

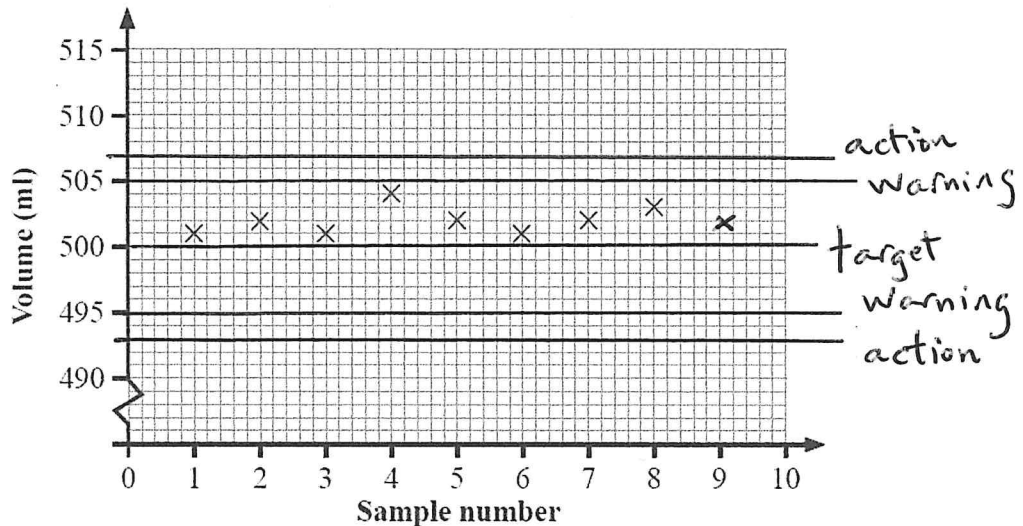
# Control Charts

**Q1** In a production process, a machine is programmed to dispense 500 ml of mouthwash into each bottle.

For quality assurance, warning and action limits are set at 5 ml and 7 ml.

Samples of bottles of mouthwash are taken at regular intervals and the mean volume of each sample is calculated.

The means of a series of eight samples are shown on the control chart below.



(a) On the control chart, draw and label the warning and action lines. [4]

For the ninth sample, five bottles are taken and the volume of mouthwash in each bottle is as follows:

501 ml      504 ml      503 ml      501 ml      501 ml

(b) Calculate the value of the ninth sample mean and plot it on the control chart.

$$\text{mean} = \frac{501 + 504 + 503 + 501 + 501}{5} = 502 \quad [3]$$

(c) Comment on what the control chart shows.

All results are within the warning lines.  
 There is no need to take another sample  
 There is no need to take action.  
 However, all results are over the target of 500. This may suggest that the [4] bottles are being overfilled. Perhaps a readjustment is required to fill closer to 500

A machine is programmed to fill bottles with 2000 ml of lemonade.

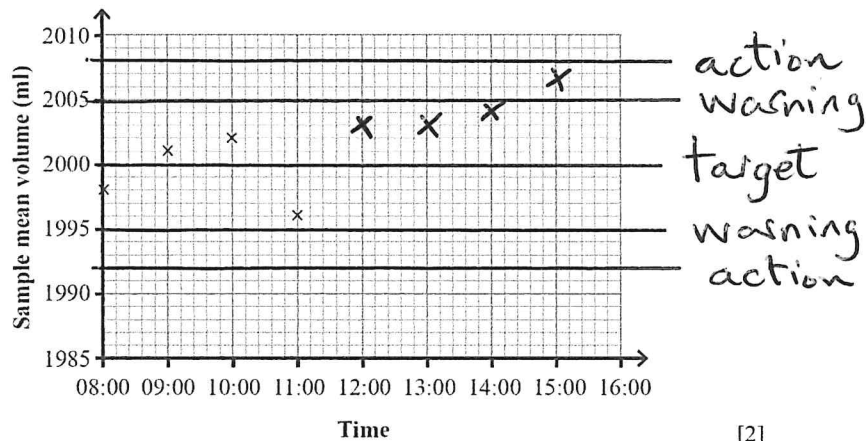
Samples are taken every hour and the sample mean is recorded.

