CLASS 8TH

POWER PLAY

"Explore the Power of Numbers!"

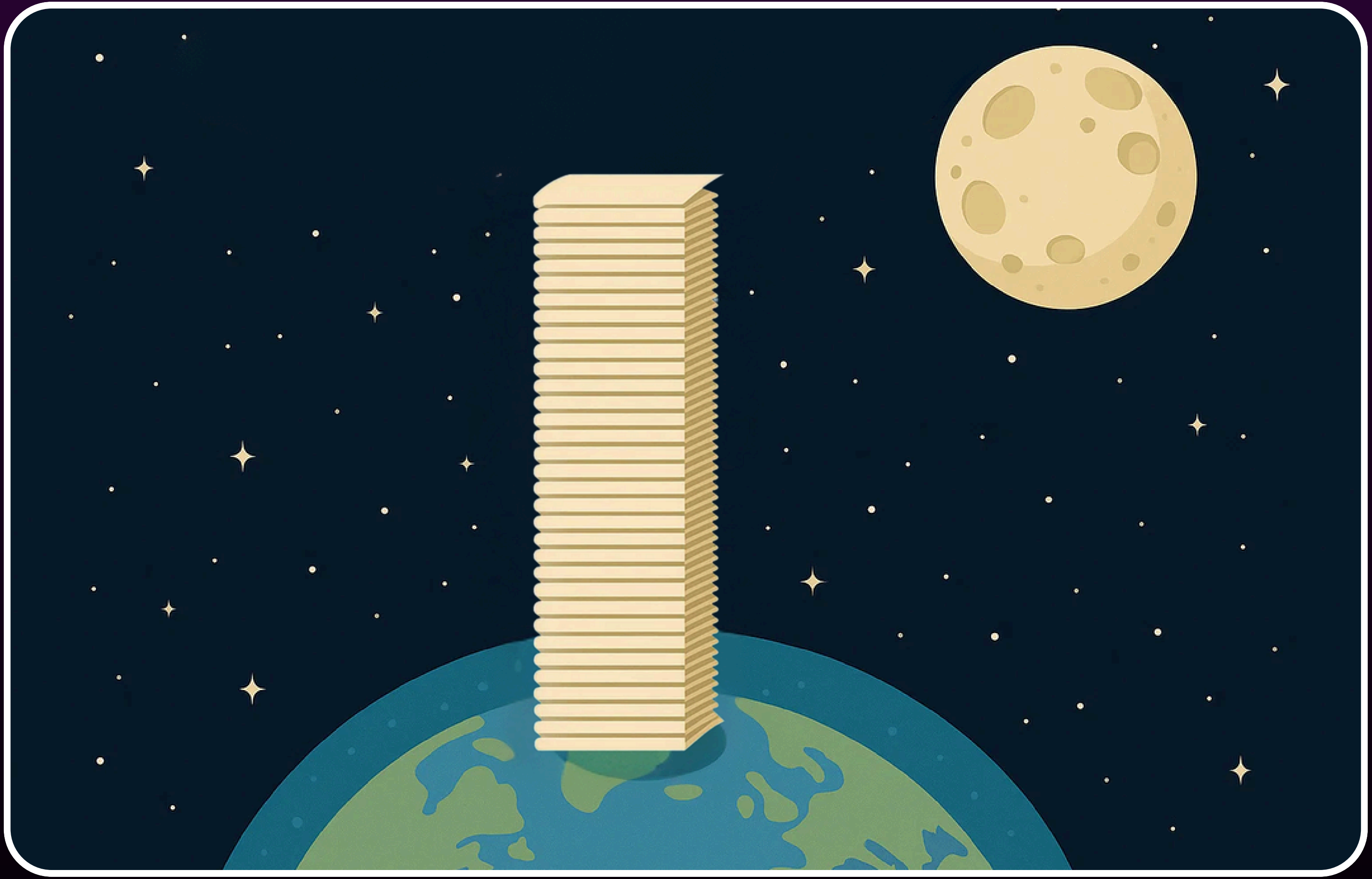
EXPERIENCING THE POWER PLAY ...

