GCE AS MARKING SCHEME

SUMMER 2024

AS
MATHEMATICS
UNIT 2 APPLIED MATHEMATICS A
2300U20-1

About this marking scheme

The purpose of this marking scheme is to provide teachers, learners, and other interested parties, with an understanding of the assessment criteria used to assess this specific assessment.

This marking scheme reflects the criteria by which this assessment was marked in a live series and was finalised following detailed discussion at an examiners' conference. A team of qualified examiners were trained specifically in the application of this marking scheme. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners. It may not be possible, or appropriate, to capture every variation that a candidate may present in their responses within this marking scheme. However, during the training conference, examiners were guided in using their professional judgement to credit alternative valid responses as instructed by the document, and through reviewing exemplar responses.

Without the benefit of participation in the examiners' conference, teachers, learners and other users, may have different views on certain matters of detail or interpretation. Therefore, it is strongly recommended that this marking scheme is used alongside other guidance, such as published exemplar materials or Guidance for Teaching. This marking scheme is final and will not be changed, unless in the event that a clear error is identified, as it reflects the criteria used to assess candidate responses during the live series.

WJEC GCE AS MATHEMATICS

UNIT 2 APPLIED MATHEMATICS A

SUMMER 2024 MARK SCHEME

SECTION A – Statistics

Qu	Solution	Mark	Notes
1 (a)	The members of the gym.	B1 **[1]**	Condone any of the following: People who go to the gym All people that use the gym The participants of the gym B0 for "The members of the gym that arrive early." B0 for "The 30 members of the gym."
(b)	Opportunity/convenience sampling.	B1 **[1]**	
(c)	Valid improvement. E.g. • Ask people at different times of the day. • Use random sampling. • Ask people on different days. • Ask more people.	B1 **[1]**	
	Total for Question 1	**3**	

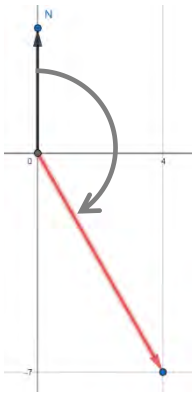
Qu	Solution	Mark	Notes
2(a)	Valid assumptions. e.g. • Cakes sold per hour must be at a constant **average** rate. • Cakes must be sold independently / randomly. • Cakes must be sold individually / singly.	E1 **[1]**	E1 for at least two valid assumptions. E0 for the following: Cakes are sold at a constant rate. Cakes are discrete. It involves rate per hour. There is a mean given for cakes sold. An average rate of cakes sold is given. Constant flow of buyers.
(b)	(Let the rv$W$ be the number of cakes sold in a 1-hour period.) $\mathrm{P}(W = 2) = \dfrac{3.5^2 \times \mathrm{e}^{-3.5}}{2!}$ $= 0.1850$	M1 A1 **[2]**	M0 if no calculation shown using the formula for the Poisson distribution. 3sf or better. M0A0 for calculator entries shown.
(c)	(Let the rv$X$ be the number of cakes sold in a 3-hour period.) $X \sim \mathrm{Po}(10.5)$ $\mathrm{P}(X > 10) = 1 - \mathrm{P}(X \leq 10)$ $= 1 - 0.5207$ $= 0.4793$	B1 M1 A1 **[3]**	si 3sf or better. M0A0 for $\mathrm{P}(X \geq 10)$
(d)	(Let the rv$Y$ be the number of cakes sold in a half hour period.) $\mathrm{Y} \sim \mathrm{Po}(1.75)$ Probability that she sells the next cake before 10:00 is $\mathrm{P}(Y \geq 1)$ $\mathrm{P}(Y \geq 1) = 1 - \mathrm{P}(Y = 0)$ $= 1 - 0.1738$ $= 0.8262$	B1 M1 A1 **[3]**	si (for realising that next cake sold before 10am means $Y \geq 1$) written or used (M1 for $1 - \mathrm{P}(Y \leq 0)$) 3sf or better. SC1 for $\mathrm{P}(Y = 1) = 0.3041$ with $\mathrm{Po}(1.75)$
(e)	Valid comment on reasonableness. e.g. e.g. Not valid because some people might buy lots of cakes. e.g. Not valid because there might be busier periods than others. e.g. Valid. It's unlikely that people would buy multiple birthday cakes. e.g. Independent assumption reasonable as at birthday parties there is only one cake. e.g. Valid. There's no reason to think that cakes wouldn't be sold at a constant rate during the working day.	E1 **[1]**	**Must comment on reasonableness.** e.g. E0 for "Cakes might be sold more than one at a time", but E1 for "cakes might be sold more than one at a time so not reasonable to assume sold individually".
	Total for Question 2	**10**	