The sample means for one day are given in the table below.

**Q2**

Time	Sample mean volume (ml)
08:00	1998
09:00	2001
10:00	2002
11:00	1996
12:00	2003
13:00	2003
14:00	2004
15:00	2007

(a) Plot the last four sample means on the control chart below.



The production manager has decided that warning lines should go onto the control chart at 5 ml above and below the target volume of 2000 ml.

Action lines should be added at 8 ml above and below the target volume.

(b) Draw and label the target, warning and action lines on the control chart. [3]

Warning 1995 + 2005      action 1992 & 2008

(c) What advice would you give to the production manager based on the control chart?

Because x is between 2005 - 2008 the manager must take a further sample immediately. This will help decide if further action is required. [3]

The general manager states:

"We should take samples every half an hour."

(d) Give an advantage and a disadvantage of this suggestion.

Advantage more results, if machine starts to overfill or underfill this will be noticed sooner  
Disadvantage more time and effort required

[1]

An engineering production line is set up to produce machine parts with a diameter of 24.50 mm.

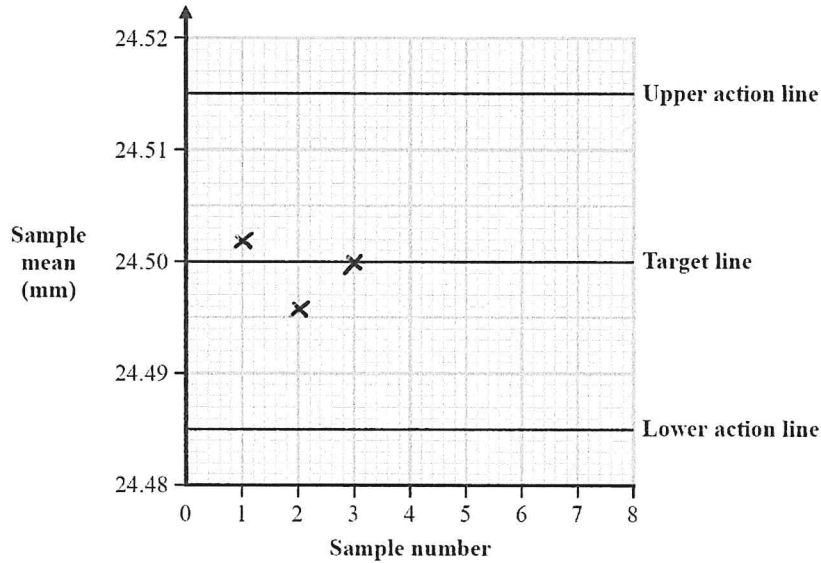
For quality control, random samples of size 4 are taken and the mean diameter of each sample is calculated.

The production line is set so that the sample means should be normally distributed with a mean of 24.50 mm and a standard deviation of 0.005 mm.

