

Quality assurance and control charts

About 50 minutes Calculator allowed 42 marks



Hints online, answers free with an account:
mathswariz.uk/worksheets/stats-quality-assurance-and-control-charts/

Date _____

A Do Now

The first question is what today's lesson needs. The others bring back earlier topics.

- | | |
|--|--|
| <p>A1 Needed today [2 marks]</p> <p>The scores in a list have mean 52 and standard deviation 14. Each score is multiplied by 3 and then 5 is added. Work out the new mean and the new standard deviation.</p> | <p>A2 Last lesson [2 marks]</p> <p>A city ward has 65 100 people, of whom 13 000 are women aged 15–44. There were 789 live births last year. Work out the general fertility rate, to 1 decimal place.</p> |
|--|--|

Answer

Answer

- | | |
|---|---|
| <p>A3 From chapter 8 [2 marks]</p> <p>A florist's cost index uses flowers (index 99, weight 6), vases (index 126, weight 8) and delivery (index 116, weight 7). Work out the weighted index number to 1 decimal place.</p> | <p>A4 Maths skill [2 marks]</p> <p>The mean of x, $x + 6$, $2x$ and $3x - 8$ is 24. Find x.</p> |
|---|---|

Answer

Answer

B Examples, then your turn

Your teacher works through each example with you. Then try the one beside it.

EXAMPLE 1

A machine fills bags with a target mass of 500 g. The sample means have a standard deviation of 4 g. Work out the warning limits and the action limits.

Hint Warning limits are 2 standard deviations from the target; action limits are 3.

- B1** A machine fills cartons with a target of 250 ml. The sample means have a standard deviation of 1.5 ml. Work out the warning limits and the action limits. [3 marks]

Answer

EXAMPLE 2

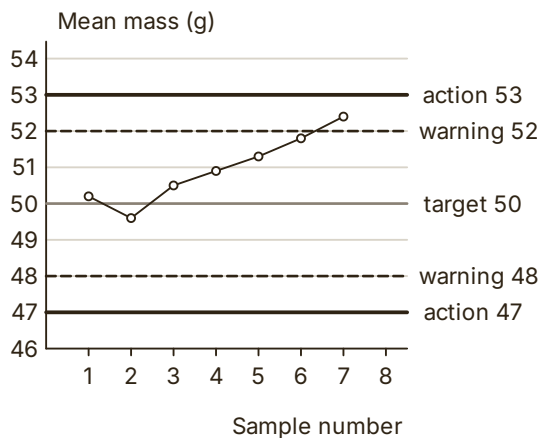
A control chart for the length of a cable has warning limits 78.6 cm and 81.4 cm, and action limits 77.9 cm and 82.1 cm. What should be done after a sample mean of (i) 81.0 cm, (ii) 81.7 cm, (iii) 82.4 cm?

Hint Find which band each mean is in: inside the warning limits, between the warning and action limits, or outside the action limits.

B2 A control chart for bottles of juice has warning limits 327 ml and 333 ml, and action limits 325.5 ml and 334.5 ml. What should be done after a sample mean of (i) 334.9 ml, (ii) 326.1 ml, (iii) 331.4 ml?

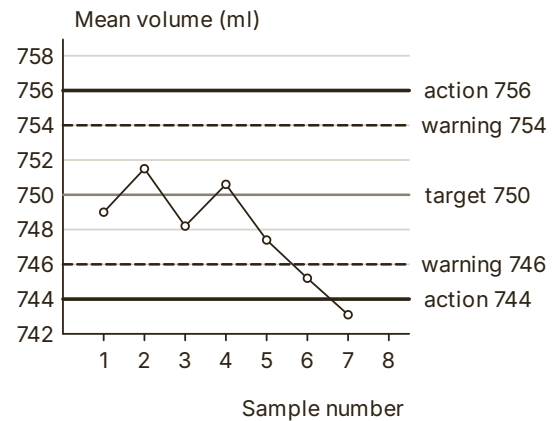
EXAMPLE 3

The chart shows the means of samples of packets of seeds. What should be done after sample 7? Describe the pattern in the means.



Hint Look at where sample 7 is, then at how the means change from sample 2 on.

B3 The chart shows the means of samples of tins of paint. What should be done after sample 6? What should be done after sample 7?

