

# Normal distribution 28.02 [47 marks]

A factory produces bags of sugar with a labelled weight of 500 g. The weights of the bags are normally distributed with a mean of 500 g and a standard deviation of 3 g.

- 1a. Write down the percentage of bags that weigh more than 500 g. [1 mark]

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A bag that weighs less than 495 g is rejected by the factory for being underweight.

- 1b. Find the probability that a randomly chosen bag is rejected for being underweight. [2 marks]

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1c. A bag that weighs more than  $k$  grams is rejected by the factory for being [3 marks] overweight. The factory rejects 2% of bags for being overweight.

Find the value of  $k$ .

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The masses of Fuji apples are normally distributed with a mean of 163 g and a standard deviation of 6.83 g.

When Fuji apples are picked, they are classified as small, medium, large or extra large depending on their mass. Large apples have a mass of between 172 g and 183 g.

- 2a. Determine the probability that a Fuji apple selected at random will be a large apple. [2 marks]

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Approximately 68% of Fuji apples have a mass within the medium-sized category, which is between  $k$  and 172 g.

2b. Find the value of  $k$ .

[3 marks]

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The Malthouse Charity Run is a 5 kilometre race. The time taken for each runner to complete the race was recorded. The data was found to be normally distributed with a mean time of 28 minutes and a standard deviation of 5 minutes.

A runner who completed the race is chosen at random.

3a. Write down the probability that the runner completed the race in more than 28 minutes. [1 mark]

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3b. Calculate the probability that the runner completed the race in less than *[2 marks]*  
26 minutes.

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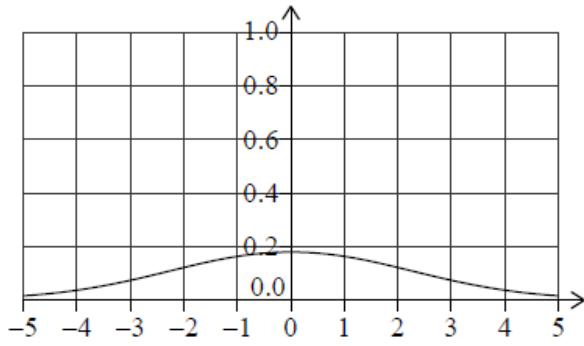
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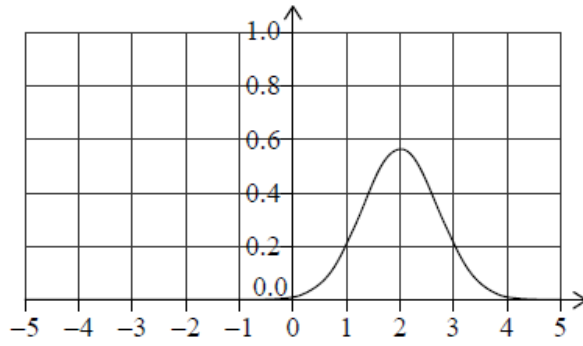


Consider the following graphs of normal distributions.

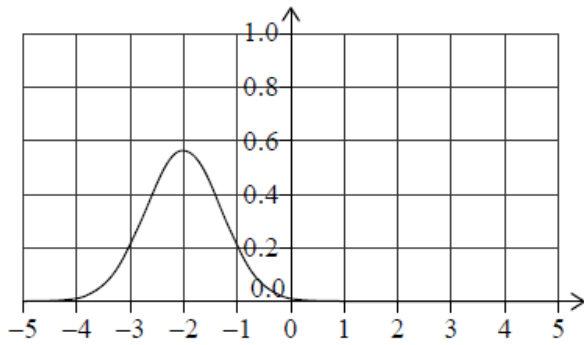
**Graph A**



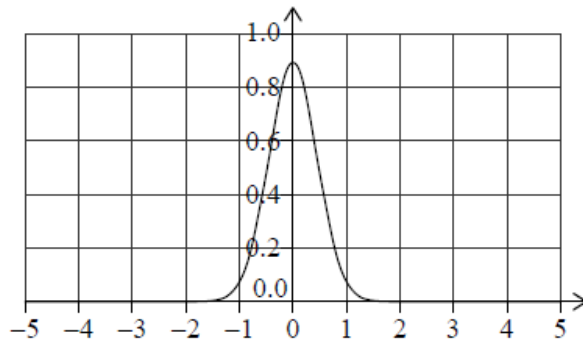
**Graph B**



**Graph C**



**Graph D**



4a. In the following table, write down the letter of the corresponding graph [2 marks] next to the given mean and standard deviation.

