HIGHER

H08-30min Quality Assurance and Control Charts: 30-minute Pack

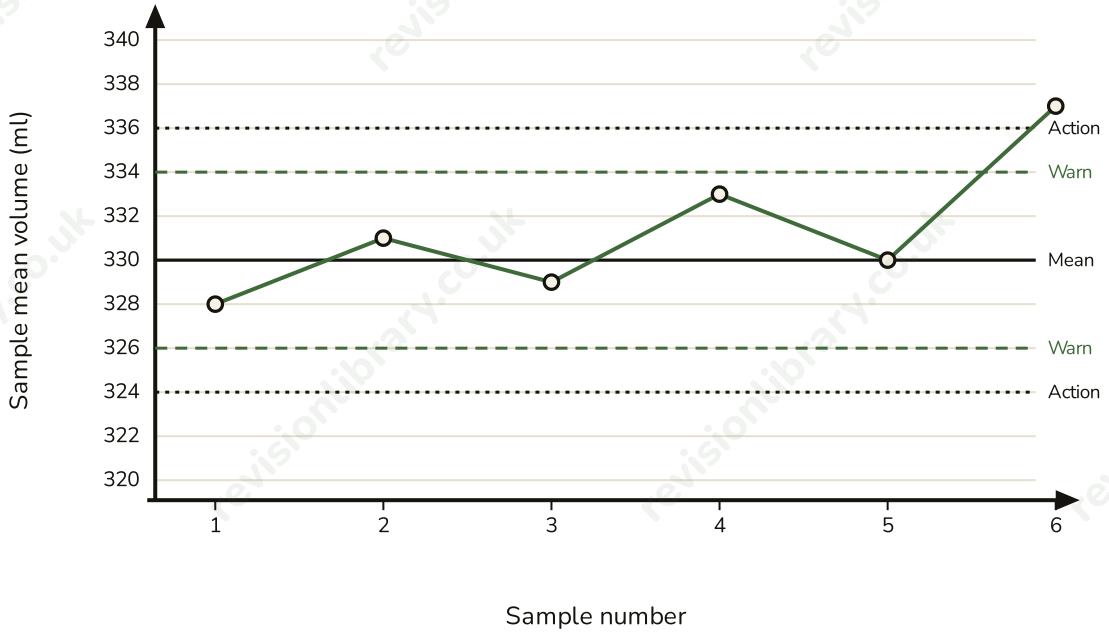
Total Marks

EDEXCEL 1ST0 · Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A factory fills bottles of fizzy drink to a target mean volume of 330 ml. The control chart shows the mean volume, in ml, of each of 6 samples taken during one shift. The warning limits are 326 ml and 334 ml; the action limits are 324 ml and 336 ml.



(a) Write down the mean volume of sample 3. **(1)**

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(b) Write down whether the mean volume of sample 4 lies within the warning limits. **(1)**

.....

