Cambridge Assessment International Education

Cambridge Pre-U

MATHEMATICS **9794/03**

Paper 3 Applications of Mathematics **May/June 2023**

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:
Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Maths-Specific Marking Principles	
1	Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.
2	Unless specified in the question, answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.
3	Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.
4	Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).
5	Where a candidate has misread a number in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 mark for the misread.
6	Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

Question	Answer	Marks	Guidance
1(a)	Attempt $k\left(1^2+2^2+3^2+4^2+5^2\right)=1$	**M1**	May verify using $\frac{1}{55}\left(1^2+2^2+3^2+4^2+5^2\right)$
	Clearly show $k=\frac{1}{55}$	**A1**	Must have correct expression and get 1 if verifying
1(b)	Attempt $\mathrm{E}(X)=k\left(1\times1^2+2\times2^2+3\times3^2+4\times4^2+5\times5^2\right)$	**M1**	At least 3 terms correct
	Get $\frac{45}{11}$	**A1**	Oe e.g. 4.09
	$\mathrm{P}\left(X>\frac{45}{11}\right)=\frac{5}{11}$	**B1ft**	Oe e.g. 0.455 ft their $\mathrm{E}(X)$

Question	Answer	Marks	Guidance
2(a)	See at least one correct binomial probability	**B1**	$\mathrm{P}(X=0)=(1-0.16)^{10}$ or $\mathrm{P}(X=1)=\binom{10}{1}\times0.16\times(1-0.16)^9$
	Use $\mathrm{P}(X\geqslant2)=1-\mathrm{P}(X=0)-\mathrm{P}(X=1)$	**M1**	Oe must attempt binomial coefficient for at least one probability.
	0.492	**A1**	0.491053576

Question	Answer	Marks	Guidance
2(b)	$np = 20 \times 0.16$	**B1**	soi
	$[12x3.2 =]$£38.40	**B1**	
2(c)	Set up an inequality/equation in n	**M1**	e.g. $1-(0.84)^n \geqslant 0.95$
	Solve to get $n \geqslant 17.1\ldots\ldots\ldots$	**A1**	Allow $n = 17.1\ldots\ldots\ldots$
	Get 18	**B1**	

Question	Answer	Marks	Guidance
3(a)	± 2.326	**B1**	
	Set up equation in σ or μ using their ± 2.326	**M1**	e.g. $\dfrac{3.6-4\sigma}{\sigma} = -2.326$ or $\dfrac{3.6-\mu}{\frac{1}{4}\mu} = -2.326$
	Get $\sigma = \dfrac{200}{93}$ or 2.15	**A1**	

Question	Answer	Marks	Guidance
3(b)	$\mathrm{P}(Y \leqslant \mu + 1.5\sigma) = 0.9332$ (a) $\mathrm{P}(Y \leqslant \mu - 1.5\sigma) = 1 - 0.9332 = 0.0668$ (b)	**B1**	For either
	Attempt $a - b$ or $2a - 1$ or $1 - 2b$	**M1**	
	0.866(4)	**A1**	

Question	Answer	Marks	Guidance
4(a)	$\overline{t} = 33.1$ and $\overline{s} = 390.5$	**B1**	Soi, may be unsimplified
	$b = \dfrac{\dfrac{130739}{10} - 390.5 \times 33.1}{\dfrac{12483}{10} - 33.1^2}$ or $b = \dfrac{130739 - \dfrac{3905 \times 331}{10}}{12483 - \dfrac{331^2}{10}}$	***M1**	Attempt at gradient
	$b = 0.972$	**A1**	0.9715576397….
	Attempt to find a with their b and their $\overline{t}$ and $\overline{s}$ to find a	**DM1**	Allow sign errors
	Get $s = 358 + 0.972t$	**A1**	358.3408213

