GCE AS MARKING SCHEME

SUMMER 2022

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

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INTRODUCTION

This marking scheme was used by WJEC for the 2022 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.

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WJEC GCE AS MATHEMATICS

UNIT 2 APPLIED MATHEMATICS A

SUMMER 2022 MARK SCHEME

SECTION A – Statistics

Qu. No.	Solution	Mark	Notes
1(a)	$\mathrm{P}(A \cap B) = 0.3 + 0.6 - 0.82$	M1	Use of addition formula
	$\mathrm{P}(A \cap B) = 0.08$	A1	Sight of 0.08 in a Venn diagram earns M1A1.
	$\mathrm{P}(A) \times \mathrm{P}(B) = 0.3 \times 0.6 = 0.18$	B1	
	Since $0.18 \neq 0.08$, A and B are not independent.	E1	FT their $P(A)P(B)$ and $P(A \cap B)$ provided one is correct. No FT for negative probabilities.
	Alternative: If A and B are independent $\mathrm{P}(A) \times \mathrm{P}(B) = 0.3 \times 0.6 = 0.18$	(B1)	
	$\mathrm{P}(A \cup B) = 0.3 + 0.6 - 0.18$	(M1)	
	$\mathrm{P}(A \cup B) = 0.72$	(A1)	
	Since $0.72 \neq 0.82$, A and B are not independent.	(E1)	FT their $P(A)P(B)$ and $P(A \cup B)$ provided one is correct. No FT for negative probabilities.
(b)	P(Exactly one of A and B) $= P(A \cup B) - \mathrm{P}(A \cap B)$	M1	Writing or using formula.
	$= 0.82 - 0.08$	M1	FT 'their 0.08' providing it is a valid probability ≠ 0.18
	$= 0.74$	A1	CAO
	Alternative 1: P(Exactly one of A and B) $= P(A \cap B') + P(B \cap A')$. OR Sight of 0.22 or 0.52	(M1) FT 'their 0.08' provided it is a valid probability ≠ 0.18	
	P(Exactly one of A and B) $= 0.22 + 0.52$	(M1)	Both values correct
	P(Exactly one of A and B) = 0.74	(A1)	CAO
	Alternative 2: P(Exactly one of A and B) $= \mathrm{P}(A) + P(B) - 2\mathrm{P}(A \cap B)$	(M1)	
	$= 0.3 + 0.6 - 2 \times 0.08$	(M1)	FT 'their 0.08' providing it is a valid probability ≠ 0.18.
	$= 0.74$	(A1) Total: **[7]**	CAO

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2 (a)	Height $= 40 \times 0.45 \div 3$	M1	M1 for $40 \times 0.45 \div (\text{their width})$
	$= 6$ units	A1	
(b)	Valid explanation. e.g., We don't know how the probability is distributed within the two groups.	E1	E0 for an explanation that refers to the probability of individual integer values of X e.g., we don't know the probability that $X = 268$. E0 for "We don't know the probability" Condone "We don't know how it is distributed within the two groups."
(c)	Valid explanation. Must imply different samples are being considered. e.g., Different samples will lead to different results. e.g., The lifetimes of the light bulbs that Celyn collects will be different from those considered in (a). e.g., If the differences are big enough this would suggest that something might have gone wrong. This explanation is the exception to the requirement to refer to samples or collections of light bulbs.	E1 **Total [4]**	Allow explanations that compare a sample with the expected values, e.g. The histogram drawn from the table of probabilities only shows the expected values, whereas the histogram that Celyn draws represents a single sample (of 40 light bulbs). Condone histogram drawn using different intervals. E0 for every light bulb is different. E0 for anything that implies it's from a distribution other than the one in the question. e.g., It might be a different type of lightbulb.

