GCE AS MARKING SCHEME

SUMMER 2019

AS (NEW)
MATHEMATICS
UNIT 2 APPLIED MATHEMATICS A
2300U20-1

INTRODUCTION

This marking scheme was used by WJEC for the 2019 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

GCE MATHEMATICS

AS UNIT 2 APPLIED MATHEMATICS A

SUMMER 2019 MARK SCHEME

SECTION A - STATISTICS

Qu. No.	Solution	Mark	Notes
1(a)	Correct use of $P(A \cup B) = P(A) + P(B) - P(A \cap B)$	M1	Use of addition formula with at least $P(A \cup B)$ and $P(B)$ correct.
	$\frac{3}{4} = P(A) + \frac{1}{5} - \frac{1}{5}P(A)$	A1	
	$P(A) = \frac{11}{16}$ (0.6875)	A1	
(b)	$P(A \cap C) = \frac{11}{16} + \frac{1}{6} - \frac{5}{6}$ $= \frac{1}{48}$ $(0.0208333\ldots)$	B1	FT 'their P(A)' provided $0 \le P(A) \le 1$ and leads to $P(A \cap C)$ being between 0 and 1.
	$P(A) \times P(C) = \frac{11}{16} \times \frac{1}{6} = \frac{11}{96}$ $(0.11458333\ldots)$	B1	FT 'their $P(A)$'
	Since $\frac{1}{48} \ne \frac{11}{96}$, A and C are not independent.	E1	Award only from appropriate working, provided B1B1 awarded.
	OR		
	If A and C are independent, then $P(A \cap C) = P(A) \times P(C)$ $= \frac{11}{16} \times \frac{1}{6} = \frac{11}{96}$ $(0.11458333\ldots)$	(B1)	si FT 'their P(A)' provided $0 \le P(A) \le 1$ and leads to $P(A \cap C)$ being between 0 and 1.
	$P(A \cup C) = P(A) + P(C) - P(A \cap C) = \frac{71}{96}$	(B1)	FT 'their $P(A)$'
	Since $\frac{71}{96} \ne \frac{5}{6}$, A and C are not independent.	(E1)	Award only from appropriate working, provided B1B1 awarded.

(c)	B and C are mutually exclusive, or equivalent.	B1 **[7]**	

Qu. No.	Solution	Mark	Notes
2(a)	$H_0: p = 0.3 \quad H_1: p > 0.3$	B1	
(b)	(Let the random variable X represent the number of people who buy at least one item of clothing) Under H_0, $X \sim B(50, 0.3)$ $P(X \geq 21) = 1 - 0.9522$ $P(X \geq 21) = 0.0478$ OR $P(X \geq 20) = 0.0848$ $P(X \geq 21) = 0.0478$ Critical value is 21. Critical region is $X \geq 21$. Since $p < 0.05$, reject H_0. OR Since 21 lies in the critical region, reject H_0.. There is sufficient evidence at the 5% level of significance to suggest that social media advertising has increased the proportion of people who buy at least one item of clothing.	 B1 M1 A1 (M1) (A1) B1 (B1) B1	 si M0 for $P(X = 21)$ M1 for $P(X \leq 20) = 0.9522$ with an attempt to find corresponding CR si oe Do not award either B1 from a conclusion based on P(X=k) Do not allow categorical statements. SC B0M1A0B1B1 available for using incorrect p
(c)	Valid statement referring to cost eg. The cost of the advertising. The projected increased profit. OR Reference to any other valid factor in context which may have caused an increase in sales. eg OR Reference to inappropriateness of sampling methodology in context.	E1	FT from (b)
(d)	Ali has constructed the alternative hypothesis based on his observations. The hypotheses should be formed independently of the data. $H_0: \theta = 0.29 \quad H_1: \theta \neq 0.29$	B1 E1 B1 **[10]**	 Or equivalent statement.

Qu. No.	Solution	Mark	Notes
3 (a)	(Let the random variable Y represent the number of patients arriving at A&E in one hour) $P(Y = 7) = \frac{e^{-5.3} \times 5.3^7}{7!}$ $= 0.1163$	M1 A1	 Or from calculator.
(b)	(Let the random variable X represent the number of patients arriving at A&E in 90 minutes) Number of arrivals X follows Po(7.95) Use calculator to find $P(X \geq 12) = 0.1084$ (OR $P(X \leq 11) = 0.8916$) $P(X \geq 13) = 0.0614$ (OR $P(X \leq 12) = 0.9386$) $n = 13$	B1 M1 A1 A1	si M1 for either 0.1084 or 0.0614. Both values required SC2 (M1 A1 A0) for approximating to Po(8) to use tables. P(X ≥ 12) = 0.1119 P(X ≥ 13) = 0.0638
(c)	Valid reason. eg. There may be times that are busier than others. Patients arriving at A&E may not be independent of each other, eg car accident	E1 **[7]**	

