Mark Scheme (Final)

Summer 2018

Pearson Edexcel GCE AS Mathematics

Statistics & Mechanics (8MA0/02)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification/indicative content will not be exhaustive.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is awarded.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

PEARSON EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 60.

2. These mark schemes use the following types of marks:

- **M** marks: Method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

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

   - **bod** – benefit of doubt
   - **ft** – follow through
   - the symbol $\surd$ will be used for correct ft
   - **cao** – correct answer only
   - **cso** - correct solution only. There must be no errors in this part of the question to obtain this mark
   - **isw** – ignore subsequent working
   - **awrt** – answers which round to
   - **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.

   A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but answers that don't logically make sense e.g. if an answer given for a probability is >1 or <0, should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response.
   If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.

7. Ignore wrong working or incorrect statements following a correct answer.

8. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternatives answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used. If no such alternative answer is provided but the response is deemed to be valid, examiners must escalate the response for a senior examiner to review.

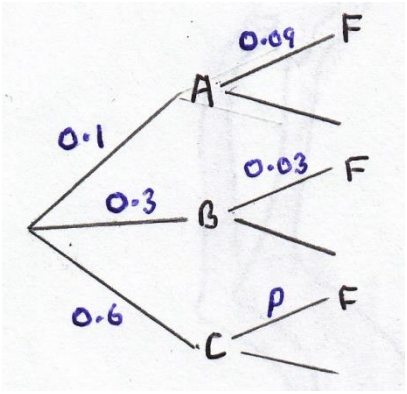
Section A: Statistics

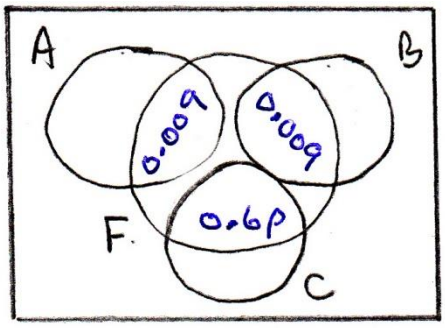
Qu	Scheme	Marks	AO
1 (a)	Positive (correlation)	B1 (1)	1.2
(b)	Every extra point gives £4.5(0) more on pay (o.e.)	B1 (1)	3.4
(c)	e.g. For points < 11 it would give pay < 0 which is ridiculous	B1 (1)	2.4
		(3 marks)	

	Notes
(a)	B1 for "positive". Allow an interpretation e.g. "as points increase pay increases" is B1 Read whole answer: contradictory comments such as "positive correlation, as points increase pay decreases" scores B0
(b)	B1 for any correct comment conveying idea of £s per point and including a correct value; must have idea of rate. Can condone missing £ sign. Accept 4.5 e.g. "every 10 points earns an extra (or increase) of £45" is B1 BUT "every point earns £4.5(0)" is B0 *doesn't have idea of rate*
(c)	B1 for a suitable comment mentioning "points" or "pay" (o.e. e.g. "amount") or commenting on "small sample" or "range of points" used to find line The following examples would score B1 Can say that n points (for $n < 10.\dot{4}$) would give negative pay so not suitable Any comment suggesting that some jobs would end up with negative pay Don't know the range of points used to find the regression line A small sample of size 8 may not be representative to cover all jobs B0 for a focus on "qualifications" or "hours" worked only The following examples would score B0 Some jobs require no (or low) skills or qualifications (*need negative pay*)

Qu	Scheme	Marks	AO
2 (a)	[Let $p = \text{P}(F \mid C)$]		
	Tree diagram or some other method to find an equation for p	M1	2.1
	$0.1\times0.09+0.3\times0.03+0.6\times p=0.06$	A1	1.1b
	$p = 0.07$ i.e. **7%**	A1	1.1b
		(3)	
(b)	e.g. $\text{P}(B \text{ and } F) = 0.3\times0.03 = 0.009$ but		
	$\text{P}(B)\times\text{P}(F) = 0.3\times0.06 = 0.018$	B1	2.4
	These are not equal so not independent		
		(1)	
		(4 marks)	

	Notes
(a)	M1 for selecting a suitable method to find the missing probability e.g. sight of tree diagram with 0.1, 0.3, 0.6 and 0.09, 0.03, p suitably placed e.g. sight of VD with 0.009 for $A\cap F$ and $B\cap F$ and 0.6p suitably placed or attempt an equation with at least one correct numerical and one "p" product (not necessarily correct) on LHS or for sight of 0.06 – (0.009 + 0.009) (o.e. e.g. 6 – 1.8 = 4.2%) 1st A1 for a correct equation for p (May be implied by a correct answer) or for the expression $\dfrac{0.06-(0.009+0.009)}{0.6}$ (o.e.) 2nd A1 for 7% (accept 0.07) **Correct Ans:** Provided there is no incorrect working seen award 3/3 e.g. may just see tree diagram with 0.07 for p (probably from trial and improv')
(b)	B1 for a suitable explanation…may talk about 2nd branches on tree diagram and point out that 0.03 ≠ 0.06 but need some supporting calculation/words Can condone incorrect use of set notation (it is not on AS spec) provided the rest of the calculations and words are correct.





