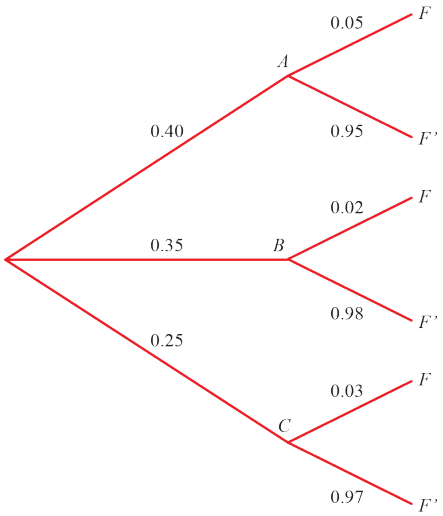
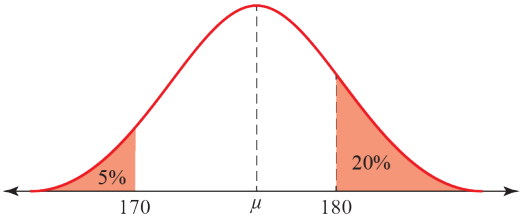
I1	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	$\log n = 0.7606 + 0.0635t$ $c = 10^{0.7606+0.0635t}$ $c = 5.76 \times 1.16^t$ (3 s.f.)	**M1** **M1** **A1**	1.1a 1.1b 1.1b	6th Understand exponential models in bivariate data.
		(3)		
b	a is a constant of proportionality.	**A1**	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				

MPH

I2	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	 Let $F \sim$ faulty	**B1** **B1** **B1**	2.5 1.1b 1.1b	3rd Draw and use tree diagrams with three branches and/or three levels.
		(3)		
b	$P(B \cap F') = 0.35 \times 0.98$	**M1**	1.1b	5th Understand and calculate conditional probabilities in the context of tree diagrams.
	$= 0.343$	**A1**	1.1b	
		(2)		
c	$P(F) = 0.4 \times 0.05 + 0.35 \times 0.02 + 0.25 \times 0.03$	**M1**	1.1b	5th Understand and calculate conditional probabilities in the context of tree diagrams.
	$= 0.0345$	**A1**	1.1b	
		(2)		
d	$P(C'\|F) = \frac{P(C' \cap F)}{P(F)} = \frac{0.4 \times 0.05 + 0.35 \times 0.02}{0.0345} = \frac{0.027}{0.0345}$	**M1** **A1ft**	3.1b 1.2	5th Calculate conditional probabilities using formulae.
	$0.7826...$ or $\frac{18}{23}$ (accept awrt 0.783)	**A1**	1.1b	
		(3)		
				(10 marks)
	Notes			

MPH

I3	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	 bell shaped	B1	1.2	5th Understand the basic features of the normal distribution including parameters, shape and notation.
	170, 180 on axis	B1	1.1b	
	5% and 20%	B1	1.1b	
		(3)		
b	$P(X < 170) = 0.05$ $\frac{170-\mu}{\sigma} = -1.6449$ $\mu = 170 + 1.6449\sigma$ $P(X > 180) = 0.2$ $\mu = 180 - 0.8416\sigma$ Solving simultaneously gives: $\mu = 176.615\ldots$ (awrt 176.6) and $\sigma = 4.021\ldots$(awrt 4.02)	M1 B1 B1 B1 M1 A1 A1	3.3 3.4 1.1b 3.4 1.1b 1.1b 1.1b	7th Find unknown means and/or standard deviations for normal distributions.
		(7)		
c	P(All three are taller than 175 cm) = $0.656\ldots^3$	M1	1.1b	5th Understand informally the link to probability distributions.
	= 0.282… (using calculator) awrt 0.282	A1	1.1b	
		(2)		
				(12 marks)
Notes				

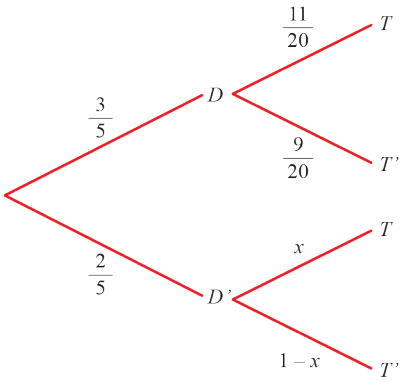
I4	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	The data seems to follow an exponential distribution.	**B1**	2.4	6th Understand exponential models in bivariate data.
		(1)		
b	$r = 0.9735$ is close to 1	**B1**	2.2a	2nd Know and understand the language of correlation and regression.
	which gives a strong positive correlation.	**B1**	2.4	
		(2)		
c	Model is a good fit with a reason. For example, Very strong positive linear correlation between t and $\log_{10} p$. The **transformed data points** lie close (enough) to a straight line.	**B2**	3.2a	6th Understand exponential models in bivariate data.
		(2)		
				(5 marks)

Notes

c

B0 for just stating the model is a good fit with no reason.

