickness | Fold | Thickness |
|---|---|---|---|---|---|
| 18 | ≈ 262 cm | 21 | ≈ 20.8 m | 24 | ≈ 166.4 m |
| 19 | ≈ 524 cm | 22 | ≈ 41.6 m | 25 | ≈ 332.8 m |
| 20 | ≈ 10.4 m | 23 | ≈ 83.2 m | 26 | ≈ 665.6 m |

**Concept-4**

After 26 folds, the thickness is approximately 670 m. Burj Khalifa in Dubai, the tallest building in the world, is 830 m tall.

| Fold | Thickness | Fold | Thickness |
|---|---|---|---|
| 27 | ~ 1.3 m | 29 | |
| 28 | | 30 | |

**Solution:**

| Fold | Thickness | Fold | Thickness |
|---|---|---|---|
| 27 | ≈ 1.3 km | 29 | ≈ 5.2 km |
| 28 | ≈ 2.6 km | 30 | ≈ 10.4 km |

**Concept-5**

After 30 folds, the thickness of the paper is about 10.7 km, the typical height at which planes fly. The deepest point discovered in the oceans is the Mariana Trench, with a depth of 11 km.

| Fold | Thickness | Fold | Thickness | Fold | Thickness |
|---|---|---|---|---|---|
| 31 | | 36 | | 41 | |
| 32 | | 37 | | 42 | |
| 33 | | 38 | | 43 | |
| 34 | | 39 | | 44 | |
| 35 | | 40 | | 45 | |

**Solution:**

| Fold | Thickness | Fold | Thickness | Fold | Thickness |
|---|---|---|---|---|---|
| 31 | ≈ 33.8 km | 36 | ≈ 165.6 km | 41 | ≈ 21,299.2 km |
| 32 | ≈ 67.6 km | 37 | ≈ 211.2 km | 42 | ≈ 42,598.4 km |
| 33 | ≈ 83.2 km | 38 | ≈ 265.5 km | 43 | ≈ 85,196.8 km |
| 34 | ≈ 105.4 km | 39 | ≈ 332.8 km | 44 | ≈ 170,393.6 km |
| 35 | ≈ 132.6 km | 40 | ≈ 415.2 km | 45 | ≈ 340,787.2 km |

**Concept-6**

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 × 10 × v

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

**Solution:**

Initial thickness of sheet = v

Since the thickness of the sheet doubles after every fold.

Therefore, the thickness of a sheet of paper after 10 folds = 2 × 2 × 2 × 2 × 2 × 2 × 2 × 2 × 2 × 2 × v = $2^{10}$v.

Therefore, (v) $2^{10}$v is the correct answer.

**Concept-7**

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

**Solution:**

$(-1)^{odd} = -1$ → Negative

$(-1)^{even} = 1$ → Positive

(i) $(-1)^5$

Since 5 is an odd number, $(-1)^5 = -1$, which is negative.

(ii) $(-1)^{56}$

Since 56 is an even number, $(-1)^{56} = 1$, which is positive.

**Concept-8**

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

**Solution:**

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

$(-2)^4 = \underline{(-2) \times (-2)} \times \underline{(-2) \times (-2)}$

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

$(-2)^4 = 16$.

So yes, $(-2)^4 = 16$ is correct.

**Concept-9**

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

Solution:

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

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

Similarly, $0^n = 0$.

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### Figure it Out

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

**Solution:**

(i) $6 \times 6 \times 6 \times 6 = 6^4$

(ii) $y \times y = y^2$

(iii) $b \times b \times b \times b = b^4$

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

(v) $2 \times 2 \times a \times a = 2^2 \times a^2$.

(vi) $a \times a \times a \times c \times c \times c \times c \times d = a^3 \times c^4 \times d$.

**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

**Solution:**

(i) $648 = 2 \times 2 \times 2 \times 3 \times 3 \times 3 \times 3 = 2^3 \times 3^4$.

