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				

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

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
3a	Total frequency = 120 P(Less than 17 cm) $= \frac{52+5}{120} = \frac{57}{120}$ 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(Between 12 cm and 18 cm) $= \frac{52+15}{120} = \frac{67}{120}$ 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				

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 Calculate probabilities from discrete distributions.
	$\Rightarrow \alpha = 0.25$	**A1**	1.1b	
		(2)		
4b	$P(-1 \leqslant X < 2) = P(-1) + P(0) + P(1) = 0.6$	**B1**	1.1b	4th Calculate probabilities from discrete distributions.
		(1)		
4c	$P(X > -2.3) = P(-2) + P(-1) + P(0) + P(1) + P(2) = 0.85$	**B1**	1.1b	4th Calculate probabilities from discrete distributions.
		(1)		
				(4 marks)
Notes				

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
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.
	$P(X = 3) = 0.17616\ldots = 0.176$ to 3 sf from calculator	**B1**	1.1b	
		(2)		
5b	$P(X \geq 4)$	**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

$P(X \geq 3) - P(X \geq 2) = 0.9144 - 0.7382$

or $\frac{9!}{3!6!}(0.2)^3(0.8)^6$

or ${}^9C_3 \times 0.2^3 \times 0.8^6$

or $84 \times 0.2^3 \times 0.8^6$

4b

0.98 is M1A0

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
6a	Understands that the pole vaulter will land when $h = 0$ or writes $\frac{1}{60}\left(125x-12x^2\right)=0$	**M1**	3.1b	3rd Understand how mechanics problems can be modelled mathematically.
	Correctly factorises to get $x\left(125-12x\right)=0$ o.e.	**M1**	1.1b	
	Solves to get $x=\frac{125}{12}=10.41...$(m) Accept awrt 10.4 (m)	**A1**	1.1b	
		(3)		
6b	States that the greatest height will occur when $x = 5.20…$(m)	**M1**	3.1b	3rd Understand how mechanics problems can be modelled mathematically.
	Makes an attempt to substitute $x = 5.20…$into the equation for h. For example, $h=\frac{1}{60}\left(125\left(5.20...\right)-12\left(5.20...\right)^2\right)$seen.	**M1**	1.1b	
	$h = 5.42…$(m) Accept awrt 5.4 (m)	**A1 ft**	1.1b	
		(3)		
6c	States $h = 4.9$ or states that $\frac{1}{60}\left(125x-12x^2\right)=4.9$	**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: $x=\frac{125\pm\sqrt{\left(-125\right)^2-4\left(12\right)\left(294\right)}}{2\left(12\right)}$	**M1**	1.1b	
	Simplifies the b^2-4ac part to get 1513 or shows $x=\frac{125\pm\sqrt{1513}}{24}$	**M1**	1.1b	
	$x = 6.82…$(m) Accept awrt 6.8 (m)	**A1**	1.1b	
	$x = 3.58…$ (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)		

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 $3.6 \leqslant x \leqslant 6.8$

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 $a = \frac{45}{16}$ (m s^{-2}) or 2.8125 (m s^{-2}). Accept awrt 2.8 (m s^{-2}).	**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 $T = \frac{1677}{200}$ (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 $F = \frac{1227}{200}$ (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 $a = -\frac{1227}{160}$ m s^{-2} or 7.66…(m s^{-2}).	**A1 ft**	1.1b	

	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**.