Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE AS Mathematics

Statistics & Mechanics (8MA0/02)

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General Marking Guidance

- x   All candidates must receive the same tre   atment. Examiners
      must mark the last candidate in exactly the same way as they
      mark the first.

- x   Mark schemes should be applied positively. Candidates must be
      rewarded for what they have shown they can do rather than
      penalised for omissions.

- x   Examiners shou ld mark according to the mark scheme not
      according to their perception of where the grade boundaries may
      lie.

- x   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
       S U H S D U H G   W R   D Z D U G   ] H U R   P D U N V   L I   W K H   F D Q G L G D W H ¶ V
      worthy of credit according to the mark scheme.

- x   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.

- x   When examiners are in doubt regarding the application of the
       P D U N   V F K H P H   W R   D   F D Q G L G D W H ¶ V   U H V S R Q V H   D   V H Q L R U
      be consulted before a mark is awarded.

- x   Crossed out work should be ma   rked 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 ma rks 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 (independen t 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 ⋀ 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 sh own, 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 <u>and indicates which response they wish to submit</u>, examiners should mark this response. If there are several attempts at a question <u>which have not been crossed out</u>, examiners should mark the final answer which is the answer that is the <u>most complete</u>.

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 acceptabl e, 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.

Qu	Scheme	Marks	AO
1 (a)	Positive (correlation)	B1 (1)	1.2
(b)	Every extra point gives £4(5) more on pay (o.e.)	B1 (1)	3.4
(c)	e.g. For points < 1 it would give pay < 0 which is ridiculous	B1 (1)	2.4
		(3 marks)	

Notes

(a) % IRU ³SRVLWLYH´
AOORZ DQ LQWHUSUHWDWLRQ RI HJ S³D\VLQ
5HDG ZKROH DQVZHU FRQWUDGLFWRU\ F
DV SRLQWV LQFUHDVH SD\ GHFUHDVHV´ VF

(b) B1 for any correct comment conveying idea of £5 per point and including a correct value; must have idea of rate. Can condone missing £ sign. Accept 4.5
    H J ³HYHU\ S extra RL QW V HQ UQ DDV OH RI …
    % 8 7 ³HYHU\ SRLQW VHGRUHQ Q¶W KDYH LGHD

(c) % IRU D VXLWDEOH FRPPHQW PHQWLRQLQ
    or commenting on ³small sample´ or ³range of points´ used to find line
    The following examples would score B1
    Can say that n points (for n <) would give negative pay so not suitable
    Any comment suggesting that some jobs would end up with negative pay
    'RQ¶W NQRZ Large of points used to find the regression line
    A small sample of size 8 may not be representative to cover all jobs

    % IRU D IRFXV RQ ³TXDOLILFDWLRQV´ RU
    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 = P(F | C)] Tree diagram or some other method to find an equation for p $p = 0.07$ i.e. <u>7%</u>	M1 A1 A1 (3)	2.1 1.1b 1.1b
(b)	e.g. P(B and F) = = 0.009 but = 0.018 These are not equal so not independent	B1 (1)	2.4
		(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, and 0.09, 0.03p suitably placed
	       e.g. sight of VD with 0.009 for and 0.6 suitably placed
	       <u>or</u> attempt an equation with at least one correct numerical and
	          ‘P(C and F)’ (not necessarily correct) on LHS
	       <u>or</u> 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)
	
	        <u>or</u> for the expression (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)	% for a suitable e.g. ‘2nd branches on tree diagram
	      and point out that 0.3 ≠ 0.06 but need some supporting calculation/words
	       Can condone incorrect use of set notation (it is not on AS spec) pro
	       the rest of the calculations and words are correct.