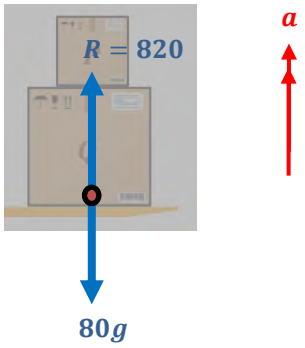
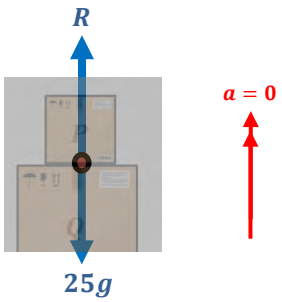
Qu	Solution	Mark	Notes
3(a)	$\left(\frac{20+x}{100}\right)\times\left(\frac{50+x}{100}\right)=\left(\frac{8+x}{100}\right)$	M1	Attempt to use $\mathrm{P}(A\cap C)=\mathrm{P}(A)\times\mathrm{P}(C)$ in terms of x to form an equation in x. Equation must involve at least one fraction. oe A1 for arriving at correct quadratic.
	$x^2-30x+200=0$	A1	
	$x=10$ or $x=20$ *ag is 10	m1	Solving their 3-term quadratic to obtain real solutions. FT their quadratic provided M1 awarded Must follow from $x=10$ or $x=20$
	Reject $x=20$ and reason, e.g. • because $x=20$ would lead to a total greater than 100 • y would be negative Therefore, $x=10$. ***ag**	A1	
	$y=8$	B1	Not dependent on any of the above marks SC2 for verification that $x=10$ [note: can still earn B1] e.g. $\mathrm{P}(A)\times\mathrm{P}(C)=\frac{30}{100}\times\frac{60}{100}=\frac{18}{100}$ and $\mathrm{P}(A\cap C)=\frac{18}{100}$, so $x=10$.
		[5]	
(b)	P(first Athletics and second only climbing) $=\frac{30}{100}\times\frac{15}{99}$	M2	M2 for correct method. M1 for either correct fraction in a product of 2 fractions Allow 0.152 or better in place of $15/99$ for M2 cao
	$=\frac{1}{22}$ or $0.0\dot{4}\dot{5}$	A1	Condone 0.045 or better from correct working. Condone 0.0454. NOTE: the exact answer of 0.045 is obtained from $\frac{30}{100}\times\frac{15}{100}$, which earns M1 only. Sight of $\frac{30}{100}$ and $\frac{15}{99}$ not in a product earns M0.
		[3]	
	Total for Question 3	**8**	

