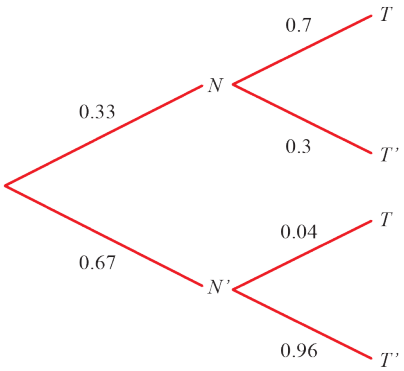
G1	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Linear association between *e* and *f*.	**B1**	1.2	2nd Know and understand the language of correlation and regression.
		(1)		
b	It requires extropolation and hence it may be unreliable.	**B1**	1.2	4th Understand the concepts of interpolation and extrapolation.
		(1)		
c	Fuel consumption (*f*)	**B1**	1.2	2nd Know and understand the language of correlation and regression.
		(1)		
d	A hypothesis test is a statistical test that is used to determine whether there is enough evidence in a sample of data to infer that a certain condition is true for the entire population.	**B1**	1.2	5th Understand the language of hypothesis testing.
		(1)		
e	$H_0 : \rho = 0$, $H_1 : \rho < 0$ Critical value = −0.3665 −0.803 < −0.3665 (test statistic in critical region) Reject H_0 There is evidence that the product moment correlation coeficient for CO_2 emissions and fuel consumption is less than zero.	**B1** **M1** **A1**	2.5 1.1b 2.2b	6th Carry out a hypothesis test for zero correlation.
		(3)		
				(7 marks)
Notes				

MPH

G2	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	 Let N~ new tyre and T~ tracking P(N) = 0.33 and P(T) = 0.67 0.7, 0.3, 0.04 and 0.96	**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(exactly one defect) = 0.33 × 0.3 + 0.67 × 0.04	**M1**	3.1b	5th Understand the language and notation of conditional probability.
	= 0.1258	**A1**	1.1b	
		(2)		
c	1 − P(no defects) =1− 0.67 × 0.96 × 0.65	**M1**	3.1b	5th Understand the language and notation of conditional probability.
	= 0.5819… awrt 0.582 (3 d.p.)	**A1**	1.1b	
		(2)		
d	To have their cars checked regularly as there is over a 50 % chance they need new tyres, tracking or brake pads.	**B1**	3.2a	5th Understand the language and notation of conditional probability.
		(1)		
				(8 marks)
Notes				

MPH

G3	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Bell shaped.	**B1**	2.2a	5th Understand the basic features of the normal distribution including parameters, shape and notation.
		(1)		
b	$X \sim$ Daily mean pressure $X \sim \text{N}(1006, 4.4^2)$	**M1**	3.3	5th Calculate probabilities for the standard normal distribution using a calculator.
	$\text{P}(X < 1000) = 0.0863$	**A1**	1.1b	
		(2)		
c	A sensible reason. For example, The tails of a Normal distribution are infinite. Cannot rule out extreme events.	**B1**	2.4	5th Understand the basic features of the normal distribution including parameters, shape and notation.
		(1)		

MPH

d	Comparison and sensible comment on means. For example, The mean daily mean pressure for Beijing is less than Jacksonville. This suggests better weather in Jacksonville. Comparison and sensible comment on standard deviations. For example, The standard deviation for Beijing is greater than that for Jacksonville. This suggests more consistent weather in Jacksonville. Student claim could be correct.	**B1** **B1** **B1** **B1**	2.2b 2.2b 2.2b 2.2b	8th Solve real-life problems in context using probability distributions.
		(4)		
				(8 marks)

Notes

a

Do not accept symmetrical with no discription of the shape.

d

B2 for Suggests better weather in Jacksonville but less consistent.

G4	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Linear association between two variables.	**B1**	1.2	2nd Know and understand the language of correlation and regression.
		(1)		
b	Negative correlation.	**B1**	1.2	2nd Know and understand the language of correlation and regression.
		(1)		
c	As daily mean pressure increases (rises) daily mean wind speed decreases (falls) in Hurn May to October in 2015. or As daily mean pressure decreases (falls) daily mean wind speed increases (rises) in Hurn May to October in 2015.	**B1**	3.2	5th Interpret the PPMC as a measure of correlation.
		(1)		
d	$H_0 : \rho = 0$, $H_1 : \rho < 0$ p-value < 0.05 There is evidence to reject H_0. There is (strong) evidence of negative correlation between the daily mean wind speed and daily mean pressure.	**B1** **M1** **A1**	2.5 1.1b 2.2b	6th Carry out a hypothesis test for zero correlation.
		(3)		
e	Daily mean wind speed = 180 − 0.170 × daily mean pressure.	**B2**	1.1b	4th Use the principles of bivariate data analysis in the context of the large data set.
		(2)		