(ii) $405 = 3 \times 3 \times 3 \times 3 \times 5 = 3^4 \times 5$.

(iii) $540 = 2 \times 2 \times 3 \times 3 \times 3 \times 5 = 2^2 \times 3^3 \times 5$.

(iv) $3600 = 2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 5 \times 5 = 2^4 \times 3^2 \times 5^2$.

**3.** Write the numerical value of each of the following:

(i) $2 \times 10^3$

(ii) $7^2 \times 2^3$

(iii) $3 \times 4^4$

(iv) $(-3)^2 \times (-5)^2$

(v) $3^2 \times 10^4$

(vi) $(-2)^5 \times (-10)^6$

**Solution:**

(i) $2 \times 10^3$

$= 2 \times (10 \times 10 \times 10)$

$= 2 \times 1000$

$= 2000$.

(ii) $7^2 \times 2^3$

$= (7 \times 7) \times (2 \times 2 \times 2)$

$= 49 \times 8$

$= 392$.

(iii) $3 \times 4^4$

$= 3 \times (4 \times 4 \times 4 \times 4)$

$= 3 \times (16 \times 16)$

$= 3 \times 256$

$= 768$.

(iv) $3^2 \times 10^4$

$= \{(-3) \times (-3)\} \times \{(-5) \times (-5)\}$

$= 9 \times 25$

$= 225$.

(v) $3^2 \times 10^4$

$= (3 \times 3) \times (10 \times 10 \times 10 \times 10)$

$= 9 \times 10000$

$= 90000$.

(vi) $(-2)^5 \times (-10)^6$

$= \{(-2) \times (-2) \times (-2) \times (-2) \times (-2)\} \times \{(-10) \times (-10) \times (-10) \times (-10) \times (-10) \times (-10)\}$

$= \{4 \times 4 \times (-2)\} \times \{100 \times 100 \times 100\}$

$= (-32) \times (1000000)$

$= -32000000$.

**Concept-10**

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

**Solution:**

Yes, $3^7$ can also be written as $3^2 \times 3^5$ because $3^7 = (3 \times 3) \times (3 \times 3 \times 3 \times 3 \times 3)$, which becomes $3^2 \times 3^5$.

**Concept-11**

$n^a \times n^b = n^{(a+b)}$, where a and b are counting numbers.
Use this observation to compute the following.
(i) $2^9$
(ii) $5^7$
(iii) $4^6$
Solution:
(i) $2^9 = (2 \times 2 \times 2) \times (2 \times 2 \times 2) \times (2 \times 2 \times 2) = 2^3 \times 2^3 \times 2^3 = 8 \times 8 \times 8 = 512$.

(ii) $5^7 = (5 \times 5) \times (5 \times 5) \times (5 \times 5) \times 5 = 5^2 \times 5^2 \times 5^2 \times 5 = 25 \times 25 \times 25 \times 5 = 78{,}125$.

(iii) $4^6 = (4 \times 4) \times (4 \times 4) \times (4 \times 4) = 4^2 \times 4^2 \times 4^2 = 16 \times 16 \times 16 = 4096$.

**Concept-12**

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) $5^8$
**Solution:**
(i) $8^6$
Two possible ways:
$8^6 = (8^3)^2$
$8^6 = (8^2)^3$

(ii) $7^{15}$

Two possible ways:

$7^{15} = (7^3)^5$

$7^{15} = (7^5)^3$

(iii) $9^{14}$

Two possible ways:

$9^{14} = (9^2)^7$

$9^{14} = (9^7)^2$

(iv) $5^8$

Two possible ways:

$5^8 = (5^2)^4$

$5^8 = (5^4)^2$

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**Concept-13**

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?

Since the number of lotuses doubles every day, the pond should be half covered on the 29th day.

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

(i) fully covered (ii) half covered

**Solution**

The number of lotuses doubles every day.

On the 30th day, the pond is fully covered.

So, on the 29th day, the pond must be half full.