Qu	Scheme	Marks	AO
3 (a) (i) (ii)	Let N = the number of games Naasir wins N ~B(15,) P(N « awrt 0.0599 P(N > 5) = 1 ±P(N « awrt 0.382	M1 A1 A1 (3)	3.3 1.1b 1.1b
(b)	 Let X = the number of games Naasir wins X ~B(32,) P(X 16) = 1 ±P(X 15) = 0.03765 (< 0.05) [Significant result so reject H (the null model) and conclude] 7 K H U H L V H Y L G H Q F H W R e.v)X S S R U W	B1 M1 A1 A1 (4)	2.5 3.3 3.4 3.5a
		(7 marks)	

	Notes
(a)	M1 for selecting a binomial model with correct n and p Award for sight of B(15,) (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
	          Accept p = or any exact equivalent. is B0
	M1 for selecting a suitable model to use for the test.
	Award for sight of B(32,) (o.e. e.g. in words) or implied by 0.03765
	Can also allow M1 for P(X 15) = 0.962 or better or P(X 14) = 0.922 or better
	1st A1 for use of the model to calculate an appropriate probability using c
	          Sight of P(X 16) and answer awrt 0.0377

ALT	CR May use CR so award 1st A1 for CR of X 16 must have seen some probabilities though: 1 of P(X 15) = 0.9623 or P(X 14) = 0.9224 or 0.9223
	
	2nd A I R U F R Q F O X V L R Q L Q F R Q W H [W W K D W
	          0 X V W P H Naasir R Ghis « D Q claim « R method«(o.e.)
	          or e.g. probability of winning a game is or has increased
	          Dependent on M1 and 1st A1 but can ignore hypotheses but see below
	If you see P(X 16) = 0.0376 followed by a correct contextualised conclus
	then please award A0A1

SC	Use of 0.3 for If used 0.3 instead of in (a) and score M0A0A0 can condone use of 0.3 in 1st A1 ft needs P(X 16) = 0.0138 or CR of X 15 and sight of 1 of P(X 15) = 0.0327 or P(X 14) = 0.0694

| | 2nd A1 as before with 0.3 instead(if appropriate) |

Qu	Scheme	Marks	AO
4 (a)	« <u>10.2</u>	B1 (1)	1.1b
(b)	« <u>3.17</u> 6 L J K W R I or ³ N Q ´ ³ N Q R WFV´Q G etc)	B1ft B1 (2)	1.1b 1.2
(c)	2 F W R E H U « V L Q F H it is windier in the autumn or month of the hurricane or latest month in the year	B1 B1 (2)	2.2b 2.4
(d)(i)	They represent outliers	B1	1.2
(ii)	Y has low median so expect low mean (but outlier so > 7 <u>and</u> Y has big range IQR or spread so expect larger st.dev Suggests B	M1 A1 (3)	2.4 2.2b
		(8 marks)	

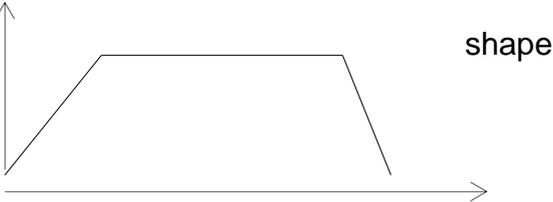|	Notes
NB	and
(a)	B1 for (allow exact fraction)
(b)	1st % I W D O O R Z I U R P Ds F R U U H F W H [S ´ I W n/a] <u>Treating n/a as 0</u> May see n = 31 or which is B0 in (a) but here in (b) it gives « sR U « D Z U W P D B1 2nd B1 accept kn accept in a)(or (b) (allow nautical miles/hour)

(c)	1st B1 choosing October but accept September.
	 2nd B1 for stating that (Camborne) is windier in autumn/winter months
	  ³ E H F D X V H L W L V Z L Q W H U D X X P Q ˝Zon G L H Mar
	     scores B1B1 I R U ³ P R Q W K ´ 6 H S for other months O G ² range

(d)(i)	B1 for outlier U R U W K H L G H D R I D Q H [W U H P H Y D
(ii)	M1 for a comment relating to location that mentions both median and mean <u>and</u> a comment relating to spread that mentions both range/IQR and standard deviation and leads to choosing B, C or D