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3(a)	**Earthworms** need to occur • at a uniform/constant average **rate**. **AND one of** • **independently** / **singly** / **randomly.**	E1	Accept equivalent statement.
(b)	The number of earthworms X is $Po(2.75)$.	B1	si
	$\mathrm{P}(X = 5) = \frac{2.75^5 \times \mathrm{e}^{-2.75}}{5!}$	M1	FT their derived mean or 11 FYI $P(X = 5) = 0.0224$ for $\lambda = 11$ $P(X = 5)$ correct for any λ other than 2.75 earns M1A0
	$\mathrm{P}(X = 5) = 0.0837861$ ...	A1	CAO M1A1 for use of calculator 3sf (awrt 0.0838)
(c)	$\mathrm{P}(X \leq 12) = 0.3585$	M1	M1A0 for 13.98 or 13.99
	$\lambda = 14$	A1 **Total [6]**	If no marks awarded, SC1 for $\lambda = 15$ Sight of $\lambda = 14$ earns M1A1

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4(a)(i)	$64 + (64 - 49.5) \times 1.5$ $(= 64 + 14.5 \times 1.5 = 85.75)$	M1	Use of rule $Q_3 + 1.5\text{IQR}$
	$87.2 > 85.75$ therefore, it's an outlier.	A1	Correct calculation and conclusion.
(ii)	Valid reason. e.g. May distort calculations and therefore inferences about population.	E1	Condone "so that the mean will not be affected by outliers." Allow "there may have been an error in measurement". Allow "may skew the data". E0 for "median does not change". E0 for "make calculations more reliable".
(iii)	Valid reason. e.g., It's only just an outlier. Still a valid measurement so should include it.	E1	Condone "to use all of the data".
(b)	The larger the hip girth, the larger the thigh girth, **on average**.	E1	oe Condone 'tends' or 'in general' in place of on average. Penalise first omission of on average only.
(c)	Each increase of 1 cm of hip girth corresponds to a 0.69 cm increase in thigh girth **on average**.	E1	Penalise first omission of on average only. Watch out for hip girth and thigh girth in the wrong order.
(d)	Using all of the data instead of a sample would lead to more accurate results.	E1 **Total [7]**	Condone increase sample size provided no nonsensical statements follow. Do not allow reference to other sampling methods.

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5(a)	$H_0: p = 0.7$ $H_1: p < 0.7$	B1	Allow other letters if defined. Allow worded hypotheses or use of 70%. B0 for 0.7% B0 for omission of p or for a non-strict inequality in H_1
(b)(i)	The critical region is the **range of values** of the **number of people** that know the name of the company that would lead us to reject H_0.	E1	Condone "The critical region is the **range of values** of the **test statistic** that would lead us to reject H_0."
(ii)	Under H_0, $X \sim \mathrm{B}(60, 0.7)$ si $P(X \leq 35) = 0.0362$	B1 M1	Award if seen in part (iii) M0 for $P(X = k)$ FT their hypotheses
	CR $X \leq 35$	A1	Do not accept as probability statement, i.e. $P(X \leq 35)$. CAO
(iii)	40 is not in the critical region so there is insufficient evidence to reject H_0.	M1	Allow use of p-value method in part (iii), $P(X \leq 40) = 0.3308$ and correct comparison with 0.05. M0 for conclusion based on $P(X = k)$ p-value not in critical region earns M0A0 FT their hypotheses
	There is insufficient evidence to say that fewer than 70% of participants know the name of the sponsoring company.	A1	Do not allow categorical statements *without reference to insufficient evidence or suggests.* FT their hypotheses
(c)	Valid comment with a reason e.g., It's worth sponsoring the event because the result of the hypothesis test suggests it is an effective way of getting brand recognition. e.g., It's unclear whether the brand recognition provides the necessary monetary compensation for the sponsorship money. e.g., The test implies that it's likely that a reasonable proportion of participants know the name of the sponsor so it may be worth doing. e.g., *Run4Lyfe* may be concerned about the proportion who know the name of the sponsor and so may wish to discontinue sponsorship. e.g., They may feel that the evidence is inconclusive and so my wish to continue for another year. e.g., Continue with their existing approaches as there is insufficient evidence to substantiate their concern.	E1 **Total [8]**	FT based on their (possible incorrect) test conclusion. Must mention sponsorship (or imply it). Do not allow e.g. "Need to advertise more" without valid justification that refers to the conclusion reached in (b).

