11			**See the exemplars at the end of the MS**			**NB. Use of a "continuity correction" loses 1st A1 only**
			<u>Hypotheses:</u>			
			H_0: $\mu = 3300$ H_1: $\mu > 3300$	**B1**	**1.1**	Allow other letter (including X) <u>only if</u> clearly defined Subtract B1 for each error eg: 2-tail B1B0 Undefined μ B1B0
			where μ = (population) mean mass	**B1**	**2.5**	not in terms of parameter B1B0 Not include 3300 B0B0 $\bar{X}$ stated or implied B0B0 $H_0 = 3300$ etc: B0B0 μ = sample mean implied B0 & (B1or B0)
			<u>Calculation and comparison</u>			
			$\bar{X} \sim N(3300, \frac{450^2}{200})$ or $N(3300, 1012.5)$ oe <u>and</u> $\bar{X} > 3360$	**M1***	**3.3**	Correct distribution and $\bar{X}$ (allow 3359.5, 3360.5, 3659) stated or implied eg by 0.0297 or 0.0307 or 0.0286 even if within incorrect statement eg $P(X = 3360) = 0.0297$ Allow $450^2 \div \sqrt{200}$ or $450^2 \div 200^2$ Not 0.0297 from $\mu = 3360$, $P(\bar{X} < 3300)$
			$P(\bar{X} > 3360) = 0.0297$ **(NB 3 sf)**	**A1**	**3.4**	**BC cao**

Question			Answer	Mark	AO	Guidance
			$0.0297 > 0.025$	A1	1.1	Explicit comparison Allow compare (**any value $\leq$ 0.35**) with 0.025
11	ctd		**Alternative method 1 for M1A1A1:** $\bar{X} \sim N(3300, \frac{450^2}{200})$ and $\bar{X} = 3360$	M1*		Correct distribution and $\bar{X}$ (allow $\bar{X} = 3359.5$ or 3360.5) stated or implied eg by 0.970 or 0.969 or 0.971 even if within incorrect statement eg $P(X = 3360) = 0.970$ Allow $450^2 \div \sqrt{200}$ or $450^2 \div 200^2$
			$P(\bar{X} < 3360) = 0.970$ **(NB 3 sf)**	A1		**BC cao**
			$0.970 < 0.975$	A1		Explicit comparison Allow compare (**any value $\geq$ 0.65**) with 0.975
			Alternative method 2 for M1A1A1: $\frac{a-3300}{450 \div \sqrt{200}} = 1.96$	M1*		May be implied, eg by 3362 Allow $450^2 \div \sqrt{200}$ or $450^2 \div 200^2$
			CR, $a = 3362$ **(NB 4 sf)**	A1		
			$3360 < 3362$ or 3360 is in acceptance region	A1		Explicit comparison of their a with 3360
			Alternative method 3 for M1A1A1: $\frac{3360-3300}{450 \div \sqrt{200}}$	M1*		Allow 3359.5 or 3360.5 May be implied, eg by 1.89 Allow $450^2 \div \sqrt{200}$ or $450^2 \div 200^2$
			CV of $z = 1.886$ or 1.89 **(NB 3 sf)**	A1		**cao**
			1.89 (or 1.90 or 1.9) < 1.96	A1		Explicit comparison

11	**ctd**		**Conclusion** Not reject H_0	**M1 dep**	**1.1**	Allow Reject H_1 or Accept H_0 Dep M1A1A1 or M1A0A1 or M1A1A0 Dep also on comparing like with like, eg not 0.970 > 0.025 May be implied by their conclusion, if M1 criterion is met ft with opposite conclusion if, eg $P(\bar{X} > 3360) = 0.024$
			There is insufficient evidence that (mean) mass (or mean) is > 3300 (g) or has increased	**A1f**	**2.2b**	Dep M1A1A1 or M1A0A1 or M1A1A0 In context, not definite; eg not "Mean mass not > 3300 g" Not "There is evidence that mean mass hasn't increased" Not "This suggests that mean mass hasn't increased" Not "Unlikely (or unsure) that mean has increased" ft with opposite conclusion if, eg $P(\bar{X} > 3360) = 0.024$
						Alternative scheme for incorrect method using 2-tails: Hypotheses **B1B0** Calculation: as above **M1A1** Compare 0.0125 oe **A1** Conclusion **M0A0**
				[7]		

