Pearson Edexcel

Mark Scheme

Mock Paper (Set 2)

December 2019

Pearson Edexcel GCE

In Mathematics (9MA0_31) Statistics

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General Marking Guidance

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- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- 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 prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- 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.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is awarded.
- Crossed out work should be marked 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 50.

2. These mark schemes use the following types of marks:

- **M** marks: 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 (independent 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 $\sqrt{}$ 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
   - $\ast$ 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 shown, 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 and indicates which response they wish to submit, examiners should mark this response.
   If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.

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 acceptable, 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.

Question	Scheme	Marks	AOs
1(a)	$5 < t \leqslant 7$ group implies area of 1 cm^2 = freq 2	M1	2.1
	$14 < t \leqslant 18$ group has area 8 cm^2 so frequency 16	A1	1.1b
		(2)	
(b)	$18 < t \leqslant 30$ group freq $=120-(10+23+51+'16')=20$	B1ft	3.1a
	$\bar{x}=\dfrac{6\times 10+8.5\times 23+12\times 51+16\times '16'+24\times '20'}{120}$	M1	1.1b
	$=\dfrac{1603.5}{120}=13.3625$ awrt 13.4	A1	1.1b
		(3)	
(c)	$15.5 + 1.5 \times (15.5 - 9.6) =$ (awrt 24.3 ~ 24.4) Limit for outlier 24.3~24.4 so (high) chance of outliers in $18 < t \leq 30$ group	M1 A1	2.4 2.2b
		(2)	
(d)	$P_5 = 5 + \dfrac{6}{10} \times 2$	M1	3.1b
	= 6.2 mins (= 6 minutes 12 seconds)	A1	1.1b
		(2)	
			(9 marks)

Notes:
(a) M1 use of $5 < t \leq 7$ group using area or freq density A1 frequency = 16 only
(b) B1 freq of $18 < t \leq 30$ group ft their '16' M1 correct method seen (at least 2 terms) for mean of grouped data, (may be implied by correct answer) A1 awrt 13.4
(c) M1 Use of $Q_3 + 1.5 \times$ IQR A1 correct limit found and correct conclusion
(d) M1 attempt to interpolate $5 < t \leq 7$ in group A1 6.2 minutes or accept 6 minutes 12 seconds.

Question	Scheme	Marks	AOs
2(a)	(Use of $X \sim \mathrm{N}(30, 2^2)$)		
(i)	$\mathrm{P}(X = 31) = 0$	B1	1.2
(ii)	From calculator, $\mathrm{P}(X > 31) = 0.3085 \ldots$ awrt 0.309	B1	1.1b
		(2)	
(b) (i)	$0.0668 \times (1 - 0.0668)^4$	M1	3.1b
	$=0.050665\ldots$ awrt 0.0507	A1	1.1b
		(2)	
(ii)	$Y \sim \mathrm{B}(5, 0.0668)$	M1	3.3
	$\mathrm{P}(Y > 1) = 1 - \mathrm{P}(Y \leq 1)$ $= 1 - 0.9610 \ldots = 0.0390$ awrt 0.039	M1 A1	3.4 1.1b
		(3)	
(c)	$H \sim \mathrm{N}(\mu, 1.5^2)$		
	$\mathrm{P}(H > 42) = 0.0005$ or $\mathrm{P}(H < 42) = 0.9995$	M1	1.1b
	$z = 3.2905268 \ldots$ awrt 3.29	B1	1.1b
	$z = \dfrac{42 - \mu}{1.5} = 3.29 \ldots$	M1	2.1
	$\mu = 37.0642 \ldots$ awrt $37.1\,^\circ c$	A1	1.1b
		(4)	
			(11 marks)

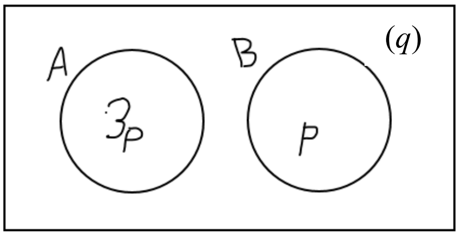
Notes:
(a)(i) B1 for 0 no working or justification required (ii) awrt 0.309
(b)(i) M1 $p(1-p)^4$ A1 awrt 0.0507
(ii) 1st M1 Binomial B(5, 0.0668) 2nd M1 use of correct Binomial to find $\mathrm{P}(Y > 1)$ A1 awrt 0.039
(c) B1 awrt 3.29 2nd M1 correct standardised expression with $z > 2$ A1 awrt 37.1