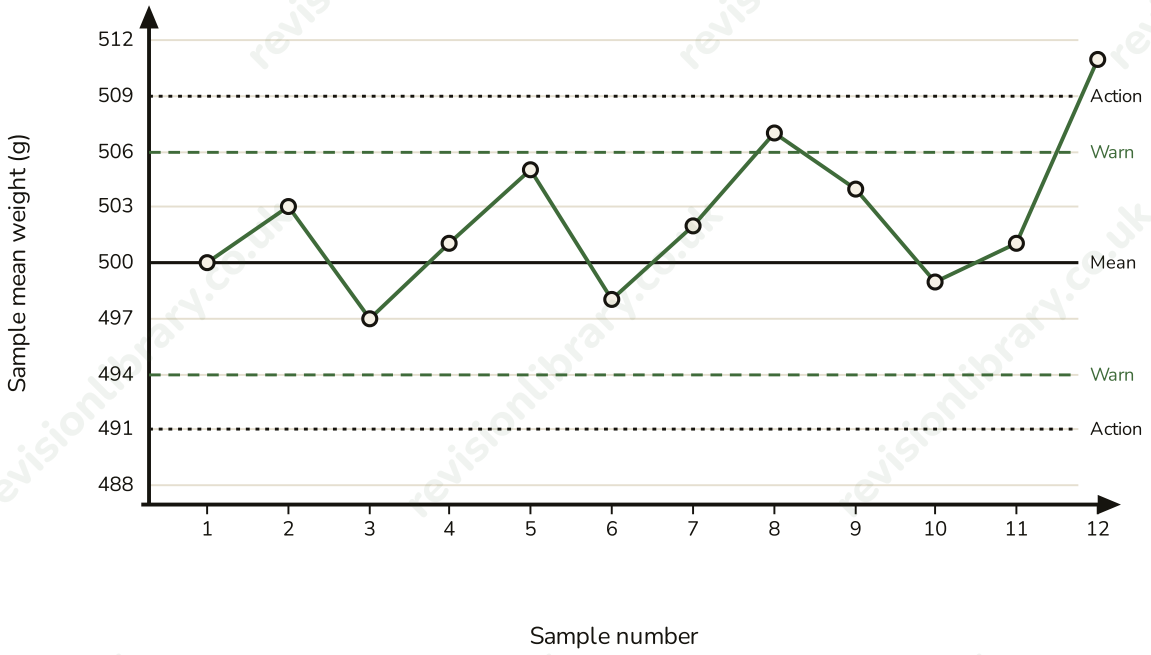
(c) Write down the number of the sample whose mean volume lies beyond an action limit. **(1)**

.....

(d) State the action the factory should take as a result of the point identified in part (c). **(1)**

(Total for Question 1 is 4 marks)

2 A machine fills bags of sugar. The target mean weight is 500 g, and the standard error of the sample mean has been calculated as 3 g. Samples of 4 bags are weighed every hour. The control chart shows the mean weight, in grams, of each of the first 12 samples taken.



(a) Work out the warning limits for this control chart. **(1)**

.....

(b) Work out the action limits for this control chart. **(1)**

.....

(c) Write down the mean weight of sample 5. **(1)**

.....

(d) Write down the number of the sample whose mean weight lies beyond an action limit. **(1)**

.....

(e) State the action that should be taken as a result of the point identified in part (d). **(2)**

(f) The mean weight of sample 8 is 507 g, which lies beyond the warning limit but not beyond the action limit. Explain how the action taken for sample 8 should differ from the action taken for sample 12. **(3)**

(Total for Question 2 is 9 marks)

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3 A soup factory uses two separate quality-control methods.

Method 1: During production, a control chart plots the mean weight of samples of 5 tins, taken every 30 minutes.

Method 2: After a batch of 2000 tins has been produced, a random sample of 40 tins is tested against a tolerance (specification) limit of 400 g ± 8 g. If more than 2 tins in the sample fall outside this tolerance, the whole batch is rejected.

(a) State the name usually given to the second quality-control method described above (Method 2). **(1)**

