

EXPONENTS AND POWERS

USE OF EXPONENTS IN EXPRESSING LARGE NUMBERS

STANDARD AND USUAL FORMS OF NUMBER

Observe the following facts.

1. The distance from the Earth to the sun is 149,600,000,000 m.
2. The speed of light is 300,000,000 m/sec.
3. Thickness of Class VII Mathematics book is 20 mm.
4. The average diameter of a Red Blood Cell is 0.000007 m.
5. The thickness of human hair is in the range of 0.005 cm to 0.01 cm.
6. The distance of moon from the Earth is 384,467,000 m (approx).
7. The size of a plant cell is 0.00001275 m.
8. Average radius of the Sun is 695000 km.
9. Mass of propellant in a space shuttle solid rocket booster is 503600 kg.
10. Thickness of a piece of paper is 0.0016 cm.
11. Diameter of a wire on a computer chip is 0.000003 m.
12. The height of Mount Everest is 8848 m.

Observe that there are few numbers which we can read like 2 cm, 8848 m, 6,95,000 km.

There are some large numbers like 150,000,000,000 m and some very small numbers like 0.000007 m. Identify very large and very small numbers from the above facts and write them in the adjacent table.

Very large numbers	Very small numbers
150,000,000,000 m	0.000007 m
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for example : $150,000,000,000 = 1.5 \times 10^{11}$ (standard form).

Now, let us try to express 0.000007 m (usual form) in standard form.

$$0.000007 = \frac{7}{1000000} = \frac{7}{10^6} = 7 \times 10^{-6}$$

$$0.000007 \text{ m} = 7 \times 10^{-6} \text{ m}$$

Note : 150000000000 decimal is moved 11 places to the left.
1110987654321

Similarly, consider the thickness of a piece of paper which is 0.0016 cm.

$$0.0016 = \frac{16}{10000} = \frac{1.6 \times 10}{10^4} = 1.6 \times 10 \times 10^{-4}$$

Note : 0.000007 decimal is moved 6 places to the right.
123456

Therefore, we can say thickness of paper is

$$1.6 \times 10^{-3} \text{ cm}$$

Note : 0.0016 decimal is moved 3 places to the right.
123

COMPARE OF NUMBERS

The diameter of the Sun is 1.4×10^9 m and the diameter of the Earth is 1.2756×10^7 m.

Suppose you want to compare the diameter of the Earth, with the diameter of the Sun.

$$\text{Diameter of the Sun} = 1.4 \times 10^9 \text{ m}$$

$$\text{Diameter of the Earth} = 1.2756 \times 10^7 \text{ m}$$

$$\text{Therefore } \frac{1.4 \times 10^9}{1.2756 \times 10^7} = \frac{1.4 \times 10^{9-7}}{1.2756} = \frac{1.4 \times 100}{1.2756}$$

which is approximately 100 So, the diameter of the Sun is about 100 times the diameter of the earth.

Let us compare the size of a Red blood cell which is 0.000007 m to that of a plant cell which is 0.00001275 m.

$$\text{Size of Red Blood cell} = 0.000007 \text{ m} = 7 \times 10^{-6} \text{ m}$$

$$\text{Size of plant cell} = 0.00001275 = 1.275 \times 10^{-5} \text{ m}$$

$$\begin{aligned} \text{Therefore, } \frac{7 \times 10^{-6}}{1.275 \times 10^{-5}} &= \frac{7 \times 10^{-6-(-5)}}{1.275} \\ &= \frac{7 \times 10^{-1}}{1.275} = \frac{0.7}{1.275} = \frac{0.7}{1.3} = \frac{1}{2} \text{ (approx.)} \end{aligned}$$

So a red blood cell is half of plant cell in size.

Mass of earth is 5.97×10^{24} kg and mass of moon is 7.35×10^{22} kg. What is the total mass ?

Note : When we have to add numbers in standard form, we convert them into numbers with the same exponents.

$$\begin{aligned} \text{Total mass} &= 5.97 \times 10^{24} \text{ kg} + 7.35 \times 10^{22} \text{ kg.} \\ &= 5.97 \times 100 \times 10^{22} + 7.35 \times 10^{22} \\ &= 597 \times 10^{22} + 7.35 \times 10^{22} \\ &= (597 + 7.35) \times 10^{22} \\ &= 604.35 \times 10^{22} \text{ kg} \end{aligned}$$

Eg. The distance between Sun and Earth is 1.496×10^{11} m and the distance between Earth and Moon is 3.84×10^8 m.

During solar eclipse moon comes in between Earth and Sun. At that time what is the distance between Moon and Sun.

$$\text{Distance between Sun and Earth} = 1.496 \times 10^{11} \text{ m}$$

$$\text{Distance between Earth and Moon} = 3.84 \times 10^8 \text{ m}$$

Distance between Sun and Moon

$$= 1.496 \times 10^{11} - 3.84 \times 10^8$$

$$= 1.496 \times 1000 \times 10^8 - 3.84 \times 10^8$$

$$= (1496 - 3.84) \times 10^8 \text{ m} = 1492.16 \times 10^8 \text{ m}$$

Ex.1 Express the following numbers in standard form.

(i) 0.000035

(ii) 4050000

Sol. (i) $0.000035 = 3.5 \times 10^{-5}$

(ii) $4050000 = 4.05 \times 10^6$

Ex.2 Express the following numbers in usual form.

(i) 3.52×10^5

(ii) 7.54×10^{-4}

(iii) 3×10^{-5}

Sol. (i) $3.52 \times 10^5 = 3.52 \times 100000 = 352000$

(ii) $7.54 \times 10^{-4} = \frac{7.54}{10^4} = \frac{7.54}{10000} = 0.000754$

(iii) $3 \times 10^{-5} = \frac{3}{10^5} = \frac{3}{100000} = 0.00003$