Question	Scheme	Marks	AOs
3(a)(i)	P(NNE) = 1/16 oe	B1	1.1b
(ii)	(Discrete) uniform distribution	B1	1.2
		(2)	
(b)	e.g. lds only gives data for months May to October or lds only gives data for 2 specific years	B1	2.4
		(1)	
(c)	Any two from eg		
	Create numbered list or sampling frame of days of the year Use random number generator/table to select 36 numbers In the range 001 to 365 (or 366) ignoring others/repeats	B1 B1	1.1b, 1.1b
		(2)	
(d)(i)	$H_1 : p \neq 0.25$	B1	2.2a
(ii)	Test statistic is in critical region so evidence to reject H_0	M1	1.1b
	e.g. Significant evidence that the daily mean wind directions are not all equally likely (oe)	A1ft	3.5a
		(3)	
			(8 marks)

Notes:
(a)(i) B1 1/16 or 0.0625 only
(b) accept reference to Sam's investigation of weather **throughout the year**
(c) any 2 valid steps. Accept numbering eg 000 to 364 etc
(d) A1ft requires valid comment in context, ft their H_1, Accept eg P(wind between 135 $^{\circ}c$ and 225$^{\circ}c$) $\neq 0.25$, but not just $p \neq 0.25$, needs context.

Question	Scheme	Marks	AOs
4(a)	$\bar{X} = \frac{1680}{60} = 28$ (minutes)	B1	1.1b
	$S_{xx} = 47654.4 - \frac{1680^2}{60} (= 614.4)$	M1	1.1b
	St dev $= \sqrt{\frac{S_{xx}}{60}} = 3.2$ minutes	A1	1.1b
		(3)	
(b)	$H_0 : \mu = 27.5 \quad H_1 : \mu > 27.5$ Using $\bar{X} \sim N\left(27.5, \frac{3^2}{60}\right)$	B1 M1	2.5 3.3
	Test value $z = \frac{28 - 27.5}{3/\sqrt{60}} = 1.2909...$	A1ft	1.1b
	Critical value $z = 1.64485...$ 1.64 or better	B1	1.1b
	Not in critical region so insufficient evidence to support Lucy's belief oe	A1cso	3.5a
		(5)	
(c)(i)	Assumption of constant probability of success, $p = 0.2$ is unreasonable oe	B1	3.4
	As 5 fastest and 5 beginners have differing chances	B1	2.4
(ii)		**(2)**	
	e.g. Model 5 fastest and 5 beginners as 2 independent binomial distributions each with $n = 5$ but different values of p	B1	3.5c
		(1)	
			(11 marks)

Notes:
(a) B1 28 cao M1 use of formula for S_{xx} oe alternative method A1 3.2 minutes or 3 minutes 12 seconds
(b) B1 both hypotheses correct, must be in terms of μ M1 correct model for $\bar{X}$ using their sample mean and standard deviation A1 ft their sample mean and standard deviation B1 correct critical value for z or correct p value (0.09835…) awrt 0.098 A1 cso correct conclusion in context
(c)(i) 1st B1 correct comment on 0.2 2nd B1 valid reason in context (ii) B1 idea of separate distributions to model each group

Question	Scheme	Marks	AOs
5(i)(a)	Box and 2 non-intersecting circles labelled *A* and *B* 	B1	2.1
(b)	$\mathrm{P}(A)+\mathrm{P}(B)\le 1$ or $4p \le 1$ oe $0<\mathrm{P}(B)\le 0.25$	M1 A1	1.1b 1.1b
		(3)	
(ii)(a)	If independent $\mathrm{P}(C \mid D)=\mathrm{P}(C)$ so *C* and *D* not independent	B1	2.4
		(1)	
(b)	Use of $\mathrm{P}(C \mid D)=\dfrac{P(C\cap D)}{P(D)}$	M1	1.1b
	$3\times \mathrm{P}(C) = \dfrac{0.5\times P(C)}{P(D)}$	A1	2.1
	$\mathrm{P(D)}=\dfrac{1}{6}$	A1	1.1b
	$P(C'\cap D')=\dfrac{7}{10}$ so $P(C\cup D)=\dfrac{3}{10}$	B1	1.1b
	Use of $P(C\cup D)=\mathrm{P}(C)+\mathrm{P}(D)-P(C\cap D)$ $\dfrac{3}{10}=\mathrm{P}(D)+\dfrac{1}{6}-0.5\times P(C)$	M1 dM1	3.1a 1.1b
	$P(C)=\dfrac{4}{15}$	A1	1.1b
		(7)	
			(11 marks)

