MATHEMATICS · GRADES 10-12

Expected value

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you work out what a bet, a raffle ticket, or a game is worth on average over many plays. One ticket might win big or win nothing, but the expected value tells you what you would get on average if you played again and again. That number tells you whether it is a fair deal or a bad one. It is how casinos, insurers, and game designers price risk.



Rule

Expected value: E = Σ (outcome × probability), added up over every outcome.

That total is what you would get on average if you played again and again.

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Worked examples

EXAMPLE 1

Q A game pays 6 dollars with chance $\frac{1}{2}$ and 0 dollars with chance $\frac{1}{2}$. Find the expected value.

SOLUTION

Multiply each value by its chance: $6 \times \frac{1}{2} = 3$, and $0 \times \frac{1}{2} = 0$

Add the products: $3 + 0$

Expected value: 3 dollars.

EXAMPLE 2

Q A die is rolled. Find the expected value of the number shown.

SOLUTION

Each face 1 to 6 has chance $\frac{1}{6}$.

$$\text{Expected value} = \frac{(1 + 2 + 3 + 4 + 5 + 6)}{6}$$

$$\text{Expected value} = \frac{21}{6} = 3.5$$

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Practice questions

1. A game pays 9 dollars with chance $\frac{1}{3}$ and 0 dollars with chance $\frac{2}{3}$. Find the expected value.

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2. A coin game pays 4 dollars for heads and loses 2 dollars for tails. Expected value?

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3. A spinner has three equal sections that pay 9 dollars, 3 dollars, and 0 dollars. Find the expected value of one spin.

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4 A spinner shows 1, 2, 3, 4 equally often. Find the expected value of the number shown.

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5 A die is rolled. Find the expected value of twice the number shown.

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6 A die is rolled. Find the expected value of the number shown -2.

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7 A fair coin is flipped 10 times. About how many heads would you expect?

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8 A lottery ticket costs 2 dollars and pays 100 dollars with chance $\frac{1}{100}$. Find the expected value per ticket.

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9 A game pays 30 dollars with chance $\frac{1}{10}$ and 0 dollars otherwise. How much should a ticket cost so the game is fair?

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10 **Two dice are rolled. What is the expected value of the sum of the two numbers?**

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ANSWER KEY

1. 3 dollars

2. 1 dollar

3. 4 dollars

4. 2.5

5. 7

6. 1.5

7. 5

8. -1 dollar

9. 3 dollars

10. 7

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