Question	Answer	Marks	Guidance
4(b)	Predicted $t = 358 + 0.972 \times 35 [= 392.02]$	**M1**	Using their a and b 392.3459952 …. is exact value
	Residual = 397 – 392.02 = 4.98	**A1ft**	4.654004846…. is exact value
	Positive, as observed value is above predicted.	**B1ft**	Oe, must be a comment on the value. FT their residual

Question	Answer	Marks	Guidance
5(a)	$2 \times 2 \times 2$ or 2^3	**B1**	
	$7!(= 5040)$	**B1**	
	$\left(\frac{8}{5040} =\right)\frac{1}{630}$	**B1**	Oe e.g. 0.00159
	Alternative using probabilities		
	$\frac{2}{7} \times \frac{1}{6} \times \frac{2}{5} \times \frac{2}{4} \times \frac{1}{3} \times \frac{1}{2} \times \frac{1}{1}$	**M1**	Get at least 4 probabilities correct
		A1	
	$\left(\frac{8}{5040} =\right)\frac{1}{630}$	**A1**	oe

Question	Answer	Marks	Guidance
5(b)	$\frac{7!}{3!}(=840)$	**B1**	Or $^7C_4$ (= 35)
	$2\times2\times2\times1\times4!(=192)$	**B1**	Or $^2C_1 x ^1C_1 x ^2C_1 x ^2C_1$=2x1x2x2 (= 8)
	$\left(\frac{192}{840}=\right)\frac{8}{35}$	**B1**	Oe eg 0.229
	Alternative using probabilities		
	$\frac{2}{7}\times\frac{1}{6}\times\frac{2}{5}\times\frac{2}{4}$	**B1**	
	4!	**B1**	
	Get $\left(\frac{2}{7}\times\frac{1}{6}\times\frac{2}{5}\times\frac{2}{4}\times4!=\right)\frac{8}{35}$	**B1**	Oe eg 0.229

Question	Answer	Marks	Guidance
6(a)	Independent if $\mathrm{P}(A\|B)=\mathrm{P}(A)$, so not independent	**B1**	

Question	Answer	Marks	Guidance
6(b)	Use $\mathrm{P}(A\|B)=\dfrac{\mathrm{P}(A\cap B)}{\mathrm{P}(B)}$,	**M1**	
	$2\times\mathrm{P}(A)=\dfrac{\frac{1}{3}\mathrm{P}(A)}{\mathrm{P}(B)}$	**A1**	May see $\mathrm{P}(B)=\dfrac{1}{6}$
	$\mathrm{P}(A\cup B)=\dfrac{1}{5}$	**B1**	oe
	Use $\mathrm{P}(A)+\mathrm{P}(B)-\mathrm{P}(A\cap B)=\mathrm{P}(A\cup B)$	**M1**	Allow with $\mathrm{P}(B)$ or their $\mathrm{P}(B)$
	Get $\mathrm{P}(A)+\dfrac{1}{6}-\dfrac{1}{3}\times\mathrm{P}(A)=\dfrac{1}{5}$	**A1ft**	FT their $\dfrac{1}{6}$ and $\dfrac{1}{5}$
	$\mathrm{P}(A)=\dfrac{1}{20}$	**A1**	oe If no marks scored then SC B1 for $\mathrm{P}(A\cap B)=\dfrac{1}{3}\times\mathrm{P}(A)$

Question	Answer	Marks	Guidance
7(a)	$DF-300-200=(1400+600)\times1.5$	**M1**	Attempt at N2L with 5 terms; allow sign errors. May have simultaneous equations in T but need to attempt to solve for DF for the M mark
	$DF=3500\,\mathrm{N}$	**A1**	

Question	Answer	Marks	Guidance
7(b)	$T - 300 = 600 \times 1.5$ or $3500 - 200 - T = 1400 \times 1.5$	**M1**	N2L attempt on either body with correct number of terms, allow sign errors, allow their 3500 used,
	$T = 1200\,\text{N}$	**A1**	