The Paper Folding Paradox

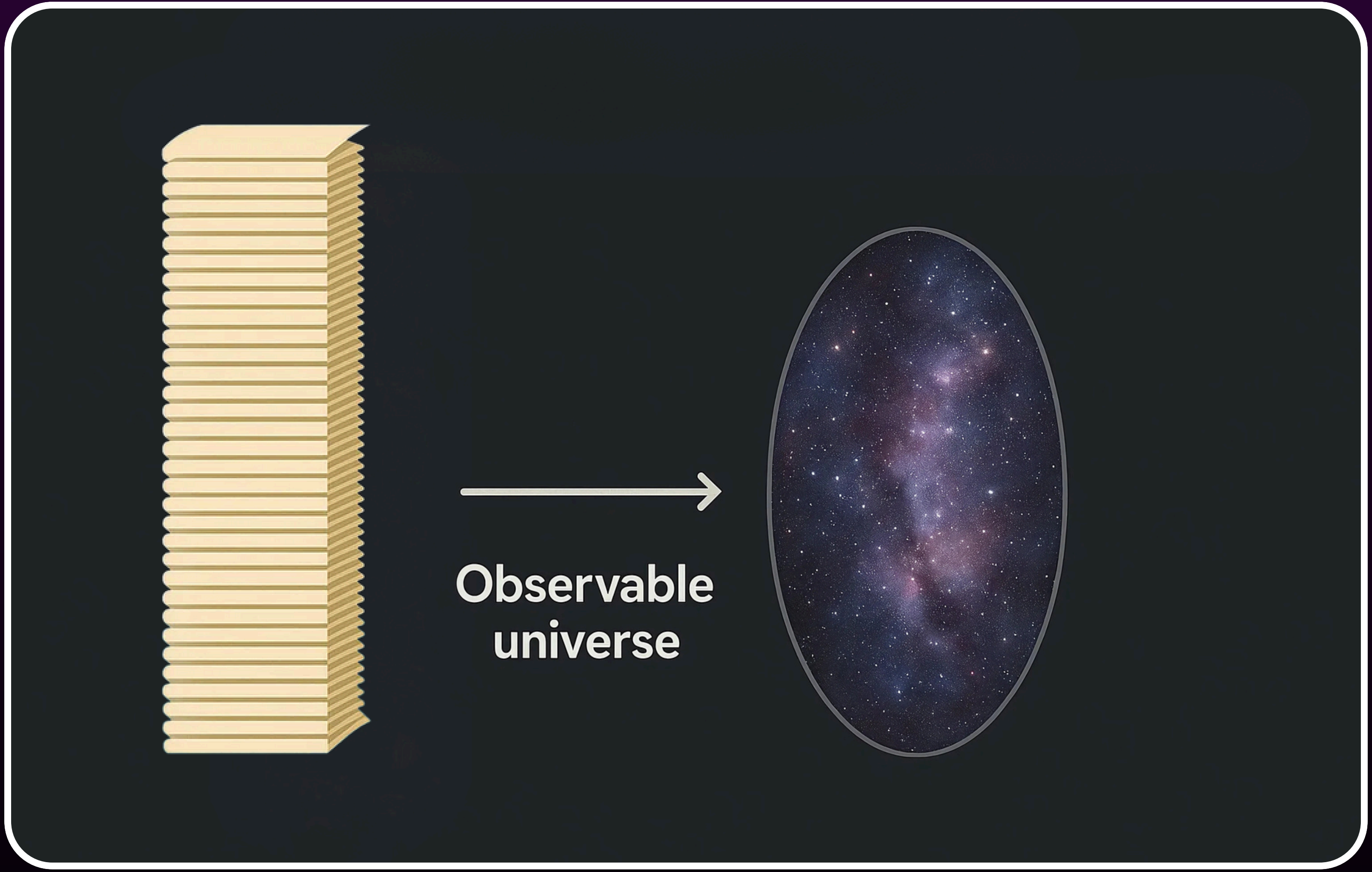
- How many times can you fold a paper over and over?

Fun Facts !

At fold 46, the paper's thickness would reach the Moon!



After fold 103, it would be thicker than the observable universe



Assume paper thickness starts at 0.001 cm:

- **1 fold: ~0.002 cm**
- **2 folds: ~0.004 cm**
- **10 folds: ~1.024 cm**

- 5 folds: ~
- 8 folds: ~
- 12 folds: ~
- 15 folds: ~
- 20 folds: ~
- 30 folds: ~
- 46 folds: ~
- 50 folds: ~

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.