Qu	Scheme	Marks	AO
3 (a)	Let N = the number of games Naasir wins $N \sim B(15, \frac{1}{3})$	M1	3.3
(i)	$P(N = 2) = 0.059946\ldots$ **awrt 0.0599**	A1	1.1b
(ii)	$P(N > 5) = 1 - P(N \leqslant 5) = 0.38162\ldots$ **awrt 0.382**	A1	1.1b
		(3)	
(b)	$H_0 : p = \frac{1}{3}$ $H_1 : p > \frac{1}{3}$	B1	2.5
	Let X = the number of games Naasir wins $X \sim B(32, \frac{1}{3})$	M1	3.3
	$P(X \geqslant 16) = 1 - P(X \leqslant 15) = 0.03765$ (< 0.05)	A1	3.4
	[Significant result so reject H_0 (the null model) and conclude:] There is evidence to support Naasir's claim (o.e.)	A1	3.5a
		(4)	
		(7 marks)	

	Notes
(a)	M1 for selecting a binomial model with correct n or p Award for sight of $B(15, \frac{1}{3})$ (o.e. e.g. in words) or implied by 1 correct answer 1st A1 for awrt 0.0599 (from a calculator). Allow 0.05995 2nd A1 for awrt 0.382 (from a calculator)
(b)	B1 for correctly stating both hypotheses in terms of p or π Accept $p = 0.\dot{3}$ or any exact equivalent. $H_1 : p \geqslant \frac{1}{3}$ is B0 M1 for selecting a suitable model to use for the test. Award for sight of $B(32, \frac{1}{3})$ (o.e. e.g. in words) or implied by 0.03765 1st A1 for use of the model to calculate an appropriate probability using calc. Sight of $P(X \geqslant 16)$ **and** answer awrt 0.0377
ALT	**CR** May use CR so award 1st A1 for CR of $X \geqslant 16$ must have seen some probabilities though: 1 of $P(X \leqslant 15) = 0.9623$ or $P(X \leqslant 14) = 0.9224$ or 0.9223 2nd A1 for conclusion in context that there is support for Naasir's claim Must mention "Naasir" or "his" and "claim" or "method" (o.e.) or e.g. probability of winning a game is $> \frac{1}{3}$ or has increased Dependent on M1 and 1st A1 but can ignore hypotheses.
SC	**Use of 0.3 for $\frac{1}{3}$** If used 0.3 instead of $\frac{1}{3}$ in (a) and score M0A0A0 can condone use of 0.3 in (b) 1st A1 ft needs $P(X \geqslant 16) = 0.0138$ or CR of $X \geqslant 15$ and sight of 1 of $P(X \geqslant 15) = 0.0327$ or $P(X \geqslant 14) = 0.0694$ 2nd A1 as before with 0.3 instead $\frac{1}{3}$ (if appropriate)

Qu	Scheme	Marks	AO
4 (a)	$\bar{x} = 10.2\,(2222\ldots)$ awrt **10.2**	B1 (1)	1.1b
(b)	$\sigma_x = 3.17\,(20227\ldots)$ awrt **3.17**	B1ft	1.1b
	Sight of "knots" or "kn" (condone knots/s etc)	B1 (2)	1.2
(c)	October ….. since	B1	2.2b
	it is windier in the autumn or month of the hurricane or latest month in the year	B1 (2)	2.4
(d)(i)	They represent outliers	B1	1.2
(ii)	*Y* has low median so expect lowish mean (but outlier so > 7) and *Y* has big range/IQR or spread so expect larger st.dev	M1	2.4
	Suggests *B*	A1 (3)	2.2b
		(8 marks)	