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6(a)	Two valid comments. e.g. 1914 is negatively skewed. 2014 is positively skewed. Fertility rates were larger in 1914 than 2014 on average.	E2	Condone 1914 is skewed to the left. 2014 is skewed to the right. Allow "people tended to have more children in 1914 than in 2014". E1 for each valid comment.
(b)	That fertility rates are increasing in (at least) one country i.e., women had more babies on average in 2014 than 1914 in that country.	E1	E0 for decreasing by -0.61.
(c)(i)	Attempt to find decrease for either.	M1	Do not allow values other than 2.5 and 6.5 without a valid justification.
	Approximately $2.5 - 1.98 = 0.52$	A1	Allow in percentage terms i.e., France fell by 20.8%
(ii)	Approximately $6.5 - 4.4 = 2.1$	A1	Allow in percentage terms, i.e., Ethiopia fell by 32.3%
(iii)	Valid reason must address the decrease. e.g., Countries with a higher fertility rate in 1914 have more of an opportunity for it to decrease. e.g., Ethiopia is a developing country and its fertility rate is likely to have decreased more rapidly in the last 100 years than France which is a developed country.	E1	Do not allow comparison of birth rates in both countries.
(iv)	Valid explanation. e.g., We have used the midpoint of the group to estimate. e.g., We have no way of knowing what the exact fertility rates of France and Ethiopia are in 1914. e.g., Exact fertility rates in 1914 are unknown.	E1 **Total [8]**	Allow responses that imply that the fertility rate may not have been measured accurately, e.g., data collection methods may differ between the countries or across the 100 years.

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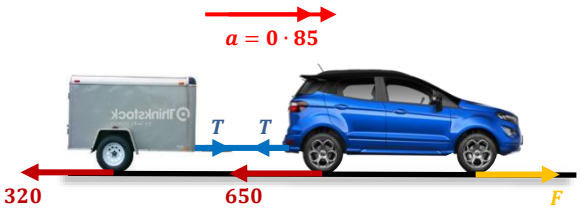
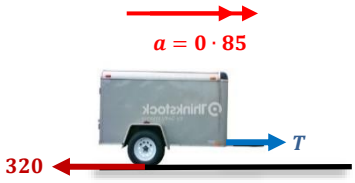
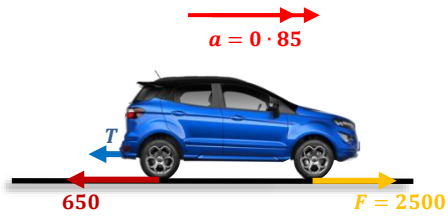
SECTION B – Mechanics

Q7	Solution	Mark	Notes
	Method 1 (Combining as one particle)		
			
	Apply N2L to vehicle **and** trailer **combined**	M1	Dimensionally correct equation F and 970 opposing
	$F - (650 + 320) = (1300 + 500)a$ $F - 970 = 1800(0 \cdot 85)$ $\quad (F - 970 = 1530)$ $F = 2500$	A1 A1	 Convincing
			
	Apply N2L to trailer	M1	Dimensionally correct equation T and 320 opposing
	$T - 320 = 500a$ $T - 320 = 500(0 \cdot 85)$ $\quad (T - 320 = 425)$ $T = 745$ (N)	A1 A1	 cao
		[6]	
	Alternative solution for finding T		
			
	Apply N2L to vehicle	(M1)	Dimensionally correct equation with all forces, T and 2500 opposing, ± 650
	$2500 - 650 - T = 1300a$ $2500 - 650 - T = 1300(0 \cdot 85)$ $\quad (1850 - T = 1105)$ $T = 745$ (N)	(A1) (A1)	 cao
	Total for Question 7	6	