A. $10v$

B. $10 + v$

C. $2 \times 10 \times v$

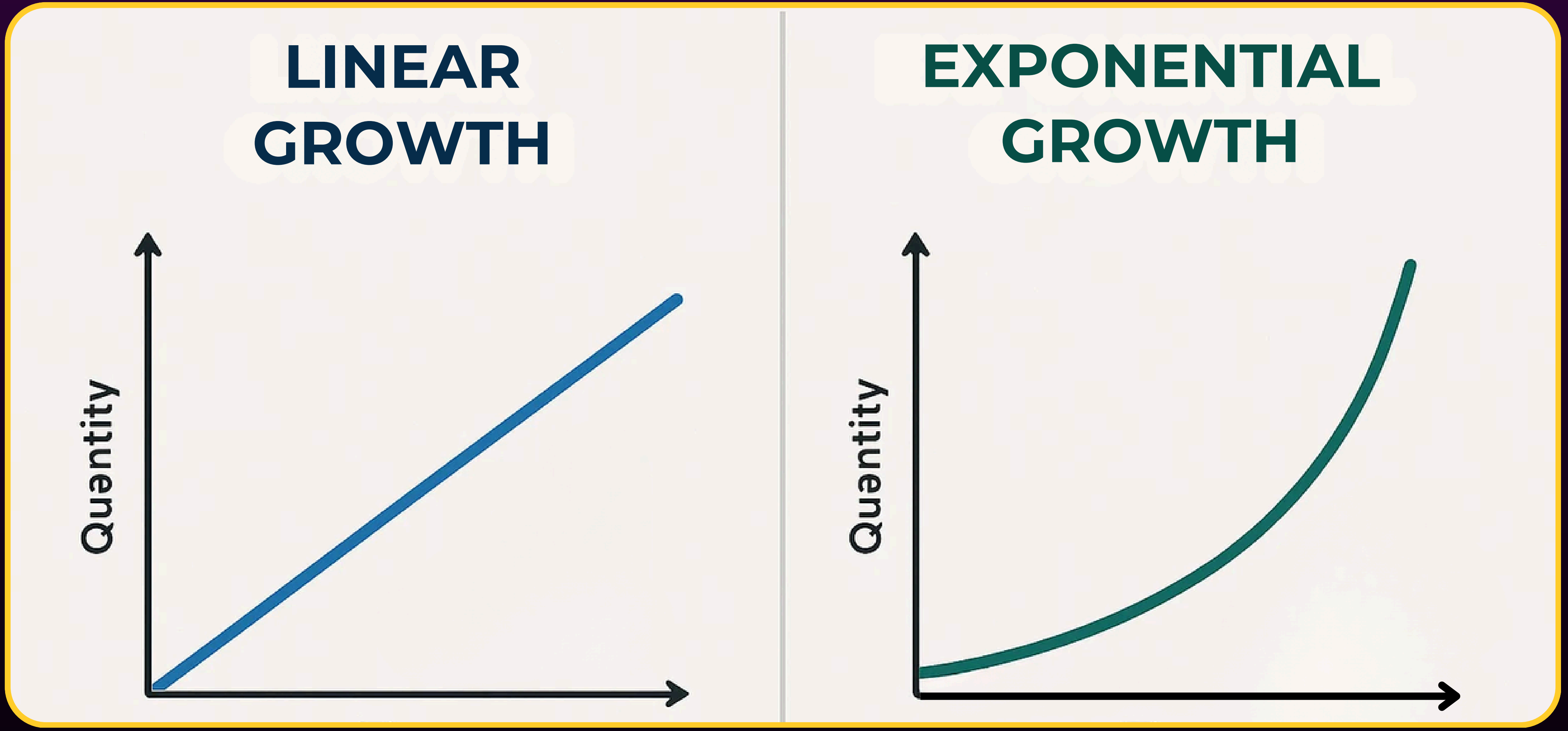
D. 2^{10}

E. $2^{10}v$

WHAT IS EXPONENTIAL GROWTH?

Exponential growth = when a quantity multiples
Linear growth = when a quantity adds

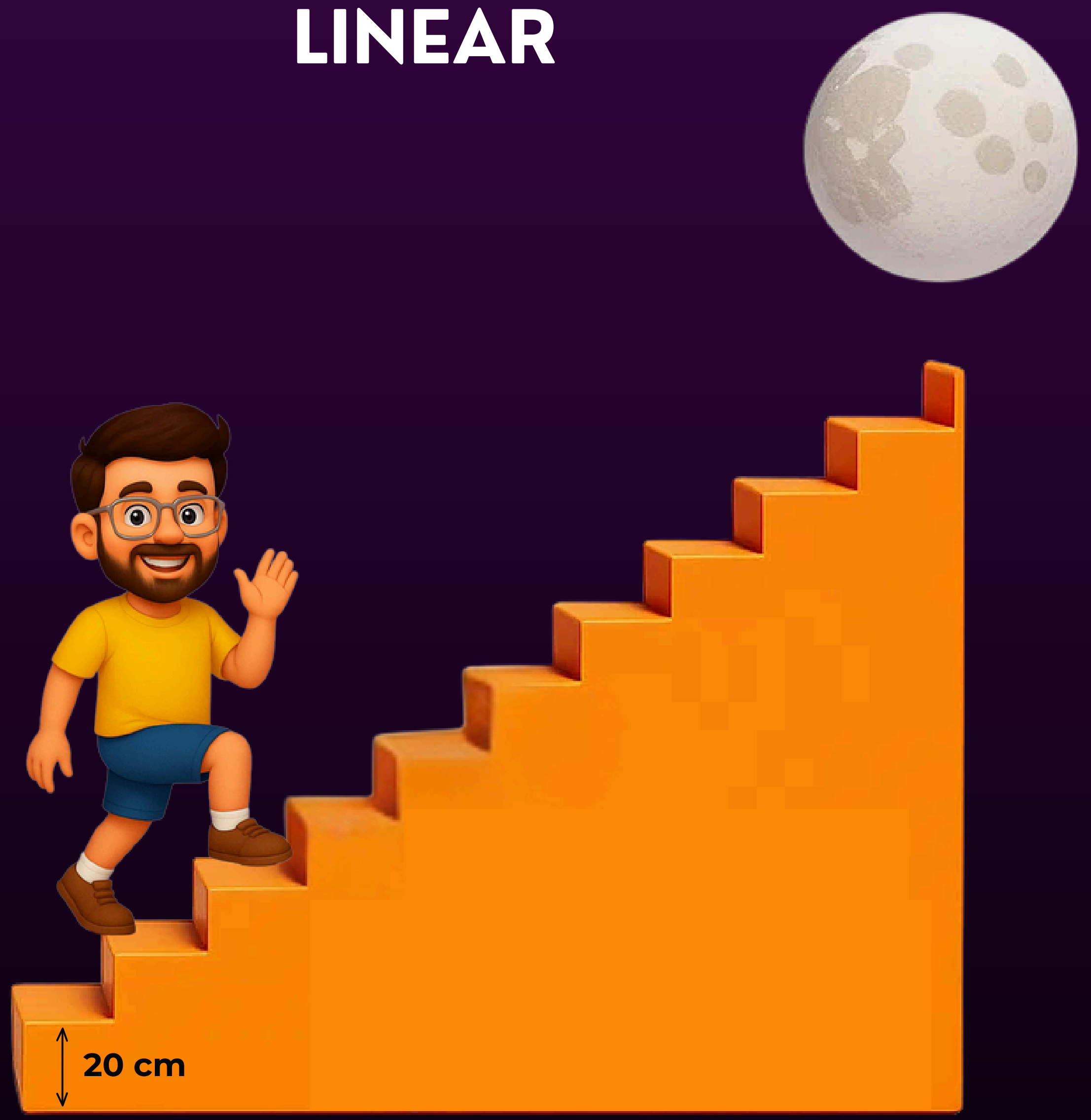
Example:
1 → 2 → 4 → 8 → 16....
the increase accelerates.