Notes:
(i) (a) B1 correct shape diagram with A and B labelled and p and $3p$ correctly placed (b) M1 correct idea for upper limit in words or inequality A1 fully correct
(ii)(a) B1 needs not independent oe **and** valid reason
(b) 1st M1 any attempt to use formula for $\mathrm{P}(\mathrm{C} \mid \mathrm{D})$ 1st A1 may be implied by sight of $\mathrm{P(D)} = \frac{1}{6}$ B1 alt award if correct region labelled with $\frac{7}{10}$ in Venn diagram 2nd M1 use of formula with their $P(C \cup D)$ and $\mathrm{P}(D)$ 3rd dM1(dependent on previous M1) complete method to find $\mathrm{P}(C)$ 3rd A1 $P(C) = \frac{4}{15}$ with valid supporting reasoning

Mark Scheme

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December 2019

Pearson Edexcel GCE Mathematics
Paper 9MA0/32 Mechanics

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- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- ∗ The answer is printed on the paper
- The second mark is dependent on gaining the first mark

4. All A marks are ‘correct answer only’ (cao.), unless shown, 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 manifestly absurd answers should never be awarded A marks.

General Principles for Mechanics Marking

(But note that specific mark schemes may sometimes override these general principles)

- Rules for M marks: correct no. of terms; dimensionally correct; all terms that need resolving (i.e. multiplied by cos or sin) are resolved.

- Omission or extra g in a resolution is an accuracy error not method error.

- Omission of mass from a resolution is a method error.

- Omission of a length from a moments equation is a method error.

- Omission of units or incorrect units is not (usually) counted as an accuracy error.

- DM indicates a dependent method mark i.e. one that can only be awarded if a previous specified method mark has been awarded.

- Any numerical answer which comes from use of g = 9.8 should be given to 2 or 3 SF.

- Use of g = 9.81 should be penalised once per (complete) question.

  N.B. Over-accuracy or under-accuracy of correct answers should only be penalised *once* per complete question. However, premature approximation should be penalised every time it occurs.

- Marks must be entered in the same order as they appear on the mark scheme.

- In all cases, if the candidate clearly labels their working under a particular part of a question i.e. (a) or (b) or (c),……then that working can only score marks for that part of the question.

- Accept column vectors in all cases.

- Misreads – if a misread does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, bearing in mind that after a misread, the subsequent A marks affected are treated as A ft

- Mechanics Abbreviations

  M(A) Taking moments about A.

  N2L Newton's Second Law (Equation of Motion)

  NEL Newton's Experimental Law (Newton's Law of Impact)

  HL Hooke's Law

  SHM Simple harmonic motion

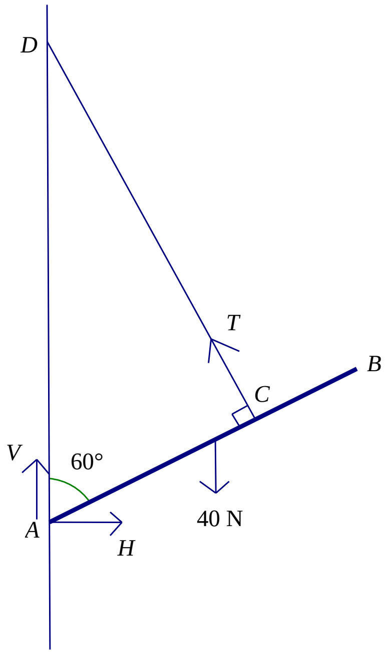
  PCLM Principle of conservation of linear momentum

RHS, LHS Right hand side, left hand side.

Question	Scheme	Marks	AOs
1 (a)	Differentiate **v** to obtain **a**	M1	3.4
	$\mathbf{a}=(6t-12)\mathbf{i}+(18t-3)\mathbf{j}$	A1	1.1b
		(2)	
(b)	Integrate **v** to obtain **r**	M1	3.4
	$\mathbf{r}=\left(t^3-6t^2\left(+C_1\right)\right)\mathbf{i}+\left(3t^3-\frac{3t^2}{2}\left(+C_2\right)\right)\mathbf{j}$	A1	1.1b
		(2)	
(c)	Solve $\mathbf{a}=\lambda\mathbf{j}$ to obtain t	M1	3.1a
	$6t-12=0 \;\Rightarrow\; t=2$	A1	1.1b
	Substitute their t	M1	1.1b
	$\mathbf{r}=-16\mathbf{i}+18\mathbf{j}$	A1	2.2a
		(4)	
			(8 marks)