Number of lotuses:

Day 1 → 1 = $2^0$

Day 2 → $2^1$

Day 3 → $2^2$

Day 4 → $2^3$

.......

Day 29 → $2^{28}$

Day 30 → $2^{29}$

(i) The number of lotuses when the pond was fully covered (Day 30) = $2^{29}$.

(ii) The number of lotuses when the pond was fully covered (Day 29) = $2^{28}$.

**Concept-14**

$m^a \times n^a = (mn)^a$, where a is a counting number.

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

**Solution:**

$2^5 \times 5^5 = (2 \times 5)^5 = (10)^5$.

**Concept-15**

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

**Solution:**

Use the rule:

$$\frac{10^4}{5^4} = \left(\frac{10}{5}\right)^4 = 2^4$$

So, the simplified exponential form is:

$$2^4$$

**Concept-16**

How Many Combinations

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.
**Solution:**
Each outfit includes one dress, one hat, and one pair of shoes.
Dresses: D1, D2, D3, D4, D5, D6, D7
Hats: H1, H2
Shoes: S1, S2, S3
Total combination of outfits = 7 × 2 × 3 = 42

| List of possible outfit combinations | | | |
|---|---|---|---|
| **Dress D1:** | **Dress D2:** | **Dress D3:** | **Dress D4:** |
| 1. D1 – H1 – S1 | 7. D2 – H1 – S1 | 13. D3 – H1 – S1 | 19. D4 – H1 – S1 |
| 2. D1 – H1 – S2 | 8. D2 – H1 – S2 | 14. D3 – H1 – S2 | 20. D4 – H1 – S2 |
| 3. D1 – H1 – S3 | 9. D2 – H1 – S3 | 15. D3 – H1 – S3 | 21. D4 – H1 – S3 |
| 4. D1 – H2 – S1 | 10. D2 – H2 – S1 | 16. D3 – H2 – S1 | 22. D4 – H2 – S1 |
| 5. D1 – H2 – S2 | 11. D2 – H2 – S2 | 17. D3 – H2 – S2 | 23. D4 – H2 – S2 |
| 6. D1 – H2 – S3 | 12. D2 – H2 – S3 | 18. D3 – H2 – S3 | 24. D4 – H2 – S3 |
| **Dress D5:** | **Dress D6:** | **Dress D7:** | |
| 25. D5 – H1 – S1 | 31. D6 – H1 – S1 | 37. D7 – H1 – S1 | |
| 26. D5 – H1 – S2 | 32. D6 – H1 – S2 | 38. D7 – H1 – S2 | |
| 27. D5 – H1 – S3 | 33. D6 – H1 – S3 | 39. D7 – H1 – S3 | |
| 28. D5 – H2 – S1 | 34. D6 – H2 – S1 | 40. D7 – H2 – S1 | |
| 29. D5 – H2 – S2 | 35. D6 – H2 – S2 | 41. D7 – H2 – S2 | |
| 30. D5 – H2 – S3 | 36. D6 – H2 – S3 | 42. D7 – H2 – S3 | |

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### Concept-17

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?

**Solution:**

Choices of letters for each slot = 26.

Total possible password combinations of a lock with 6 slots =

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

### Concept-18

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

**Solution:**

$$2^{100} \div 2^{25} = \frac{2^{100}}{2^{25}} = \frac{2^{25} \times 2^{25} \times 2^{25} \times 2^{25}}{2^{25}} = 2^{25} \times 2^{25} \times 2^{25} = 2^{25+25+25} = 2^{75}.$$

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### Concept-19

Consider the following general forms we have identified.

$n^a \times n^b = n^{a+b}$

$(n^a)^b = (n^b)^a = n^{a \times b}$

$n^a \div n^b = n^{a-b}$

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

**Solution:**

Yes, the generalised forms are valid for all integers a and b, as long as the base n ≠ 0.