LINEAR V/S EXPONENTIAL GROWTH

Contrasts steady growth with exponential rise.

LINEAR



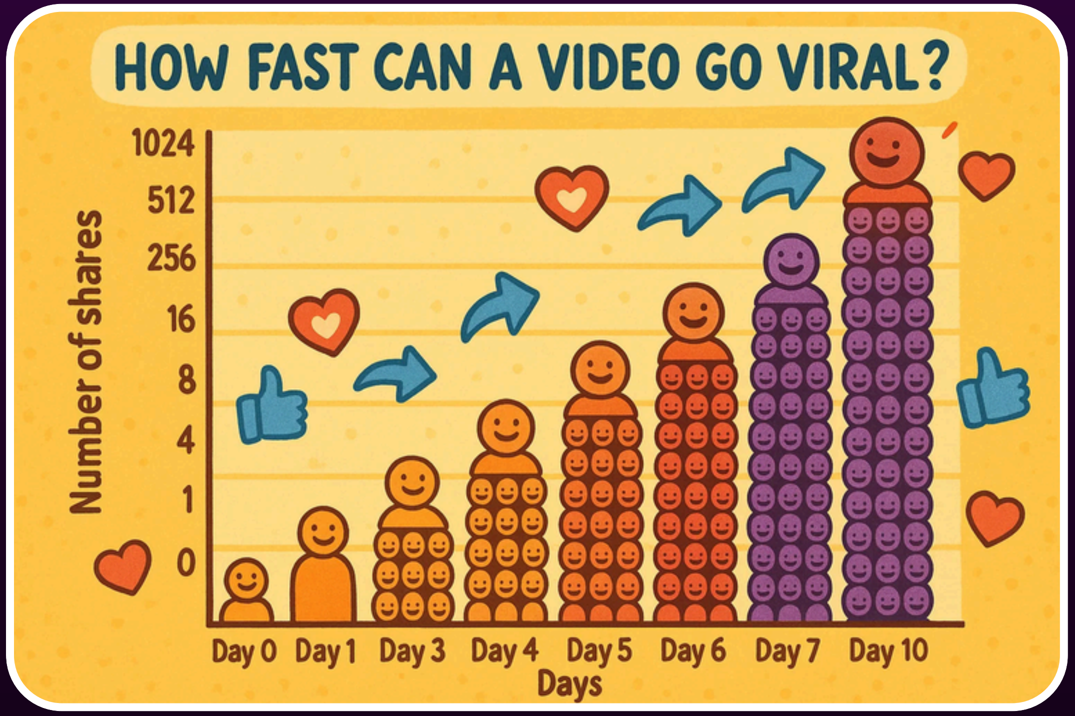
CLIMB STAIRS TO MOON
AT 20 CM PER STEP
= 1,92 BILLION STEPS

EXPONENTIAL

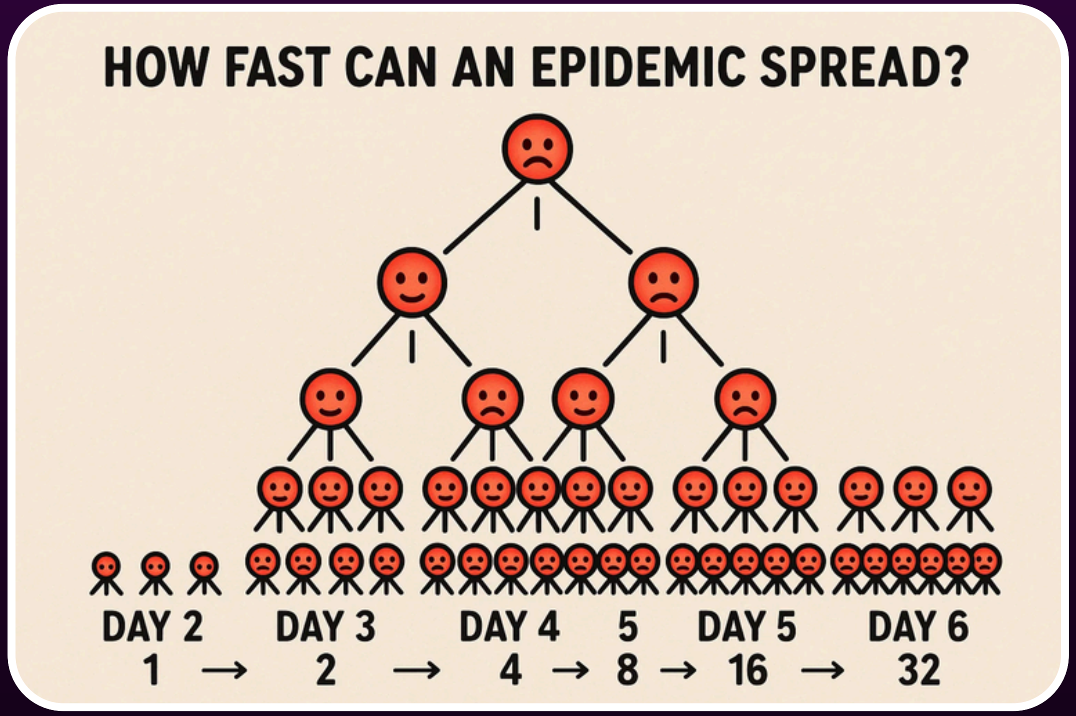
PAPER FOLDED 46 TIMES
= REACHES MOON

Real-World Relevance

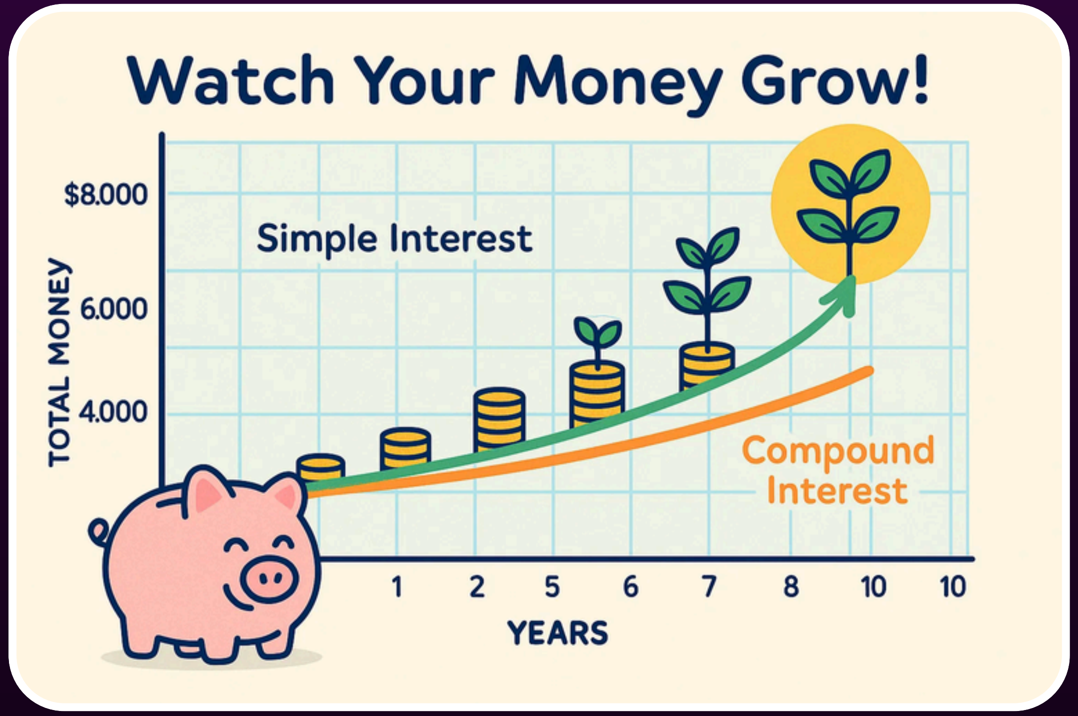
Where do we see exponential growth?



Viral videos
(shares double)



Epidemic spread
(1 infects 2, 2 infect 4...)



Compound interest
(money grows faster
over time).

WHAT IS EXPONENTIAL NOTATION?

Exponential notation expresses repeated multiplication using a base and an exponent.

$2^4 = 2 \times 2 \times 2 \times 2 = 16$

UNDERSTANDING THE PARTS

Base and Exponent explained in a^n :

- Base (a) – the no being multiplied
- Exponent (n) – how many times it's multiplied.

Eg: In 5^3,
5 is the base and 3 is the exponent.