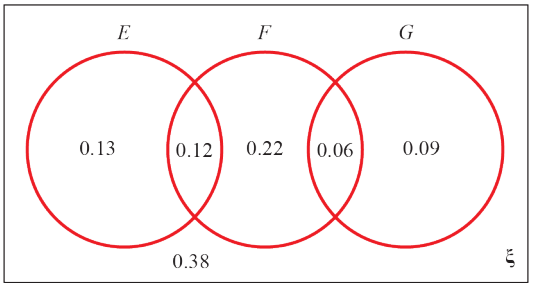
MPH

f	The regression model suggests for every hPa increase in daily mean pressure the daily mean wind speed decreases by 0.1694 knots. or The regression model suggests for every hPa decrease in daily mean pressure the daily mean wind speed increases by 0.1694 knots.	**B1**	3.2	4th Use the principles of bivariate data analysis in the context of the large data set.
		(1)		
g	Sensible comment. For example, Not very accurate as very few or no points Not very accurate as near the bottom range for the data.	**B1**	3.5b	4th Make predictions using the regression line within the range of the data.
		(1)		
				(10 marks)

Notes

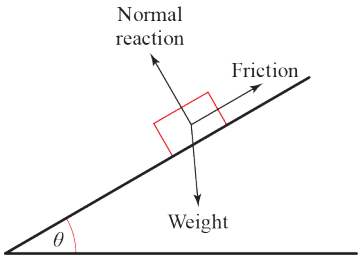
e

B1 $y = 180.0 - 0.1694x$ unless x and y are defined.

G5	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	$P(E'\|F') = \frac{P(E' \cap F')}{P(F')}$ or $\frac{0.47}{0.6}$	M1	3.1a	4th Calculate probabilities using set notation.
	$= \frac{47}{60}$ or 0.783 (3 s.f.)	A1	1.1b	
		(2)		
B	$P(E) \times P(F) = 0.25 \times 0.4 = 0.1 \neq P(E \cap F) = 0.12$	M1	2.1	4th Understand and use the definition of independence in probability calculations.
	So, E and F are not statistically independent.	A1	2.4	
		(2)		
c		B1	2.5	3rd Understand and use Venn diagrams for multiple events.
	Use of independence and all values in G correct.	M1A1	3.1a	
	All values correct.	M1A1	1.1b 1.1b 1.1b	
		(5)		
d	$P([F \cup G]') = 0.13 + 0.38$	M1	3.1a	4th Calculate probabilities using set notation.
	$= 0.51$	A1	1.1b	
		(2)		
				(11 marks)
	Notes			

G6	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
	$X \sim \text{B}(200, 0.54)$	**B1**	3.3	7th Use the normal distribution to approximate a binomial distribution.
	$Y \sim \text{N}(108, 49.68)$	**B2**	3.1b	
	$\text{P}(X > 100) = \text{P}(X \geqslant 101)$	**M1**	3.4	
	$= \text{P}\left(Z \text{ Ö} \frac{100.5 - 108}{\sqrt{49.68}}\right)$	**M1**	1.1b	
	$= \text{P}(Z \geqslant -1.06...) = 0.8554$	**A1**	1.1b	
				(6 marks)
Notes				

G7	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
	Moment on see-saw is force × distance from pivot.	**M1**	1.1a	5th Solve equilibrium problems involving horizontal bars.
	Moment on Poppy's see-saw due to Poppy is $pg \times 3 = 3pg$ (N m)	**M1**	2.2a	
	Force on Bob due to Poppy is $\frac{3pg}{2}$ (N)	**A1**	2.2a	
	Force on Bob due to Quentin is $\frac{3qg}{2}$ (N)	**A1**	2.2a	
	Total force on Bob is $\frac{3}{2}(p+q)g$ (N)	**M1**	2.2a	
	Weight of Bob is $80g$ (N)	**M1**	1.1b	
	Forces are equal so $\frac{3}{2}(p+q)g = 80g$	**M1**	3.1b	
	$p + q = 53$ to the nearest whole number.	**A1**	2.4	
				(8 marks)