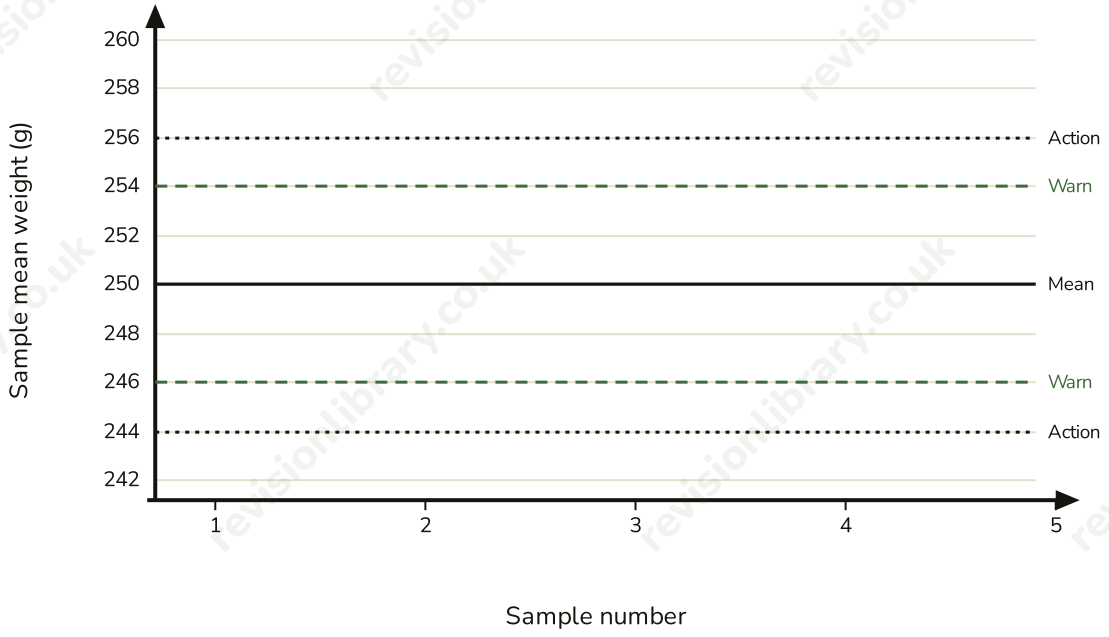
(b) Give two ways in which acceptance sampling of the finished batch (Method 2) is different from monitoring the process with a control chart (Method 1). **(2)**

(c) In a sample of 40 tins tested from one batch, 3 tins are found to weigh outside the tolerance limits of 400 g ± 8 g. Using the factory's rule, state with a reason whether this batch should be accepted or rejected. **(2)**

(Total for Question 3 is 5 marks)

4 A chocolate factory wraps bars with a target mean weight of 250 g. On the control chart provided, the mean (target) line, the warning limits (246 g and 254 g) and the action limits (244 g and 256 g) have already been drawn. Five samples of 4 bars were weighed. The individual weights, in grams, are shown in the table.

Sample	Bar weights (g)
1	248, 251, 249, 252
2	253, 250, 254, 251
3	247, 249, 246, 250
4	256, 254, 255, 255
5	260, 257, 258, 257



(a) Work out the mean weight of each of the 5 samples. **(2)**

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(b) Plot the five sample means on the control chart. **(2)**

(Total for Question 4 is 4 marks)

5 A trainee quality inspector at a cereal factory is setting up a control chart. The machine has a target mean box weight of 750 g and a process standard deviation of 12 g. Samples of 9 boxes are weighed at a time. Here is the trainee's working:

Standard error = 12 (used the standard deviation directly, without dividing by the square root of the sample size)
Warning limits = 750 ± 2 x 12 = 726 g and 774 g
Action limits = 750 ± 3 x 12 = 714 g and 786 g

(a) Identify the mistake in the trainee's working. **(1)**

(b) Work out the correct standard error, and the correct warning and action limits. **(3)**

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(Total for Question 5 is 4 marks)

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6 A control chart for a paint-can filling process has a target mean fill volume of 2000 ml. The process standard deviation is 24 ml. The action limits on the chart are set at 1976 ml and 2024 ml.

(a) Use the action limits and the target mean to work out the standard error of the sample mean used for this chart. **(2)**

.....

(b) Given that the process standard deviation is 24 ml, work out the sample size used for each sample on this chart. **(2)**

.....

(c) The factory wants to narrow the gap between the warning and action limits without changing the process itself. State whether the factory should increase or decrease the sample size, and explain why. **(2)**

(Total for Question 6 is 6 marks)

Mark scheme · H08-30min Quality Assurance and Control Charts: 30-minute Pack

Question 1

- (a) **B1** 329 (ml) cao
- **(a) Answer: 329 ml**
- (b) **B1** Yes/within the warning limits (333 ml is less than the upper warning limit of 334 ml) cao
- **(b) Answer: Yes - 333 ml is within the warning limits (326 ml to 334 ml).**
- (c) **B1** 6 cao
- **(c) Answer: Sample 6**
- (d) **B1** stop the filling process and investigate/correct it before continuing production, oe
- **(d) Answer: Stop the process and investigate before continuing.**

