# Section 2: Probability distributions

## Section test

1. A discrete random variable $X$ has the following probability distribution:

| $r$ | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $\mathbf{P(X = r)}$ | 0.04 | 0.14 | $a$ | 0.34 | 0.44 |

What is the value of $a$?

2. Two tetrahedral dice, each with faces labelled 1, 2, 3 and 4, are thrown and the random variable $Y$ is the greater of the scores shown. A student produced the following probability distribution of $Y$. There must be a mistake as the sum of the probabilities is not 1. Which probability is wrong?

| $r$ | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $\mathbf{P(Y = r)}$ | 0.0625 | 0.1875 | 0.3225 | 0.4375 |

(a) 0.0625
(b) 0.3225
(c) 0.1875
(d) 0.4375

3. A discrete random variable $Z$ has the following probability distribution:

| $r$ | -5 | -3 | -1 | 0 | 1 | 3 | 5 |
|---|---|---|---|---|---|---|---|
| $\mathbf{P(Z = r)}$ | 0.1 | 0.15 | 0.15 | 0.25 | 0.2 | 0.05 | 0.1 |

What is $P(-3 \leq r < 1)$?
What is $P(|r| < 3)$?

4. The probability distribution of a discrete random variable $X$ is given by:

$$P(X = r) = \frac{kr}{30} \quad \text{for } r = 3, 5, 7$$
$$P(X = r) = 0 \quad \text{otherwise}$$

What is the value of $k$?

5. The probability distribution of a discrete random variable $Y$ is given by:

$$P(Y = r) = \frac{1}{35}(6r - r^2) \quad \text{for } r = 1, 2, 3, 4, 5$$
$$P(Y = r) = 0 \quad \text{otherwise}$$

What is $P(1 < r \leq 4)$?
What is the most likely value?

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6. The score on a biased die when it is thrown once is denoted by the random variable $Z$, which has the following probability distribution:

| $r$ | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| $\mathbf{P(Z = r)}$ | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 |

The die is thrown twice.
What is the probability that the scores on the two dice are the same?
What is the probability that the total of the two scores is greater than 9?

7. The probability distribution of a discrete random variable $Y$ is given by:

$$P(Y = r) = k\left(\frac{2}{3}\right)^r \quad \text{for } r = 0, 1, 2, 3$$

$$P(Y = r) = 0 \quad \text{otherwise}$$

What is the value of $k$?

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## Solutions to section test

1. The probabilities must add up to 1: $0.04 + 0.14 + a + 0.34 + 0.44 = 1$

$$a = 0.04$$

2.

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 1 | 2 | 3 | 4 |
| 2 | 2 | 2 | 3 | 4 |
| 3 | 3 | 3 | 3 | 4 |
| 4 | 4 | 4 | 4 | 4 |

$P(Y = 1) = \frac{1}{16} = 0.0625$ $P(Y = 2) = \frac{3}{16} = 0.1875$

$P(Y = 3) = \frac{5}{16} = 0.3125$ $P(Y = 4) = \frac{7}{16} = 0.4375$

The probability which is wrong is 0.3225.

3. $P(-3 \leq r < 1) = 0.15 + 0.15 + 0.25 = 0.55$

$P(|r| < 3) = P(-3 < r < 3) = 0.15 + 0.25 + 0.2 = 0.6$

4. $\frac{3k}{30} + \frac{5k}{30} + \frac{7k}{30} = 1$

$\frac{15k}{30} = 1$

$k = 2$

5.

| $r$ | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| $P(Y = r)$ | $\frac{5}{35}$ | $\frac{8}{35}$ | $\frac{9}{35}$ | $\frac{8}{35}$ | $\frac{5}{35}$ | 0 |

$P(1 < r \leq 4) = \frac{8 + 9 + 8}{35} = \frac{25}{35} = \frac{5}{7}$

The highest probability is for $r = 3$, so the most likely value is 3.

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6. $P(\text{both the same}) = 0.1^2 + 0.2^2 + 0.1^2 + 0.2^2 + 0.2^2 + 0.2^2$

$= 0.18$

$P(\text{total is } 10) = (0.2 \times 0.2) + (0.2 \times 0.2) + (0.2 \times 0.2) = 0.12$

$P(\text{total is } 11) = (0.2 \times 0.2) + (0.2 \times 0.2) = 0.08$

$P(\text{total is } 12) = 0.2 \times 0.2 = 0.04$

$P(\text{score is more than } 9) = 0.12 + 0.08 + 0.04 = 0.24$

7. $k\left(\left(\frac{2}{3}\right)^0 + \left(\frac{2}{3}\right)^1 + \left(\frac{2}{3}\right)^2 + \left(\frac{2}{3}\right)^3\right) = 1$

$k\left(1 + \frac{2}{3} + \frac{4}{9} + \frac{8}{27}\right) = 1$

$k\left(\frac{27 + 18 + 12 + 8}{27}\right) = 1$

$k = \frac{27}{65}$