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General Certificate of Education

Mathematics 6360

MM1B Mechanics 1B

Mark Scheme

2005 examination - June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Key to mark scheme and abbreviations used in marking

M mark is for method

m or dM mark is dependent on one or more M marks and is for method mark is dependent on M or m marks and is for accuracy

B mark is independent of M or m marks and is for method and accuracy

E mark is for explanation

√or ft or F follow through from previous

incorrect result MC mis-copy correct answer only MR mis-read

CSO correct solution only RA required accuracy AWFW anything which falls within FW further work

AWRT anything which rounds to **ISW** ignore subsequent work any correct form **ACF FIW** from incorrect work answer given given benefit of doubt AG **BOD** SC special case WR work replaced by candidate

OE OE FB formulae book A2,1 2 or 1 (or 0) accuracy marks NOS not on scheme -x EE deduct x marks for each error G graph

NMS no method shown c candidate
PI possibly implied sf significant figure(s)

SCA substantially correct approach dp significant figure(
decimal place(s)

Application of Mark Scheme

No method shown:

CAO

Correct answer without working mark as in scheme

Incorrect answer without working zero marks unless specified otherwise

More than one method / choice of solution:

2 or more complete attempts, neither/none crossed out mark both/all fully and award the mean

mark rounded down

1 complete and 1 partial attempt, neither crossed out award credit for the complete solution only

Crossed out work do not mark unless it has not been replaced

Alternative solution using a correct or partially correct method award method and accuracy marks as

appropriate

MM1B

Q	Solution	Marks	Total	Comments
1(a)	$m \begin{bmatrix} 4 \\ 2 \end{bmatrix} + 3 \begin{bmatrix} -1 \\ -1 \end{bmatrix} = (m+3) \begin{bmatrix} 1 \\ V \end{bmatrix}$	M1		M1: Conservation of momentum equation
	4m - 3 = m + 3 AG	A1		with 3 terms A1: Correct momentum equation
	3m = 6	M1		M1: Solving equation
	m=2	A1	4	A1: Correct <i>m</i> from correct working
	2			Note: Deduct one mark for using mg
(L)		N/1		instead of m
(b)	4 - 3 = 5V	M1		M1: Conservation of momentum equation for component containing <i>V</i>
		A1		A1: Correct equation
	V = 0.2	A1	3	A1: Correct V
2()	Total		7	
2(a)	$s_1 = \frac{1}{2} \times 15 \times 20 = 150$	M1		M1: Finding length of first stage
	2	M1		M1: Finding length of second stage
	$s_2 = \frac{1}{2} \times 15 \times 80 = 600$	A1		A1: Both distances correct
	s = 600 + 150 = 750 m			
	7 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	A1	4	A1: Correct total distance
(b)(i)	$t = \frac{750}{15} = 50 \text{ s}$	B1ft	1	B1: Correct time or their distance
(8)(1)	15	Biit	1	correctly divided by 15
				3
(ii)	Delay = $120 - 50 = 70 \text{ s}$	B1ft	1	B1: Correct time or their previous time
				correctly subtracted from 120 to give a
(c)	15 3	M1		positive answer M1: Finding acceleration
	$a = \frac{15}{80} = \frac{3}{16} = 0.1875 \text{ ms}^{-2}$	A1		A1: Correct acceleration
	$F = 500000 \times 0.1875 = 93800 \text{ N (to 3sf)}$	M1		M1: Use of $F = ma$
	,	A1	4	A1: Correct force
	Total		10	
3(a)	$2\cos\alpha=0.8$	M1		M1: Use of cos or sin to find α with 2
	0.8	A1		and 0.8 A1: Correct equation
	$\cos \alpha = \frac{0.8}{2}$ AG	711		711. Concer equation
	$\alpha = \cos^{-1}\left(\frac{0.8}{2}\right) = 66.4^{\circ}$			
	$\alpha = \cos \left(\frac{1}{2}\right) = 66.4^{\circ}$	A1	3	A1: Correct α from correct working
(b)(i)	$v = \sqrt{2^2 - 0.8^2} = 1.83 \text{ ms}^{-1}$	M1		M1: Use of Pythagoras with 2 and 0.8 or
(3)(1)	$v = \sqrt{2^2 - 0.8^2} = 1.83 \text{ ms}^{-1}$	1VI I		trigonometry with angle from above
	or			The state of the s
	$v = 2\sin 66.4^{\circ} = 1.83 \text{ ms}^{-1}$	A1	2	A1: Correct velocity
(ii)	$t = \frac{14}{1.83} = 7.64 \text{ s}$	M1		M1: Use of distance over speed from
		A1	2	previous
	Allow 7.65 s Total	Al	7	A1: Correct time
	1 Otal		1	

