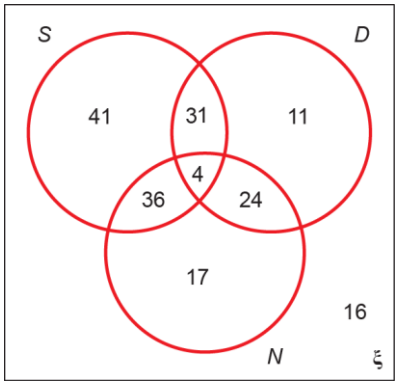
AS Practice Paper E (Statistics & Mechanics) mark scheme

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	 Three closed curves and four in centre. Evidence of subtraction (any one of 31, 36, 24, 41, 17 or 11). Any three of 31, 36, 24, 41, 17 or 11 correct. All correct. Labels on sets, 16 and closed curve or box outside.	**M1** **M1** **A1** **A1** **B1**	3.1a 3.3 1.1b 1.1b 1.1b	3rd Understand and use Venn diagrams for multiple events.
		(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(Takes all three options $\mid$ 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	$P(X > 4) = 1 - P(X \leqslant 4)$ $= 1 - 0.9974$	**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 $a = -\frac{3}{2}$ (m s^{-2}) or $a = -1.5$ (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.