Qu	Solution	Mark	Notes
4(a)	$H_0: p = 0.136 \quad H_1: p < 0.136$	B1 **[1]**	Allow use of θ Condone other letters if defined as proportion/prob. Allow $H_0: \mathrm{P}(\text{blue}) = 0.136$, $H_1: \mathrm{P}(\text{blue}) < 0.136$ Allow 13.6% (B0 for $p = 13.6$) B0 for non-strict inequality in H_1 B0 for omission of p (oe) [e.g. $H_0 = 0.136$] B0 for $H_0: x = 0.136$ or $H_0: \mathrm{P}(X = 0.136)$ B0 for hypothesis labels omitted Allow worded hypotheses (must refer to proportion/prob.). Do not award retrospectively from (b).
(b)(i)	Under $H_0, X \sim \mathrm{B}(80, 0.136)$ $\mathrm{P}(X \leq 5) = 0.0309$ and/or $\mathrm{P}(X \leq 6) = 0.0690$ CR $(0 \leq) X \leq 5$	B1 M1 A1	si M0 for $\mathrm{P}(X = 5)$ or $\mathrm{P}(X = 6)$. Do not accept as probability statement, i.e. $\mathrm{P}(X \leq 5)$ is the CR.
(ii)	6 is not in the critical region so there is insufficient evidence to reject H_0. There is insufficient evidence to suggest that the proportion of blue sweets is less than the company's claim.	M1 A1 **[5]**	FT their CR for M1 (provided a region) Accept $\mathrm{P}(X \leq 6) = 0.06902 > 0.05$ as justification to not reject H_0. M0 for $\mathrm{P}(X = 6)$. CSO (all previous marks in (b) awarded)
(c)	$\mathrm{P}(\text{reject } H_0) = \mathrm{P}(X \leq 5) = 0.0309$ Expected number of occasions $= 20 \times 0.0309$ $= 0.618$	 M1 A1 **[2]**	 FT the probability of their CR for M1A1 provided a region A0 for sight of 1 only without seeing 0.618 SC1 for $20 \times 0.05 = 1$
(d)	Prob (Type II error) = $\mathrm{P}(X \geq 6 \mid X \sim \mathrm{B}(80, 0.07))$ $= 0.49183$ Valid interpretation. e.g. There is almost a 50% chance of failing to detect that the proportion of blue sweets is less than the company's claim (when in fact it is 7%). e.g. The probability of failing to reject the hypothesis that the proportion of blue sweets is not less than the company's claim when, in fact, it should have been rejected is almost 50%. e.g. There is a 49.183% chance of supporting the company's claim when in fact it is false. e.g. There is a 49.183% chance of concluding the proportion of blue sweets has not reduced, when in fact it has.	M1 A1 E1 **[3]**	si FT their CR provided a region for M1A1 3sf or better FT their Type II error (even if M0 awarded). E0 for "You would make the wrong decision almost 50% of the time." E0 for "There is almost a 50% chance that the company makes a false negative." E0 for "This error probability is too large" or "this is not a good test".
	Total for Question 4	**11**	

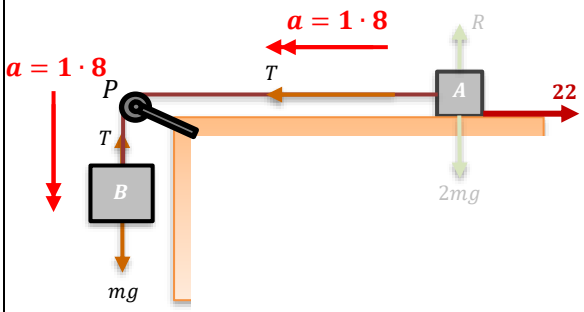
Qu	Solution	Mark	Notes
5(a)	Valid explanation, e.g., • It implies that the numbers of vaccines administered falling is a bad thing rather than an inevitable part of more of the population being vaccinated. • Seeing the graphs tailing off could cause alarm.	E1 **[1]**	E0 for "Vaccines increased from March to May 2021" or "There are sections of the graph where number of vaccines increase." E1 "less people need a second dose because they've had it already." No requirement to reference the quote directly.
(b)(i)	$\bar{x} = \frac{\Sigma fx}{\Sigma f} = \frac{21150}{61}$ $= 346.721$ Mean number of vaccines $= 346\,721$ $\sigma = \sqrt{\frac{\Sigma fx^2}{\Sigma f} - \bar{x}^2}$ $= \sqrt{\frac{8272500}{61} - \left(\frac{21150}{61}\right)^2}$ $= 124.093$ Standard deviation $= 124093$	M1 A1 M1 A1	Correct method for Σfx, allow one slip. Allow embedded for M1. M1A1 for use of calculator Must be labelled as mean or $\bar{x}$. Accept correctly rounded answers. -1 if ×1000 is omitted. Penalise once only. Allow 346.721 thousands. Allow 347(1000s). FT their $\bar{x}$ for M1 only M1A1 for use of calculator Accept correctly rounded answers. -1 if ×1000 is omitted. Penalise once only. Allow 124.093 thousands. Allow 124.093(1000s). Accept calculation of $s = \sqrt{\frac{1}{60}\left(8272500 - \frac{21150^2}{61}\right)} = 125.12289$ leading to 125123, which can earn M1A1 SC1 for sight of any of 15399.08627, 1.5399×10^{10}, 15655.7377, 1.5656×10^{10} (in place of final two marks) M0 for sight of method for variance with no numerical answer. Alternative method: $\sigma = \sqrt{\frac{\Sigma f(x-\bar{x})^2}{n}} = \sqrt{\frac{939344.2623}{61}} = 124.093$
(b)(ii)	Data is negatively skewed.	B1 **[5]**	Accept left skew / skewed to the left. Ignore additional non-contradictory comments such as "but only very slightly". NOTE: mean>median/mode is a contradictory comment.
(c)	Valid reason for the pattern, e.g., • There seem to be lower bars on a weekly cycle. This could be a Sunday when some vaccine centres are closed. • People are more likely to get vaccinated on the weekend when not working. • More likely to get vaccines on certain days. • More workers available on days with higher peaks.	E1 **[1]**	E1 for comments about the weekly pattern. E0 for vaccines may have been done in batches. E0 for "Affected by number of vaccines available." E0 for "Dips are where the last of the age are group getting the vaccine." E0 for a comment relating to the overall increasing trend of the graph.
(d)	Valid reason, e.g., • It may not be incorrect because it could be a bank holiday weekend. • It may be incorrect because it doesn't match the pattern of the rest of the graph. • It may not be incorrect as there may have been an event on these dates that many people are participating in.	E1 **[1]**	Must comment on correctness. Need to see decision with a reason. Must have reason for saying anomaly / anomalous result – reason may include, for example, the data for these days does not fit with the rest of the data / other days were higher, etc. E1 for unable to tell if the data is correct just from the graph. E1 for a comment relating to supplies of the vaccine. Allow E1 for correct because they are government figures. Allow E1 for incorrect because they are government figures.
	Total for Question 5	**8**	

