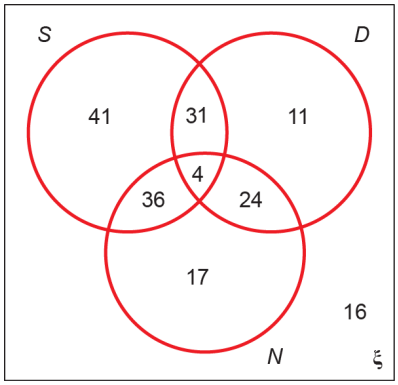
AS Practice Paper E (Statistics & Mechanics) mark scheme

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
1a	Observation or measurement of every member of a population.	**B1**	1.2	2nd Understand the vocabulary of sampling.
		(1)		
1b	Two from: • takes a long time/costly • difficult to ensure whole population surveyed • cannot be used if the measurement process destroys the item • can be hard to manage and analyse all the data.	**B1** **B1**	1.2 1.2	3rd Comment on the advantages and disadvantages of samples and censuses.
		(2)		
1c	The list of unique serial numbers.	**B1**	1.2	2nd Understand the vocabulary of sampling.
		(1)		
1d	A circuit board.	**B1**	1.2	2nd Understand the vocabulary of sampling.
		(1)		
				(5 marks)
Notes				

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
2a				3rd Understand and use Venn diagrams for multiple events.
	Three closed curves and four in centre.	**M1**	3.1a	
	Evidence of subtraction (any one of 31, 36, 24, 41, 17 or 11).	**M1**	3.3	
	Any three of 31, 36, 24, 41, 17 or 11 correct.	**A1**	1.1b	
	All correct.	**A1**	1.1b	
	Labels on sets, 16 and closed curve or box outside.	**B1**	1.1b	
		(5)		
2bi	P(None of the 3 options) $= \frac{16}{180} = \frac{4}{45}$ or awrt 0.0889	**B1**	3.4	3rd Understand and use Venn diagrams for multiple events.
		(1)		
2bii	P(Networking only) $= \frac{17}{180}$ or awrt 0.0944	**B1**	3.4	3rd Understand and use Venn diagrams for multiple events.
		(1)		
2c	$P(\text{Takes all three options} \mid \text{takes S and N}) = \frac{4}{40} = \frac{1}{10}$ or 0.1	**M1** **A1**	3.4 1.1b	3rd Understand and use Venn diagrams for multiple events.
		(2)		
				(9 marks)
Notes				

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
3a	$19.5+\frac{(60-29)}{43}\times 10 = 26.7093\ldots$ (Accept awrt **26.7** miles)	**M1** **A1**	1.1b 1.1b	3rd Estimate median values, quartiles and percentiles using linear interpolation.
		(2)		
3b	$\bar{x}=\frac{3552.5}{120}=29.6041\ldots$ o.e. (Accept awrt **29.6** miles)	**B1**	1.1b	4th Calculate variance and standard deviation from grouped data and summary statistics.
	$\sigma=\sqrt{\left(\frac{138\,043.13}{120}-\bar{x}^2\right)}$ or $\sigma^2=\frac{138\,043.13}{120}-\bar{x}^2$ or $s=\sqrt{\frac{120\sigma^2}{119}}$	**M1**	1.1a	
	$\sigma = 16.5515\ldots$ (Accept awrt **16.6** miles) (or $s = 16.6208\ldots$ = **16.6** miles)	**A1**	1.1b	
		(3)		
3c	Any sensible reason linked to the shape of the distribution. For example: The distribution is (positively) skewed. A few large distances (values) distort the mean.	**B1**	2.4	4th Calculate means, medians, quartiles and standard deviation.
		(1)		

