The normal distribution

Grade 8 | Worked solutions

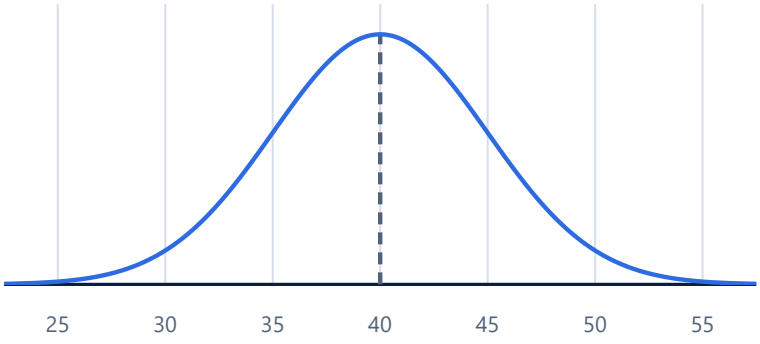
GCSE Statistics topic practice

1 The times taken by people to solve a puzzle are normally distributed with mean 40 seconds and standard deviation 5 seconds. The diagram shows this distribution.

a. Write down the median time. (1)

b. Write down the percentage of people who take between 35 seconds and 45 seconds to solve the puzzle. (1)

c. Lena takes 58 seconds to solve the puzzle. Her friend says that this is a very unusual time. Is her friend correct? Give a reason for your answer. (2)



(4 marks)

a) A normal distribution is symmetrical

median = mean = 40 seconds

b) 35 and 45 are 1 sd either side of the mean

68% of values are within 1 sd of the mean

c) Almost all values (99.7%) are within 3 sd of the mean

40 + 3 x 5 = 55

58 is greater than 55

Yes, 58 seconds is more than 3 sd above the mean

a) 40 s b) 68% c) yes, more than 3 sd above the mean

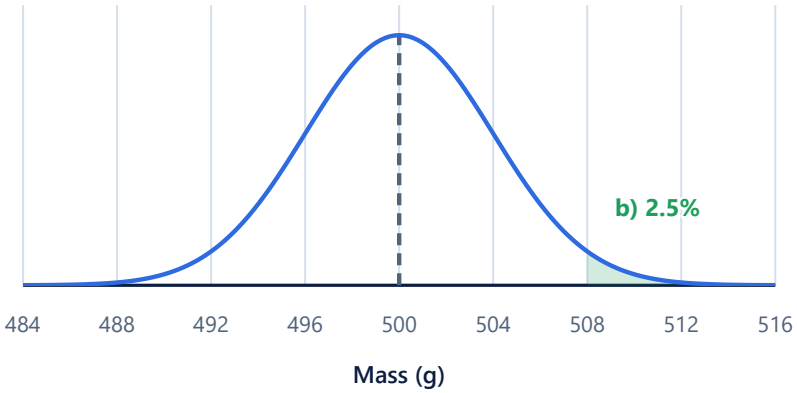
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2 A machine fills bags with flour. The masses of the bags are normally distributed with mean 500 g and standard deviation 4 g. The diagram shows this distribution.

a. Write down the percentage of bags with a mass between 496 g and 504 g. (1)

b. Work out the percentage of bags with a mass of more than 508 g. (2)

c. The machine fills 4000 bags in one day. Work out an estimate for the number of these bags with a mass of less than 488 g. (2)



(5 marks)

a) 496 and 504 are 1 sd either side of the mean

68% of values are within 1 sd of the mean

b) 508 = 500 + 2 × 4, so it is 2 sd above the mean

95% of values are within 2 sd of the mean

100% − 95% = 5%

Half of this is above 508

5% ÷ 2 = 2.5%

c) 488 = 500 − 3 × 4, so it is 3 sd below the mean

99.7% of values are within 3 sd of the mean

100% − 99.7% = 0.3%

0.3% ÷ 2 = 0.15%

0.0015 × 4000 = 6

a) 68% b) 2.5% c) 6 bags

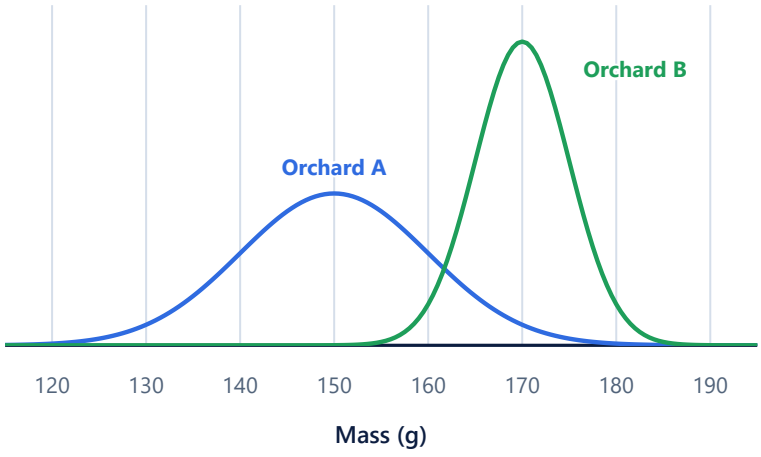
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3 The masses of the apples from orchard A are normally distributed with mean 150 g and standard deviation 10 g. The diagram shows this distribution.