MPH

I5	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	 T = hand assignments in on time, D = start assignments on the day they are issued	**B1** **B1** **B1**	2.5 1.1b 1.1b	2nd Draw and use simple tree diagrams with two branches and two levels.
		(3)		
b i	$P(T \cap D) = P(T\|D) \times P(D)$	**M1**	3.1b	5th Understand and calculate conditional probabilities in the context of tree diagrams.
	$= \frac{3}{5} \times \frac{11}{20}$ $= \frac{33}{100}$ or 0.33	**A1**	1.1b	
		(2)		
b ii	$\frac{3}{5} \times \frac{11}{20} + x \times \frac{2}{5} = \frac{2}{3}$	**M1**	3.1b	5th Understand and calculate conditional probabilities in the context of tree diagrams.
	$x = \frac{101}{120}$ or 0.841…	**A1**	1.1b	
	$P(T' \cap D') = = \frac{2}{5}\left(1 - \frac{101}{120}\right)$	**M1**	1.1b	
	$= \frac{19}{300}$ or 0.0633… (accept awrt 0.0633)	**A1**	1.1b	
		(4)		

c	$P(T \cap D) = \frac{33}{100} \neq P(T) \times P(D) = \frac{2}{3} \times \frac{3}{5} = \frac{2}{5}$	**M1**	2.1	4th Understand and use the definition of independence in probability calculations.
	So, T and D are not statistically independent.	**A1**	2.4	
		(2)		
				(11 marks)

Notes

b ii Alternative solution

$P(T' \cap D') = 1 - P(T \cup D)$

$P(T \cup D) = \frac{2}{3} + \frac{3}{5} - \frac{33}{100}$

$= \frac{281}{300}$

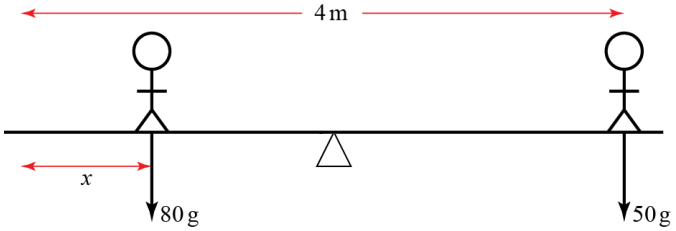
$P(T' \cap D') = 1 - \frac{281}{300} = \frac{19}{300}$

MPH

I6	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	A critical value is the point (or points) on the scale of the test statistic beyond which we reject the null hypothesis.	**B1**	1.2	5th Understand the language of hypothesis testing.
		(1)		
b	$H_0 : \rho = 0$, $H_1 : \rho > 0$ Critical value = 0.5494 0.714 > 0.5494 (test statistic in critical region) There is evidence to reject H_0 There is evidence that there is a positive correlation between the number of vehicles and road traffic accidents.	**B1** **M1** **A1**	2.5 1.1b 2.2b	6th Carry out a hypothesis test for zero correlation.
		(3)		
c	$r = -7.0 + 0.02v$	**B1**	1.2	4th Make predictions using the regression line within the range of the data.
		(1)		
d	Road fatalities per 100 000 population.	**B1**	1.2	2nd Know and understand the language of correlation and regression.
		(1)		
e	Outside the range of the data used in the model. or This would require extrapolation.	**B1**	3.5b	4th Understand the concepts of interpolation and extrapolation.
		(1)		
				(7 marks)
Notes				

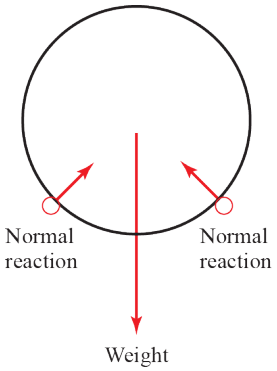
I7	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Moment from bus = $5000 \times 2 \times g$	**M1**	3.1a	5th Find resultant moments by considering direction.
	$= 10\,000g$ (N m)	**A1**	1.1b	
	Moment from gold = $1000 \times 12 \times g$	**M1**	3.1b	
	$= 12\,000g$ (N m)	**A1**	1.1b	
	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)

