AS Practice Paper G (Statistics & Mechanics) mark scheme

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
1a	One of: • to obtain a representative sample • large number of students compared to staff so would be unfair to take same numbers of both.	**B1**	2.4	5th Select and critique a sampling technique in a given context.
		(1)		
1b	A list of the names of staff and students.	**B1**	1.2	2nd Understand the vocabulary of sampling.
		(1)		
1c	A member of staff or a student.	**B1**	1.2	2nd Understand the vocabulary of sampling.
		(1)		
1d	Find proportions for different strata out of 60 (either explained or some sensible calculation seen).	**M1**	3.1b	3rd Understand and carry out stratified sampling.
	$\frac{250}{280}\times 60 \approx 54$ students, $\frac{30}{280}\times 60 \approx 6$ staff.	**A1**	1.1b	
	Select at random using a random number generator.	**B1**	1.1b	
		(3)		
1e	One of: • absence on the day of the survey • sampling frame may contain errors.	**B1**	2.2b	5th Select and critique a sampling technique in a given context.
		(1)		
				(7 marks)

Notes
1d Must be whole numbers for A1.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
2a	Order the data. 125, 160, 169, 171, 175, 186, 210, 243, 250, 258, 390, 420	**M1**	1.1b	2nd Understand quartiles and percentiles.
	$Q_3 = \frac{1}{2}(250 + 258) = 254$	**A1**	1.1b	
		(2)		
2b	$Q_3 + 1.5(Q_3 - Q_1) = 254 + 1.5(254 - 170)$	**M1**	1.1b	4th Calculate outliers in data sets and clean data.
	$= 380$	**A1**	1.1b	
	Patients *F* (420) and *B* (390) are outliers (so may be suspected by the doctor as smoking more than one packet of cigarettes per day).	**B1**	3.2a	
		(3)		
				(5 marks)

Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
3a	$\frac{2+3}{\text{total number of students}} = \frac{5}{30} = \frac{1}{6}$ or awrt 0.167	**M1** **A1**	1.1b 1.1b	1st Calculate probabilities for single events.
		(2)		
3b	$\frac{4+2+5+3}{\text{total}}$	**M1**	1.1b	3rd Understand and use Venn diagrams for multiple events.
	$= \frac{14}{30}$ or $\frac{7}{15}$ or awrt 0.467	**A1**	1.1b	
		(2)		
3c	0	**B1**	1.1b	3rd Understand and use the definition of mutually exclusive in probability calculations.
	No student reads both magazine *A* and magazine *C*.	**B1**	1.1b	
		(2)		
3d	$\text{P}(C \mid \text{reads at least one magazine}) = \frac{6+3}{20} = \frac{9}{20}$	**B1**	1.1b	3rd Understand and use Venn diagrams for multiple events.
		(1)		
3e	$\text{P}(B) = \frac{10}{30} = \frac{1}{3}$, $\text{P}(C) = \frac{9}{30} = \frac{3}{10}$	**B1**	2.1	4th Understand and use the definition of independence in probability calculations.
	$\text{P}(B \text{ and C}) = \frac{3}{30} = \frac{1}{10}$, and	**M1**	2.2a	
	$\text{P}(B) \times \text{P}(C) = \frac{1}{3} \times \frac{3}{10} = \frac{1}{10} = \text{P}(B \text{ and C})$ So yes, they are independent.	**A1**	2.4	
		(3)		
				(10 marks)

Notes

3e

Allow alternative using formal conditional probability: P(B) = $\frac{1}{3}$ (B1). Finding P($B|C$) = $\frac{3}{(3+6)} = \frac{1}{3}$ and comparing with P(B) (M1). Correct conclusion (A1).

Or P(C) = $\frac{3}{10}$ (B1). Finding P($C|B$) = $\frac{3}{(2+3+5)} = \frac{3}{10}$ and comparing with P(C) (M1). Correct conclusion (A1).