Mean and standard deviation	Graph
Mean = -2; standard deviation = 0.707	
Mean = 0; standard deviation = 0.447	

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At an airport, the weights of suitcases (in kg) were measured. The weights are normally distributed with a mean of 20 kg and standard deviation of 3.5 kg.

4b. Find the probability that a suitcase weighs less than 15 kg. *[2 marks]*

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4c. Any suitcase that weighs more than  $k$  kg is identified as excess baggage. *[2 marks]*  
19.6 % of the suitcases at this airport are identified as excess baggage.  
Find the value of  $k$ .

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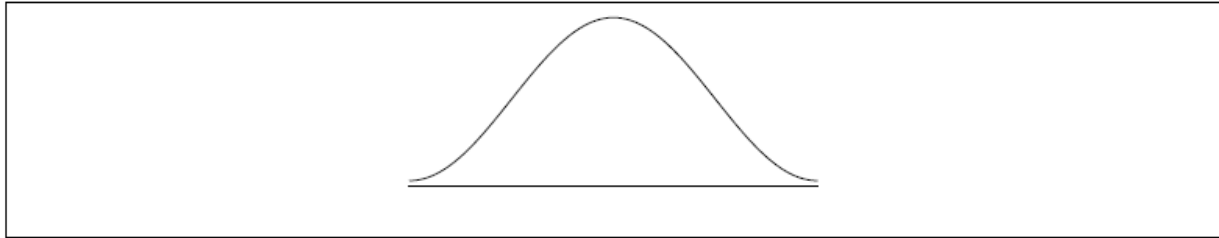
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The price per kilogram of tomatoes, in euro, sold in various markets in a city is found to be normally distributed with a mean of 3.22 and a standard deviation of 0.84.

- 5a. On the following diagram, shade the region representing the probability [1 mark] that the price of a kilogram of tomatoes, chosen at random, will be higher than 3.22 euro.



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- 5b. Find the price that is two standard deviations above the mean price. [1 mark]

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- 5c. Find the probability that the price of a kilogram of tomatoes, chosen at random, will be between 2.00 and 3.00 euro. [2 marks]

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5d. To stimulate reasonable pricing, the city offers a free permit to the sellers whose price of a kilogram of tomatoes is in the lowest 20%. [2 marks]

Find the highest price that a seller can charge and still receive a free permit.

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Malthouse school opens at 08:00 every morning.

The daily arrival times of the 500 students at Malthouse school follow a normal distribution. The mean arrival time is 52 minutes after the school opens and the standard deviation is 5 minutes.

6a. Find the probability that a student, chosen at random arrives at least 60 minutes after the school opens. [2 marks]

6b. Find the probability that a student, chosen at random arrives between 45 minutes and 55 minutes after the school opens. [2 marks]

6c. A second school, Mulberry Park, also opens at 08:00 every morning. The arrival times of the students at this school follows exactly the same distribution as Malthouse school. [2 marks]

Given that, on one morning, 15 students arrive at least 60 minutes after the school opens, estimate the number of students at Mulberry Park school.

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Applicants for a job had to complete a mathematics test. The time they took to complete the test is normally distributed with a mean of 53 minutes and a standard deviation of 16.3. One of the applicants is chosen at random.

7a. Find the probability that this applicant took at least 40 minutes to complete the test. *[2 marks]*

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For 11% of the applicants it took longer than  $k$  minutes to complete the test.

7b. Find the value of  $k$ . *[2 marks]*

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There were 400 applicants for the job.

7c. Estimate the number of applicants who completed the test in less than 25 minutes. [2 marks]

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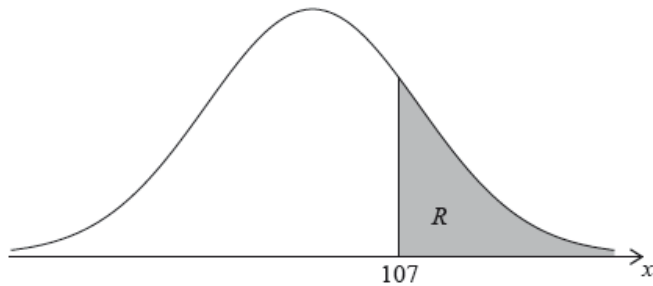
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The random variable  $X$  is normally distributed with a mean of 100. The following diagram shows the normal curve for  $X$ .



Let  $R$  be the shaded region under the curve, to the right of 107. The area of  $R$  is 0.24.

8a. Write down  $P(X > 107)$ . [1 mark]

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8b. Find  $P(100 < X < 107)$ .

[3 marks]

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8c. Find  $P(93 < X < 107)$ .

[2 marks]

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