MATHEMATICS · GRADES 10-12

# Probability distributions

### Difficulty level: Advanced

### Mathematics: Grades 10-12

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## *Overview of the concept*

This is how you see the full odds of something at a glance, like every possible score on a test and how likely each one is. A teacher looks at the spread of scores to see whether a test was too hard or too easy, and a game designer looks at the odds of every roll to keep a game fair. A factory checks the distribution of its part sizes to catch a machine drifting out of line. Seeing all the outcomes together tells you far more than any single chance on its own.



## *Rule*

**A probability distribution lists every possible value and its chance.**

The chances must add to 1, and no chance can be negative.

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## Worked examples

EXAMPLE 1

**Q** A fair coin is tossed once. Give the distribution of the number of heads.

| Number of heads | Probability |
|---|---|
| 0 | ? |
| 1 | ? |

### SOLUTION

A fair coin has two equally likely outcomes, heads and tails.

Values: 0 heads with chance $\frac{1}{2}$, 1 head with chance $\frac{1}{2}$.

Check: $\frac{1}{2} + \frac{1}{2} = 1$

That is the whole distribution.

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EXAMPLE 2

## Q A fair die is rolled. Give the chance of each value.

| Die value | Probability |
|---|---|
| 1 | ? |
| 2 | ? |
| 3 | ? |
| 4 | ? |
| 5 | ? |
| 6 | ? |

### SOLUTION

A fair die has six equally likely faces, 1 to 6.

Values 1 to 6, each with chance $\frac{1}{6}$.

Check: $6 \times \frac{1}{6} = 1$

That is the distribution.

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## Practice questions

**1** A spinner has equal sections:

1

2

3

4

Give the distribution.

**A** Each of 1, 2, 3, 4 has chance $\frac{1}{4}$

**B** Each of 1, 2, 3, 4 has chance $\frac{1}{2}$

**C** 1 has chance $\frac{1}{4}$, the rest have chance $\frac{1}{2}$

**D** Each of 1, 2, 3, 4 has chance 1

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**2** **A bag has 3 red balls and 1 blue ball, one drawn at random. Give the distribution of the colour drawn.**

A. Red with chance $\frac{1}{2}$, blue with chance $\frac{1}{2}$

B. Red with chance $\frac{3}{4}$, blue with chance $\frac{1}{4}$

C. Red with chance $\frac{1}{4}$, blue with chance $\frac{3}{4}$

D. Red with chance 1, blue with chance 0

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**3** **A fair coin is tossed twice. Give the distribution of the number of heads.**

**A** 0 heads with chance $\frac{1}{4}$, 1 head with chance $\frac{1}{2}$, 2 heads with chance $\frac{1}{4}$

**B** 0 heads with chance $\frac{1}{3}$, 1 head with chance $\frac{1}{3}$, 2 heads with chance $\frac{1}{3}$

**C** 0 heads with chance $\frac{1}{2}$, 1 head with chance $\frac{1}{4}$, 2 heads with chance $\frac{1}{4}$

**D** 0 heads with chance $\frac{1}{8}$, 1 head with chance $\frac{3}{8}$, 2 heads with chance $\frac{1}{2}$

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**4** A spinner distribution lists these chances: 1 with chance $\frac{1}{2}$, 2 with chance $\frac{1}{4}$, 3 with chance $\frac{1}{4}$. Do they add to 1?

A. Yes, they add to 1

B. No, they add to $\frac{3}{4}$

C. No, they add to $\frac{1}{2}$

D. No, they add to 2

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**5** A fair coin is tossed three times. What is the chance of exactly 2 heads?

- **A** $\frac{1}{8}$
- **B** $\frac{3}{8}$
- **C** $\frac{1}{2}$
- **D** $\frac{5}{8}$

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**6** The distribution of a bag draw is: red with chance $\frac{3}{4}$, blue with chance $\frac{1}{4}$. What is the chance of not drawing red?

A $\frac{1}{4}$

B $\frac{3}{4}$

C $\frac{1}{2}$

D 1

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**7** What must the chances in a distribution add to?

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## 8 What is a probability distribution?

- **A** A list of every value of a random variable with its chance
- **B** A list of the most likely value only
- **C** The chance of one single outcome
- **D** A table of values with no chances

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## 9 A fair die is rolled. What is the chance of an even number?

- **A** $\frac{1}{6}$
- **B** $\frac{1}{3}$
- **C** $\frac{1}{2}$
- **D** $\frac{2}{3}$

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10

## Can a chance in a distribution be negative?

A Yes

B No

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## ANSWER KEY

**1.** Each of 1, 2, 3, 4 has chance $\frac{1}{4}$

**2.** Red with chance $\frac{3}{4}$, blue with chance $\frac{1}{4}$

**3.** 0 heads with chance $\frac{1}{4}$, 1 head with chance $\frac{1}{2}$, 2 heads with chance $\frac{1}{4}$

**4.** Yes, they add to 1

**5.** $\frac{3}{8}$

**6.** $\frac{1}{4}$

**7.** 1

**8.** A list of every value of a random variable with its chance

**9.** $\frac{1}{2}$

**10.** No

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