January 2019

Mark Scheme

Mock Paper (Set1)

Pearson Edexcel GCE A Level Mathematics

Statistics (9MA0/31)

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General Marking Guidance

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PEARSON EDEXCEL GCE MATHEMATICS

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   These are some of the traditional marking abbreviations that will appear in the mark schemes.

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   - **cao** – correct answer only
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   - **isw** – ignore subsequent working
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   - **SC**: special case
   - **o.e.** – or equivalent (and appropriate)
   - **d** or **dep** – dependent
   - **indep** – independent
   - **dp** decimal places
   - **sf** significant figures
   - ***** The answer is printed on the paper or ag- answer given

4. All M marks are follow through.

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Question	Scheme	Marks	AOs
1(a)	$[\bar{x} =] \frac{798}{30} = 26.6$	B1 cao	1.1b
	$[\sigma_x =] \sqrt{\frac{21357.5}{30} - \bar{x}^2} = \sqrt{4.35666\ldots} = \text{awrt} 2.09$ Allow $[s =] \sqrt{\frac{21357.5 - 30\bar{x}^2}{29}} = \text{awrt} 2.12$	B1	1.1b
		(2)	
(b)	$[\bar{x} - 3\sigma =] 14.8 - 3 \times 2.37 = 7.69$ or $[\bar{x} + 3\sigma =] 14.8 + 3 \times 2.37 = 21.91$	M1	2.1
	$8.8 > 7.69$ and $18.5 < 21.91$ so no outliers	A1	1.1b
		(2)	
(c)(i)	Mean for Perth is lower than mean for Jacksonville which suggests the daily mean air temperature is higher in the northern hemisphere (in June).	B1	2.2b
	Standard deviations are similar which suggests similar levels of variation of the daily mean air temperature in each hemisphere (in June). OR Sizes of standard deviations are small compared with the difference in mean temperatures making it more likely that the difference in means is significant.	B1	2.2b
		(2)	
(ii)	This is based on one location in each hemisphere and therefore is not valid as temperatures are likely to vary across each hemisphere.	B1 (1)	2.4
(d)	$\mathrm{P}(X > 29) = 0.17045\ldots$	M1	3.4
	5.11 days (accept awrt 5)	A1	1.1b
		(2)	
			(9 marks)

Question 1 continued

Notes:

(a)
B1: for mean
B1: awrt 2.09 (allow $s = 2.12$)

(b)
M1: for a correct method to find the lower or upper limit for outliers
A1: for comparing minimum and maximum values to outlier limits and concluding

(c) (i)
B1: for a suitable comparison of means and comment in context
B1: for a suitable comparison of standard deviations and comment in context
Do not accept e.g "Standard deviation for Perth is higher than standard deviation for Jacksonville which suggests daily mean air temperature is more consistent in the northern hemisphere (in June)" because students should be familiar with the idea that small differences in these statistics are not always meaningful and should be aware of the likely size of differences having explored the large data set.
(ii)
B1: a suitable explanation why assumption is not valid.

(d)
M1: for use of the model to attempt a correct probability
A1: for a correct prediction

Question	Scheme	Marks	AOs
2(a)(i)	Extrapolation is making predictions outside the original data range.	B1	1.2
(a)(ii)	This is unreliable as the trend may not continue.	B1	2.4
		(2)	
(b)	The product moment correlation coefficient cannot be greater than 1	B1	1.2
		(1)	
(c)	$r = 0.76279\ldots$ awrt 0.763	B1	1.1b
		(1)	
(d)	$\mathrm{H}_0\colon \rho = 0 \qquad \mathrm{H}_1\colon \rho > 0$	B1	2.5
	Critical value 0.7155	M1	1.1a
	Reject H_0		
	There is evidence that the product moment correlation coefficient is greater than 0	A1ft	2.2b
		(3)	
(e)	This suggests that on average (female hook-billed) kites with longer tails have longer wings.	B1	3.2a
		(1)	
			(8 marks)