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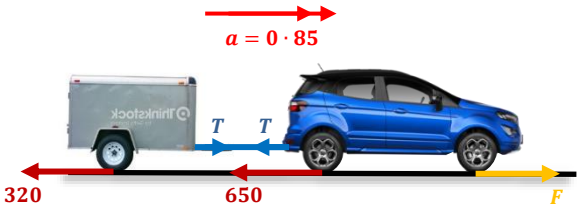
Q7	Solution	Mark	Notes
	Method 2 (Car and Trailer separate particles)  		M1 available once for N2L with this method
	Apply N2L to trailer	M1	Dimensionally correct equation T and 320 opposing
	$T - 320 = 500a$ $T - 320 = 500(0 \cdot 85)$ $\quad (T - 320 = 425)$ $T = 745$ (N)	A1 A1	
	Apply N2L to vehicle	(M1)	Dim. correct. All terms. F and T opposing, ± 650
	$F - 650 - T = 1300a$ $F - 650 - 745 = 1300(0 \cdot 85)$ $\quad (F - 1395 = 1105)$ $F = 2500$	A1 m1 A1	For substituting their T Convincing
		[6]	
	Alternative Solution using elimination of T		
	Apply N2L to trailer	M1	Dimensionally correct equation T and 320 opposing
	$T - 320 = 500a$	A1	
	Apply N2L to vehicle	(M1)	Dim. correct. All terms. F and T opposing, ± 650
	$F - 650 - T = 1300a$	A1	
	Adding	m1	Eliminating T
	$F - 970 = 1800a$ $F - 970 = 1800(0 \cdot 85)$ $\quad (F - 970 = 1530)$ $F = 2500$	 A1	Convincing
	$T = 745$ (N)	A1	cao
		[6]	
	Total for Question 7	6	

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Q8	Solution	Mark	Notes
(a)	$v = u + at,\ u = 4, a = 1 \cdot 5, t = 8$ $v = 4 + (1 \cdot 5)(8)$ $v = 16 \quad (\text{ms}^{-1})$	M1 A1 **[2]**	Used cao
(b)	$v^2 = u^2 + 2as,\ v = 78, u = 4, a = 1 \cdot 5$ $(78)^2 = (4)^2 + 2(1 \cdot 5)s \qquad (6084 = 16 + 3s)$ minimum $AB, s = \frac{6068}{3} = 2022 \cdot 66 \ldots \quad (\text{m})$	M1 A1 A1 **[3]**	Used, FT their velocity from (a) cso, allow answer rounding to 2020 (3sf)
	Total for Question 8	**5**	

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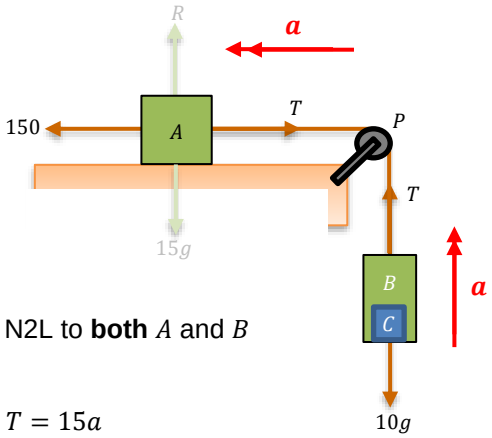
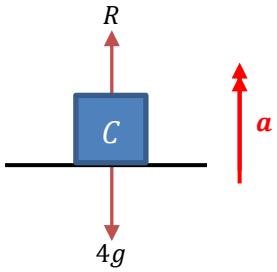
Q9	Solution	Mark	Notes
(a)	 Apply N2L to **both** A and B	M1	Dimensionally correct equation for at least 1 object T and $10g/150$ opposing
	$150 - T = 15a$	B1	1st correct equation
	$T - 10g = 10a$	A1	2nd correct equation
	Eliminating T $150 - 10g = 25a$	m1	
	$a = 2 \cdot 08 \quad (\text{ms}^{-2})$ $T = 118 \cdot 8 \quad (\text{N})$	A1 A1	cao FT their a if substituted into a correct equation
		[6]	
(b)	 Apply N2L to C	M1	Dimensionally correct equation R and $4g$ opposing
	$R - 4g = 4a$ $R = 4(2 \cdot 08) + 4(9 \cdot 8)$	A1	
	$R = 47 \cdot 52 \ (\text{N})$	A1	FT their a
		[3]	
	Total for Question 9	**9**	