PRODUCT RULE

Multiply with same base: Add exponents

Rule: $a^m \times a^n = a^{m+n}$

Example: $2^3 \times 2^4 = 2^{3+4}$

Power of a Power

Nested exponents: Multiply the exponents

Rule: $(a^{m})^{n} = a^{m \times n}$

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

QUOTIENT RULE

Divide with same base: Subtract exponents

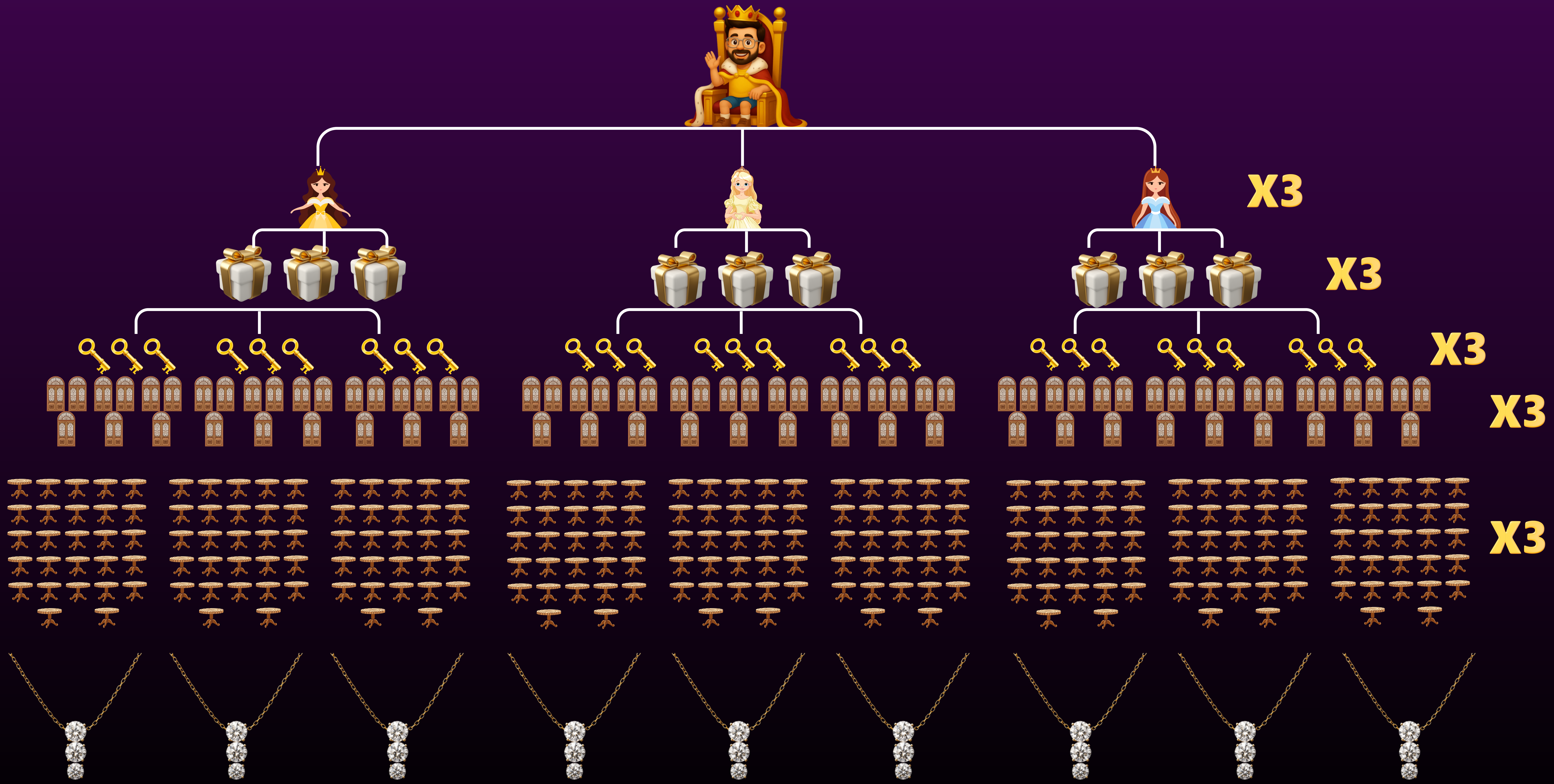
Rule: $\dfrac{a^m}{a^n} = a^{m-n}$

Example: $\dfrac{5^6}{5^2} = 5^{6-2} = 5^4$

How many diamonds are there in total?

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?

HOW MANY DIAMONDS ARE THERE IN TOTAL?



The number of lotuses in a pond doubles every day. If the pond is completely covered on Day 30, when was it half-covered?