ALT	Choosing A or E is M0 Incorrect/false statements score M0 e.g. $Q_3 =$ (mean $+ V$ or identify $Q_2 =$ mean or Y has small spread Use of outliers: outlier is (mean $+ 3V$) (B = 19.9), C = 18.95), D = 20.2) Must see at least one of these values and compare to V [R X W O LD or U > 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	M1 A1	2.1 1.1b

x	1	2	3	4
P(X = x)	0.15	0.35	0.15	[0.35]

Qu	Scheme	Marks	AO
			(2)
(b)	Let A = number of spins that land on 4 A ~ B(60, 0.35²)	B1ft	3.3
	[P(A > 30) =] 1 − P(A ≤ 30)	M1	3.4
	= 1 − … awrt 0.00589	A1	1.1b
			(3)
(c)	(since X > 0) o.e.	M1	3.1a
	i.e. so	M1	1.1b
	= 0.85	A1	3.2a
			(3)
		(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 … H
	                    or as a probability function
	 [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 ≤ 30) = awrt 0.9941 or final answer = awrt 0.005
	 M1 for using their model and "interpreting" more …
	        Need to see 1 − P(A ≤ 30) . Can be implied by awrt 0.00589
	        Can ignore incorrect LHS such as
	 A1 for awrt 0.00589

(c)	1ˢᵗ M1 for translating the probability 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

or values of Y ±X = 11, 4, 1, ±1

	Notes
	2ⁿᵈ M1 for solving the inequality leading to a range of values, allow 1 or 2 sl May be a quadratic or cubic but must lead to a set of values X or Y ±X
ALT	Table or values: They must state clearly which values are required "Both Ms can be implied by a correct a… A1 for interpreting the inequality and solving the problem 0.85 cao

Question	Scheme	Marks	AOs
6.	Equation in t only	M1	2.1
		A1	1.1b
		DM1	1.1b
	T = 2 (only)	A1	1.1b
		(4)	

(4 marks)

Notes:

M1: Complete method to give equation in t only. This mark is for a complete method for the TOTAL time i.e. for finding sufficient equations with usual rules, correct no. of terms in each equation but condone sign errors and g does not need to be substituted

A1: A correct equation or correct equations (e.g. if they find the speed 11 ms^{-1}, when the ball strikes the ground and then use that to find the total time or if they split the time (e.g. 0.9s up and 1.1s down or 0.9s + 0.9s + 0.2s)

N.B. g = 10 must be substituted in all equations used.

DM1: Dependent on first M1, for solving a 3 term quadratic to find T or for solving their equations to find T or for solving their equations and adding their split times to find T

A1: T = 2 only (i.e. A0 if they give two times)

N.B. If solving a correct quadratic, the DM1 can be implied by a correct answer i.e. the method does not need to be shown, but if there is no method shown and the answer is wrong then award D

Question	Scheme	Marks	AOs
7(a) (i)	24 ( )	B1	1.1b
(ii)	48 (s)	B1	1.1b
(iii)	shape	B1	1.1b
		(3)	
(b)	Equating area under graph to 4800 to give equation in one unkno	M1	3.1b
	OR oe	A1ft	1.1b
	T = 136 so total time is 264 (s)	A1	1.1b
		(3)	
(c)	Accept Either: a smooth change from acceleration to constant velocity from constant velocity to deceleration. Or have train accelerating and/or decelerating at a variable rate Do not accept e.g. Comments on air resistance or resistive forces, straightness of track, horizontal track, friction, length of train, mass of train, not having train moving with constant velocity. <u>B0 if either an incorrect extra is included or an incorrect reason for a valid improvement is included</u> <u>N.B.</u> Variable acceleration due to air resistance is B0 BUT Variable acceleration due to variable air resistance is B1	B1	3.5c
		(1)	
		(7 marks)	

Notes:	
(a)
(i)   B1: 24 (   ) Must be stated i.e. not just inserted on the graph
(ii) B1: 48 (s) (Allow ±48 changed to 48) Must be stated i.e. not just inserted on the graph
(iii) B1: A trapezium starting at the origin and ending on the *t* axis.
(b)
M1: Complete method to find area of trapezium using trapezium rule with correct structure or using two triangles and a rectangle and equate to 4800 to give equation in one unknown

N.B.   is M0 (equivalent to using three triangles)