**EXAMPLE 4**

For bags of flour, the mean chart has action limits 296 g and 304 g, and the range chart has an upper action limit of 9 g. A sample of five bags has masses 302, 297, 305, 295 and 301 g. What should be done?

Hint Work out the mean AND the range, and check each on its own chart.

B4 For packs of butter, the mean chart has warning limits 497 g and 503 g. The range chart has an upper warning limit of 8 g and an upper action limit of 11 g. A sample of five packs has masses 498, 504, 501, 496 and 506 g. Work out the mean and the range. What should be done?

EXAMPLE 5

Explain why the action limits are 3 standard deviations from the target.

Hint How often is a sample mean more than 3 standard deviations from the target when the process is working?

- B5** A factory moves its action limits from 3 to 2.5 standard deviations from the target. Give one advantage and one disadvantage of this change. [2 marks]

C Practice

- C1** Bags of sugar have a target mass of 1500 g. The sample means have a standard deviation of 6 g. Work out the action limits. [2 marks]

Answer

- C2** A chart for the width of planks has warning limits 47.6 mm and 52.4 mm, and action limits 46.4 mm and 53.6 mm. What should be done after a sample mean of (i) 52.9 mm, (ii) 46.1 mm? [2 marks]

- C3** The mean chart for a batch of rolls has warning limits 58 g and 62 g, and action limits 57 g and 63 g. The range chart has an upper warning limit of 6 g and an upper action limit of 8 g. A sample of five rolls has masses 61, 58, 64, 57 and 60 g. What should be done? Give a reason. [3 marks]

- C4** A process is working correctly and 200 samples are taken. About how many sample means would you expect to fall outside the warning limits? [2 marks]

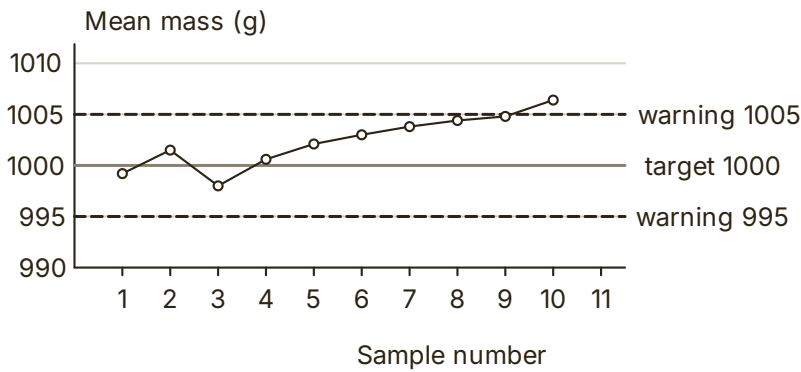
Answer

D Exam-style questions

- D1** The mean chart for cans of soup has action limits 247 g and 253 g, and the range chart has an upper action limit of 6 g. A sample of four cans has masses 251, 246, 253 and 254 g. Ben says, "The mean is inside the action limits, so the machine can carry on." [3 marks]

Is Ben correct? Show your working.

D2 A machine fills bags of potatoes with a target mass of 1000 g. The control chart shows the target, the warning limits and the means of the first 10 samples.



(a) Work out the standard deviation of the sample means used for this chart. [2 marks]

Answer

(b) Work out the action limits. [2 marks]

Answer

(c) What should be done after sample 10? Give a reason, and comment on the pattern in the means. [2 marks]

Total for D2: 6 marks

E Extension

No route is given. The hints are at the end of the sheet. Use one at a time.

E1
A control chart for jars of honey has action limits of 493.4 g and 506.6 g. Work out its warning limits.

[3 marks]

Answer

Extension hints

Cover these with paper. Uncover one at a time.

- E1**

Hint 1
The target is halfway between the action limits.

Hint 2
The target is 500 g, and each action limit is 3 standard deviations from it: $6.6 \div 3 = 2.2$.

Hint 3
The warning limits are $500 \pm 2 \times 2.2$.

How did it go?

Colour one circle on each line: not yet, nearly, yes.

- I can work out the warning and action limits from a target and a standard deviation.
- ☐ ☐ ☐
- I can decide what to do after a sample, using its mean and its range.
- ☐ ☐ ☐
- I can explain why the action limits are 3 standard deviations from the target.
- ☐ ☐ ☐