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MM1B (cont)

4(a) $9g - T = 9a$ $T - 5g = 5a$ $4g = 14a$ $a = \frac{4g}{14} = 2.8 \text{ ms}^2$ MI AGMI: Equation for one particle AI: Correct equation AI: Correct equation AI: Correct equation for AI: Correct a from correct working(b) $T - 5g = 5 \times 2.8$ $T = 63 \text{ N}$ MI AIMI: Substituting acceleration to find T AI: Correct a from correct working(c) $s = \frac{1}{2} \times 2.8 \times 0.5^3$ $= 0.35 \text{ m}$ Total $= 2 \times 0.35 = 0.7 \text{ m}$ MIAI AII AIIIMI: Constant acceleration equation with $u = 0$ and $a \neq g$ to find s . Allow \pm answers AI: Correct equation AI: Correct equation of motion AI: Correct equation of motion AI: Correct equation AI: Correct equation AI: Correct equation AI: Correct equation(b)(i) $0.2 \times 8 = 0.2 \times 9.8 - R$ $R = 0.36 \text{ N}$ MI AI AI AI: Correct equation AI: Correct equation(b)(ii)Increases as the speed increasesBII BI: Correct explanation(c) (i) $\pm 9.8 \text{ ms}^2$ (ii)BII BI: Correct explanation(c) (i) $\pm 9.8 \text{ ms}^2$ (ii)BII BI: Correct explanation(b)(ii) $A = 1.00 \times 5 \times 9.0 \text{ m}$ AG AIIMII: Equation for orterical motion with height zero AI: Correct equation AI: Co	MM1B (c	Solution	Mark	Total	Comments
$T-5g=5a \ 4g=14a \ 4g=14a \ 4g=14a \ 4g=2.8 \text{ ms}^2 \ AG \ AI \ 4g=4a \ 4g=2.8 \text{ ms}^2 \ AG \ AI \ AI \ AI \ Correct equation \ AI : Correct tension \ AI : Correct equation \ AI : Correct explanation \ AI : Correct equation \ AI : Correct explanation \ AI : Correct explanation \ AI : Correct explanation \ AI : Correct equation \ AI : Correct equation \ AI : Correct equation \ AI : Correct explanation \ AI : Correct equation \ AI : Correct equat$	Q 4(a)	9a - T = 9a		าบเลา	
	4(a)	7g 1 – 7u			
$a = \frac{4g}{14} = 2.8 \text{ ms}^2 \qquad AG \qquad A1 \qquad 5 \qquad A1: \text{ Correct equation} \qquad A1: \text{ Correct a from correct working}$ (b) $T - 5g = 5 \times 2.8 \qquad M1 \qquad A1: \text{ Substituting acceleration to find } T \qquad A1: \text{ Correct tension}$ (c) $s = \frac{1}{2} \times 2.8 \times 0.5^2 \qquad M1A1 \qquad 0.35 = 0.7 \text{ m} \qquad A1 \qquad A1: \text{ Correct tension}$ (d) $S = \frac{1}{2} \times 2.8 \times 0.5^2 \qquad M1A1 \qquad 0.35 = 0.7 \text{ m} \qquad A1 \qquad A1: \text{ Correct distance equation with } u \qquad 0.30 = 0.35 \text{ m} \qquad A1: \text{ Correct equation} \qquad A1: \text{ Correct distance equation} \qquad A1: \text{ Correct distance endown} \qquad A1: \text{ Correct distance endown} \qquad A1: \text{ Correct equation} \qquad A1: \text{ Correct distance endown} \qquad A1: \text{ Correct equation} \qquad A1: \text{ Correct explanation} \qquad A1: \text{ Correct equation} \qquad A1: Corre$		1 - 3g = 3a			
$a = \frac{4g}{14} = 2.8 \text{ ms}^2 \qquad \text{AG} \qquad \qquad \text{A1} \qquad 5 \qquad \text{A1: Correct } a \text{ from correct working}$ (b) $T - 5g = 5 \times 2.8$		4g = 14a			
(b) $T-5g=5\times2.8$ $T=63$ N $A1$ 2 $A1:$ Correct tension T $A1:$ Correct tension T $A1:$ Correct tension T $A1:$ Correct tension T $T-5g=5\times2.8$ $T=63$ N $A1$ 2 $A1:$ Correct tension T $A1:$ Correct distance equation with T $T=63$ N $T=64$ N $T=63$ N $T=64$ N $T=$		4g		5	
(c) $s = \frac{1}{2} \times 2.8 \times 0.5^2$		$a = \frac{1}{14} = 2.8 \text{ ms}^2$ AG	AI	3	A1. Correct a from correct working