**Q3**

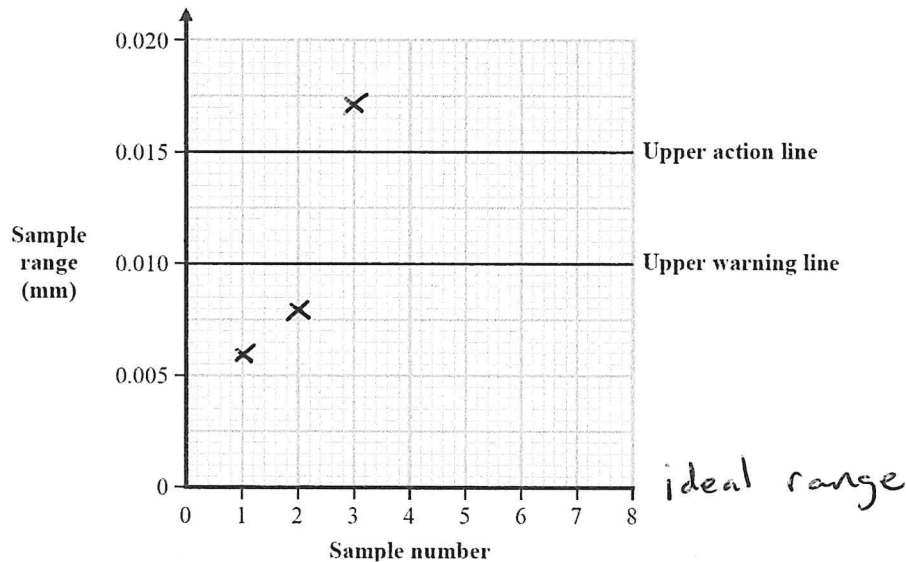
(a) Using this information, draw warning lines on the control chart for the sample means.

Action lines have already been drawn on the chart.



(2)

A control chart for the sample ranges is also used and is shown below.



(b) Explain why it is not appropriate to have lower warning lines and lower action lines on the control chart for sample ranges.

*The ideal range is zero that is when there is no variation*

(1)

The first two samples taken have the following summary statistics.

	Sample 1	Sample 2
Sample mean (mm)	24.502 ✓	24.496 ✓
Sample range (mm)	0.006	0.008

(c) Plot the summary statistics for these two samples on the control charts.

*careful with scales!*

The machine parts in Sample 3 had the following diameters:

