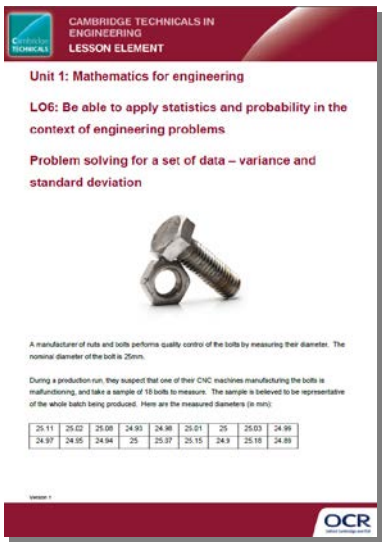
Unit 1: Mathematics for engineering

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 deviaton' *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	24.9	25.16	24.89

OCR

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

Version 1

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 σ^2 = average or the squared differences from the mean $= 0.1120 / (18\text{-}1)$

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 $= \sqrt{}$ 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)**

$5/18\text{x } 100\% = 27.8\%$ 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 σ^2 = average or the squared differences from the mean $= 178 / 20$

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

Variance σ^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 $= \sqrt{}$ 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 to12.9666 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.

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