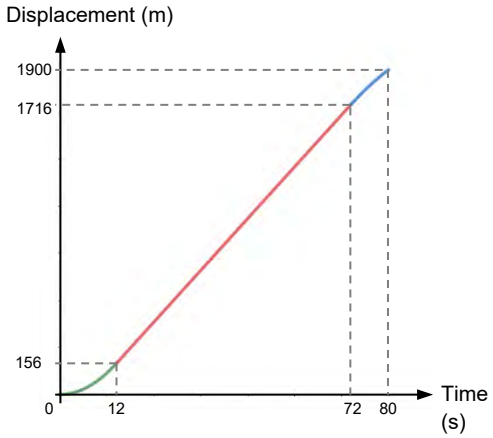
SECTION B – Mechanics

Q6	Solution	Mark	Notes
	 $(4\,\mathbf{i} - 7\,\mathbf{j})\ \text{ms}^{-1}$		
	Speed $= \sqrt{(4)^2 + (\mp 7)^2}$	M1	
	$= \sqrt{65} = 8 \cdot 06(225 \ldots)\ \ (\text{ms}^{-1})$	A1	cao
	Direction		
	$\theta = \begin{cases} \tan^{-1}\left(\frac{\pm 7}{4}\right) = (\pm 60 \cdot 255^{\circ} \ldots) \\ \text{OR} \\ \tan^{-1}\left(\frac{\pm 4}{7}\right) = (\pm 29 \cdot 744^{\circ} \ldots) \end{cases}$	M1	oe
	Bearing $90 + 60 \cdot 255^{\circ} \ldots$ OR $180 - 29 \cdot 744^{\circ} \ldots$		
	Bearing is $150°$	A1	cao
		[4]	
	Total for Question 6	**4**	

Q7	Solution	Mark	Notes
a)			
	N2L applied to **BOTH** boxes, upwards positive	M1	Dimensionally correct equation $R/820$ and $80g$ opposing
	$R - 80g = 80a$ $\quad (R - 55g - 25g = (55 + 25)a)$ $820 - 80g = 80a$ $\quad (820 - 539 - 245 = (55 + 25)a)$ $820 - 784 = 80a$ $36 = 80a$	A1	Correct equation
	$a = 0 \cdot 45$ or $\frac{9}{20}$ (ms^{-2})	A1 **[3]**	cao
b)			
	At constant speed		
	$R = 25g = 245$ $\quad (\text{N})$	B1 **[1]**	cao, any form
	Total for Question 7	**4**	