For example:

$n^a \times n^{-b} = n^{a+(-b)} = n^{a-b}$

$(n^a)^{-b} = (n^{-b})^a = n^{a \times (-b)}$

$n^{-a} \div n^b = n^{-a-b}$

**Concept-20**

Write equivalent forms of the following.

(i) $2^{-4}$

(ii) $10^{-5}$

(iii) $(-7)^{-2}$

(iv) $(-5)^{-3}$

(v) $10^{-100}$

**Solution:**

(i) $2^{-4} = \frac{1}{2^4}$

(ii) $10^{-5} = \frac{1}{10^5}$

(iii) $(-7)^{-2} = \frac{1}{(-7)^2}$

(iv) $(-5)^{-3} = \frac{1}{(-5)^3}$

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

**Concept-21**

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) $8^p \times 8^q$

**Solution:**

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

(ii) $3^2 \times 3^{-5} \times 3^6 = 3^{2+(-5)+6} = 3^{8+(-5)} = 3^{8-5} = 3^3.$

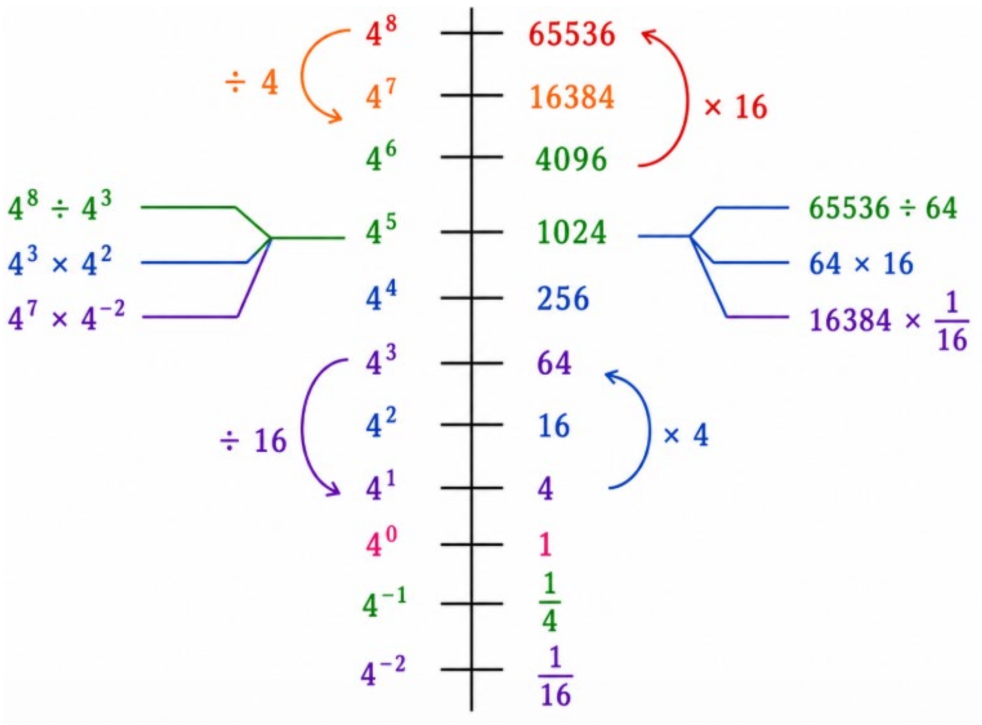
(iii) $p^3 \times p^{-10} = p^{3+(-10)} = p^{3-10} = p^{-7} = \frac{1}{p^7}.$

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

(v) $8^p \times 8^q = (8)^{p+q} = (2 \times 2 \times 2)^{p+q} = (2^3)^{p+q} = 2^{3(p+q)} = (2)^{3p+3q}.$