Question	Answer	Marks	Guidance
8	$R = 0.3g\cos 35$	**B1**	
	$0.3g\sin 35 - F = 0.3 \times 2.3$	**M1**	Resolve with 3 terms; allow sign errors, allow sin/cos mix, must have component of $0.3g$
		A1	
	Use $F = \mu R$, to get an equation in μ only	**M1**	Where R is a weight component, from equation with no missing or extra terms
	$\mu = 0.419$	**A1**	

Question	Answer	Marks	Guidance
9(a)	$(s_P =)20t-5t^2$ or $(s_Q =)8t-5t^2$	***M1**	Use suvat on either particle, using $a=\pm g$
	$20t-5t^2 = 8t-5t^2+15$	**DM1**	Use $\pm s_P = \pm s_Q \pm 15$, but s_P and s_Q of correct form
	Get $t=1.25$	**A1**	Oe allow 2sf
	Use $v=u+at$ to find v_P or v_Q	**DM1**	Dependent on first 2 M marks awarded. Using $a=\pm g$, but opposite sign to u
	$v_P = 7.5\,\text{ms}^{-1}$ **and** $v_Q = -4.5\,\text{ms}^{-1}$	**A1**	Ignore comment about direction Allow $v_P = -7.5\,\text{ms}^{-1}$ **and** $v_Q = 4.5\,\text{ms}^{-1}$
9(b)	$0 = 20-10t$	**M1**	Attempt time for *P* rising
	Get 0.75 s	**A1ft**	ft their t from (a)

Question	Answer	Marks	Guidance
10(a)	$x = U\cos\theta t$	**B1**	oe
	$y = U\sin\theta t - \frac{1}{2}gt^2$	**B1**	oe
	Eliminate t	**M1**	
	Clearly get $y = x\tan\theta - \frac{5x^2\sec^2\theta}{U^2}$	**A1**	

Question	Answer	Marks	Guidance
10(b)	Substitute $U=10, x=4, y=3$ and use $\sec^2\theta = 1+\tan^2\theta$	*M1	
	Solve their 3 term quadratic for $\tan\theta$	DM1	
	Get $\frac{5-\sqrt{6}}{2} \leqslant \tan\theta \leqslant \frac{5+\sqrt{6}}{2}$	A1	oe; allow <

Question	Answer	Marks	Guidance
11(a)	–2	B1	
11(b)	Solve $-2+4.5t-t^2=0$	M1	Must get at least an expression for t or one value for t
	$t=0.5,\ t=4$	A1	
11(c)	Attempt to integrate $-2+4.5t-t^2$	M1	Increase power by 1 and change coefficient in at least one term.
	Get $-2t+\frac{4.5}{2}t^2-\frac{1}{3}t^3=-2t+2.25t^2-\frac{1}{3}t^3$	A1	Allow unsimplified, including indices
	Use limits (0, 0.5) or (0.5, 4) or (4, 5)	M1	Allow their $0.5 \neq 0$ and their $4 \neq 5 \text{ or } 0$ May see $-\frac{23}{48}, \frac{343}{48}, -\frac{25}{12}$
	Attempt sum of 3 positive distances	M1	
	Get $\frac{233}{24}$ m or 9.71 m	A1	

Question	Answer	Marks	Guidance
12(a)	Use conservation of linear momentum	**M1**	3 non zero terms, allow sign errors
	$(m)u = (m)v_A + 5(m)v_B$	**A1**	Must be consistent with restitution equation
	Use restitution	**M1**	Allow sign errors
	$\frac{v_A - v_B}{u} = -e$	**A1**	Must be consistent with momentum equation
	Solve for v_A or v_B	**M1**	Must get $v_A = \ldots$ or $v_B = \ldots$
	Get $v_A = \frac{1}{6}(1-5e)u$	**A1**	**AG**
	and $v_B = \frac{1}{6}(1+e)u$	**A1**	
12(b)	$\frac{1}{6}(5e-1)u > \frac{1}{6}(1+e)u$	**B1**	
	Get $e > \frac{1}{2}$	**B1**	