Question 2

- (a) **B1** 494 g and 506 g cao
- **(a) Answer: 494 g and 506 g**
- (b) **B1** 491 g and 509 g cao
- **(b) Answer: 491 g and 509 g**
- (c) **B1** 505 (g) cao
- **(c) Answer: 505 g**
- (d) **B1** 12 cao
- **(d) Answer: Sample 12**
- (e) **B1** stop the filling process immediately, oe
- (e) **B1** investigate the cause and adjust/recalibrate the machine before restarting production, oe
- **(e) Answer: Stop the process immediately; investigate and correct the machine before restarting.**
- (f) **B1** for sample 8, the process is not stopped and the machine keeps running, oe
- (f) **B1** instead, another sample is taken straight away (or the process is monitored closely), since a single point just beyond a warning limit could still be due to chance, oe
- (f) **B1** whereas sample 12 lies beyond the action limit, which is much less likely to be due to chance alone, so it requires immediate stopping and correction (unlike sample 8), oe
- **(f) Answer: Sample 8 (warning-limit breach only): keep the process running but take another sample immediately to check. Sample 12 (action-limit breach): stop the process immediately, since this is very unlikely to be due to chance alone.**

Question 3

- (a) **B1** acceptance sampling cao
- **(a) Answer: Acceptance sampling**
- (b) **B1** acceptance sampling checks a sample of finished/completed tins after production and compares them with a fixed tolerance (specification) limit, to decide whether to accept or reject the whole batch, oe
- (b) **B1** a control chart monitors the process continuously while it is running, comparing sample means with warning/action limits based on the process's own variation, to decide whether the process itself needs adjusting, oe
- **(b) Answer: Acceptance sampling tests finished tins against a fixed tolerance limit to accept or reject the whole batch; a control chart monitors sample means continuously during production, using limits based on the process's own variation, to decide whether the process needs adjusting.**
- (c) **M1** comparing 3 with the factory's threshold of 2
- (c) **A1** rejected, because 3 is more than the 2 tins allowed outside tolerance
- **(c) Answer: Rejected - 3 tins is more than the 2 allowed outside tolerance.**

Question 4

- (a) **M1** a correct method shown for at least one sample (e.g. summing the four weights and dividing by 4)
- (a) **A1** all five means correct: 250 g, 252 g, 248 g, 255 g, 258 g
- **(a) Answer: 250 g, 252 g, 248 g, 255 g, 258 g**
- (b) **B1** points plotted at the correct heights for samples 1, 2 and 3 (± half a small square), ft their means from (a)
- (b) **B1** points plotted at the correct heights for samples 4 and 5, showing sample 4 beyond the warning limit and sample 5 beyond the action limit, ft their means from (a)
- **(b) Answer: Points plotted at 250, 252, 248, 255 (beyond the warning limit) and 258 (beyond the action limit).**

Question 5

- (a) **B1** the trainee used the standard deviation itself as the standard error, instead of dividing it by the square root of the sample size ($\sqrt{9} = 3$), oe
- **(a) Answer: The trainee did not divide the standard deviation by $\sqrt{9}$; they used the standard deviation itself as the standard error.**
- (b) **M1** $12 / \sqrt{9}$ (= 4), oe
- (b) **A1** warning limits 742 g and 758 g
- (b) **A1** action limits 738 g and 762 g
- **(b) Answer: SE = 4 g; warning limits 742 g and 758 g; action limits 738 g and 762 g.**

Question 6

- (a) **M1** (2024 - 2000)/3, or (2000 - 1976)/3, oe
- (a) **A1** 8 (ml) cao
- **(a) Answer: 8 ml**
- (b) **M1** $n = (24/8)^2$, oe
- (b) **A1** 9 cao
- **(b) Answer: 9**
- (c) **B1** increase the sample size, oe
- (c) **B1** because a larger sample size reduces the standard error (SE = standard deviation / $\sqrt{\text{sample size}}$), which narrows both the warning and action limits (they move closer to the mean), oe
- **(c) Answer: Increase the sample size; a larger sample reduces the standard error, which narrows the warning and action limits.**