**Concept-22**

### Power Lines




**Concept-23**

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

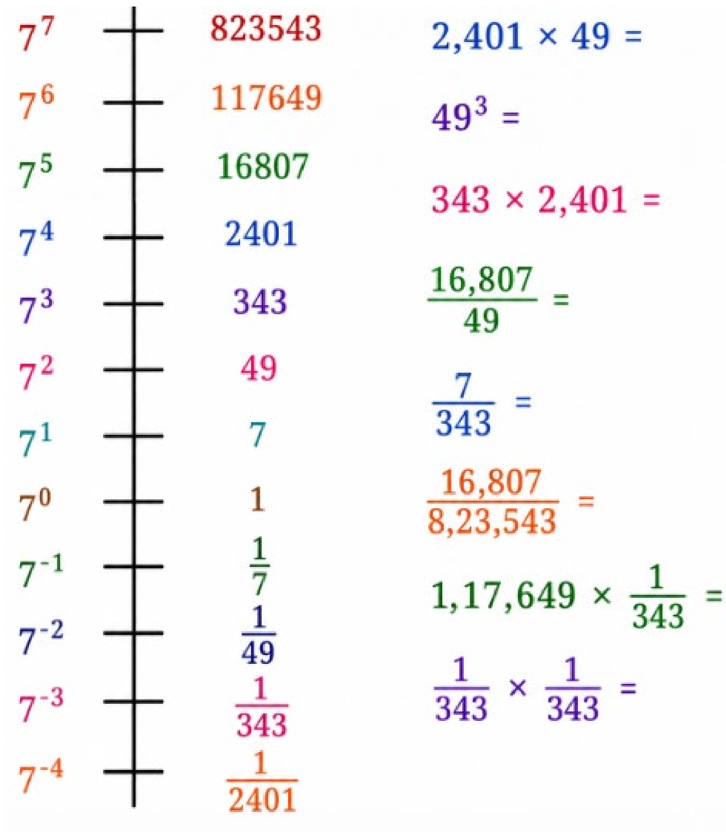
**Solution:**

Since, $4^2 \div 4^{-2} = 4^4$.

Therefore, $4^2$ is 256 ($4^4$) times larger than $4^{-2}$.

**Concept-24**

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




**Solution:**

$$2401 \times 49 = 7^4 \times 7^2 = 7^{4+2} = 7^6.$$
$$49^3 = (7^2)^3 = 7^{2\times 3} = 7^6.$$
$$343 \times 2401 = 7^3 \times 7^4 = 7^{3+4} = 7^7.$$
$$\frac{16,807}{49} = \frac{7^5}{7^2} = 7^{5-2} = 7^3.$$
$$\frac{7}{343} = \frac{7}{7^3} = 7^{1-3} = 7^{-2} = \frac{1}{7^2}.$$
$$\frac{16,807}{8,23,543} = \frac{7^5}{7^7} = 7^{5-7} = 7^{-2} = \frac{1}{7^2}.$$
$$1,17,649 \times \frac{1}{343} = 7^6 \times 7^{-3} = 7^{6-3} = 7^3.$$
$$\frac{1}{343} \times \frac{1}{343} = 7^{-3} \times 7^{-3} = 7^{-3-3} = 7^{-6} = \frac{1}{7^6}.$$

**Concept-25**

**Powers of 10**

We have used numbers like 10, 100, 1000, and so on when writing Indian numerals in an expanded form. For example:

$$47561 = (4 \times 10000) + (7 \times 1000) + (5 \times 100) + (6 \times 10) + 1.$$

This can be written using powers of 10 as

$$47561 = (4 \times 10^4) + (7 \times 10^3) + (5 \times 10^2) + (6 \times 10^1) + (1 \times 10^0).$$

Write these numbers in the same way:

(i) 172, (ii) 5642, (iii) 6374.