Notes:
(a) B1: for a correct definition of extrapolation B1: for a correct statement of the dangers of extrapolation
(b) B1: for a correct statement
(c) B1: for awrt 0.763
(d) B1: for both hypotheses in terms of ρ M1: for selecting a suitable 1% critical value compatible with their H_1 A1: for correct conclusion stated ft their (c) provided $-1 \leq r \leq 1$
(e) B1: for correct interpretation in context ft their (d) provided $-1 \leq r \leq 1$

Question	Scheme	Marks	AOs
3(a)	$\frac{82}{65+82+231+262} \times 100\ (= 12.8125)$	M1	1.1b
	13	A1	1.1b
		(2)	
(b)(i)	$[F = \text{faulty}, T = \text{tests positive}]\ \ \mathrm{P}(F\|T) = \frac{\mathrm{P}(F \cap T)}{\mathrm{P}(T)}$	M1	3.1b
	$\mathrm{P}(F \cap T) = 0.02 \times 0.7\ [= 0.014]$	M1	1.1b
	$\mathrm{P}(T) = 0.02\ \times 0.7 + 0.98\ \times 0.1\ [= 0.112]$	M1	1.1b
	$\mathrm{P}(F\|T) = 0.125$	A1	1.1b
		(4)	
b(ii)	Most machines that test positive do not have faults therefore the company's test is not very useful oe	B1	3.2a
		(1)	
(c)	$P(A \cap B) = 0.18$	M1	2.1
	e.g. $P(A) \times P(B) = 0.35 \times 0.55 = 0.1925 \neq P(A \cap B) = 0.18$	A1	1.1b
		(2)	
(d)	$P(A\ or\ B \text{ not both}) = 0.35 + 0.55 - 2 \times 0.18$ oe	M1	3.1b
	=0.54	A1	1.1b
		(2)	
			(10 marks)

Notes:
(a) M1: for a correct calculation for the strata size A1: for 13
(b) M1: for identifying correct calculation M1: for method for finding $P(F \cap T)$ M1: for method for finding $P(T)$ A1: a correct answer
(c) M1: for correctly finding $P(A \cap B)$ oe A1: for a fully correct explanation: correct probabilities and correct comparisons
(d) M1: for a correct expression A1: cao

Question	Scheme	Marks	AOs
4(a)	$[\mathrm{P}(T > 22) > 0.1]$ $\frac{22-16}{\sigma} = \textit{their z value}$	M1	3.4
	1.28155….	B1	1.1b
	$\frac{22-16}{1.28155\ldots} = 4.6818\ldots$ $\cong 4.68$	A1	1.1b
		(3)	
(b)	$\mathrm{P}(L < 13) = \mathrm{P}\left(Z < \frac{13-16}{4.68}\right)$ = 0.2607… 26.1%	B1	1.1b
		(1)	
(c)	$\mathrm{P}(S > 17) = 0.2$ or $\mathrm{P}(S < 8) = 0.1$		
	$\therefore \frac{17-\mu}{\sigma} = 0.8416$ or $\therefore \frac{8-\mu}{\sigma} = -1.2816$	M1	3.4
	0.8416 and -1.2816	B1	1.1b
	$\therefore \frac{17-\mu}{\sigma} = 0.8416$ and $\therefore \frac{8-\mu}{\sigma} = -1.2816$	A1	1.1b
	$17 - \mu = 0.8416\sigma$ $-(8 - \mu = -1.2816\sigma)$	M1	1.1b
	$\sigma = 4.238\ldots$	A1	1.1b
	$\mu = 13.432\ldots$	A1	1.1b
		(6)	
(d)	$\mu = 13.4 < 16$	B1	2.4
	Yes, supports supervisor's belief		
		(1)	
			(11 marks)

