

AS Practice Paper J (Statistics & Mechanics) mark scheme

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
1a	There are a very large number of bags.	B1	2.4	3rd Comment on the advantages and disadvantages of samples and censuses.
	Bags are tested to destruction – there would be no bags left.	B1	2.4	
			(2)	
1b	One value is less than 12 kg	B1	2.4	3rd Comment on the advantages and disadvantages of samples and censuses.
	therefore claim is not reliable.	B1	2.3	
			(2)	
1c	Different samples can lead to different conclusions due to natural variations.	B1	2.3	3rd Comment on the advantages and disadvantages of samples and censuses.
	Only a small sample taken so unreliable.	B1	2.3	
			(2)	
1d	Larger sample.	B1	2.4	3rd Comment on the advantages and disadvantages of samples and censuses.
		(1)		
	(7 marks)			
Notes				

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2	$\bar{y} = \frac{-467}{200} = -2.335$ (seen or implied) $\bar{x} = 2.5\bar{y} + 755.0$ $= 2.5\left(\frac{-467}{200}\right) + 755.0$ $= 749.1625$ (Accept awrt 749) $\sigma_y = \sqrt{\frac{9179}{200} - \left(\frac{-467}{200}\right)^2}$ $= 6.3594\dots$ $\sigma_x = 2.5 \times 6.3594\dots$ $= 15.8986\dots$ (Accept awrt 15.9)	B1 M1 M1 A1 M1 A1 A1 M1 A1	1.1b 3.1a 1.1b 1.1b 1.1b 1.1b 3.1a 1.1b 1.1b	5th Calculate the mean and standard deviation of coded data.
		(9)		
(9 marks)				
Notes				

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Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
3a	Total frequency = 120 $P(\text{Less than 17 cm}) = \frac{52+5}{120} = \frac{57}{120} \text{ or equivalent or } 0.475$	B1 M1 A1	3.1a 1.1b 1.1b	2nd Calculate probabilities from relative frequency tables and real data.
		(3)		
3b	$P(\text{Between 12 cm and 18 cm}) = \frac{52+15}{120} = \frac{67}{120} \text{ or awrt } 0.558$ Assumption: foot lengths between 17 and 19 are uniformly distributed.	M1 A1 B1	2.2b 1.1b 3.5b	2nd Calculate probabilities from relative frequency tables and real data.
		(3)		
(6 marks)				
Notes				

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Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
4a	$0.15 + 0.15 + \alpha + \alpha + 0.1 + 0.1 = 2\alpha + 0.5 = 1$	M1	1.1b	4th
	$\Rightarrow \alpha = 0.25$	A1	1.1b	Calculate probabilities from discrete distributions.
		(2)		
4b	$P(-1 \leq X < 2) = P(-1) + P(0) + P(1) = 0.6$	B1	1.1b	4th
		(1)		Calculate probabilities from discrete distributions.
4c	$P(X > -2.3) = P(-2) + P(-1) + P(0) + P(1) + P(2) = 0.85$	B1	1.1b	4th
		(1)		Calculate probabilities from discrete distributions.
(4 marks)				
Notes				

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5a	Let X be the random variable the number of games Amir loses. $X \sim B(9, 0.2)$	B1	3.3	5th Calculate binomial probabilities.
	$P(X = 3) = 0.17616... = 0.176$ to 3 sf from calculator	B1	1.1b	
		(2)		
5b	$P(X \leq 4)$	M1	3.4	6th Use statistical tables and calculators to find cumulative binomial probabilities.
	= awrt 0.980 from calculator	A1	1.1b	
		(2)		
(4 marks)				
Notes 5a $P(X \leq 3) - P(X \leq 2) = 0.9144 - 0.7382$ or $\frac{9!}{3!6!}(0.2)^3(0.8)^6$ or ${}^9C_3 \cdot 0.2^3 \cdot 0.8^6$ or $84 \cdot 0.2^3 \cdot 0.8^6$ 4b 0.98 is M1A0				