Notes:

(a)	
M1	Powers going down by 1
A1	Correct only
(b)	
M1	Powers going up by 1. Condone missing constants of integration
A1	Correct only
(c)	
M1	Set coefficient of **i** equal to zero and solve for t
A1	Correct only
M1	Substitute their t in an expression of the form $\mathbf{r}=\left(at^3-bt^2+c\right)\mathbf{i}+\left(dt^3-et^2+f\right)\mathbf{j}$ where $abde\neq 0$
A1	Correct only

Question	Scheme	Marks	AOs
2 (a)			
	Take moments about A:	M1	3.3
	$T \times 2 = 40 \times 1.5 \cos 30°$	A1	1.1b
	$T = 15\sqrt{3}(\text{N}) \quad 26.0(\text{N})$	A1	1.1b
		(3)	
(b)	Resolve horizontally	M1	3.4
	$H = T\cos 60° \left(= \dfrac{15\sqrt{3}}{2} = 12.99....\right)$	A1	1.1b
	Resolve vertically	M1	3.4
	$V + T\cos 30° = 40 \quad (V = 17.5)$	A1	1.1b
	Combine components : $\sqrt{17.5^2 + 225 \times \dfrac{3}{4}}$	M1	3.1b
	$= \sqrt{475} = 5\sqrt{19} = 22(\text{N})$	A1	2.2a
		(6)	
(b) alt	Resolve parallel to the beam	M1	3.4
	$X = 40\cos 60° \quad (= 20)$	A1	1.1b
	Resolve perpendicular to the beam	M1	3.4
	$Y + T = 40\cos 30° \quad \left(Y = 20\sqrt{3} - 15\sqrt{3} = 5\sqrt{3}\right)$	A1	1.1b
	Combine components : $\sqrt{20^2 + 25 \times 3}$	M1	3.1b

	$=\sqrt{475}=5\sqrt{19}=22(\text{N})$	A1	2.2a
		(6)	
(c)	The tension will not be constant	B1	3.5a
	The tension will increase as you go up the rope since it is supporting more rope	B1	2.4
		(2)	
			(11 marks)

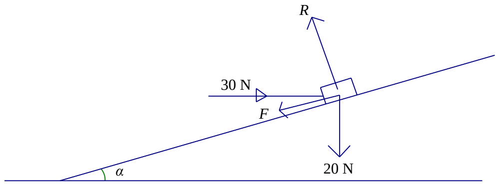
Notes:

(a)	
M1	Or alternative complete method to form an equation in T
A1	Correct unsimplified equation in T
A1	26 or better
(b)	
M1	First equation. Required terms and no extras. Condone sign errors and sin/cos confusion.
A1	Correct unsimplified equation
M1	Second equation. Required terms and no extras. Condone sign errors and sin/cos confusion.
A1	Correct unsimplified equation
M1	Correct strategy to find the resultant force
A1	22 or better (21.79….)
	N.B. There are many approaches to this. Alternative equations include e.g. moments about *C* and moments about *D*
(c)	
B1	Correct answer
B1	Correct reasoning

Question	Scheme	Marks	AOs
3 (a)	Distance travelled	M1	3.1b
	$=\frac{(15+17)}{2}\times 16\times 60+\frac{(10+12)}{2}\times 16\times 60$	A1	1.1b
	$=16\times 16\times 60+11\times 16\times 60=15360+10560$ $=25920\,\text{m}=25.92\,\text{km}$	A1	1.1b
		(3)	
(b)	Both trains have travelled the same distance	M1	3.1b
	$\Rightarrow 25920=\frac{(M+(M-2))}{2}\times 24\times 60$	A1ft A1ft	1.1b 1.1b
	Solve for T	M1	1.1b
	$M-1=18\Rightarrow T=33-19=14$	A1	2.2a
		(5)	
(c)	e.g. the platforms at A, B and C have no length the trains have no length A, B and C modelled as points the trains are modelled as particles.	B1	3.5b
		(1)	
			(9 marks)

Notes:

(a)	
M1	Complete method to find the distance AC. Condone confusion between minutes and seconds.
A1	Unsimplified expression with at most one error (the omission of $\times 60$ in each term is one error)
A1	$26000\,\text{m}$ or 26 km or better
(b)	
M1	Equate the distance travelled by Y to their answer from (a)
A1ft **A1ft**	Unsimplified equation in one unknown with at most one error. Follow their (a) Correct unsimplified equation in one unknown. Follow their (a)
M1	Solve for T
A1	Correct answer only
(c)	
B1	Any relevant assumption