Qu. No.	Solution	Mark	Notes
4 (a) (i)	Two appropriate statements. eg. She has plotted the year / she has drawn a horizontal line for the number of accidents in Wales. She has mixed up Gwent and North Wales	B2	B1 for each valid statement. Allow one reason per region
(ii)	Valid statement. eg. The population of each region. The length of road of each region.	B1	
(b)	$\bar{x} = \frac{\Sigma fx}{\Sigma f} = \frac{2058}{22}$ $= 93.5(4545 \ldots)$ $\sigma = \sqrt{\frac{\Sigma fx^2}{\Sigma f} - \bar{x}^2}$ $= \sqrt{\frac{285654}{22} - \left(\frac{2058}{22}\right)^2}$ $= 65.(06551 \ldots)$	M1 A1 M1 A1	 ft their mean ft their mean provided positive term within square root for M1 and A1
(c)(i)	The y-axis should be labelled frequency density.	B1	
(ii)	Valid comment specific to the given histogram. eg. It is not possible to tell because it is possible that all 5 response times in the 8 to 10 interval all happened between 9 and 10 minutes.	B1	
(iii)	Positive skew. (There is a long right-hand tail.)	B1 **[10]**	

Qu. No.	Solution	Mark	Notes
5(a)	Opportunity sampling.	B1	
(b)	Valid comment. eg. Go to different areas, as this is a biased sample. Many of his responders will be from the same community.	B1	
(c)	Appropriate statement. eg. The line is only valid for predicting the number of primary schools in counties with populations between approximately 100,000 and 2,800,000.	E1	Allow: The model predicts that a county with a population of 0 has about 23 primary schools
(d)	$\text{No. of Primary Schools} = 22.7 + 0.2406 \times 889$ $= 237 \text{ schools}$	M1 A1	M0 for using 889,000 A0 for 236.5934
(e)	Appropriate comment. eg. It is likely that number of primary schools IS caused by a greater population (because local authorities are obliged to provide education). Closing a school doesn't automatically decrease the county population (as pupils would be absorbed into other local schools) Increasing the county population doesn't automatically increase the number of schools, (but they are clearly related)	E1 **[6]**	Do not accept a categorical statement of causation

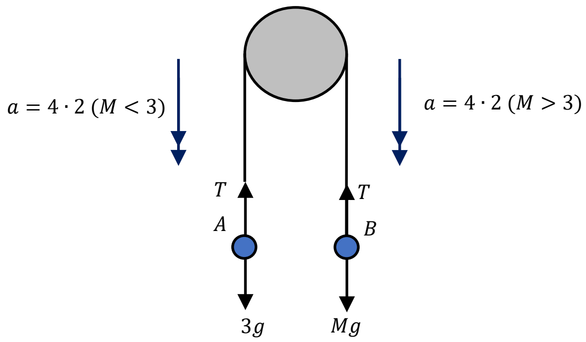
SECTION B - MECHANICS

Q6	Solution	Mark	Notes
(a)	Resultant, $\mathbf{F} = \mathbf{F_1} + \mathbf{F_2} + \mathbf{F_3}$ $= (6\mathbf{i} - 7\mathbf{j}) + (a\mathbf{i} + 2\mathbf{j}) + (5\mathbf{i} + b\mathbf{j})$ $= (11 + a)\mathbf{i} + (b - 5)\mathbf{j}$	B1	Simplification not necessary, must be a sum of forces
	Using N2L, $\mathbf{F} = m\mathbf{a}$ $(11 + a)\mathbf{i} + (b - 5)\mathbf{j} = 2(7\mathbf{i} - 3\mathbf{j})$	M1	
	$11 + a = 2 \times 7$ or $b - 5 = 2 \times -3$	m1	Comparison of at least one coefficient
	$a = 3$ and $b = -1$	A1	cao, both values
		[4]	
(b)	Constant velocity $\Rightarrow$ Resultant $= 0$	M1	Resultant $= 0$ used
	$\mathbf{F_4} = -(\mathbf{F_1} + \mathbf{F_2} + \mathbf{F_3}) = -(14\mathbf{i} - 6\mathbf{j})$		
	$\mathbf{F_4} = -14\mathbf{i} + 6\mathbf{j}$	A1 **[2]**	FT candidate's a and b from (a) with their resultant; $\mathbf{F_4} = -(11 + a)\mathbf{i} - (b - 5)\mathbf{j}$
Total for Question 6		**6**	

Q7	Solution	Mark	Notes
(a)	Distance travelled $= 16 + 16 + 9 + 9$ $(= 50\text{ m})$	B1	cao
	Average speed $= \frac{\text{total distance travelled}}{8}$	M1	Used with candidate's distance
	$= \frac{50}{8} = 6 \cdot 25 \quad (\text{ms}^{-1})$	A1	cao
		[3]	
(b)	$t = 4 \quad (\text{s})$ and $t = 7 \quad (\text{s}) \qquad (t = 0 \quad (\text{s}))$	B1	**Both** non-zero times required.
		[1]	
(c)	(i) $4 < t < 7$ oe	B1	Statement (mathematical or otherwise) to the effect that interval is between the given boundaries.
	(ii) $6 < t < 7$ oe	B1	Condone equality.
		[2]	Cao for each B1
	Total for Question 7	**6**	