<table>
<tr><th>Q</th><th>Scheme</th><th>Marks</th><th>AOs</th><th>Pearson Progression Step and Progress descriptor</th></tr>
<tr><td rowspan="3">4a</td><td>$2k + k + 0 + k = 1$</td><td>M1</td><td>2.1</td><td rowspan="2">4th
Calculate probabilities from discrete distributions.</td></tr>
<tr><td>$\Rightarrow 4k = 1$, so $k = 0.25$ (answer given).</td><td>A1*</td><td>1.1b</td></tr>
<tr><td></td><td>(2)</td><td></td><td></td></tr>
<tr><td rowspan="3">4b</td><td>$P(X_1 + X_2 = 5) = P(X_1 = 3 \text{ and } X_2 = 2) + P(X_1 = 2 \text{ and } X_2 = 3)$
$= 0 + 0 = 0$ (answer given).</td><td>B1*</td><td>2.4</td><td>4th
Calculate probabilities from discrete distributions.</td></tr>
<tr><td></td><td>(1)</td><td></td><td></td></tr>
<tr><td rowspan="3">4c</td><td><table><tr><td>$x_1 + x_2$</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>$P(X_1 + X_2)$</td><td>0.25</td><td>0.25</td><td>0.0625</td><td>0.25</td><td>0.125</td><td>0</td><td>0.0625</td></tr></table></td><td>M1
A1
A1</td><td>2.5
1.1b
1.1b</td><td>4th
Calculate probabilities from discrete distributions.</td></tr>
<tr><td></td><td>(3)</td><td></td><td></td></tr>
<tr><td rowspan="3">4d</td><td>$P(1.3 \leqslant X_1 + X_2 \leqslant 3.2) = P(X_1 + X_2 = 2) + P(X_1 + X_2 = 3)$</td><td>M1</td><td>3.4</td><td rowspan="2">4th
Calculate probabilities from discrete distributions.</td></tr>
<tr><td>$= 0.0625 + 0.25 = 0.3125$ or $\frac{5}{16}$</td><td>A1ft</td><td>1.1b</td></tr>
<tr><td></td><td>(2)</td><td></td><td></td></tr>
<tr><td colspan="5">(8 marks)</td></tr>
</table>

Notes

4b

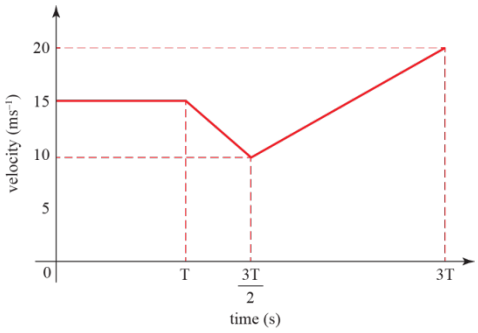
Must show that 5 can only be obtained from 2 and 3 or 3 and 2, and so must use $P(X = 2) = 0$ but condone explanation in words.

4c

M1 for correct set of values for $X_1 + X_2$. Condone omission of 5 column.

A1 for correct probabilities for 0, 2 and 6. A1 for others. Equivalent fractions are $\frac{1}{4}, \frac{1}{4}, \frac{1}{16}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}$

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
5a	States correct answer: 5.3 ($m\,s^{-1}$)	**B1**	2.2a	4th Understand the difference between a scalar and a vector.
		(1)		
5b	States correct answer: -4.8 ($m\,s^{-1}$)	**B1**	2.2a	4th Understand the difference between a scalar and a vector.
		(1)		
5c	States correct answer: -30 (m)	**B1**	2.2a	4th Understand the difference between a scalar and a vector.
		(1)		
				(3 marks)
Notes				

