Using Central Limit Theorem (Form OCR 4733)

Q1, (Jun 2009, Q6)

(i)	33.6	B1		33.6 clearly stated [not recoverable later]
	$\frac{115782.84}{100} - 33.6^2$ [= 28.8684]	M1		Correct formula used for biased estimate
	$\times\frac{100}{99}$ = **29.16**	M1 A1	**4**	$\times\frac{100}{99}$, M's independent. Eg $\frac{\Sigma r^2}{99}[-33.6^2]$ **SR** B1 variance in range [29.1, 29.2]
(ii)	$\bar{R} \sim N(33.6, 29.16/9)$ $= N(33.6, 1.8^2)$	M1 A1		Normal, their μ, stated or implied Variance [their (i)]÷9 [*not* ÷100]
	$1-\Phi\left(\frac{32-33.6}{\sqrt{3.24}}\right)$ [= Φ(0.8889)]	M1		Standardise & use Φ, 9 used, answer > 0.5, allow √ errors, allow cc 0.05 but *not* 0.5
	= **0.8130**	A1	**4**	Answer, art 0.813
(iii)	No, distribution of R is normal so that of $\bar{R}$ is normal	B2	**2**	Must be saying this. Eg "9 is not large enough": B0. Both: B1 max, unless saying that n is irrelevant.

Q2, (Jan 2012, Q4)

N(2.5, 0.025)	M1	Normal (any – can be implied by standardisation)
$\Phi\left(\frac{2.59-2.5}{\sqrt{0.025}}\right)$ = Φ (0.5692)	A1	Mean 2.5
	A1	Variance or SD 1.25 ÷ 50 stated or used
	A1	Standardise 2.59 or 2.61, with √(1.25/50)
= **0.7154**	A1	Answer in range [0.715, 0.716] *or* [0.736, 0.737] from 0.632
	[5]	

Q3, (Jun 2012, Q3)

(i)		$\left(\frac{71.2-72.0}{\sigma/\sqrt{40}}\right) = -0.3853$	M1	Standardise with Φ^{-1} & √40, allow cc, √ errors eg σ^2	RHS must be Φ^{-1}, i.e. *not* 0.7411 or 0.2589 or 0.6368 or 0.35. "1 –" error or ×40/39: M1A0
			A1	Square roots and sign correct, no cc, no "1 –" error	
			B1	z in range (±) [0.385, 0.386] seen	[0.674 may be from "1 – 0.35 = 0.75"]
		[σ = 13.13,] Var(V) = **172.4**	A1	*Final* answer in range [172, 173], or 13.1^2 cwo	Needs variance, not SD
			[4]		NB: Look out for –13.1 → 172, M1A0B1A0
(ii)		Parent distribution not known	B1	Or clear equivalent. Not "*sample* not normal"	Don't bother about order of these statements.
		n is large	B1	Or clear equiv, e.g. sample size > 30. Extras: max 1	If numerical must be 30. Ignore "continuous".
				"n large, $n > n_0$": B1 if $n_0 \geq 30$.	
			[2]		

Q4, (Jun 2013, Q4)

(i)		$\frac{\mu-157.18}{\sigma/\sqrt{80}}=1.282\ ;\ \frac{\mu-164.76}{\sigma/\sqrt{80}}=0.5244$ Solve simultaneously: $\boldsymbol{\mu=170}$ $\boldsymbol{\sigma=89.44}$	M1 A1 B1 B1 A1 A1 **6**	Standardise once with $\sqrt{80}$ or 80 and z, signs may be wrong, allow "1–" errors Both correct ***including signs***, no cc 1.28(155) seen anywhere, correct to 3 SF [0.524, 0.525] seen anywhere μ, a.r.t. 170 to 3 SF (169.98) σ, in range [89, 90], *not* isw *Don't* allow surds, e.g. $40\sqrt{5}$	Allow cc, but *not* 0.1, 0.7, 0.9, 0.3 or Φ(these) [= .5398, .758, .8159, .6179] z may be wrong (provided it *is* z) Ignore signs Ignore signs CWO×2 but allow from inaccurate z if answer(s) within limits. Look out for –89.44: A0A0
(ii)	**(a)** **(b)** **(c)**	In using normal tables Parent distribution not known n large, nothing wrong seen [must be in correct order, no repeats]	B1 B1 B1 **3**	Or equiv, e.g. "standardising", "dist of $\bar{Y}$" Allow "it is not normal", etc If numerical, must be of the form "$n > n_0$" or "$n \geq n_0$" with $30 \leq n_0 \leq 60$	Any reference to $\sigma/\sqrt{80}$: B0 No extras *Not* "≥ 80".

Q5, (Jun 2018, Q5)

(i)	$E(Y)=\Sigma yP(Y=y)$ [= 1.1] $Var(Y)=\Sigma y^2P(Y=y)-1.1^2=2.3-1.1^2=1.09$ Normal, mean their 1.1 variance their $\sigma^2/50=0.0218$	M1 A1 M1 A1ft B1ft [5]	Allow if $\Sigma p(Y=y)$ wrongly evaluated. *Not* for 1.1/50 if this is used to find var Exact only, can be implied Expect to see N(1.1, 0.0218) FT on their E(Y), numerical value needed FT on their Var(Y), numerical value needed as final answer, but allow "1.09/50". Not from binomial unless explicitly "variance"
(ii)	1.4, 1.42, 1.44, 1.46, 1.48, 1.5	B1 [1]	These only, but allow omission of 1.4 and 1.5