

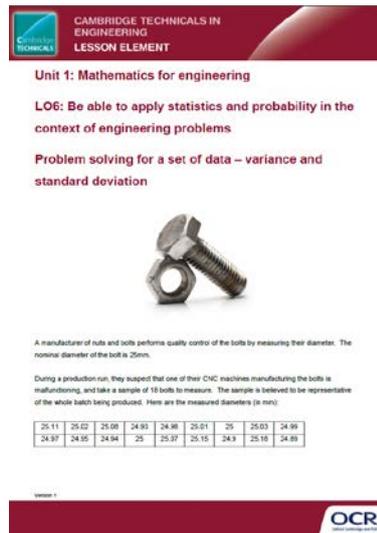
Unit 1: Mathematics for engineering

LO6: Be able to apply statistics and probability in the context of engineering problems

Problem solving for a set of data – variance and standard deviation

Instructions and answers for teachers

These instructions should accompany the OCR resource: 'Problem solving for a set data – variance and standard deviation' activity which supports OCR Level 3 Cambridge Technicals in Engineering.



**CAMBRIDGE TECHNICALS IN
ENGINEERING
LESSON ELEMENT**

Unit 1: Mathematics for engineering

LO6: Be able to apply statistics and probability in the context of engineering problems

Problem solving for a set of data – variance and standard deviation



A manufacturer of nuts and bolts performs quality control of the bolts by measuring their diameter. The nominal diameter of the bolt is 25mm.

During a production run, they suspect that one of their CNC machines manufacturing the bolts is malfunctioning, and take a sample of 18 bolts to measure. The sample is believed to be representative of the whole batch being produced. Here are the measured diameters (in mm):

25.11	25.02	25.08	24.93	24.98	25.01	25	25.03	24.99
24.97	24.95	24.94	25	25.07	25.15	24.8	25.18	24.88

Version 1



The Activity:

Problem solving for a set of data – variance and standard deviation



This activity offers an opportunity for English skills development.



This activity offers an opportunity for maths skills development.

Suggested timings:

1 hour

Activity 1

To note – this problem involves sample data. The formula for Variance and Standard Deviation must take account of this with N-1 being used.

The solutions to this problem have been calculated with the aid of a spreadsheet (supplied). Learners may calculate solutions manually, or could use ICT to develop a solution.

Mean Diameter = $450.2/16 = 25.0111$ mm **(solution to part a)**

Variance $\sigma^2 =$ average of the squared differences from the mean = $0.1120 / (18-1)$

Note: for sample data, $N = N-1$ i.e. $18 - 1$

Variance $\sigma^2 = 0.0066$ **(solution to part b)**

Standard Deviation $s = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$

Standard Deviation = $\sqrt{\text{variance}} = \sqrt{0.0066} = 0.0812$ mm **(solution to part c)**

So:

1SD higher than mean = $25.0111 + 0.0812 = 25.0923$ mm

1SD lower than mean = $25.0111 - 0.0812 = 24.93$ mm

In order to pass quality control checks, the diameter of bolts must be in the range 24.93 mm to 25.0923 mm

For the sample ... 5 out of 18 bolts fail **(solution to part d)**

$5/18 \times 100\% = 27.8\%$ bolts fail **(solution to part e)**

If the sample is representative of the batch, then the CNC machine is indeed malfunctioning.

You may wish to develop similar example problems.

Activity 2

To note – this problem involves population data. The formula for Variance and Standard Deviation must take account of this with N being used.

The solutions to this problem have been calculated with the aid of a spreadsheet (supplied). Again, solutions could be determined manually or using ICT.

Mean Concentration = $140/20 = 7$ mol/l **(solution to part a)**

Variance $\sigma^2 =$ average of the squared differences from the mean = $178 / 20$

Note: for population data $N = N$ i.e. 20

Variance $\sigma^2 = 8.9$ **(solution to part b)**

Standard Deviation $s = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2}$

Standard Deviation = $\sqrt{\text{variance}} = \sqrt{8.9} = 2.9833$ mol/l **(solution to part c)**

So:

2SD higher than mean = $7 + (2 \times 2.9833) = 12.9666$ mol/l

2SD lower than mean = $7 - (2 \times 2.9833) = 1.0334$ mol/l

In order to pass quality control, all concentration readings must be in the range 1.0334 mol/l to 12.9666 mol/l

For the population data, all values are in the range, and so the batch of sulphuric acid passes. **(solution to part d)**

You may wish to develop similar example problems.



CAMBRIDGE TECHNICALS IN ENGINEERING LESSON ELEMENT

We'd like to know your view on the resources we produce. By clicking on '[Like](#)' or '[Dislike](#)' you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

If you do not currently offer this OCR qualification but would like to do so, please complete the Expression of Interest Form which can be found here: www.ocr.org.uk/expression-of-interest

OCR Resources: *the small print*

OCR's resources are provided to support the teaching of OCR specifications, but in no way constitute an endorsed teaching method that is required by the Board, and the decision to use them lies with the individual teacher. Whilst every effort is made to ensure the accuracy of the content, OCR cannot be held responsible for any errors or omissions within these resources.

© OCR 2015 - This resource may be freely copied and distributed, as long as the OCR logo and this message remain intact and OCR is acknowledged as the originator of this work. OCR is aware that third party material has been used within these resources, but it has not been possible to acquire permission for use of this material.

Please get in touch if you want to discuss the accessibility of resources we offer to support delivery of our qualifications: resources.feedback@ocr.org.uk