**Solution:**

**(i)**

$$\begin{aligned} 172 &= (1 \times 100) + (7 \times 10) + 2 \\ &= (1 \times 10^2) + (7 \times 10^1) + (2 \times 10^0). \end{aligned}$$

**(ii)**

$$\begin{aligned} 5642 &= (5 \times 1000) + (6 \times 100) + (4 \times 10) + 2 \\ &= (5 \times 10^3) + (6 \times 10^2) + (4 \times 10^1) + (2 \times 10^0). \end{aligned}$$

**(iii)**

$$\begin{aligned} 6374 &= (6 \times 1000) + (3 \times 100) + (7 \times 10) + 4 \\ &= (6 \times 10^3) + (3 \times 10^2) + (7 \times 10^1) + (4 \times 10^0). \end{aligned}$$

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

**Concept-26**

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

**Solution:**
Since $10^{11} < 10^{12}$.
Therefore, the distance between the Sun and Earth is the smallest.

**Concept-27**

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


**Solution:**


**Concept-28**

Express the following numbers in standard form.
(i) 59,853
(ii) 65,950
(iii) 34,30,000
(iv) 70,04,00,00,000

**Solution:**

(i) 59,853 = $5.9853 \times 10^4$.

(ii) 65,950 = $6.595 \times 10^4$.

(iii) 34,30,000 = $3.43 \times 10^6$.

(iv) 70,04,00,00,000 = $7.004 \times 10^{10}$.

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**Concept-28**

Continuing this, a thousand trillion is a quadrillion ($10^{15}$). This pattern continues. Observe the names **mi**llion ($10^6$), **bi**llion ($10^9$), **tr**illion ($10^{12}$), **quad**rillion ($10^{15}$), **quin**tillion ($10^{18}$), **sext**illion ($10^{21}$), **sept**illion ($10^{24}$), **oct**illion ($10^{27}$), **non**illion ($10^{30}$), **dec**illion ($10^{33}$). What does the first part of each name denote?

**Solution:**

The first part of each name denotes a Latin or Greek prefix indicating the number of groups of three zeros that follow after the initial 1,000 or $10^3$.

| Name | Power of 10 | | Groups of 3 zeros after $10^3$ |
|---|---|---|---|
| million | $10^6$ | $10^3 \times 10^3$ | 1 |
| billion | $10^9$ | $10^3 \times 10^3 \times 10^3$ | 2 |
| trillion | $10^{12}$ | $10^3 \times 10^3 \times 10^3 \times 10^3$ | 3 |
| quadrillion | $10^{15}$ | $10^3 \times 10^3 \times 10^3 \times 10^3 \times 10^3$ | 4 |
| quintillion | $10^{18}$ | $10^3 \times 10^3 \times 10^3 \times 10^3 \times 10^3 \times 10^3$ | 5 |
| sextillion | $10^{21}$ | $10^3 \times 10^3 \times 10^3 \times 10^3 \times 10^3 \times 10^3 \times 10^3$ | 6 |
| septillion | $10^{24}$ | $10^3 \times 10^3 \times 10^3 \times 10^3 \times 10^3 \times 10^3 \times 10^3 \times 10^3$ | 7 |

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## Figure it Out

**Concept-29**

1. Find out the units digit in the value of $2^{224} \div 4^{32}$ ?

**Solution:**

$2^{224} \div 4^{32}$

$= 2^{224} \div (2^2)^{32}$

$= 2^{224} \div 2^{2 \times 32}$

$= 2^{224} \div 2^{64}$

$= 2^{224 - 64} = 2^{160}$

$2^1 = 2$ (units digit 2)

$2^2 = 4$ (units digit 4)

$2^3 = 8$ (units digit 8)

$2^4 = 16$ (units digit 6)

$2^5 = 32$ (units digit 2)

$2^6 = 64$ (units digit 4)

$2^7 = 128$ (units digit 8)

...........

...........

Here, the pattern repeats after every 4 steps.

So, the unit's digit of $2^{160}$ is the same as that of $2^4$, which is 6.

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?

**Solution:**

Number of containers added every day = 1

Number of containers after 40 days = 40 containers

Number of bottles in a container = 5

Total bottles in 40 containers = 5 × 40 = 200 bottles

Therefore, there would be 200 bottles after 40 days.