Q8	Solution	Mark	Notes
(a)	$v^2 = u^2 + 2as,\ v = 0, a = \pm g, s = \pm 10$ $0 = u^2 + 2(\pm 9\cdot 8)(\mp 10)$ $u = (\mp)14 \quad (\mathrm{ms}^{-1})$	M1 A1 A1 **[3]**	 g opposing s Convincing
(b)	$s = ut + \frac{1}{2}at^2,\ s = \pm 0\cdot 9, u = \pm 14, a = \pm g$ $\pm 0\cdot 9 = (\mp 14)t + \frac{1}{2}(\pm 9\cdot 8)t^2$ $4\cdot 9t^2 - 14t - 0\cdot 9 = 0$ (oe) Solving their quadratic $\left(t = \frac{14 \pm \sqrt{196 - 4(4\cdot 9)(-0\cdot 9)}}{9\cdot 8}\right)$ $t = 2\cdot 9\ \mathrm{s}$ (must be 1 d.p.)	M1 A1 m1 A1 **[4]**	 g **and** s opposing u Calculator gives $t = \frac{10+\sqrt{109}}{7}$ cao
(c)	Any sensible assumption. e.g. Ball modelled as a particle. Acceleration due to gravity is constant.	 B1 **[1]**	
(d)	(The ball would not reach the ceiling.) Calculations are independent of the mass/weight of the ball.	 B1 **[1]**	
Total for Question 8		**9**	

Q9	Solution	Mark	Notes
(a)	$v = \int (2t - 8)\,\mathrm{d}t$ $v = t^2 - 8t\ (+C)$ When $t = 0, v = 12$ $C = 12$ $v = t^2 - 8t + 12$	M1 A1 A1 **[3]**	Attempt to integrate a with sight of at least one increase in power cao
(b)	At $t = 5$, $v = (5)^2 - 8(5) + 12$ $v = -3$ Use of $a = 2$ for $t > 5$ (uniform acceleration) $v = u + at, u = -3, a = 2, t = 14 - 5$ $v = -3 + (2)(9)$ $v = 15\quad(\mathrm{ms}^{-1})$ <u>Alternative solution</u> For $t > 5$, $v = \int 2\,\mathrm{d}t = 2t\ (+C)$ When $t = 5, v = -3$ $C = -13$ $v = 2t - 13$ At $t = 14$, $v = 2(14) - 13$ $v = 15\quad(\mathrm{ms}^{-1})$	 B1 M1 A1 **[3]** (B1) (M1) (A1) **([3])**	FT candidate's quadratic expression for v from (a) for $t = 5$ only. Either 'their u' or t correct FT incorrect v from (a) provided B1 awarded **and** $t = 9$ Integration with an attempt to find C with $t \neq 0, v \neq 12$
	Total for Question 9	**6**	

Q10	Solution	Mark	Notes
(a)			
	Apply N2L to particle A	M1	Dimensionally correct equation, T opposing $3g$
	$\pm T \mp 3g = 3(4\cdot2)$	A1	Either form, oe
	Apply N2L to particle B	(M1)	M1 available once for N2L to either particle (see above)
	$\pm Mg \mp T = M(4\cdot2)$	A1	Either form, oe
	Adding	m1	Eliminating T
	$\pm Mg \mp 3g = 4\cdot2(M+3)$ $\pm Mg - 4\cdot2M = 3(4\cdot2) \pm 3g$		
	$5\cdot6M = 42$ OR $14M = 16\cdot8$		
	$M = 7\cdot5$ (kg) $M = 1\cdot2$ (kg)	A1	Either value, cao
	$T = 3(\pm4\cdot2) + 3g$		
	$T = 42$ (N) OR $T = 16\cdot8$ (N)	A1 A1	Either value, cao Both corresponding pairs,cao $7\cdot5$ kg, 42 N & $1\cdot2$ kg, $16\cdot8$ N
		[7]	
	<u>Alternative solution</u>		
	Apply N2L to particle A	M1	Dimensionally correct equation, T opposing $3g$
	$\pm T \mp 3g = 3(4\cdot2)$	A1	Either form, oe
	$T = \begin{cases} 3(4\cdot2) + 3g \\ -3(4\cdot2) + 3g \end{cases}$		
	$T = \begin{cases} 42 \\ 16\cdot8 \end{cases}$ (N)	A1	Either value, cao
	Apply N2L to particle B	(M1)	M1 available once for N2L to either particle (see above)
	$\pm Mg \mp T = M(4\cdot2)$	A1	Either form, oe
	$9\cdot8M - 4\cdot2M = 42$ OR $4\cdot2M + 9.8M = 16\cdot8$ $5\cdot6M = 42$ OR $14M = 16\cdot8$	m1	For substituting their T
	$M = \begin{cases} 7\cdot5 \\ 1\cdot2 \end{cases}$ (kg)	A1 A1	Either value, cao Both corresponding pairs, cao $7\cdot5$ kg, 42 N & $1\cdot2$ kg, $16\cdot8$ N
		([7])	

(b)	No longer able to assume that tension is the same (throughout the string) OR No longer able to assume that tension is equal on both sides	B1 **[1]**	
	Total for Question 10	**8**	