3d	Comparison of the two means. For example, the mean distance for London is smaller than for Devon. Sensible interpretation comparing a county to a city. For example, distance to work into one city may not be as far as travelling to different cities in a county. For example, commuters need to travel further to the cities in Devon for work. Comparison of the two standard deviations: For example, the standard deviation for London is larger than for Devon. Sensible interpretation relating to variability/consistency For example, there is more variability (less consistency) in the commute distances from the Greater London station than from the Devon station.	**B1** **B1** **B1** **B1**	1.1b 2.2b 1.1b 2.2b	4th Compare data sets using a range of familiar calculations and diagrams.
		(4)		
				(10 marks)

Notes

3a

Allow consistent use of $n + 1$ (i.e. for median 60.5th rather than 60th), median = 26.8

3c

Candidates must compare both the means and standard deviations with interpretations for full marks.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
4a	$X \sim B(20, 0.05)$ B1 for binomial B1 for 20 and 0.05	**B1** **B1**	3.1b 3.1b	5th Understand the binomial distribution (and its notation) and its use as a model.
		(2)		
4b	$P(X = 0) = 0.358$ (awrt)	**B1** **A1**	3.4 1.1b	5th Calculate binomial probabilities.
		(2)		
4c	$P(X > 4) = 1 - P(X \text{ Ñ } 4)$ $= 1 - 0.9974$	**M1**	3.4	6th Use statistical tables and calculators to find cumulative binomial probabilities.
	$= 0.0026$ (2 s.f.) (answer given)	**A1***	1.1b	
		(2)		
				(6 marks)

Notes

4b

$P(X = 0) = 0.95^{20}$

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
5ai	States that $x = 0$ needs to be substituted or implies it by writing $h = 1.7 + 0.18(0) - 0.01(0)^2$	**M1**	3.1b	3rd Understand how mechanics problems can be modelled mathematically.
	Correctly substitutes $x = 0$ to get $h = 1.7$ (m)	**A1**	1.1b	
		(2)		
5aii	States that $x = 7$ needs to be substituted or implies it by writing $h = 1.7 + 0.18(7) - 0.01(7)^2$	**M1**	3.1b	3rd Understand how mechanics problems can be modelled mathematically.
	Correctly substitutes $x = 7$ to get $h = 2.47$ (m) Accept awrt 2.5 (m)	**A1**	1.1b	
		(2)		
5b	Understands that the ball will hit the ground when $h = 0$ or writes $1.7 + 0.18x - 0.01x^2 = 0$	**M1**	3.1b	3rd Understand how mechanics problems can be modelled mathematically.
	Realises that the quadratic formula is needed to solve the quadratic. For example $a = 0.01$, $b = -0.18$, $c = -1.7$ seen, or makes attempt to use the formula: $x = \dfrac{0.18 \pm \sqrt{(-0.18)^2 - 4(0.01)(-1.7)}}{2(0.01)}$	**M1**	1.1b	
	Simplifies the $b^2 - 4ac$ part to get 0.1004 or shows $x = \dfrac{0.18 \pm \sqrt{0.1004}}{0.02}$	**M1**	1.1b	
	Calculates $x = 24.84\ldots$ (m) Accept awrt 24.8 (m) Does not need to show that $x \neq -6.84...$ (m)	**A1**	1.1b	
	States that the ball will be called 'in', or says, for example, yes as $24.84\ldots < 25$.	**B1**	3.2a	
		(5)		

5c	$\frac{2\,\text{km}}{1\,\text{min}} \times \frac{1000\,\text{m}}{1\,\text{km}} \times \frac{1\,\text{min}}{60\,\text{sec}}$ Award 1 method mark for multiplication by 1000 and 1 method mark for division by 60.	**M2**	1.1b	3rd Understand how mechanics problems can be modelled mathematically.
	$33.3\,(\text{m s}^{-1})$ or $33.\dot{3}\,(\text{m s}^{-1})$	**A1**	1.1b	
		(3)		
				(12 marks)

Notes

5ai

Award both marks for a correct final answer.

5aii

Award both marks for a correct final answer.