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) $32^{-5}$

**Solution:**

(i) $64^3$

$64 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^6$

$64^3 = (2^6)^3 = 2^{18}$

Three different ways:

1. $64^3 = 2^{18} = 2^9 \times 2^9$
2. $64^3 = 2^{18} = 2^{10} \times 2^8$
3. $64^3 = 2^{18} = 2^6 \times 2^6 \times 2^6$

(ii) $192^8$

$192 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 3 = 2^6 \times 3$

$192^8 = (2^6 \times 3)^8 = 2^{6 \times 8} \times 3^8 = 2^{48} \times 3^8$

Three different ways:

1. $192^8 = 2^{48} \times 3^8 = 2^{40} \times 2^8 \times 3^8 = 2^{40} \times (2\times3)^8 = 2^{40} \times 6^8$
2. $192^8 = 2^{48} \times 3^8 = (2^{24}\times3^4)\times(2^{24}\times3^4)$
3. $192^8 = 2^{48} \times 3^8 = (2^6)^8 \times 3^8$

(iii) $32^{-5}$

$32 = 2 \times 2 \times 2 \times 2 \times 2 = 2^5$

$32^{-5} = (2^5)^{-5} = 2^{-25}$

Three different ways:

1. $32^{-5} = 2^{-25} = 2^{-15} \times 2^{-10}$
2. $32^{-5} = 2^{-25} = 2^{-5} \times 2^{-5} \times 2^{-5} \times 2^{-5} \times 2^{-5}$
3. $32^{-5} = 2^{-25} = 2^{-5} \times 2^{-20}$

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) q46 is both a 4th power and a 6th power (*q* is a prime number).

**Solution:**

(i) Only sometimes true.

Explanation: $64 = 2^6 = (2^3)^2 = (2^2)^3$ is both a cube and a square.

But $8 = 2^3$ is a cube, not a square.

(ii) Always true.
Eplanation: $3^4 = (3^2)^2 = 9^2$.
$5^4 = (5^2)^2 = 25^2$.

(iii) Always true.
Explanation: $a^5 = a^3 \times a^2$ and is divisible by $a^3$.

(iv) Always true.
Explanation: $8 = 2^3$, $27 = 3^3$
$8 \times 27 = 216$, which is $6^3$.

(v) Never true.
Explanation: Since 46 is not divisible by 4 or 6. Therefore, there is no prime number q such that $q^{46}$ is both a perfect fourth power and a perfect sixth power.

**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) $m^5n^{12}(mn)^9$
**Solution:**
(i) $10^{-2} \times 10^{-5} = 10^{-2-5} = 10^{-7}$

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

(iii) $9^{-7} \div 9^4 = 9^{-7+4} = 9^{-3}$

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

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

**6.** If $12^2 = 144$ what is
(i) $(1.2)^2$
(ii) $(0.12)^2$
(iii) $(0.012)^2$
(iv) $120^2$
**Solution:**

(i) $(1.2)^2 = \left(\frac{12}{10}\right)^2 = \frac{12^2}{10^2} = \frac{144}{100} = 1.44$

(ii) $(0.12)^2 = \left(\frac{12}{100}\right)^2 = \frac{12^2}{100^2} = \frac{144}{10000} = 0.0144$

(iii) $(0.012)^2 = \left(\frac{12}{1000}\right)^2 = \frac{12^2}{1000^2} = \frac{144}{1000000} = 0.000144$

(iv) $120^2 = 120 \times 120 = 14{,}400$

7. Circle the numbers that are the same —
$2^4 \times 3^6$, $6^4 \times 3^2$, $6^{10}$, $18^2 \times 6^2$, $6^{24}$
**Solution:**
(i) $2^4 \times 3^6$

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

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

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

(v) $6^{24} = (2 \times 3)^{24} = 2^{24} \times 3^{24}$

Therefore, $2^4 \times 3^6$, 64 × 32, and $18^2 \times 6^2$ are the same.