I8	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Net force is **C** + **W**	**M1**	3.1b	4th Calculate resultant forces using vectors.
	$=\begin{pmatrix}5\\-1\end{pmatrix}$	**A1**	1.1b	
		(2)		
b	Use of Newton's 2nd Law.	**M1**	3.1b	5th Use Newton's second law to model motion in two directions.
	$\mathbf{a}=\frac{F}{m}$	**M1**	1.1b	
	$=\begin{pmatrix}50\\-10\end{pmatrix}$	**A1**	1.1b	
		(3)		
c	$\mathbf{s}=\mathbf{u}t+\frac{1}{2}\mathbf{a}t^2$	**M1**	1.1a	5th Use the equations of motion to solve problems in familiar contexts.
	$=\begin{pmatrix}1\\1\end{pmatrix}t+\frac{1}{2}\begin{pmatrix}50\\-10\end{pmatrix}t^2$	**M1**	1.1b	
	$x=t+25t^2$	**A1**	1.1b	
	$y=t-5t^2$	**A1**	1.1b	
		(4)		
d	Substitute $t = 10$	**M1**	3.1b	5th Use the equations of motion to solve problems in familiar contexts.
	$x = 2510$	**A1**	1.1b	
	$y = -490$	**A1**	1.1b	
	Distance travelled $=\sqrt{2510^2+(-490)^2}$	**M1**	1.1a	
	2557.38…(m) (Accept awrt 2560)	**A1**	3.2a	
		(5)		
				(14 marks)
	Notes			

I9	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	**Figure 1**  Force labels one mark each Allow explicit evaluation with g.	**B2**	2.5	4th Calculate moments.
		(2)		
b	Alice: Moment = $2 \times 50 \times g$	**M1**	1.1b	5th Calculate sums of moments.
	$= 100g$ (N m)	**A1**	1.1b	
	Bob: Moment = $(2 - x) \times 80 \times g$	**M1**	3.4	
	$= 80(2 - x)g$ (N m)	**A1**	1.1b	
	Total clockwise moment = $20g(4x - 3)$ (N m)	**A1**	1.1b	
		(5)		
c	Equating to 0 and solving	**M1**	3.4	5th Solve equilibrium problems involving horizontal bars.
	$x = 0.75$ (m)	**A1**	1.1b	
		(2)		
d	Identifying 2 as a limit	**M1**	2.4	7th Solve problems involving bodies on the point of tilting.
	So tilts towards Alice when $0.75 < x \leqslant 2$	**A1**	2.2a	
		(2)		
e	Any valid limitation. For example, Pivot not a point. Alice can't sit exactly on the end. The see-saw might bend.	**A1**	3.5	3rd Understand assumptions common in mathematical modelling.
		(1)		

MPH

I10	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Use of $s = ut + \frac{1}{2}at^2$	**M1**	1.1a	6th Resolve velocity into horizontal and vertical components.
	Initial velocity is $(\cos\theta, \sin\theta)$	**A1**	3.4	
	$x = t\cos\theta$	**A1**	1.1b	
	$y = t\sin\theta - 5t^2$	**B1**	1.1b	
		(4)		
b	Solve $y = 0$ for t	**M1**	3.4	5th Model horizontal projection under gravity.
	$t(\sin\theta - 5t) = 0$	**A1**	1.1b	
	$t = 0$ or $t = \frac{\sin\theta}{5}$	**A1**	1.1b	
	$t = 0$ is initial position so $t = \frac{\sin\theta}{5}$	**M1**	2.4	
	$x = \frac{\cos\theta\sin\theta}{5} = \frac{2\sin\theta\cos\theta}{10} = \frac{\sin 2\theta}{10}$	**A1**	1.1b	
		(5)		
c	Sketch of $\sin 2\theta$ or other legitimate method.	**M1**	2.2a	6th Resolve velocity into horizontal and vertical components.
	Maximum is at $\theta = 45°$	**A1**	2.4	
		(2)		
d	Correct limitation. For example, air resistance.	**B1**	3.5b	3rd Understand assumptions common in mathematical modelling.
		(1)		
				(12 marks)
Notes				

I11	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a				3rd Draw force diagrams.
	One correct force with correct label.	B1	2.5	
	Two more correct forces with correct labels.	B1	2.5	
		(2)		
b	Resolve vertically.	M1	1.1b	5th Calculate resultant forces in perpendicular directions.
	Weight = $8g$	M1	1.1b	
	= 78.4	M1	1.1b	
	Vertical part of normal reaction is $2R\cos 40$	A1	1.1b	
	$2R\cos 40 = 78.4$	M1	1.1b	
	Solve for R	M1	1.1b	
	$R = 51.171\ldots$ (N) accept awrt 51	A1	1.1b	
		(7)		
				(9 marks)