Notes:
(a) M1: for a suitable equation to find σ with attempt at a z value B1: for awrt 1.28 A1: for a complete solution showing that σ is 4.68 to 3 significant figures cso
(c) B1: for 0.842 and -1.28 or better 2nd M1: for a method to solve simultaneous equations A1: for awrt $\sigma = 4.24$ A1: for awrt $\mu = 13.4$ Ignore units
(d) B1: for a suitable comparison of mean and conclusion

Question	Scheme	Marks	AOs
5(a)	W = number of scratch cards out of 20 that win, $W \sim \mathrm{B}(20,0.45)$	B1	3.3
	S=number of stores with at least 12 winning cards $S \sim \mathrm{B}(8,p)$	M1	3.1b
	$p = \mathrm{P}(W \geq 12) = 0.130765$	A1	3.4
	$1 - [\mathrm{P}(S = 1) + \mathrm{P}(S = 0)]$	M1	3.4
	So $\mathrm{P}(S \geq 2) = 0.2818 \ldots$	A1	1.1b
		(5)	
(b)	Number of trials is large and probability of success is close to 0.5	B1	1.2
		(1)	
(c)	$X \sim \mathrm{N}(135, 74.25)$	B1, B1	1.1b,1.1b
	$\mathrm{P}(X < 122.5) = \mathrm{P}\left(Z < \frac{122.5-135}{\sqrt{74.25}}\right)$	M1	3.4
	$= 0.0734 \ldots$	A1	1.1b
		(4)	
(d)	The probability is greater than 0.025 therefore there is insufficient evidence at the 5% significance level to suggest that the proportion is different from 45%	B1	2.2b
		(1)	
			(11 marks)

Notes:
(a) B1 may be implied by subsequent working 1st M1: for selection of appropriate model for *S* 1st A1: for a correct values of the parameter *p* 2nd A1: for awrt 0.282
(b) B1: both correct conditions Accept *n* is large, $np > 5$ and $n(1-p) > 5$
(c) B1: for correct mean B1: for correct variance M1: for continuity correction A1 awrt 0.0734
(d) B1: for correct statement

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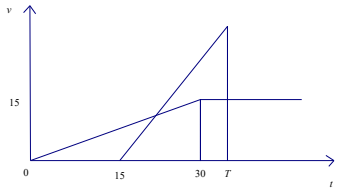
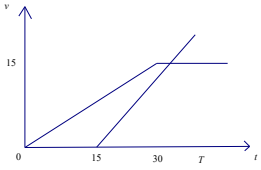
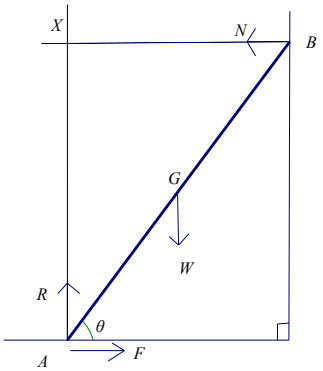
1(a)			
	One line correct	B1	3.4
	Second line correct and with correct start relative to the first line and steeper gradient Condone 	B1	1.1b
	Key values shown	B1	1.1b
		(3)	
1(b)	Equate distances	M1	3.4
	Car: $\frac{1}{2}\times 30\times 15+15(T-30)$	A1	1.1b
	Motorbike: $\frac{1}{2}\times(T-15)\times\frac{3}{2}(T-15)\left(=\frac{3}{4}(T-15)^2\right)$ $\Rightarrow\frac{3}{4}(T-15)^2=15^2+15(T-30)$	A1	1.1b
	$T^2-50T+525=0$, $T=35$	M1	1.1b
	$\text{Speed}=(35-15)\times 1.5$	M1	1.1b
	$=30$ (m s^{-1})	A1	2.2a
		(6)	
			(9 marks)

Notes:		
1(a)	B1	Either line correct
	B1	Second line in correct position to the first and both continue until after the car reaches constant speed.
	B1	15, 30, T and 15 shown
1(b)	M1	Use the fact that to catch up they must both have travelled the same distances.
	A1	One distance expressed correctly in terms of T
	A1	Both distances correct. Correct equation in T in any equivalent form
	M1	Create and solve a quadratic in T.
	M1	Use their T to find the required speed.
	A1	Correct only. If speed = 0 seen then it must be rejected.

