1	$\frac{20-25}{\sigma} = \Phi^{-1}(0.25) = -0.674$ $\sigma = 5 \div 0.674$ $= 7.42$	M1 B1 M1 A1 **4**	Standardise and equate to Φ^{-1} [*not* .7754 or .5987] z in range [–0.675, –0.674], allow + (±) 5 ÷ z-value [*not* $\Phi(z)$ or 0.75] Answer in range [7.41, 7.42], no sign fudges [SR: σ^2: M1B1M0A0 cc: M1B1M1A0]
2	P (1.2) Tables or correct formula used 0.8795	B1 M1 A1 **3**	

3 (i)	*Two of:* Distribution symmetric No substantial truncation Unimodal/Increasingly unlikely further from μ, etc	B1 B1 **2**	One property Another definitely different property Don't give both marks for just these two "Bell-shaped": B1 only unless "no truncation"
(ii)	Variance $8^2/20$ $z = \frac{47.0 - 50.0}{\sqrt{8^2/20}} = -1.677$ $\Phi(1.677) = 0.9532$	M1 A1 A1 A1 **4**	Standardise, allow cc, don't need *n* Denominator (8 or 8^2 or √8) ÷ (20 or √20 or 20^2) z-value, a.r.t. –1.68 or +1.68 Answer, a.r.t. 0.953

4	( )	**(a)**	$\frac{15.0-20.0}{\sigma}=-0.253$	M1		For standardising and equating to $\Phi^{-1}(p)$
				B1		For correct value 0.253 (or 0.254) seen
			Hence $\sigma=\frac{5}{0.253}\approx 19.8$	M1		For solving equation for σ
				A1	**4**	For correct value 19.8
		(b)	$g=25.0$, using symmetry	B1		For stating (or finding) the value of g
			Hence $\text{P}(G>2g)=1-\Phi\left(\frac{50.0-20.0}{19.8}\right)$	M1		For correct process for upper tail prob
			$=1-0.935=0.065$	A1	**3**	For correct answer
	(ii)	If normal, $\text{P}(G<0)$ is substantial		M1		For considering relevant normal probability
		Hence the assumption seems unjustified		A1	**2**	For stating the appropriate conclusion

9

Question			Answer	Marks	Guidance	
5			$\frac{150-\mu}{\sigma}=2.00$	M1	Standardise with σ, μ at least once, ignore cc, √ errors, equate to z	z not used, e.g. equated to 0.0228 and 0.9332 or 0.5092 and 0.8246: max M0M1
			$\frac{143-\mu}{\sigma}=-1.5$	A1	Both LHS and signs of RHS correct	One z, one not: M1A0B0
				B1	Both z-values correct to 3 SF	
			Solve to get	M1	Correct method for solution	Withhold if elimination done wrongly
			μ = 146, σ = 2	A1	$\mu \in [145.95, 146.05)$ www	$\sqrt{\sigma}$ or σ^2: can get M1A0B1M1A1A0
				A1	$\sigma \in [1.995, 2.005)$ or $\sigma^2 = 4$ www	cc: M1A0B1M1A0A0
				6		

(*6a*)	$X \sim N(42,3^2)$ $P(X > 50.0) = P\left(Z > \frac{50.0 - 42.0}{3.0}\right)$ $= P(Z > 2.667)$ $= 1 - \Phi(2.667) = 1 - 0.9962$ $= 0.0038$	M1 for standardizing M1 for prob. calc. with correct tail A1 **NB answer given**	**3**
(*6b*)	P(not positive) = 0.9962 P(At least one is out of 7 is positive) $= 1 - 0.9962^7 = 1 - 0.9737$ $= 0.0263$	B1 for use of 0.9962 in binomial expression M1 for correct method A1 CAO	**3**
(*6c*)	If an innocent athlete is tested 7 times in a year there is a reasonable possibility (1 in 40 chance) of testing positive. Thus it is likely that a number of innocent athletes may come under suspicion and suffer a suspension so the penalty could be regarded as unfair. *Or* this is a necessary evil in the fight against performance enhancing drugs in sport.	E1 comment on their probability in (i) B E1 for sensible contextual conclusion consistent with first comment	**2**
(*6d*)	B(1000, 0.0038)	B1 for B(,) or Binomial B1 *dep* for both parameters	**2**
(*6e*)	A suitable approximating distribution is Poisson(3.8) P(at least 10 positive tests) $= P(X \geq 10) = 1 - P(X \leq 9)$ $= 1 - 0.9942$ $= 0.0058$ *NB Do not allow use of Normal approximation.*	B1 for Poisson soi B1FT *dep* for $\lambda = 3.8$ M1 for attempt to use $1 - P(X \leq 9)$ A1 FT	**4**
(6f)	P(not testing positive) = 0.995 From tables $z = \Phi^{-1}(0.995) = 2.576$ $\frac{h - 48.0}{2.0} = 2.576$ $h = 48.0 + 2.576 \times 2.0 = 53.15$	B1 for 0.995 seen (or implied by 2.576) B1 for 2.576 (FT their 0.995) M1 for equation in *h* and positive z-value A1 CAO	**4**
			18

7. 0.677 (6)

8a. 0.126 (3)

8b. 0.281 (6)

9a. 0.298 (3)

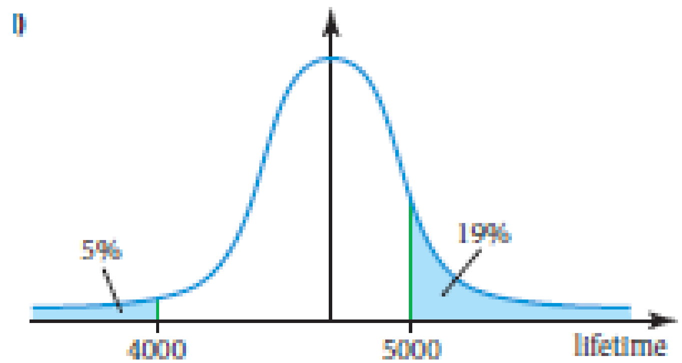
9b. 0.118 (6)

9c. 13 (3)

10a. 8.75 (4)

10b. 0.546 (3)

11a.



(2)

11b. $\mu = 4650$ (2)

11c. 0.44 (2 s.f.) (3)

11d. 3700 hours (3)

11e. 0.76 (2 s.f.) (3)