Q8	Solution	Mark	Notes
a)	Using N2L, $4a = 12\sqrt{t} - 32$ $a = 3\sqrt{t} - 8$ When $t = 9$, $a = 3\sqrt{9} - 8$ $a = 1 \quad (\text{ms}^{-2})$	M1 A1 **[2]**	Used cao
OR	When $t = 9$, $F = 12\sqrt{9} - 32$ $F = 4$ Using N2L, $4a = 4$ $a = 1 \quad (\text{ms}^{-2})$	 (M1) (A1) **([2])**	 Used, FT F cao
b)	$v = \int (3\sqrt{t} - 8)\,\text{d}t \quad = \int \left(3t^{\frac{1}{2}} - 8\right)\text{d}t$ $v = \frac{3}{3/2}t^{\frac{3}{2}} - 8t\ (+C) \quad \left[= 2t^{\frac{3}{2}} - 8t\ (+C)\right]$ When $t = 4, v = -1$ $C = 15$ $v = 2t^{\frac{3}{2}} - 8t + 15$	M1 A1 A1 **[3]**	Attempt to integrate a cao
c)	When $t = 9$, $v = 2(9)^{\frac{3}{2}} - 8(9) + 15$ $(v = -3)$ When $t = 9, a > 0$ (from part a)) and $v < 0$ $\therefore v$ is increasing $\Longrightarrow$ speed is **decreasing**	M1 A1 **[2]**	FT derived v
	Total for Question 8	**7**	

Q9	Solution	Mark	Notes
a)	$v^2 = u^2 + 2as$, with $s = 0\cdot4, u = 0, v = 1\cdot2$ $(1\cdot2)^2 = (0)^2 + 2a(0\cdot4)$ $\quad (1\cdot44 = 0\cdot8a)$ $a = 1\cdot8 \ \ (\text{ms}^{-2})$	M1 A1 **[2]**	Used, oe $a = \frac{v^2-u^2}{2s} = \frac{(1\cdot2)^2-(0)^2}{2(0\cdot4)}$ Convincing
b)	 Apply N2L to **both** A and B separately A: $\quad T - 22 = 2ma$ $\quad$ OR $\quad T - 22 = 3\cdot6m$ B: $\quad mg - T = ma$ $\quad$ OR $\quad 9\cdot8m - T = 1\cdot8m$ $T = 8m$ Eliminating T $mg - 22 = 3ma$ $\quad$ OR $\quad 9\cdot8m - 22 = 5\cdot4m$ $m = 5$ $T = 40 \quad (\text{N})$	 M1 B1 A1 m1 A1 A1 **[6]**	 At least one dimensionally correct equation T and $mg/22$ opposing 1st correct equation 2nd correct equation Attempted cao cao
c)	Inextensible string enables me to assume that (the magnitude of) the **acceleration** of objects A and B is **equal.**	 E1 **[1]**	
	Total for Question 9	**9**	

Q10	Solution	Mark	Notes
a)	Distance travelled during acceleration $s = \frac{1}{2}(u+v)t,\ u = 0, v = 26, t = 12$ $s = 156 \quad (\text{m})$	M1 A1 **[2]**	Used Convincing
b)	**(i)** Distance covered at constant speed $60 \times 26 = 1560\ (\text{m})$	B1	
	(ii) Distance travelled whilst decelerating $1900 - 1560 - 156 = 184 \quad (\text{m})$ Time for deceleration $s = ut + \frac{1}{2}at^2,\ s = 184, u = 26, a = (\pm)0 \cdot 75$ $184 = 26t + \frac{1}{2}(-0 \cdot 75)t^2$ $0 \cdot 75t^2 - 52t + 368 = 0$ Solving the quadratic $\left(t = 8 \quad \text{or} \quad t = \frac{184}{3} = 61 \cdot 33 \ldots.\right)$ $t = 8 \quad (\text{s})$	B1 M1 A1 m1 A1 **[6]**	FT answer to (i) FT distance cao $t = \frac{184}{3}$ clearly discounted.
c)	Sketch  	B1 B1 B1 **[3]**	B1 for any 1 below B2 for any 2 below **Concave up** from $(0,0)$ to $(12,156)$ OR **Straight line** from $(12,156)$ to $(72,156+1560)$ (FT '1560') OR **Concave down** to $(72+8, 1900)$ (FT '72' and '8') All correct
	Total for Question 10	11	