Exemplars for Q11

Hypotheses

A	H_0: $\mu = 3300$ H_1: $\mu > 3300$ where μ = (pop) mean mass	 B1B1
B	H_0: $\mu = 3300$ H_1: $\mu > 3300$	 B1B0
C	H_0: The (pop) mean mass is 3300 H_1: The (pop) mean mass is greater than 3300 See Specimen paper q10 MS "Must be in terms of parameter values"	 B1B0
D	$H_0 = 3300$ $H_0 > 3300$	 B0B0
E	H_0: $\mu = 3300$ H_1: $\mu \neq 3300$ where μ = (pop) mean mass	 B1B0
F	H_0: $\mu = 3300$ H_1: $\mu \neq 3300$	 B0B0

Calculation, comparison and conclusion

G	No statement of distribution $P(\bar{X} = 3360) = 0.0297$ $0.0297 > 0.025$ Don't reject H_0 There is no evidence that mean mass has increased	 M1A1 A1 M1 A1
H	$P(\bar{X} = 3360.5) = 0.0286$ $0.0286 > 0.025$ Accept H_0 There is evidence that mean mass hasn't increased	M1A0 A1 M1 A0
I	$P(\bar{X} > 3360.5) = 0.0286$ Accept H_0 There is evidence that mean mass hasn't increased	M1A0 A0 M1 A0
J	$P(\bar{X} = 3359.5) = 0.024$ $0.024 < 0.025$ Reject H_0 There is evidence that mean mass has increased	M1A0 A1 M1 A1ft
K	$P(\bar{X} < 3360) = 0.970$ $0.970 < 0.975$ Reject H_1 Insufficient evidence that mean mass has changed	M1A1 A1 M1 A0
L	$P(\bar{X} > 3360) = 0.970$ $0.970 > 0.025$ Insufficient evidence that mean mass has increased	M1A1 A0 M0A0

M	$\overline{X} \sim N(3300, 1012.5)$	
	$P(\overline{X} > 3360) = 0.297$	M1A0
	$0.297 > 0.025$	A1
	Insufficient evidence that mean mass has increased	M1A1
N	$\mu \pm 1.96\sigma = 3237$ to 3362	M1A1
	3360 lies within this range	A1
	Can't reject H_0	M1
	Mean mass hasn't increased	A0
O	CV = 3362	M1A1
	$3360 < 3362$	A1
	Reject H_0. Evidence that level of poll't has increased.	M0A0
P	$(3360 - 3300) \div (450 \div \sqrt{200} = 1.886$	M1A1
	$1.866 < 1.96$	A1
	Don't reject H_0. Mean mass hasn't increased.	M1A0

<u>2-tail</u>

Q	H_0: $\mu = 3360$	
	H_1: $\mu \neq 3360$	B0B0
	$0.0297 > 0.0125$	A1
	Don't reject H_0	M0
	There is no evidence that mean mass has changed	A0
R	H_0: $\mu = 3360$	
	H_1: $\mu \neq 3360$ where μ = (pop) mean mass	B1B0
	$0.0297 > 0.025$	A0
	Don't reject H_0	M0
	There is no evidence that mean mass has changed	A0
S	H_0: The (pop) mean mass = 3360	
	H_1: The (pop) mean mass $\neq$ 3360	B0B0
	$0.97 < 0.9875$	A1
	Accept H_0	M0
	There is no evidence that mean mass has changed	A0