Question	Scheme	Marks	AOs
2a			
	Moments about A:	M1	3.3
	$W \times a\cos\theta = N \times 2a\sin\theta \quad (W = 2N\tan\theta)$	A1	1.1b
	$\updownarrow R = W$	B1	3.4
	$\leftrightarrow F = N$	B1	3.4
	$F = \mu R \Rightarrow N = \mu W$	M1	1.2
	Complete strategy to form an equation in μ and θ	M1	3.1b
	$N = \mu \times 2N\tan\theta$, $\mu = \dfrac{1}{2\tan\theta}$ *	A1*	2.2a
		(7)	
2b	Position of centre of mass affects value of N, which affects value of μ	B1	3.5a
	Closer to A, μ smaller, further from A, μ larger	B1	2.4
		(2)	
			(9 marks)

Notes:		
2a	M1	Moments equation. Must be dimensionally correct and include all terms. Condone sign errors. Alternative equations: M(B): $2a\sin\theta\times F + a\cos\theta\times W = 2a\cos\theta\times R$ M(G): $a\sin\theta\times N + a\sin\theta\times F = a\cos\theta\times R$ M(X): $2a\sin\theta\times F = a\cos\theta\times W$
	A1	Correct unsimplified equation
	B1	Second equation e.g. by resolving vertically
	B1	Achieve a complete set of equations to solve for μ
	M1	Use of $F = \mu R$
	M1	Complete strategy to form an equation in μ and θ e.g. by taking moments, resolving and eliminating other variables.
	A1*	Derive the given result from correct working.
2b	B1	Correct reasoning
	B1	Correct conclusion

Question	Scheme	Marks	AOs
3(a)	$\mathbf{v} = \frac{\mathrm{d}}{\mathrm{d}t}(\mathbf{r})$	M1	1.1b
	$\mathbf{v} = (3t^2 - 5)\mathbf{i} + (10t + 6)\mathbf{j}$	A1	1.1b
	Parallel to $(\mathbf{i} + 2\mathbf{j}) \Rightarrow (10T + 6) = 2(3T^2 - 5)$	M1	3.1a
	$6T^2 - 10T - 16 = 0$	A1	1.1b
	$T = \frac{8}{3}$	A1	2.2a
		(5)	
(b)	$\mathbf{a} = \frac{\mathrm{d}}{\mathrm{d}t}(\mathbf{v})$, $(\mathbf{a} = 6t\mathbf{i} + 10\mathbf{j})$	M1	1.1b
	$\mathbf{F} = 0.5(12\mathbf{i} + 10\mathbf{j})(= 6\mathbf{i} + 5\mathbf{j})$	M1	2.1
	$\lvert\mathbf{F}\rvert = \sqrt{6^2 + 5^2}$	M1	1.1b
	$= \sqrt{61}(= 7.8(1....))$	A1	1.1b
		(4)	
			(9 marks)

Notes:

(a)	M1	Differentiate – majority of powers going down, correct coefficient of t or t^2.
	A1	Any equivalent form
	M1	Use ratio to form equation in T.
	A1	Correct unsimplified expression in T. Any equivalent form
	A1	Correct only. Allow 2.7 or better. If $T = -1$ is seen, it must be rejected.
(b)	M1	Differentiate their **v** to obtain **a**
	M1	Substitute $t = 2$ and use $\mathbf{F} = m\mathbf{a}$
	M1	Use of Pythagoras to find modulus of **F** or **a**
	A1	7.8 or better

