Question	Scheme	Marks	AOs
5(a)	$\left[X \sim \mathrm{N}\left(443, 6^2\right)\right]$		
	$\mathrm{P}\left(X < 440\right) =$	M1	3.4
	0.30853… awrt 0.309	A1	1.1b
		(2)	
(b)	$\mathrm{P}\left(X < 435 \cup X > 445\right) = 1 - \mathrm{P}\left(435 < X < 445\right)$ oe $= 1 - 0.53934...$	M1	3.1b/ 3.4?
	0.46065… awrt 0.461	A1	1.1b
		(2)	
(c)	$\mathrm{H}_0 : \mu = 443 \quad \mathrm{H}_1 : \mu < 443$	B1	2.5
	$\bar{X} \sim \mathrm{N}\left(443, \frac{4.5^2}{20}\right)$	M1	3.3
	p value = 0.16015… (> 0.05)	dM1	3.4
	Not in critical region, insufficient evidence to reject H_0, no significant evidence to support Kim's claim	A1	2.2b
		(4)	
(d)	Standardising, $\frac{438 - \mu}{\sigma} = -0.8416$ And $\frac{445 - \mu}{\sigma} = 1.2816$	M1 M1 B1 A1	3.1b 3.4 1.1b 1.1b
	Solving simultaneous equations $\mu = 440.77... = 440.8$ Hz cao $\sigma = 3.296... = 3.3$ Hz cao	M1 A1	1.1b 1.1b
		(6)	
			(14 marks)

Notes:

(a)

M1: attempt to use model with correct inequality

A1: awrt 0.309

(b)

M1: Use of $1 - \mathrm{P}\left(435 < X < 445\right)$ or $\mathrm{P}\left(X < 435\right) + \mathrm{P}\left(X > 445\right)$

If answer incorrect M1 could be given for sight of 0.539 … or 0.0912 **and** 0.369

A1: awrt 0.461

(c)

B1: hypotheses must be in terms of μ

M1: allow variance of $4.5^2/20$ but not just 4.5 or 4.5^2

dM1: dependent on previous M1, p value awrt 0.16

Alt method; Test statistic $z = \dfrac{442-443}{\dfrac{4.5}{\sqrt{20}}} = -0.9938...$ and critical value $z = (-)1.645$ or better

A1: correct conclusion in context, must mention **Kim's claim** or **mean frequency**

(d)

M1: attempt to standardise at least one of 438 and 445

M1: one equation formed condone sign errors

B1: $(-)0.8416$ or 1.2816 (or better) seen or implied

A1: both equations correct including signs

M1: solving their simultaneous equations

A1: 440.8 and 3.3 cao