H1	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
	$X \sim$ females $X \sim N(165, 9^2)$, $Y \sim$ males $Y \sim N(178, 10^2)$	**M1**	3.3	5th Calculate probabilities for the standard normal distribution using a calculator.
	$P(X > 177) = P(Z > 1.33)$ (or = 0.0912)	**M1**	1.1b	
	$P(Y > 190) = P(Z > 1.20)$ (or = 0.1151)	**A1**	1.1b	
	Therefore the females are relatively taller.	**A1**	2.2a	
				(4 marks)

H2	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	$\log_{10} c = 1.89 - 0.0131t$ $c = 10^{1.89-0.0131t}$ $c = 77.6 \times 0.970^t$ (3 s.f.)	**M1** **M1** **A1**	1.1a 1.1b 1.1b	6th Understand exponential models in bivariate data.
		(3)		
b	b is the proportional rate at which the temperature changes per minute.	**A1**	3.2a	6th Understand exponential models in bivariate data.
		(1)		
c	Extrapolation/out of the range of the data.	**A1**	2.4	4th Understand the concepts of interpolation and extrapolation.
		(1)		
				(5 marks)
Notes				

H3	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	$\frac{29+21}{29+21+17+23+18+17}=\frac{50}{125}$	**M1**	1.1b	2nd Calculate probabilities from relative frequency tables and real data.
	$=0.4$	**A1**	1.1b	
		(2)		
b	$\frac{125-17}{125}=\frac{108}{125}$	**M1**	3.1a	4th Understand set notation.
	$=0.864$	**A1**	1.1b	
		(2)		
c	$\mathrm{P}(S\cap A)=\frac{17}{125}=0.136\neq \mathrm{P}(S)\times \mathrm{P}(A)=\frac{40}{125}\times\frac{64}{125}=0.163\ldots$	**M1**	2.1	4th Understand and use the definition of independence in probability calculations.
	So, S and A are not statistically independent.	**A1**	2.4	
		(2)		
d	B and C are not mutally exclusive	**B1**	2.2a	3rd Understand and use the definition of mutually exclusive in probability calculations.
	Being in team C does not exclude the possibility of winning a bronze medal	**B1**	2.4	
		(2)		
e	$\frac{15+24+14}{125}=\frac{53}{125}$	**M1**	3.1b	5th Calculate conditional probabilities using formulae.
	$=0.424$	**A1**	1.1b	
		(2)		
				(10 marks)
Notes				

H4	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	P($M < 850$) = 0.3085 (using calculator)	**B1**	1.1b	5th Calculate probabilities for the standard normal distribution using a calculator.
		(1)		
b	P($M < a$) = 0.1 and P($M < b$) = 0.9	**M1**	3.1b	5th Calculate probabilities for the standard normal distribution using a calculator.
	(using calculator) a = 772 g	**A1**	1.1b	
	b = 1028 g	**A1**	1.1b	
		(3)		
				(4 marks)
Notes				

H5	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	$H_0 : \rho = 0$, $H_1 : \rho < 0$ Critical value = -0.6319 $-0.6319 < -0.136$ no evidence to reject H_0 (test statistic not in critical region) There is insufficient evidence to suggest that the weight of chickens and average weight of eggs are negatively correlated.	**B1** **M1** **A1**	2.5 1.1a 2.2b	6th Carry out a hypothesis test for zero correlation.
		(3)		
b	Sensible explanation. For example, correlation shows there is no (or extremely weak) linear realtionship between the two variables.	**B1**	1.2	7th Interpret the results of a hypothesis test for zero correlation.
	For example, there could be a non-linear relationship between the two variables.	**B1**	3.5b	
		(2)		
				(5 marks)
Notes				

