MATHEMATICS · GRADES 10-12

Exponential growth and decay

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you describe things that grow or shrink by a steady percentage. An investment grows by a set share each year, and medicine wears off by a set share each hour. The same maths covers both directions, growth and decay, just with a different sign. It is the pattern behind savings, populations, and anything that changes by a percentage at a time.



Rule

Exponential growth and decay: the amount after t steps is A = starting amount × (growth or decay factor)^t.

A factor above 1 means growth, and a factor below 1 means decay.

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Worked examples

EXAMPLE 1

Q A population of 100 doubles every year. How many after 3 years?

SOLUTION

Write the model: population = 100×2^t

Substitute t = 3: $100 \times 2^3 = 100 \times 8$

So the population is 800

EXAMPLE 2

Q A substance of 200 grams halves every half-life. How much after 2 half-lives?

SOLUTION

Write the model: amount = $200 \times (\frac{1}{2})^n$

Substitute n = 2: $200 \times (\frac{1}{4}) = 50$

So 50 grams remain.

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Practice questions

1. A rabbit population of 50 doubles every year. How many are there after 2 years?

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2. A town grows by a factor of 3 each year. After 2 years there are 9000 people. How many people were there at the start?

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3. A substance of 400 grams halves each half-life. How much is left after 1 half-life?

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4 A substance of 400 grams halves each half-life. After how many half-lives is 50 grams left?

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5 A deer population grows by 20 percent each year. What is the growth factor?

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6 An amount of 1000 decays to half each year. How much is left after 4 years?

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7 A bacteria population of 80 doubles each year. How many bacteria are added during the 4th year, from year 3 to year 4?

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8 An amount of 640 halves each step. After 2 steps, what fraction of the original amount is left?

A $\frac{1}{4}$

B $\frac{1}{2}$

C $\frac{1}{8}$

D $\frac{2}{3}$

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9 A wolf population grows by a factor of 2 each year. It is 2400 after 3 years. What was it after 1 year?

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10 An amount of 500 decays to half each year. What is the decay factor?

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ANSWER KEY

1. 200

2. 1000

3. 200 grams

4. 3

5. 1.2

6. 62.5

7. 640

8. $\frac{1}{4}$

9. 600

10. 0.5

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