Question	Scheme	Marks	AOs
5(a)	$\frac{24.63-25}{'\sigma'} = -1.0364$	M1	3.1b
	$[\sigma =]0.357$ (must come from compatible signs)	A1	1.1b
	$P(D > k) = 0.4$ or $P(D < k) = 0.6$	B1	1.1b
	$\frac{k-25}{'0.357'} = 0.2533$	M1	3.4
	k = awrt **25.09**	A1	1.1b
		(5)	
(b)	$[Y \sim B(200, 0.45) \rightarrow]\ W \sim N(90, 49.5)$	B1	3.3
	$P(Y < 100) \approx P(W < 99.5)$ $\left[= P\left(Z < \frac{99.5-90}{\sqrt{49.5}} \right) \right]$	M1	3.4
	$= 0.9115\ldots$ awrt **0.912**	A1	1.1b
		(3)	
(c)	$H_0 : \mu = 25$ $H_1 : \mu < 25$	B1	2.5
	$[\bar{D} \sim] N\left(25, \frac{0.16^2}{20}\right)$	M1	3.3
	$P(\bar{D} < 24.94)[= P(Z < -1.677...)] = 0.046766...$	A1	3.4
	$p = 0.047 < 0.05$ or $z = -1.677\ldots < -1.6449$ or $24.94 < 24.94115\ldots$ or reject H_0 /in the critical region/significant	M1	1.1b
	There is sufficient evidence to support Hannah's belief.	A1	2.2b
		(5)	
			(13 marks)

Notes

(a)

M1: for standardising 24.63, 25 and 'σ' (ignore label) and setting = to z where $1 < |z| < 2$
A1: **[**$\sigma =$**]** awrt 0.36. Do **not** award this mark if signs are not compatible.
B1: for either correct probability statement (may be implied by correct answer)
this mark may be scored for a correct region shown on a diagram
M1: for a correct expression with z = awrt 0.253 (may be implied by correct answer)
A1: awrt 25.09 (Correct answer with no incorrect working scores 5 out of 5)

(b)

B1: setting up normal distribution approximation of binomial N(90, 49.5) (may be implied by a correct answer) Look out for e.g. $\sigma = \frac{3\sqrt{22}}{2}$ or $\sigma =$ awrt 7.04
M1: attempting a probability using a continuity correction i.e. $P(W < 100.5)$, $P(W < 99.5)$ or $P(W < 98.5)$ condone $\leq$ (The continuity correction may be seen in a standardisation).
A1: awrt 0.912 [Note: 0.911299… from binomial scores 0 out of 3]

(c)

B1: for both hypotheses in terms of μ
M1: selecting suitable model must see N(ormal), mean 25, sd = $\frac{0.16}{\sqrt{20}}$ (o.e.) or var = $\frac{4}{3125}$ (o.e.)
Condone N(25, $\frac{0.16}{\sqrt{20}}$) if $\frac{0.16}{\sqrt{20}}$ then used as s.d.
A1: p value = awrt 0.047 or **test statistic** awrt –1.68 or **CV** awrt 24.941
(any of these values imply the M1 provided they do not come from Normal mean = 24.94)
M1: a correct comparison (including compatible signs) **or** correct non-contextual conclusion (f.t. their p value, test statistic or critical value in the comparison)
M1 may be implied by a correct contextual statement
NB Any contradictory non contextual statements/comparisons score M0A0 e.g. '$p < 0.05$, not significant'
A1: correct conclusion in context mentioning Hannah's belief
or the mean amount/liquid in each bottle is now less than 25ml (**dep on M1A1M1**)