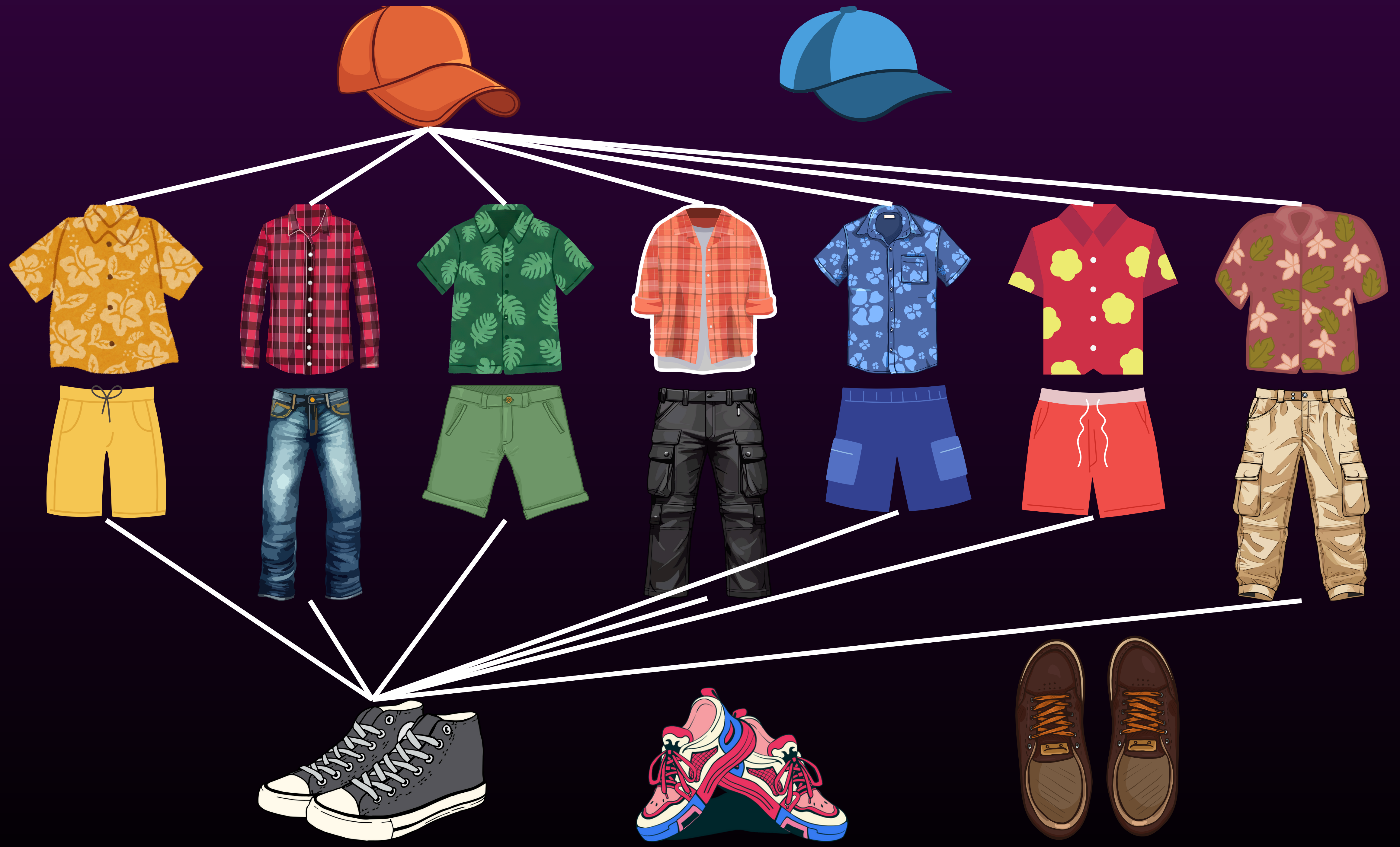
The Magical Pond

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.

YoYo has 7 dresses, 2 hats, and 3 pairs of shoes. How many different outfits can she create?

Exponents in Combinations

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



PASSWORD POSSIBILITIES

Badshah and YoYo 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.

Badshah and YoYo had to try all possible combinations to open a safe with a 5-digit password. How many passwords did they check?

To evaluate : (i) 3^4 (ii) 4^5 (iii) 5^6

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

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

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

Zero Exponent Rule

Any base to power 0 equals 1

Rule: $a^0 = 1$ **where** $a \neq 1$

Example: $7^0 = 1$

NEGATIVE EXPONENTS

Turn into reciprocals

Rule: $a^{-n} = \dfrac{1}{a^n}$

Example: $2^{-3} = \dfrac{1}{2^3} = \dfrac{1}{8}$

Write equivalent forms of the following.

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

Simplify and write the answers in exponential form.

(i) $3^2 \times 3^{-5} \times 3^6$ **(ii)** $(p)^3 \times p^{-10}$ **(iii)** $8^p \times 8^q$

Powers of 10

47561= (4×10000) + (7×1000) + (5×100) + (6×10) + 1

When using powers of 10, this becomes:

$$(4 \times 10^4) + (7 \times 10^3) + (5 \times 10^2) + (6 \times 10^1) + 1$$

Write these numbers in power of 10 :

(i) 172 (ii) 5642

SCIENTIFIC NOTATION

A compact way to write very big or small numbers

Scientific notation rewrites numbers as: $a \times 10^n$

where $1 \leqslant a < 10$ and n is an integer.