H6	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	n is large	**B1**	1.2	5th Understand the binomial distribution (and its notation) and its use as a model.
	p is close to 0.5	**B1**	1.2	
		(2)		
b	Mean = np	**B1**	1.2	5th Understand the binomial distribution (and its notation) and its use as a model.
	Variance = $np(1-p)$	**B1**	1.2	
		(2)		
c	There would be no batteries left.	**B1**	2.4	5th Select and critique a sampling technique in a given context.
		(1)		
d	H_0: $p = 0.55$ H_1: $p > 0.55$	**B1**	2.5	5th Carry out 1-tail tests for the binomial distribution.
		(1)		
e	$X \sim N(165, 74.25)$ $P(X \geqslant 183.5)$ $= P\left(Z \geqslant \frac{183.5-165}{\sqrt{74.25}}\right)$ $= P(Z \geqslant 2.146...)$ $=1 - 0.9838$ $= 0.0159$ Reject H_0, it is in the critical region. There is evidence to support the manufacturer's claim.	**B1** **M1** **M1** **A1** **A1** **M1** **A1**	3.3 3.4 1.1b 1.1b 1.1b 1.1b 2.2b	7th Interpret the results of a hypothesis test for the mean of a normal distribution.
		(7)		
				(13 marks)
Notes				

H7	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	$X \sim$ women's body temperature $X \sim N(36.73, 0.1482)$	**M1**	3.3	5th Calculate probabilities for the standard normal distribution using a calculator.
	$P(X > 38.1) = 0.000186$	**B1**	1.1b	
		(2)		
b	Sensible reason. For example, Call the doctor as very unlikely the temperature would be so high.	**B1**	2.2a	8th Solve real-life problems in context using probability distributions.
		(1)		
				(3 marks)
Notes				

H8	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	A statistic that is calculated from sample data in order to test a hypothesis about a population.	**B1**	1.2	5th Understand the language of hypothesis testing.
		(1)		
b	$H_0 : \rho = 0$, $H_1 : \rho \neq 0$ p-value < 0.05 There is evidence to reject H_0 There is evidence (at 5% level) of a correlation between the daily mean temperature and daily mean pressure.	**B1** **M1** **A1**	2.5 1.1b 2.2b	6th Carry out a hypothesis test for zero correlation.
		(3)		
c	Two sensible interpretations or observations. For example, Two distinct distributions Similar gradients of regression line. Similar correlations for each season. Lower temperaure in autumn. More spread for the daily mean pressure in autumn.	**B2**	3.2a	4th Use the principles of bivariate data analysis in the context of the large data set.
		(2)		
				(6 marks)
Notes				

H9	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Use of Newton's second law.	**M1**	3.1b	8th Understand general kinematics problems with vectors.
	$\mathbf{a} = \frac{\mathbf{F}}{2}$	**M1**	1.1b	
	$= \begin{pmatrix} 4 \\ 2 \end{pmatrix} t + \begin{pmatrix} 3 \\ -6 \end{pmatrix} t^2 (\text{m s}^{-2})$	**A1**	1.1b	
		(3)		
b	Integrate **a**	**M1**	1.1a	8th Solve general kinematics problems using calculus of vectors.
	$\mathbf{v} = \begin{pmatrix} 2 \\ 1 \end{pmatrix} t^2 + \begin{pmatrix} 1 \\ -2 \end{pmatrix} t^3 + \mathbf{c} (\text{m s}^{-1})$	**A1**	1.1b	
	$\mathbf{c} = 0$ because initially at rest.	**A1**	2.4	
	Integrate **v**	**M1**	1.1a	
	$\mathbf{r} = \begin{pmatrix} \frac{2}{3} \\ \frac{1}{3} \end{pmatrix} t^3 + \begin{pmatrix} \frac{1}{4} \\ -\frac{1}{2} \end{pmatrix} t^4 + \mathbf{c} (\text{m})$	**A1**	1.1b	
	$\mathbf{c} = 0$ because initially at origin.	**A1**	2.4	
		(6)		
c	Subsititute $t = 1$	**M1**	1.1a	6th Understand general kinematics problems with vectors.
	$\mathbf{v} = \begin{pmatrix} 2 \\ 1 \end{pmatrix} + \begin{pmatrix} 1 \\ -2 \end{pmatrix}$	**M1**	1.1b	
	$= \begin{pmatrix} 3 \\ -1 \end{pmatrix} (\text{m s}^{-1})$	**A1**	1.1b	
		(3)		
				(12 marks)
	Notes			