5b

$a = -0.01, b = 0.18, c = 1.7$ is also acceptable.

5b

Award the third method mark even if this step is not seen, providing the final answer is correct.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
6a	Demonstrates an understanding of the need to use $s = ut + \frac{1}{2}at^2$ This can implied by using the equation in the next step(s).	**M1**	3.1b	5th Use equations of motion to solve problems in familiar contexts.
	Demonstrates the need to use $(t - 3)$ when finding the displacement of Q from A (or use $(t + 3)$ when finding the displacement of P from A). Can be implied in either of the following steps.	**M1**	3.1b	
	Displacement of P: $s = 2.8t + 0.06t^2$	**A1**	1.1b	
	Displacement of Q: $s = 2.4(t-3) + 0.1(t-3)^2$	**A1**	1.1b	
		(4)		
6b	Writes $2.8t + 0.06t^2 = 2.4(t-3) + 0.1(t-3)^2$	**M1**	3.1b	5th Use equations of motion to solve problems in familiar contexts.
	Makes an attempt to simplify this equation. For example, $2.8t + 0.06t^2 = 2.4t - 7.2 + 0.1(t^2 - 6t + 9)$ $2.8t + 0.06t^2 = 2.4t - 7.2 + 0.1t^2 - 0.6t + 0.9$ $0.04t^2 - t - 6.3 = 0$	**M1**	1.1b	
	Simplifies this expression to $2t^2 - 50t - 315 = 0$	**A1**	1.1b	
		(3)		
6c	Makes an attempt to use the quadratic formula: $t = \frac{50 \pm \sqrt{(-50)^2 - 4(2)(-315)}}{2(2)}$	**M1**	2.2a	5th Use equations of motion to solve problems in familiar contexts.
	Solves to find $t = 30.21...$ (s). Could also show that $t \neq -5.21...$ (s).	**A1**	1.1b	
	States or implies $s = ut + \frac{1}{2}at^2$	**M1**	3.1b	
	Makes a substitution using their 30.21… into the formula: $s = (2.8)(30.2...) + \frac{1}{2}(0.12)(30.2...)^2$	**M1**	1.1b	
	Finds $s = 139.36...$ (m). Accept awrt 139 (m).	**A1 ft**	1.1b	
		(5)		
				(12 marks)

Notes

6a

Award both accuracy marks if the following is seen:

Displacement of P from A: $s = 2.8(t+3) + 0.06(t+3)^2$

Displacement of Q from A: $s = 2.4t + 0.1t^2$

6c

Award ft marks for a correct answer using their '30.2'. They will have previously lost the first accuracy mark.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
7a	States $F = ma$ or implies use of $F = ma$ For example, $-120 = 80 \times a$ is seen.	**M1**	3.3	4th Use Newton's second law to model motion in one direction.
	Correctly finds $a = -\frac{3}{2}(\text{m s}^{-2})$ or $a = -1.5\ (\text{m s}^{-2})$.	**A1**	1.1b	
	States $v = u + at$, or implies its use. For example, $0 = 18 + \left(-\frac{3}{2}\right)t$ is seen.	**M1**	3.1b	
	Finds $t = 12$ (s).	**A1 ft**	1.1b	
		(4)		
7b	States that $v^2 = u^2 + 2as$ or implies it use by writing $0^2 = 18^2 + 2\left(-\frac{3}{2}\right)s$	**M1**	2.2a	4th Use Newton's second law to model motion in one direction.
	Correctly finds $s = 108$ (m).	**A1 ft**	1.1b	
		(2)		
7c	States that the cyclist is not a particle, or states that the resistive force is unlikely to be constant.	**B1**	3.5	4th Use Newton's second law to model motion in one direction.
		(1)		
				(7 marks)

Notes

7a

Award ft marks for a correct answer using their value for acceleration.

7b

Award ft marks for a correct answer using their value for acceleration.