(c) $s = \frac{1}{2} \times 2.8 \times 0.5^2$					
(c) $s = \frac{1}{2} \times 2.8 \times 0.5^2$	(b)	$T - 5g = 5 \times 2.8$	M1		M1: Substituting acceleration to find T
(c) $s = \frac{1}{2} \times 2.8 \times 0.5^2$	()			2	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		1 03 11			
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	(c)	1 .			M1: Constant acceleration equation with u
	(0)	$s = \frac{1}{2} \times 2.8 \times 0.5^2$	M1A1		
Total = $2 \times 0.35 = 0.7 \text{m}$ Al Alfh		=	1,11111		
Total = 2 × 0.35 = 0.7 m			A1		
Total T		Total = $2 \times 0.35 = 0.7 \text{ m}$		4	
5(a)No air resistance/Only gravity or weightB11B1: Acceptable assumption(b)(i) $0.2 \times 8 = 0.2 \times 9.8 - R$ $R = 0.36 \text{ N}$ M1 A1 A1 					
(b)(i) $0.2 \times 8 = 0.2 \times 9.8 - R$ M1 A1 A1 A1: Correct equation of motion A1: Correct equation of motion A1: Correct magnitude of the resistance force B1: Correct magnitude of the resistance force B1: Correct explanation (c) (i) $\pm 9.8 \text{ ms}^2$ B1 1 B1: CAO (ii) Decreases towards zero B1 1 B1: Correct explanation Total 7 6(a) Ball is a particle/no spin B1 2 B1: One assumption No air resistance/Only gravity or weight B1 2 B1: Second assumption (b)(i) $24.5t - 4.9t^2 = 0$ M1 M1: Equation for vertical motion with height zero A1: Correct equation dM1: Solving for t A1: Correct time from correct working (b)(ii) $R = 10 \times 5 = 50 \text{ m}$ M1 M1: Use of horizontal component of velocity to find the range M1: Horizontal equation A1: Time to reach wall dM1: Solving for t A1: Correct range M1: Horizontal equation A1: Time to reach wall dM1: Solving for t A1: Correct height with t		Total		11	1
R = 0.36 N	5(a)	No air resistance/Only gravity or weight	B1	1	B1: Acceptable assumption
R = 0.36 N					
(b)(ii) Increases as the speed increases B1 1 B1: Correct explanation (c) (i) $\pm 9.8 \text{ ms}^2$ B1 1 B1: CAO (ii) Decreases towards zero B1 1 B1: CAO (b)(i) $\pm 9.8 \text{ ms}^2$ B1 1 B1: Correct explanation (b)(i) Decreases towards zero B1 1 B1: Correct explanation (b)(i) $\pm 9.8 \text{ ms}^2$ B1 1 B1: Correct explanation (b)(i) $\pm 9.8 \text{ ms}^2$ B1 1 B1: Correct explanation (b)(i) $\pm 9.8 \text{ ms}^2$ B1 1 B1: Correct explanation (b)(i) $\pm 9.8 \text{ ms}^2$ B1 1 B1: Correct explanation (b)(i) $\pm 9.8 \text{ ms}^2$ B1 2 B1: One assumption M1: Equation for vertical motion with height zero A1: Correct equation dM1: Solving for t A1: Correct time from correct working (c) $\pm 9.8 \text{ ms}^2$ A1 A1: Correct explanation A1: Correct explanation M1: Equation for vertical motion with height zero A1: Correct equation dM1: Solving for t A1: Correct time from correct working A1: Correct time from correct working A1: Time to reach wall dM1: Vertical equation for height with $u = 24.5 \text{ snd}$ a negative acceleration A1: Time to reach wall dM1: Vertical equation for height with $u = 24.5 \text{ snd}$ a negative acceleration A1: Time to reach wall dM1: Vertical equation for height with $u = 24.5 \text{ snd}$ a negative acceleration A1: Correct height (d) No change as acceleration and initial velocity do not change with the mass B1: No change B1: Explanation	(b)(i)	$0.2 \times 8 = 0.2 \times 9.8 - R$	M1		M1: Three term equation of motion
(b)(ii) Increases as the speed increases B1		R = 0.36 N	A1		A1: Correct equation