Very Large Numbers

Distance between Sun to Earth

149,600,000 km

$\approx 1.5 \times 10^8 km$

Mass of Earth

5,972,370,000,000 ,000,000,000 kg

$\approx 5.9722 \times 10^{24} kg$

Speed of light

299 792 458 m / s

$\approx 3 \times 10^8 m\backslash s$

Very Small Numbers

Size of ant

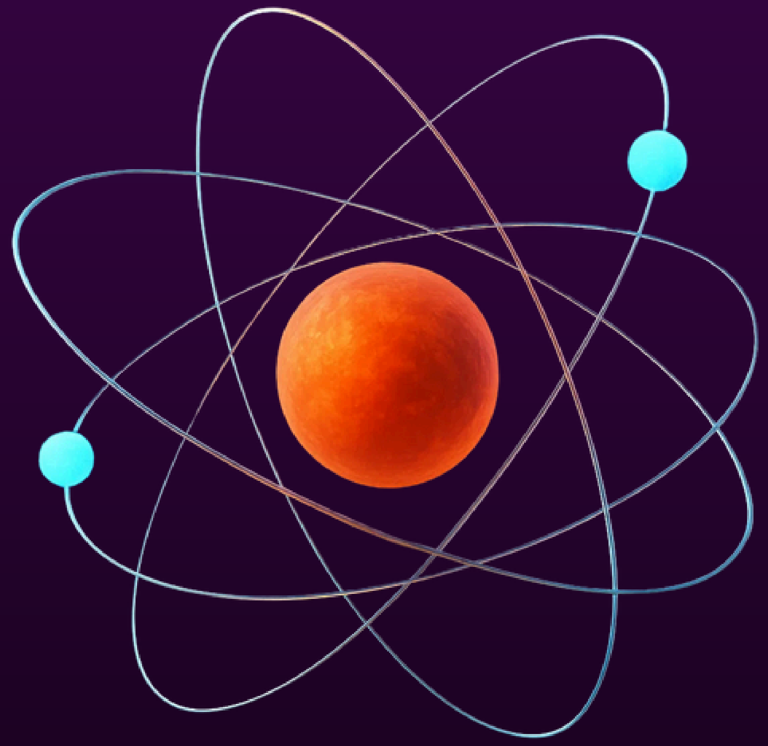
52mm or 5 cm

$$\approx 5.2 \times 10^{-4} mm$$

size of niddle

60 mm

$$\approx 6.0 \times 10^{-4} mm$$



size of atom

0.1 nm

$$\approx 1.0 \times 10^{-9} m$$

Express the following numbers in standard form.

(i) 59853 (ii) 65,950 (iii) 34,30,000 (iv) 70,04,00,00,000

TULĀBHĀRA PRACTICE

E.g.

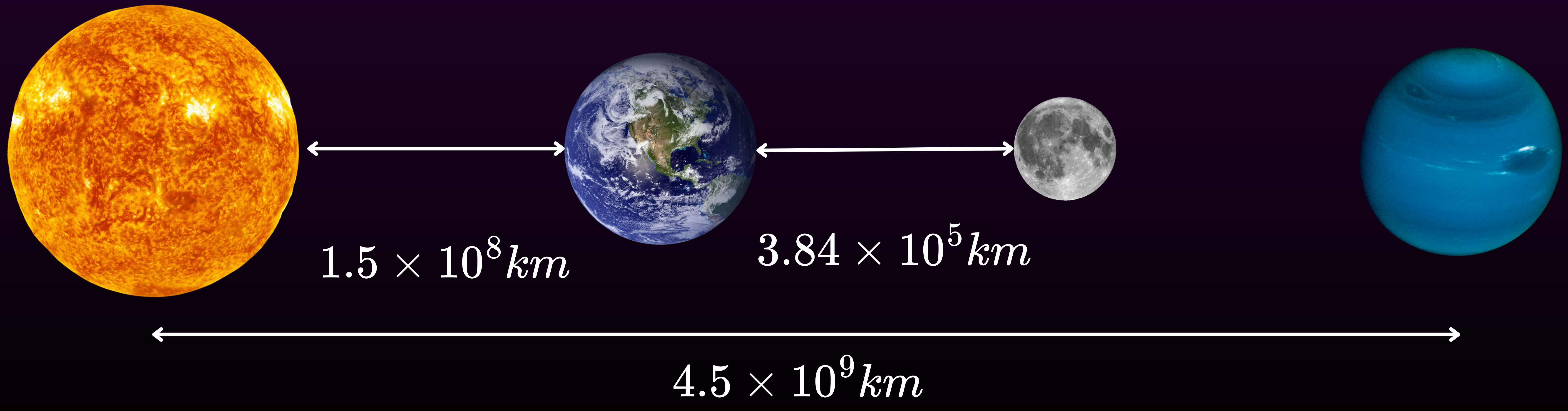
- 1 person = 60 kg
- 1000 people ≈ kg

PLANETARY DISTANCES

Astronomical scales need exponents

Examples:

- Earth–Moon: 3.84×10^5 km
- Earth–Sun: 1.5×10^8 km
- Neptune–Sun: 4.5×10^9 km



ESTIMATING POPULATIONS

Simplify billions into powers of 10

Example:

- India: ~ 1.4 billion = 1.4×10^9
- World: ~ 8 billion = 8×10^9

Modern Naming of Large Numbers

Name	Power of 10
Lakh	$10^2 \times 10^3 = 10^5$
Crore	$10^2 \times 10^5 = 10^7$
Arab	$10^2 \times 10^7 = 10^9$
Kharab	$10^2 \times 10^9 = 10^{11}$
Neel	
Padma	
Shankh	
Maha Shankh	

International Numbering System

Name	Value	Power of 10
Million	$1000 \times 1000 = 1{,}000{,}000$	$10^3 \times 10^3 = 10^6$
Billion	$1000 \times 1{,}000{,}000 = 1{,}000{,}000{,}000$	$10^3 \times 10^6 = 10^9$
Trillion	$1000 \times 1{,}000{,}000{,}000 = 10^{12}$	$10^3 \times 10^9 = 10^{12}$
Quadrillion	10^{15}	
Quintillion	10^{18}	
Sextillion	10^{21}	
Septillion	10^{24}	
Octillion	10^{27}	
Nonillion	10^{30}	
Decillion	10^{33}	

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

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?

Thank you