Q	Scheme		Marks	AOs	Pearson Progression Step and Progress descriptor
6a	**Figure 1**  	General shape of the graph is correct. i.e. horizontal line, followed by negative gradient, followed by a positive gradient.	**M1**	3.3	4th Use and interpret graphs of velocity against time.
		Vertical axis labelled correctly.	**A1**	1.1b	
		Horizontal axis labelled correctly.	**A1**	1.1b	
			(3)		
6b	Makes an attempt to find the area of trapezoidal section where the car is decelerating. For example, $\frac{T}{4}(15+10)$ is seen.		**M1**	1.1b	4th Calculate and interpret areas under velocity–time graphs.
	Makes an attempt to find the area of the trapezoidal section where the car is accelerating. For example, $\frac{3T}{4}(10+20)$ is seen.		**M1**	1.1b	
	States that $15T+\frac{25T}{4}+\frac{90T}{4}=1312.5$		**M1**	1.1b	
	Solves to find the value of T: $T=30$ (s).		**A1**	1.1b	
			(4)		
					(7 marks)

Notes

6a

Accept the horizontal axis labelled with the correct intervals.

6b

Award full marks for correct final answer, even if some work is missing.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
7a	States, or implies in a subsequent step, that the resistances to motion will total $1600k$ (N). (Any variable is acceptable.)	**M1**	3.1b	4th Solve problems of connected particles in one dimension.
	Uses $F = ma$ to write $3200 - 1600k = 1600(0.4)$	**M1**	3.3	
	Solves the equation to find $k = 1.6$	**A1**	1.1b	
	Finds the resistance forces acting on the trailer: $R_{\text{trailer}} = 400 \times 1.6 = 640\,(\text{N})$.	**A1**	1.1b	
		(4)		
7b	Demonstrates an understanding that the resultant force for the trailer is $T - 640$, or for the car is $3200 - 1920 - T$	**M1**	3.1b	4th Solve problems of connected particles in one dimension.
	Either states $T - 640 = 400(0.4)$ using the trailer or states $3200 - 1920 - T = 1200(0.4)$ using the car.	**M1**	3.3	
	Correctly finds $T = 800$ (N).	**A1 ft**	1.1b	
		(3)		
7c	Uses $F = ma$ to write $-640 = 400a$	**M1**	3.3	4th Solve problems of connected particles in one dimension.
	Correctly solves to find $a = -1.6\ \text{m s}^{-2}$	**A1 ft**	1.1b	
	Uses $v^2 = u^2 + 2as$ to write $0 = 25^2 + 2(-1.6)s$	**M1**	3.1b	
	Correctly solves to find $s = 195.31\ldots$ (m). Accept awrt 195 (m).	**A1 ft**	1.1b	
		(4)		
7d	States 'the acceleration of the car will be equal to the acceleration of the trailer' or states 'the car and the trailer will move as one'.	**B1**	3.5	4th Solve problems of connected particles in one dimension.
		(1)		
				(12 marks)

Notes

7b

Award ft marks for a correct answer using their value from part **a** for the resistance acting on the trailer.

7c

Award ft marks for a correct answer using their value from part **a** for the resistance acting on the trailer and from part **b** for tension.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
8	Integrates $a = 12t - 4$ to obtain $v = 6t^2 - 4t + A$ Any constant is acceptable.	**M1**	3.1b	6th Uses integration to solve problems in kinematics.
	Integrates $v = 6t^2 - 4t + A$ to obtain $s = 2t^3 - 2t^2 + At + B$. Any constant are acceptable.	**M1**	3.1b	
	Makes an attempt to form a pair of simultaneous equations by separately substituting (1, 2) and (3, 30) into the equation. For example: $2 = 2 - 2 + A + B$ and $30 = 54 - 18 + 3A + B$ are seen.	**M1**	3.1b	
	Simplifies to obtain a correctly pair of simultaneous equations: $A + B = 2$ and $3A + B = -6$ are seen.	**M1**	1.1b	
	Solves to find $A = -4$	**A1**	1.1b	
	Solves to find $B = 6$	**A1**	1.1b	
	Attempts to make a substitution of $t = 2$ into $s = 2t^3 - 2t^2 - 4t + 6$ For example, $s = 2(2)^3 - 2(2)^2 - 4(2) + 6$ is seen.	**M1**	1.1b	
	Correctly finds $s = 6$ (m).	**A1 ft**	1.1b	
		(8)		
				(8 marks)

Notes

8

Award the final method mark and the final accuracy mark for a correct substitution using their values for A and B.