Question	Scheme	Marks	AOs
4(a)	$(\lambda\mathbf{i} = 9\mathbf{i})\quad \lambda = 9$	B1	3.3
	Vertical distance:	M1	3.4
	$9^2 = 12^2 - 2gh$	A1ft	1.1b
	$h = 3.2(1)$	A1	1.1b
		(4)	
(b)	Min speed = 9 (m s^{-1})	B1	2.2a
		(1)	
(c)	Vertical component of velocity $= \sqrt{12^2 - 9^2}\left(= \sqrt{63}\right)$	M1	3.1b
	$\Rightarrow -\sqrt{63} = \sqrt{63} - gt$	A1ft	1.1b
	Complete strategy to find the required time	M1	3.1b
	$t = 1.6(2)$ (s)	A1	2.2a
		(4)	
(d)	Consider the dimensions of the ball	B1	3.5c
		(1)	
			(10 marks)

Notes:

(a)	B1	Comparison of horizontal components of velocities.
	M1	Use the model and *suvat* to form an equation in h. Condone sign errors
	A1ft	Correct unsimplified equation. Follow their λ .
	A1	3.2 or 3.21 only (follows use of 9.8)
(b)	B1	Correct answer only
(c)	M1	Use of Pythagoras to find vertical component
	A1ft	Correct unsimplified equation in t OR find both solutions of $12 - gt = \pm\sqrt{63}$. Follow their vertical component.
	M1	Complete strategy for the required time e.g. find the vertical component of the velocity when speed is 12 m s^{-1} and use *suvat*
	A1	1.6 or 1.62 only (follows use of 9.8)
(d)	B1	e.g consider the dimensions of the ball the ball could be spinning the effect of the wind

Question	Scheme	Marks	AOs
5(a)	Motion of A:	M1	3.4
	$T - 3g\sin\theta = 3a$	A1	1.1b
	Motion of B:	M1	3.4
	$3g - T = 3a$	A1	1.1b
	Complete strategy to find tension	M1	3.1b
	$\Rightarrow T - 3g\sin\theta = 3g - T, \quad 2T = 3g(1+\sin\theta) = \frac{27g}{7}$ $T = 18.9 \quad (19)$	A1	2.1
		(6)	
(b)	Obtain $a = 3.5$	B1	1.1b
	Speed when B reaches the ground: $v^2 = 2\times 3.5\times 0.8 (= 5.6)$	M1	3.3
	Magnitude of the accn. of A when the string is slack: $g\sin\theta$	B1	3.1b
	Extra distance: $0 = 5.6 - 2\times g\sin\theta\times s \quad (s = 1)$	M1	3.1b
	Total distance 1.8 m	A1	2.2a
		(5)	
(c)	If the rope is not inextensible then cannot assume equal acceleration The model takes no account of the size of the packages	B1 B1	3.5b 3.5b
		(2)	
			(13 marks)

Notes:		
(a)	M1	Use the model to form equation of motion for A or B. Must include all relevant terms. Condone sign errors and sin/cos confusion
	A1	Correct unsimplified equation
	M1	Use the model to form second equation of motion. Condone a combined equation
	A1	Correct unsimplified equation
	M1	Complete strategy e.g. form simultaneous equations using equations of motion for A and B and solve for T
	A1	2sf or 3sf or $\frac{27g}{14}$.
(b)	B1	Accept $\frac{5g}{14}$ Correct model for motion, seen or implied
	M1	Complete method using *suvat* to find v or v^2 using $v^2 = 2as$ for their $a \neq g$
	B1	Correct model for motion when the string is slack
	M1	Complete method using *suvat* to find the additional distance using $a \neq$ their 3.5
	A1	Any equivalent form
(c)	B1 B1	Any 2 independent limitations/consequences of the modelling assumptions e.g Have not considered air resistance which will affect the tension, if the rope is not light then the tension in it is not constant, if the pulley is not smooth then the tension is not the same on either side of the pulley.