The masses of the apples from orchard B are normally distributed with mean 170 g and standard deviation 5 g.

a. On the same axes, sketch the distribution of the masses of the apples from orchard B. (2)

b. Almost all (99.7%) of the apples from orchard B have a mass between two values. Work out these two values. (2)



(4 marks)

a) The mean is 170, so centre the curve on 170

The sd is smaller, so the curve is narrower

The curve is also taller than the curve for orchard A

b) 99.7% of values are within 3 sd of the mean

$170 - 3 \times 5 = 155$

$170 + 3 \times 5 = 185$

Between 155 g and 185 g

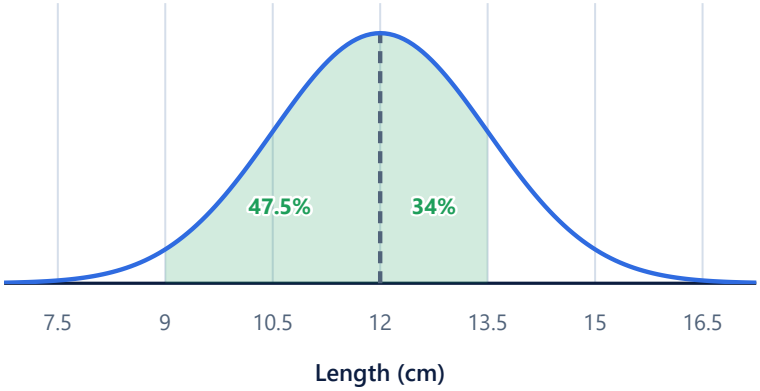
a) curve drawn b) 155 g and 185 g

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4 The lengths of the leaves on a bay tree are normally distributed with mean 12 cm and standard deviation 1.5 cm. The diagram shows this distribution.

a. Work out the percentage of the leaves with a length between 9 cm and 13.5 cm. (3)

b. Kofi picks 400 of the leaves at random. Work out an estimate for the number of these leaves that are longer than 13.5 cm. (2)



(5 marks)

a) 9 = 12 - 2 × 1.5, so 9 is 2 sd below the mean

95% of values are within 2 sd of the mean

Half of these are between 9 and 12

95% ÷ 2 = 47.5%

13.5 = 12 + 1.5, so 13.5 is 1 sd above the mean

68% of values are within 1 sd of the mean

Half of these are between 12 and 13.5

68% ÷ 2 = 34%

47.5% + 34% = 81.5%

81.5% of the leaves

b) 13.5 is 1 sd above the mean

100% - 68% = 32%

32% ÷ 2 = 16%

0.16 × 400 = 64

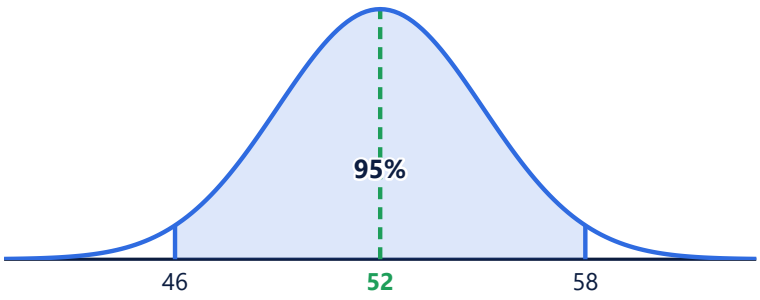
a) 81.5% b) 64 leaves

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5 The lifetimes of a type of battery are normally distributed. The diagram shows this distribution. The middle 95% of the batteries, shown shaded, have a lifetime between 46 hours and 58 hours.

a. Work out the mean and the standard deviation of the lifetimes. (3)

b. Work out the percentage of the batteries with a lifetime of more than 55 hours. (2)



(5 marks)

a) The curve is symmetrical, so the mean is halfway

$$\text{mean} = \frac{46 + 58}{2}$$

$$\text{mean} = 52 \text{ hours}$$

95% of values are within 2 sd of the mean

So from 46 to 58 is 4 sd

$$4 \text{ sd} = 58 - 46$$

$$4 \text{ sd} = 12$$

$$\text{sd} = 3 \text{ hours}$$

Mean 52 hours, sd 3 hours

b) 55 = 52 + 3, so 55 is 1 sd above the mean

68% of values are within 1 sd of the mean

$$100\% - 68\% = 32\%$$

$$32\% \div 2 = 16\%$$

a) mean 52 hours, sd 3 hours b) 16%

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