(b)(ii)Increases as the speed increasesB11B1: Correct explanation(c) (i) $\pm 9.8 \text{ ms}^{-2}$ B11B1: CAO(iii)Decreases towards zeroB11B1: Correct explanation6(a)Ball is a particle/no spin No air resistance/Only gravity or weightTotal7(b)(i) $24.5t - 4.9t^2 = 0$ M1B1: Second assumption(b)(i) $24.5t - 4.9t^2 = 0$ M1M1: Equation for vertical motion with height zero A1: Correct equation dM1: Solving for t A1: Correct time from correct working(b)(ii) $R = 10 \times 5 = 50 \text{ m}$ M1M1: Use of horizontal component of velocity to find the range A1: Correct range(c) $20 = 10t$ $t = 2$ $h = 24.5 \times 2 - 4.9 \times 2^2 = 29.4 \text{ m}$ M1M1: Horizontal equation A1: Time to reach wall dM1: Vertical equation for height with $u = 24.5$ and a negative acceleration(d)No change as acceleration and initial velocity do not change with the massB1B1: No change B1: Explanation			A1	3	A1: Correct magnitude of the resistance
(c) (i) $\pm 9.8 \text{ ms}^{-2}$ (ii) Decreases towards zero B1					
(ii)Decreases towards zeroB11B1: Correct explanation6(a)Ball is a particle/no spin No air resistance/Only gravity or weightB17(b)(i) $24.5t - 4.9t^2 = 0$	(b)(ii)	Increases as the speed increases	B1	1	B1: Correct explanation
(ii)Decreases towards zeroB11B1: Correct explanation6(a)Ball is a particle/no spin No air resistance/Only gravity or weightB17(b)(i) $24.5t - 4.9t^2 = 0$					
(ii)Decreases towards zeroB11B1: Correct explanation6(a)Ball is a particle/no spin No air resistance/Only gravity or weightB17(b)(i) $24.5t - 4.9t^2 = 0$	(c) (i)	$\pm 9.8 \text{ ms}^{-2}$	B1	1	B1: CAO
Total76(a)Ball is a particle/no spin No air resistance/Only gravity or weightB12B1: One assumption(b)(i) $24.5t - 4.9t^2 = 0$ M1M1: Equation for vertical motion with height zero A1: Correct equation dM1: Solving for t A1: Correct time from correct workingAGM1M1: Use of horizontal component of velocity to find the range(b)(ii) $R = 10 \times 5 = 50$ mM1M1: Use of horizontal component of velocity to find the range(c) $20 = 10t$ M1M1: Horizontal equation $t = 2$ A1A1A1: Time to reach wall dM1: Vertical equation for height with $u = 24.5$ and a negative acceleration(d)No change as acceleration and initial velocity do not change with the massB1B1: No change B1: No change B1: Explanation		D	D1	1	D1. C
6(a)Ball is a particle/no spin No air resistance/Only gravity or weightB1 B12B1: One assumption B1: Second assumption(b)(i) $24.5t - 4.9t^2 = 0$ $t = 0$ or $t = \frac{24.5}{4.9} = 5$ sM1 AGM1: Equation for vertical motion with height zero A1: Correct equation dM1: Solving for t A1: Correct time from correct working(b)(ii) $R = 10 \times 5 = 50$ mM1M1: Use of horizontal component of velocity to find the range(c) $20 = 10t$ $t = 2$ $h = 24.5 \times 2 - 4.9 \times 2^2 = 29.4$ mM1 A1 A1 A1A1 A1: Time to reach wall dM1: Vertical equation for height with $u = 24.5$ and a negative acceleration A1: Correct height(d)No change as acceleration and initial velocity do not change with the massB1 B1 B1: No change B1: Explanation	(11)	Decreases towards zero	DI	1	B1. Coffect explanation
No air resistance/Only gravity or weight (b)(i) $24.5t - 4.9t^2 = 0$ $t = 0$ or $t = \frac{24.5}{4.9} = 5$ s AG AG M1: Equation for vertical motion with height zero A1: Correct equation dM1: Solving for t A1: Correct time from correct working M1: Use of horizontal component of velocity to find the range A1: Correct range M1: Horizontal equation A1: Time to reach wall dM1: Vertical equation for height with $u = 24.5 \times 2 - 4.9 \times 2^2 = 29.4$ m (d) No change as acceleration and initial velocity do not change with the mass $t = 0$ $t =$				7	