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 $2^{100}$
**Solution:**
(i) $4^3$ or $3^4$
$4^3 = 64$ , $3^4 = 81$
So, $3^4$ is greater.

(ii) $2^8$ or $8^2$
$2^8 = 256$, $8^2 = 64$
So, $2^8$ is greater.

(iii) $100^2$ or $2^{100}$
$100^2 = 10{,}000$
$2^{100} = (2^{10})^{10} = 1024^{10}$, which is far greater than 10,000.
So, $2^{100}$ is greater than $100^2$.

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?
**Solution:**
8.5 billion = 8,500,000,000

| Number of Digits | Max Unique Numbers |
|---|---|
| 1 | 10 (0 to 9) |
| 2 | 10 × 10 = 100 |
| 3 | 10 × 10 × 10 = 1,000 |
| 4 | 10,000 |
| 5 | 100,000 |
| 6 | 1,000,000 |
| 7 | 10,000,000 |
| 8 | 100,000,000 |
| 9 | 1,000,000,000 |
| 10 | 10,000,000,000 |

Therefore, the code should contain at least 10 digits to get a unique ID for each packet.

**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?

**Solution:**

Yes, there are other numbers that are both squares and cubes. For example:

$729 = 9^3$ (cube number) = $27^2$ (perfect square)

$4096 = 16^3$ (cube number) = $64^2$ (perfect square)

General Rule: The sixth power of any number (i.e., $n^6$) is both a square and a cube.

i.e.

$1^6 = 1$

$2^6 = 64$

$3^6 = 729$

$4^6 = 4096$

$5^6 = 15,625$

**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?

**Solution:**

Length of passcode = 5

Total choices of alphabets and letters for each slot = 26 + 10 = 36
Total possible codes = 36 × 36 × 36 × 36 × 36 = $36^5$

**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) $2 \times 10^9$ (vi) $10^9 + 10^9$

**Solution:**
Population of sheep = $10^9$
Population of goats = $10^9$
Total population of sheep and goats = $10^9 + 10^9$ or $2 \times 10^9$
Therefore, (v) $2 \times 10^9$ and (vi) $10^9 + 10^9$ are the correct answers.

**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.

**Solution:**
(i) Estimated world population: ≈ 8 billion = $8 \times 10^9$
Number of pieces of clothing each person had = 30 pieces
Total number of pieces of clothing = $8 \times 10^9 \times 30 = 2.4 \times 10^{11}$

(ii) Number of bee colonies in the world = 100 million = $1 \times 10^8$
Number of bees in each colony = 50,000 = $5 \times 10^4$
Total number of honeybees = $1 \times 10^8 \times 5 \times 10^4 = 5 \times 10^{12}$

(iii) World population ≈ $8 \times 10^9$
Number of bacterial cells in human body = 38 trillion = $3.8 \times 10^{13}$
Total bacterial population residing in all humans in the world = $(3.8 \times 10^{13}) \times (8 \times 10^9)$
$= 30.4 \times 10^{22} = 3.04 \times 10^{23}$

(iv) Average person's lifespan = 80 years
Time spent eating daily = 1.5 hours
Total eating time per day in seconds = 1.5 × 3600 = 5400 seconds
Number of days in 80 years = 80 × 365 = 29,200
Total seconds spent eating in a lifetime in seconds = 5400 × 29,200 = $1.5768 \times 10^8$

**14.** What was the date 1 arab/1 billion seconds ago?

**Solution:**

1 billion seconds = 1,000,000,000 seconds

1,000,000,000 ÷ (60 × 60 × 24 × 365) = 31.71 years

31.71 years = 31 full years and 0.71 × 365 = 259 days

Today is: 28 July 2025

Subtracting 31 years → 28 July 1994

Going back 259 days from 28 July 1994 → 11 November 1993.

So, 1 billion seconds ago was November 11, 1993.