G8	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	 B1 for each correct force with correct label.	B3	2.5	3rd Draw force diagrams.
		(3)		
b	Resolve horizontally/vertically or along/perp to plane.	M1	1.1b	7th The concept of limiting equilibrium.
	$R = 3g\cos\theta$	A1	1.1b	
	$F = 3g\sin\theta$	A1	1.1b	
	Limiting equilibrium means $\mu R = F$ $\mu R = 3\mu g\cos\theta$	A1	1.1b	
	$3\mu g\cos\theta = 3g\sin\theta$	M1	1.1b	
	$\mu = \tan\theta$	A1	1.1b	
		(6)		
c	$\tan 30 = 0.577\ldots$	A1	3.1a	7th The concept of limiting equilibrium.
	For limiting equilibrium, $\mu = 0.577\ldots$	M1	3.1a	
	But $\mu = 0.3$ so less friction.	M1	3.1a	
	Hence the object slips.	A1	3.2a	
		(4)		
d	No object would remain in equilibrium, because normal reaction becomes zero.	B1 A1	3.2a	7th The concept of limiting equilibrium.
		(2)		
				(15 marks)

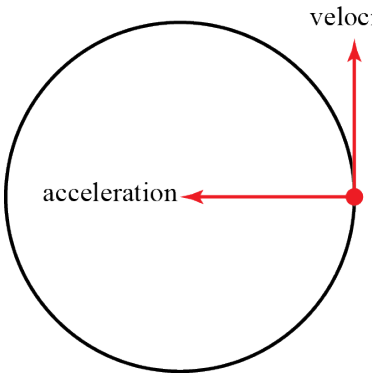
G9	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
	Suvat equation.	**M1**	3.1a	8th Derive formulae for projectile motion.
	$y = 8t\sin 60 - \frac{1}{2}gt^2$	**M1**	1.1b	
	$= 4\sqrt{3}t - 4.9t^2$ (allow awrt 6.9)	**A1**	1.1b	
	Solve $y = 2$	**M1**	1.1a	
	$t = 0.404\ldots$ or $t = 1.009\ldots$ (accept awrt 0.40 and 1.01)	**A2**	1.1b	
	Time spent above 2 m is difference.	**M1**	2.4	
	0.605… (s) (accept awrt 0.61)	**A1ft**	3.4a	
				(8 marks)
Notes				

G10	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Resultant force is **A** + **B**	**M1**	3.1b	5th Use Newton's second law to model motion in two directions.
	$= 3\mathbf{i} - \mathbf{j}$ (N)	**A1**	1.1b	
	Use of Newton's 2nd Law.	**M1**	3.1b	
	$\mathbf{a} = \frac{F}{m}$	**M1**	1.1b	
	$6\mathbf{i} - 2\mathbf{j}$ (m s^{-2})	**A1**	1.1b	
	$\mathbf{s} = \mathbf{s}_0 + \frac{1}{2}\mathbf{a}t^2$	**M1**	1.1a	
	$= 3\mathbf{i} + 4\mathbf{j} + \frac{1}{2}(6\mathbf{i} - 2\mathbf{j})t^2$	**M1**	1.1b	
	$x = 3 + 3t^2$	**A1**	1.1b	
	$y = 4 - t^2$	**A1**	1.1b	
		(9)		
b	$x = 3 + 3t^2 > 0$ for all $t > 0$	**M1**	2.4	4th Complete proofs by deduction and direct algebraic methods.
	so $x \neq 3$	**A1**	2.2a	
		(2)		
c	Anything resonable. For example, a ball in a river with wind. Descriptions of **A** and **B**. For example, **A** is force due to water. For example, **B** is force due to wind.	**B1** **B1**	3.5 3.5	3rd Understand assumptions common in mathematical modelling.
		(2)		
				(13 marks)

Notes

b

Accept any valid argument (For example, equivalent argument for y)

G11	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
a	Differentiate **r** w.r.t. time	**M1**	1.1a	8th Solve general kinematics problems using calculus of vectors.
	$\mathbf{v} = \begin{pmatrix} -2\sin 2t \\ 2\cos 2t \end{pmatrix}$	**A1**	1.1b	
	$\mathbf{a} = \begin{pmatrix} -4\cos 2t \\ -4\sin 2t \end{pmatrix}$	**A1**	1.1b	
		(3)		
b	$\mathbf{a} = -4\begin{pmatrix} \cos 2t \\ \sin 2t \end{pmatrix} = -4\mathbf{r}$	**B1**	2.2a	8th Solve general kinematics problems in a range of contexts using vectors.
		(1)		
c	 Diagram of circular orbit with velocity tangent to circle and acceleration pointing towards centre. Velocity must be in vertical direction.	**B1** **B1**	2.5 2.5	8th Solve general kinematics problems in a range of contexts using vectors.
		(2)		
				(6 marks)

Notes

c

B1 for correct velocity direction

B1 for correct acceleration direction