(b)(i)	6(a)	•			-
		No air resistance/Only gravity or weight	B1	2	B1: Second assumption
	~ \ A				
AGdM1 A14dM1: Solving for t A1: Correct time from correct working(b)(ii) $R = 10 \times 5 = 50 \text{ m}$ M1M1: Use of horizontal component of velocity to find the range(c) $20 = 10t$ $t = 2$ $h = 24.5 \times 2 - 4.9 \times 2^2 = 29.4 \text{ m}$ M1 M1 A1A1 A1 A1A1: Time to reach wall dM1: Vertical equation for height with $u = 24.5$ and a negative acceleration A1: Correct height(d)No change as acceleration and initial velocity do not change with the massB1 B1 B1: Explanation	(b)(i)	$24.5t - 4.9t^2 = 0$	M1		*
AGdM1 A14dM1: Solving for t A1: Correct time from correct working(b)(ii) $R = 10 \times 5 = 50 \text{ m}$ M1M1: Use of horizontal component of velocity to find the range(c) $20 = 10t$ $t = 2$ $h = 24.5 \times 2 - 4.9 \times 2^2 = 29.4 \text{ m}$ M1 M1 A1A1 A1 A1A1: Time to reach wall dM1: Vertical equation for height with $u = 24.5$ and a negative acceleration A1: Correct height(d)No change as acceleration and initial velocity do not change with the massB1 B1 B1: Explanation		$\left(t=0 \text{ or } t=\frac{24.5}{1000}=5.8\right)$			
(b)(ii) $R = 10 \times 5 = 50 \text{ m}$ M1		$\begin{pmatrix} \iota & 0 & 0 & 1 & \iota \\ & & 4.9 & & 1 \end{pmatrix}$			•
(b)(ii) $R = 10 \times 5 = 50 \text{ m}$ M1		\mathbf{AG}		4	
(c) $20 = 10t$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$			Al	4	A1: Correct time from correct working
(c) $20 = 10t$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$ $A1$	(b)(;;)	$P = 10 \times 5 = 50 \text{ m}$	M1		M1: Use of horizontal component of
(c) $20=10t$ $M1$ $M1$: Horizontal equation $M1$: Time to reach wall $M1$: Vertical equation for height with U	(11)(11)	N − 10 ∧ J − JU III	1711		
(c) $20 = 10t$ $t = 2$ $h = 24.5 \times 2 - 4.9 \times 2^2 = 29.4 \text{ m}$ (d) No change as acceleration and initial velocity do not change with the mass M1 A1 A1 A1: Time to reach wall dM1: Vertical equation for height with $u = 24.5$ and a negative acceleration A1: Correct height B1 B1: No change with the mass B1 B1: Explanation			Δ1	2	, , , , , , , , , , , , , , , , , , ,
$t = 2$ $h = 24.5 \times 2 - 4.9 \times 2^2 = 29.4 \text{ m}$ A1 $dM1$ A1: Time to reach wall dM1: Vertical equation for height with $u = 24.5$ and a negative acceleration A1: Correct height (d) No change as acceleration and initial velocity do not change with the mass B1 B1: No change velocity do not change with the mass B1: Explanation	(c)	20 = 10t			_
$h = 24.5 \times 2 - 4.9 \times 2^2 = 29.4 \text{ m}$ $(d) \text{ No change as acceleration and initial velocity do not change with the mass}$ $dM1 $					*
(d) No change as acceleration and initial velocity do not change with the mass A1 4 A1: Correct height B1: No change B1: Explanation		$n = 24.3 \times 2 - 4.9 \times 2^{2} = 29.4 \text{ m}$			
(d) No change as acceleration and initial velocity do not change with the mass B1 B1: No change B1: Explanation			A1	4	
velocity do not change with the mass B1 2 B1: Explanation					
velocity do not change with the mass B1 2 B1: Explanation	(d)	No change as acceleration and initial	B1		B1: No change
	\ \frac{1}{2}	· ·	B1	2	
10141 14		Total		14	•