	Notes
NB	$\bar{x} = \frac{184}{18}$ and $\sigma_x = \sqrt{\frac{2062}{18} - \bar{x}^2}$
(a)	B1 for $\bar{x} = 10.2$ (allow exact fraction) [This is an LDS mark]
(b)	1st B1ft allow 3.2 from a correct expr' accept $s = 3.26(3984\ldots)$ [ft use of n/a] Treating n/a as 0 May see $n = 31$ or $\bar{x} = 5.9354...$ which is B0 in (a) but here in (b) it gives $\sigma_x = 5.59(34\ldots)$ or $s = 5.6858\ldots$(awrt 5.69) and scores 1st B1 2nd B1 accept kn accept in (a) or (b) (allow nautical miles/hour) [This is an LDS mark]
(c)	1st B1 choosing October but accept September. [This is an LDS mark] 2nd B1 for stating that (Camborne) is windier in autumn/winter months "because it is winter/autumn/windier/colder in "month" " Sep $\leqslant$ "month" $\leqslant$ Mar scores B1B1 for "month" = Sep or Oct and B0B1 for other months in range
(d)(i)	B1 for outlier or the idea of an extreme value allow "anomaly"
(ii)	M1 for a comment relating to location that mentions both median and mean and a comment relating to spread that mentions both range/IQR and standard deviation and leads to choosing *B*, *C* or *D* **Choosing *A* or *E* is M0** Incorrect/false statements score M0 e.g. Q_3 = (mean + σ) or identify Q_2 = mean or *Y* has small spread
ALT	**Use of outliers:** outlier is (mean + 3σ) (*B* = 19.9), (*C* = 18.95), (*D* = 20.2) Must see at least one of these values and compare to *Y*'s outlier[leads to *D* or *B*]
	A1 for suitable inference i.e. *B* (accept *D* or *B* or *D*) M1 **must** be scored

Qu	Scheme	Marks	AO
5(a)	$P(X=4) = P(X=2)$ so $P(X=4) = 0.35$ $P(X=1) = P(X=3)$ and $P(X=1) + P(X=3) = 1 - 0.7$ So x | 1 | 2 | 3 | 4 $P(X=x)$ | 0.15 | 0.35 | 0.15 | [0.35]	M1 A1 (2)	2.1 1.1b
(b)	Let A = number of spins that land on 4 $A \sim B(60, "0.35")$	B1ft	3.3
	$[P(A > 30) =]$ $1 - P(A \leqslant 30)$ $= 1 - 0.99411\ldots$ = **awrt 0.00589**	M1 A1 (3)	3.4 1.1b
(c)	$Y - X \leqslant 4 \Rightarrow \frac{12}{X} - X \leqslant 4$ <u>or</u> $12 - X^2 \leqslant 4X$ (since $X > 0$) o.e.	M1	3.1a
	i.e. $0 \leqslant X^2 + 4X - 12 \Rightarrow 0 \leqslant (X+6)(X-2)$ so $X \geqslant 2$	M1	1.1b
	$P(Y - X \leqslant 4) = P(X \geqslant 2) = 0.35 + 0.15 + 0.35$ = **<u>0.85</u>**	A1 (3)	3.2a
		(8 marks)	

	Notes
(a)	M1 for using the given information to obtain $P(X=4)$ Award for statement $P(X=4) = P(X=2)$ <u>or</u> writing $P(X=4) = 0.35$ A1 for getting fully correct distribution (any form that clearly identifies probs) e.g. can be list $P(X=1) = 0.15$, $P(X=3) = \ldots$etc or as a probability function $P(X=x) = \begin{cases} 0.15 & x = 1,3 \\ 0.35 & x = 2,4 \end{cases}$ [Condone missing $P(X=2)$ as this is given in QP]
(b)	B1 for selecting a suitable model, sight of B(60, their 0.35) o.e. in words f.t. their $P(X=4)$ from part (a). Can be implied by $P(A \leqslant 30)$ = awrt 0.9941 or final answer = awrt 0.00589 M1 for using their model and interpreting "more than half" Need to see $1 - P(A \leqslant 30)$. Can be implied by awrt 0.00589 Can ignore incorrect LHS such as $P(A \geqslant 30)$ A1 for awrt 0.00589
(c)	1st M1 for translating the prob. problem into a <u>correct</u> mathematical inequality Just an inequality in 1 variable. May be inside a probability statement. **ALT** **Table of values:** X | 1 | 2 | 3 | 4; Y | 12 | 6 | 4 | 3 <u>or</u> values of $Y - X = 11, 4, 1, -1$ 2nd M1 for solving the inequality leading to a range of values, allow 1 or 2 slips May be a quadratic or cubic but must lead to a set of values of X or $Y - X$ **ALT** **Table or values:** They must state clearly which values are required **Both Ms can be implied by a correct answer (or correct ft of their distb'n)** A1 for interpreting the inequality and solving the problem i.e. 0.85 cao