24.498 mm    24.492 mm    24.501 mm    24.509 mm

(d) Use these results to complete both control charts for Sample 3

*mean = 24.500  
range = 0.017*

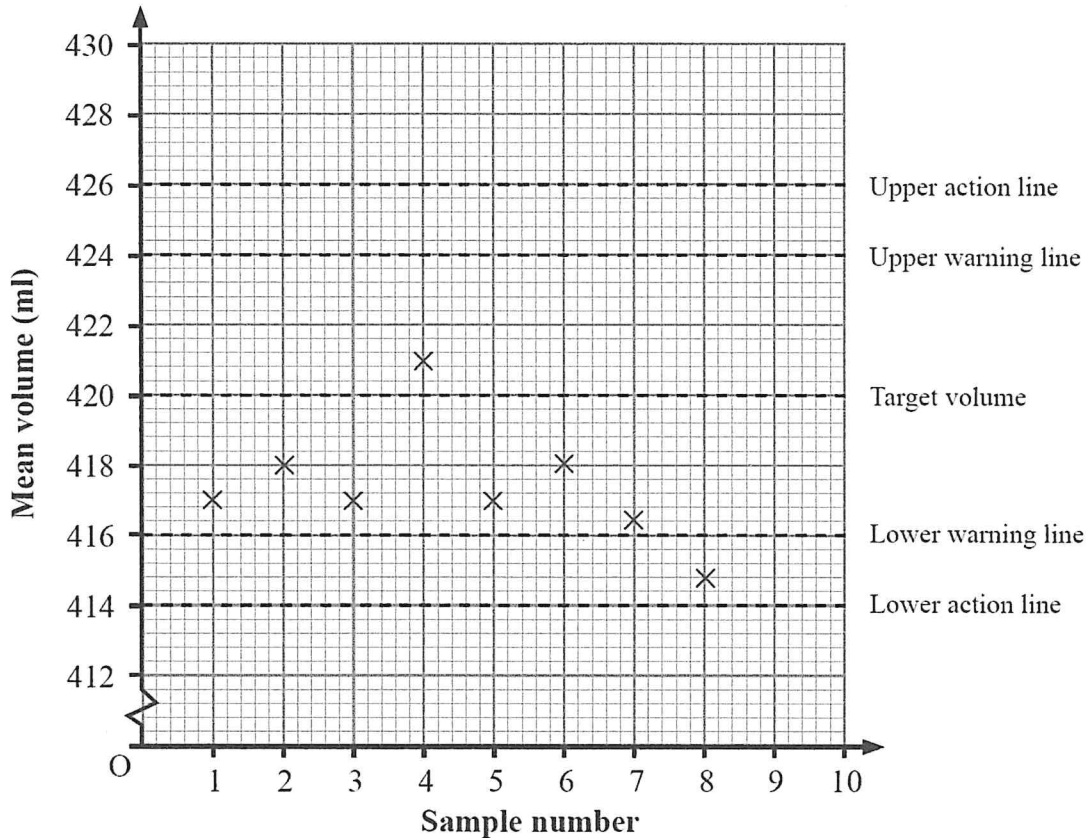
## Q4

A machine is designed to fill containers with soup.

The label on the container states that it holds 420 ml of soup.

For quality control, a sample of containers of soup is taken at regular intervals and the mean volume of soup is calculated.

The control chart below shows the mean volume of soup in the first eight samples during one day's production.



How might the value of the eighth sample mean be interpreted and what action, if any, needs to be taken?

The eighth sample is in the warning zone. This means a further sample should be taken immediately. If this sample is within the 416-424 zone then continue as normal

If sample 9 is within 414-416 or 424-426

then machine should be checked and recalibrated

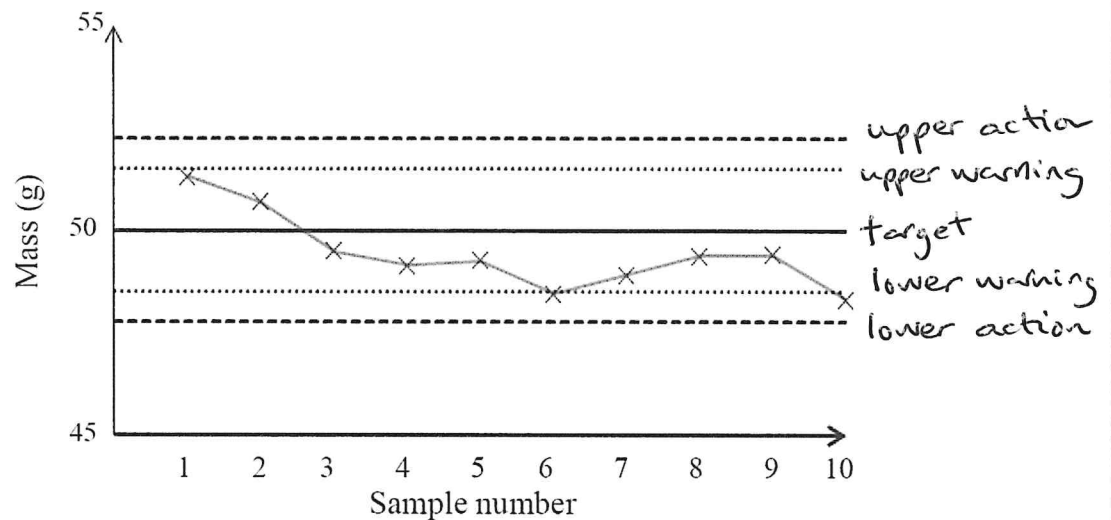
If sample is in action zone below 414 or above 426

then machine should be stopped, checked recalibrated

[5]

**Q5**

A factory produces packets of dried fruit. Each packet should have a mass of 50 g. Samples of packets are taken every hour and the mean mass of the sample is plotted on the control chart below.



- (a) Label the target line and the lower warning line on the chart. [2]
- (b) The machine packing the dried fruit needs to be checked if the control chart shows one (or more) of the following:
- One point outside the action lines;
  - Two out of three consecutive points outside the warning lines;
  - • Eight consecutive points are on the same side of the target line.

Explain how the control chart shows that the machine needs to be checked.

Because samples 3 → 10 are all below target of 50g the machine must be checked. This follows the 3rd regulation if eight consecutive points are on the same side. [1]