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MM1B (cont)

Q	Solution	Marks	Total	Comments
7(a)	$\mathbf{v} = 4\mathbf{j} + (3\mathbf{i} - 5\mathbf{j})t$	M1A1	2	M1: Use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$ and $\mathbf{u} \neq 0$ or integration A1: Correct expression
(b)	$\mathbf{v} = 3t\mathbf{i} + (4 - 5t)\mathbf{j}$ $4 - 5t = 0$	M1		M1: j component of velocity equal to zero
	t = 0.8 s	A1	2	A1: Correct t
(c)	$\mathbf{v} = 12\mathbf{i} - 16\mathbf{j}$	M1		M1: Finding velocity when $t = 4$
		A1		A1: Correct velocity
	$\mathbf{v} = \sqrt{12^2 + 16^2} = 20$ AG	dM1		dM1:Finding the magnitude
		A1	4	A1:Correct speed from correct working
	Total		8	
8(a)	R T Mg	B1	1	B1: Correct force diagram
(b)	$R + 20 \sin 30^{\circ} = 6g \cos 10^{\circ}$ $R = 6g \cos 10^{\circ} - 20 \sin 30^{\circ}$ R = 47.9 N (to 3 sf)	M1 A1		M1: Resolving perpendicular to the slope with 3 terms A1: Correct equation
	AG	dM1	4	dM1 Solving for R
		A1	4	A1: Correct R from correct working
(c)	$F = \mu R$	M1		M1: Use of $F = \mu R$
	$6 \times 0.4 = 20\cos 30^{\circ} - 6g\sin 10^{\circ} - \mu R$	M1		M1: Resolving parallel to slope to get 4
		A1		term equation of motion
	$\mu R = 4.710$	A1		A1: Correct equation A1: Correct $F/\mu R$
		Ai		711. Contout 1 / μ K
	$\mu = \frac{4.710}{47.91} = 0.0983$	dM1		dM1: Solving for μ
	47.91	A1	6	A1: AWRT 0.098
	Total		11	
	Total		75	

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