H11	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Moment from bus = $5000 \times 2 \times g$	**M1**	3.1a	5th Find resultant moments by considering direction.
	$= 10\,000g$ (N m)	**A1**	1.1b	
	Moment from gold = $1000 \times 12 \times g$	**M1**	3.1b	
	$= 12\,000g$ (N m)	**A1**	1.1b	
	Moment from people = $70 \times 8 \times n \times g$	**M1**	3.1a	
	$= 560ng$ (N m)	**A1**	1.1b	
	Total moment = $(22\,000 - 560n)g$ (N m)	**A1**	1.1b	
		(7)		
b	Forming an equation or inequality for n and solving to find ($n = 39.28\ldots$)	**M1**	1.1b	5th Solve equilibrium problems involving horizontal bars.
	Need 40 people.	**A1**	3.2a	
		(2)		
c	New moment from gold and extra person is $1070 \times 12 \times g$ (N)	**M1**	3.1a	5th Solve equilibrium problems involving horizontal bars.
	New total moment = $(22840 - 560n)g$ (N m)	**M1**	1.1b	
	$n = 40.78\ldots$	**A1**	3.2a	
	42 people (including the extra)	**A1**	2.4	
		(4)		
				(13 marks)

H10	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Use of suvat equations	**M1**	1.1a	8th Derive formulae for projectile motion.
	$x = 10t\cos\theta$	**A1**	1.1b	
	$y = 10t\sin\theta - \frac{1}{2}gt^2$	**M1**	1.1b	
	$= 10t\sin\theta - 5t^2$	**A1**	1.1b	
	Substitute $x = 10$ and $y = -5$	**M1**	1.1a	
	Solve x equation for t	**M1**	1.1b	
	$t = \frac{1}{\cos\theta}$	**A1**	1.1b	
	Substitute into y equation	**M1**	1.1a	
	$-5 = 10\tan\theta - 5\sec^2\theta$	**A1**	2.1	
	Use of $\sec^2\theta = 1 + \tan^2\theta$	**M1**	2.1	
	$(\tan\theta - 1)^2 = 1$ legitimately obtained	**A1**	2.1	
		(11)		
b	Solve for $\tan\theta$	**M1**	1.1a	8th Solve problems in unfamiliar contexts using the concepts of friction and motion.
	$\tan\theta = 0$ or $\tan\theta = 2$	**A1**	1.1b	
	$\theta = 0$ or 63.43…(°) (accept awrt 63)	**A1**	1.1b	
		(3)		
				(14 marks)
	Notes			

H12	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Integrate a w.r.t. t	**M1**	1.1a	5th Use integration to determine functions for velocity and/or displacement.
	$a = 180t - 180t^2$	**A1**	1.1b	
		(2)		
b	$180t - 180t^2 > 40$	**M1**	3.1a	7th Solve general kinematics problems in less familiar contexts.
	$20(3t-2)(3t-1) < 0$	**A1**	1.1b	
	$\frac{1}{3} < t < \frac{2}{3}$	**A1**	2.4	
	Breaking the speed limit between 20 and 40 minutes.	**A1**	3.2a	
		(4)		
c	Integrate v w.r.t. t	**M1**	1.1a	5th Use integration to determine functions for velocity and/or displacement.
	$x = 90t^2 - 60t^3\ (+C)$	**A1**	1.1b	
	When $t = 1, x = 30$	**A1**	3.1b	
	Average speed $= \frac{\text{distance}}{\text{time}}$	**M1**	1.1b	
	$30\ \text{km h}^{-1}$	**A1**	1.1b	
		(5)		
				(11 marks)
	Notes			