Question	Scheme	Marks	AOs
4 (a)			
	Resolve perpendicular to the plane: $R = 20\cos\alpha + 30\sin\alpha$	M1	3.4
	$R = 20\times\frac{12}{13} + 30\times\frac{5}{13} = 30$ (N)	A1	1.1b
		(2)	
(b)	Forces parallel to the plane:	M1	3.1b
	$30\cos\alpha \leq F_{\max} + 20\sin\alpha$	A1ft	1.1b
	Use of $F_{\max} = \mu R$	M1	1.2
	$30\mu \geq 30\times\frac{12}{13} - 20\times\frac{5}{13}$, $\quad \mu \geq \frac{2}{3}$	A1	2.2a
		(4)	
(c)	Resolve perpendicular to the plane and use $F_{\max} = \mu R$	M1	3.1b
	$F_{\max} = \frac{1}{3}\times 20\cos\alpha \quad \left(= \frac{80}{13}\right)$	A1	1.1b
	Equation of motion:	M1	3.3
	$20\sin\alpha - F_{\max} = \frac{20}{g}a \quad \left(\frac{100}{13} - \frac{80}{13} = \frac{20}{g}a\right)$	A1ft	1.1b
	$a = \frac{g}{13}$, 0.75 or 0.754 (m s^{-2})	A1	2.2a
		(5)	
			(11 marks)

Notes:	
(a)	
M1	All terms required. Condone sign errors and sin/cos confusion
A1	Correct answer only
(b)	
M1	All terms required. Condone sign errors and sin/cos confusion. Condone equality
A1ft	Correct unsimplified inequality follow their R

M1	Use $F_{\max} = \mu R$ to find the range of values for μ
A1	$\mu \leqslant 0.67$ or better
(c)	
M1	Resolve perpendicular to the plane and use $F = \frac{1}{3}R$. No additional terms in resolution. Condone sin/cos confusion.
A1	Correct unsimplified equation for $F_{\max}$
M1	Equation of motion down the slope. Condone missing g
A1ft	Correct unsimplified equation. Follow their $F_{\max}$
A1	Exact or 0.75 or 0.754

Question	Scheme	Marks	AOs
5 (a)	Vertical speed:	M1	3.4
	$-u\sin\theta = u\sin\theta - gt \qquad \left(t = \dfrac{2u\sin\theta}{g}\right)$	A1	1.1b
	Horizontal distance $= u\cos\theta t$	B1	3.4
	$= u\cos\theta \times \dfrac{2u\sin\theta}{g}$	M1	2.1
	$= \dfrac{u^2}{g} \times 2\sin\theta\cos\theta = \dfrac{u^2\sin 2\theta}{g}$ *	A1*	2.2a
		(5)	
(b)	$\dfrac{25^2\sin 2\theta}{g} \geqslant 40 \quad \Rightarrow \quad \sin 2\theta \geqslant \dfrac{40g}{625} \quad (= 0.627......)$	M1	3.4
	$\Rightarrow (38.8° \leqslant\ )\, 2\theta \leqslant 141.2° \qquad \theta_{MAX} = 70.6° (71°)$	A1	1.1b
		(2)	
(c)	Vertical height : $3 = u\sin\theta t - \dfrac{1}{2}gt^2$	M1	3.1b
	$3 = \dfrac{25}{2}t - \dfrac{1}{2}gt^2$	A1	1.1b
	$4.9t^2 - 12.5t + 3 = 0$	M1	3.1a
	$\Rightarrow T = 2.28282.. - 0.26819.. = 2.01 \quad (2.0)$	A1	1.1b
		(4)	
			(11 marks)

Notes:

(a)	
M1	Complete method using *suvat* to find t Condone sign errors and sin/cos confusion
A1	Correct unsimplified equation in t
B1	Correct expression in u, θ and t for the horizontal distance travelled. Seen or implied.
M1	Obtain expression for distance in terms of u and θ
A1*	Correct justification of given answer from correct working.
(b)	
M1	Use given formula or complete *suvat* method to find inequality in θ
A1	$71°$ or $70.6°$

(c)	
M1	Use *suvat* to form an equation in t. Condone sign errors and sin/cos confusion
A1	Correct unsimplified equation
M1	Solve to find T
A1	2.0 or 2.01 only

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