MATHEMATICS · GRADES 10-12

Exponential decay

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how things fade away by a steady percentage. Medicine wears off in your body by a set share each hour, and a car loses a set share of its value each year. The amount drops fast at first, then more slowly, but always by the same percentage. Knowing the pattern tells you how much will be left after any amount of time.



Rule

Exponential decay: the amount after t steps is A = starting amount × (decay factor)^t, where the decay factor is 1 minus the percentage lost each step.

So 800 decaying by 10 percent each year is 800×0.90^t.

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Worked examples

EXAMPLE 1

Q An amount of 800 decays by 10 percent each year. How much after 2 years?

SOLUTION

Write the model: 800×0.90^{t}

Substitute t = 2: $800 \times 0.90^{2} = 800 \times 0.81 = 648$

So 648 remains.

EXAMPLE 2

Q An amount of 1000 halves each year. How much after 3 years?

SOLUTION

Write the model: $1000 \times (\frac{1}{2})^{t}$

Substitute t = 3: $1000 \times (\frac{1}{2})^{3} = 1000 \times (\frac{1}{8}) = 125$

So 125 remains.

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Practice questions

1 A medicine of 1000 mg decays by 10 percent each year. How much is left after 1 year?

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2 A medicine of 1000 mg decays by 10 percent each year. How much is left after 2 years?

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3 500 g of a medicine loses half its strength every year. After 2 years, how much full-strength medicine is left?

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4 A medicine decays by 20 percent each year. What is the decay factor?

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5 A chemical decays by 20 percent each year. After 2 years, 512 g is left. How much was there at the start?

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6 A radioactive sample of 2000 g halves each year. How much is left after 1 year?

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7 Fish food in a pond breaks down by 25 percent each year. There are 400 g to start. How much is lost after 1 year, in grams?

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8 400 g of plant food decays by 25 percent each year. After how many years is 225 g left?

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9 A phone battery holds 100 units of charge. It loses 5 percent of its charge each year. What percentage of its charge is left after 1 year?

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10 A 1000 g sample of a medicine decays by 50 percent each year. What is its half-life, in years?

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ANSWER KEY

1. 900

2. 810

3. 125

4. 0.8

5. 800

6. 1000

7. 100

8. 2

9. 95

10. 1

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