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Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
6a	Understands that the pole vaulter will land when $h = 0$ or writes $\frac{1}{60}(125x - 12x^2) = 0$	M1	3.1b	3rd Understand how mechanics problems can be modelled mathematically.
	Correctly factorises to get $x(125 - 12x) = 0$ o.e.	M1	1.1b	
	Solves to get $x = \frac{125}{12} = 10.41\ldots(\text{m})$ Accept awrt 10.4 (m)	A1	1.1b	
		(3)		
6b	States that the greatest height will occur when $x = 5.20\ldots(\text{m})$	M1	3.1b	3rd Understand how mechanics problems can be modelled mathematically.
	Makes an attempt to substitute $x = 5.20\ldots$ into the equation for h . For example, $h = \frac{1}{60}(125(5.20\ldots) - 12(5.20\ldots)^2)$ seen.	M1	1.1b	
	$h = 5.42\ldots(\text{m})$ Accept awrt 5.4 (m)	A1 ft	1.1b	
		(3)		
6c	States $h = 4.9$ or states that $\frac{1}{60}(125x - 12x^2) = 4.9$	M1	3.1b	3rd Understand how mechanics problems can be modelled mathematically.
	Simplifies this to reach $12x^2 - 125x + 294 = 0$ o.e.	M1	1.1b	
	Realises that the quadratic formula is needed to solve the quadratic. For example $a = 12$, $b = -125$, $c = 294$ seen, or makes attempt to use the formula: $x = \frac{125 \pm \sqrt{(-125)^2 - 4(12)(294)}}{2(12)}$	M1	1.1b	
	Simplifies the $b^2 - 4ac$ part to get 1513 or shows $x = \frac{125 \pm \sqrt{1513}}{24}$	M1	1.1b	
	$x = 6.82\ldots(\text{m})$ Accept awrt 6.8 (m)	A1	1.1b	
	$x = 3.58\ldots(\text{m})$ Accept awrt 3.6 (m)	A1	1.1b	
	The pole vaulter can leave the ground between 3.6 m and 6.8 m from the bar.	B1	3.2a	
		(7)		

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6di	Allows the person to be treated as a single mass and allows the effects of rotational forces to be ignored.	B1	3.4	3rd Understand assumptions common in mathematical modelling.
		(1)		
6dii	The effects of air resistance can be ignored.	B1	3.4	3rd Understand assumptions common in mathematical modelling.
		(1)		
(15 marks)				
Notes 6b For the first method mark, accept their answer to part a divided by 2. Continue to award marks for a correct answer using their initial incorrect value. 6c Accept $3.6 \leq x \leq 6.8$				

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Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
7a	Correctly uses $s = ut + \frac{1}{2}at^2$ to write $0.9 = (0)t + \frac{1}{2} \times a \times (0.8)^2$	M1	3.1b	5th Solve problems of connected particles using pulleys.
	Correctly finds $a = \frac{45}{16} \text{ (m s}^{-2}\text{)}$ or $2.8125 \text{ (m s}^{-2}\text{)}$. Accept awrt $2.8 \text{ (m s}^{-2}\text{)}$.	A1	1.1b	
		(2)		
7b	Demonstrates an understanding that the resultant force acting on sphere B is $1.2g - T$.	M1	3.1b	5th Solve problems of connected particles using pulleys.
	Uses $F = ma$ to write $1.2g - T = 1.2\left(\frac{45}{16}\right)$	M1	3.3	
	Correctly solves to find $T = \frac{1677}{200} \text{ (N)}$ or 8.385 (N) . Accept 8.4 (N) .	A1 ft	1.1b	
		(3)		
7c	Demonstrates an understanding that the resultant force acting on box A is $T - F$.	M1	3.1b	5th Solve problems of connected particles using pulleys.
	Uses $F = ma$ to write $\frac{1677}{200} - F = 0.8\left(\frac{45}{16}\right)$	M1	3.3	
	Correctly solves to find $F = \frac{1227}{200} \text{ (N)}$ or 6.135 (N) . Accept 6.1 (N) .	A1ft	1.1b	
		(3)		
7d	Uses $v = u + at$ to write $v = 0 + \frac{45}{16} \times 0.8$	M1	3.1b	5th Solve problems of connected particles using pulleys.
	Solves to find $v = \frac{9}{4}$ or 2.25 m s^{-1} .	A1 ft	1.1b	
	Uses $F = ma$ to write $-F = 0.8a$ or $-\frac{1227}{200} = 0.8a$	M1	3.1b	
	Solves to find $a = -\frac{1227}{160} \text{ m s}^{-2}$ or $7.66\dots \text{ (m s}^{-2}\text{)}$.	A1 ft	1.1b	

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	Uses $v^2 = u^2 + 2as$ to write $0 = \left(\frac{9}{4}\right)^2 + 2\left(-\frac{1227}{160}\right)s$	M1	2.2a	
	Solves to find $s = \frac{135}{409}$ (m) or 0.33... (m). Accept awrt 0.33 (m).	A1 ft	1.1b	
	States that the total distance travelled will be 1.23 m (0.9 + 0.33).	B1 ft	3.2	
		(7)		
(15 marks)				
Notes 7b Award ft marks for a correct answer using their value from part a for acceleration. 7c Award ft marks for a correct answer using their values from part a for acceleration and part b for tension. 7d Award ft marks for a correct answer using their values from parts a, b and c.				