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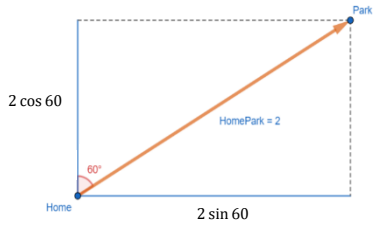
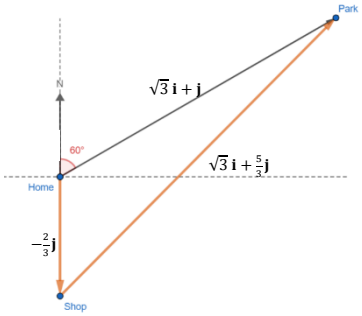
Q10	Solution	Mark	Notes
(a)	 $\mathbf{r}_{park} = (2\sin 60)\mathbf{i} + (2\cos 60)\mathbf{j}$ $\left(= 2\left(\frac{\sqrt{3}}{2}\right)\mathbf{i} + 2\left(\frac{1}{2}\right)\mathbf{j}\right)$ $= \sqrt{3}\,\mathbf{i} + \mathbf{j}$	M1 A1 **[2]**	Allow sin/cos error **i**, **j** not necessary with supporting diagram Convincing
(b)	 $SP = \sqrt{3}\,\mathbf{i} + \mathbf{j} - \left(-\frac{2}{3}\mathbf{j}\right)$ $= \sqrt{3}\,\mathbf{i} + \frac{5}{3}\mathbf{j}$ $\lvert SP\rvert = \sqrt{\left(\sqrt{3}\right)^2 + \left(\frac{5}{3}\right)^2}\quad \left(= \frac{2\sqrt{13}}{3} = 2\cdot 4037\ldots\right)$ distance travelled $= \frac{2\sqrt{13}}{3} + \frac{2}{3} = 3\cdot 0703\ldots$ (km) <u>Alternative Solution (Cosine Rule)</u> $SP^2 = \left(\frac{2}{3}\right)^2 + (2)^2 - 2\left(\frac{2}{3}\right)(2)\cos 120^\circ$ $\lvert SP\rvert = \frac{2\sqrt{13}}{3} = 2\cdot 4037\ldots$ distance travelled $= \frac{2\sqrt{13}}{3} + \frac{2}{3} = 3\cdot 0703\ldots$ (km)	B1 M1 A1 **[3]** M1 A1 A1 **[3]**	si, or $SP = -PS$ **i**, **j** not necessary with supporting diagram cao $SP^2 = \frac{52}{9}$ cso, allow answer rounding to $3\cdot 1$ (1 dp)
(c)	Any sensible assumption, for example • Unlikely to walk in straight lines • Actual route may not be a straight line • Route may not be flat (be hilly)	E1 **[1]**	
	Total for Question 10	**6**	

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Q11	Solution	Mark	Notes
(a)	At rest, $v = 0$ $3t^2 - 24t + 36 = 0$ $3(t-2)(t-6) = 0$ $t = 2, 6 \quad (\text{s})$	M1 A1 **[2]**	Used cao
(b)	Velocity decreasing $\frac{\mathrm{d}v}{\mathrm{d}t} = a = 6t - 24 \quad (< 0),$ $t < 4$ For $0 < t < 2$, Distance $= \int_0^2 (3t^2 - 24t + 36)\mathrm{d}t$ $= [t^3 - 12t^2 + 36t]_0^2$ $= 32$ For $2 < t < 4$, Distance $= -\int_2^4 (3t^2 - 24t + 36)\mathrm{d}t$ $= -[t^3 - 12t^2 + 36t]_2^4$ $= -[-16]$ $= 16$ Required distance $= 32 + 16$ $= 48$	M1 A1 si M1 A1 A1 A1 A1 **[7]**	Attempt to differentiate, at least one term correct, oe Not dependent on above M1 Use of integration, limits not needed, at least one term correct Correct integration Condone –16 cao
	Total for Question 11	**9**	

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