OR they may use suvat on one or more sections (must have *a* = 0 for middle section) and equate total distance travelled to 4800 to give equation in one unknown

A1ft: For a correct equation in the unknown ft on their 24 and 48 (but must be positive times)

A1:   For 264 (s)

(c)
B1:
Either: Include time to change from constant accln to constant velocity and/or time to change from constant velocity to constant deceleration oe
Or: Have train accelerating and/or decelerating at a variable rate

Question	Scheme	Marks	AOs
8(a)	Multiply out and differentiate wrt to time (or use of product rule i.e. must have two terms with correct structure)	M1	1.1a
		A1	1.1b
	= 0 and solve:	DM1	1.1b
	$t = 0$ or or $t = 1$; any two	A1	1.1b
	All three	A1	1.1b
		(5)	
(b)	Find x when $t = 0$, , 1 and 2 : (0, , 0 , 2)	M1	2.1
	Distance = + + 2	M1	2.1
	2 (m) oe or 2.06 or better	A1	1.1b
		(3)	
(c)		M1	3.1a
	perfect square so 0 i.e. never negative	A1 cso	2.4
		(2)	
		(10 marks)	

Notes:

(a)

M1: Must have 3 terms and at least two powers going down by 1

A1: A correct expression

DM1: Dependent on first M, for equating to zero and attempting to solve a <u>cubic</u>

A1: Any two of the three values (Two correct answers can imply a correct method)

A1: The third value

(b)

M1: For attempting to find the values of x (at least two) at their t values found in (a) or at $t = 2$

or equivalent e.g. they may integrate their v and sub in at least two of their t values

M1: Using a correct strategy to combine their distances (must have at least 3 distances)

A1: 2 (m) oe or 2.06 or better

(c)

M1: Identify strategy to solve the problem such as

    (i)   writing x as perfect square

    (ii)   or using x values identified in (b)
    (iii)   or using calculus i.e. identifying min points on x–t graph
    (iv)   or using x-t graph

A1 cso: Fully correct explanation to show that $x \geq 0$ i.e. never negative

Question	Scheme	Marks	AOs
9(a)	Equation of motion for P	M1	3.3
		A1	1.1b
		A1	1.1b
		(3)	
(b)	Since the string is modelled as being inextensible	B1	3.4
		(1)	
(c)	Equation of motion for Q OR for whole system	M1	3.3
	OR	A1	1.1b
	oe and solve for k	DM1	1.1b
	or 0.333 or better	A1	1.1b
		(4)	
(d)	e.g The model does not take account of the mass of the string (see notes below for alternatives)	B1	3.5b
		(1)	

(9 marks)

Notes: Condone both equations of motion appearing in (a) if used in (c)

(a)

M1: Resolving vertically for P with usual rules, correct no. of terms but condone sign errors and a does not need to be substituted (NB. inconsistent omission of g is M0). Allow ma on RHS for M1

A1: A correct equation (allow if they use 7 instead of)

A1: A correct answer of form cmg, where $c =$ oe or 0.57 or better

(b)

B1: String is inextensible. N.B. B0 if any extras (wrong or irrelevant) given

(c)

M1: Resolving vertically for Q or for a whole system equation, with usual rules, correct no. of terms but condone sign errors and either T nor a does need to be substituted

(N.B. inconsistent omission of g is M0 and M0 if k is omitted from LHS or RHS or both.)

A1: A correct equation (allow if they use 7 instead of g)

DM1: Sub for T using their answer from (a), if necessary, and solve to give a numerical value of k (i.e. $m g \sin \alpha - \mu mg \cos \alpha$)

A1: or 0.333 or better

(d)

B1: e.g. Pulley may not be smooth

　　　　Pulley may not be light

　　　　Particles may not be moving freely e.g. air resistance

　　　　Balls may not be particles

　　　　String may not be light

　　　　String may not be inextensible

　　　　but allow converses in all cases e.g. "pul..."

N.B. B0 if any extra incorrect answer is given BUT ignore incorrect consequence of a correct answer

Also note: B0 : Use of a more accurate value of g