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INTERNATIONAL A LEVEL MATHEMATICS • MECHANICS 1 (WME01)

Mechanics 1 Practice Paper 2

Mark Scheme

AIMING FOR A

Written in the style of the Pearson Edexcel International Advanced Level paper (WME01/01) • 75 marks

Every question marked line by line the way an examiner marks it, with notes on the common errors

Mark every line, not just the answer. Method marks are given for a correct method even when the final answer is wrong. If you lost marks, find the *first* line where your working differs from the scheme. That is the thing to fix.

Code	Meaning
M1	Method mark: for knowing a correct method and attempting to apply it. Small slips in the working do not lose this mark.
dM1	Dependent method mark: can only be given if the method mark before it has been given.
A1	Accuracy mark: for a correct answer or line of working. It depends on the method mark before it.
B1	Independent mark: for a correct result or statement, whatever method was used.
*	The answer is given in the question. Every step must be shown, and the answer must follow from correct working (cso).
cao / cso	Correct answer only / correct solution only, with no errors anywhere in the working.
ft / oe	Follow through from your own earlier answer / or any correct equivalent form.
awrt	Answers which round to the value given, so 21.52... earns “awrt 21.5”.

How mechanics marks work. A method mark for an equation (resolving, moments, $F = ma$, momentum) needs the right number of terms and the right dimensions; sign slips and sin/cos confusion are condoned there but lose the accuracy mark. Use $g = 9.8\,\text{m s}^{-2}$, and after using it give final answers to 2 or 3 significant figures.

Rough grade guide (out of 75): A **55** • B **47** • C **39**

Based on recent WME01 grade boundaries. Real boundaries change every series, so treat this as a guide, not a grade.

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What to revise next

Write in your score for each question. Where you dropped marks, tap the chapter to practise ten more exam questions on it.

Q	What it tested	Marks	Practise it	Score
1	An impulse, friction and a collision	9	Ch 6 Momentum and Impulse Ch 5 Forces and Friction	
2	Position vectors of two ships; closest approach	10	Ch 3 Vectors in Mechanics Ch 2 Constant Acceleration	
3	Moments: a non-uniform rod in two arrangements	10	Ch 8 Moments	
4	Limiting friction both ways with a horizontal force	11	Ch 7 Statics of a Particle Ch 5 Forces and Friction	
5	A lift: speed-time graph, cable tension and reaction	11	Ch 4 Dynamics of a Particle Ch 2 Constant Acceleration	
6	A slope and a pulley; the second stage after landing	12	Ch 4 Dynamics of a Particle Ch 5 Forces and Friction	
7	A car and trailer; a towbar in tension and in thrust	12	Ch 4 Dynamics of a Particle Ch 2 Constant Acceleration	
	Total	**75**		

Where did the marks go? If you lost the first marks of a question, the method needs work: go back to that chapter's key skills page. If you lost the final marks, the method is fine and the gap is a link between stages: a speed carried from one part to the next, a force whose direction has changed, or a second stage of motion. Paper 3 gives no route at all and hides a trap in every question.

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Question 1

9 marks

Part	Scheme	Marks
(a)	Impulse = change in momentum: $4 = 0.5u$	M1
	$\boxed{8\,\text{m s}^{-1}}$	A1
		(2)
(b)	$F = \mu R = \frac{2}{7} \times 0.5g = 1.4\,\text{N}$, so the deceleration is $\frac{1.4}{0.5}$, then $v^2 = 8^2 - 2a \times 5$	M1
	$a = 2.8\,\text{m s}^{-2}$	A1
	$v^2 = 64 - 28 = 36$: $\boxed{6\,\text{m s}^{-1}}$	A1
		(3)
(c)	Conservation of momentum: $0.5 \times 6 = 0.5v + 1.5 \times 2.5$	M1
	$v = -1.5$	A1
	$\boxed{1.5\,\text{m s}^{-1}}$, with A's direction of motion reversed	A1
	The negative sign is the evidence that A has turned round; the answer must say so in words.	
		(3)
(d)	$1.5 \times 2.5 = \boxed{3.75\,\text{N s}}$	B1
		(1)
		Total for Question 1: 9 marks

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Question 2

10 marks

Part	Scheme	Marks
(a)	$\tan\theta = \frac{3}{4}$, with θ measured clockwise from north	M1
	$\boxed{037^\circ}$ (awrt 036.9°)	A1
		(2)
(b)	Due north: the $\mathbf{i}$ components are equal, $2+3t = 14-3t$	M1
	$t = 2$, so at $\boxed{2\,\text{pm}}$	A1
	A at $(8\mathbf{i}+13\mathbf{j})$, B at $(8\mathbf{i}+15\mathbf{j})$: $\boxed{2\,\text{km}}$ apart	A1
	The $\mathbf{j}$ component of B must be the larger one for B to be north of A: check it.	
		(3)
(c)	$\overrightarrow{AB} = \mathbf{b}-\mathbf{a} = (12-6t)\mathbf{i}+(2t-2)\mathbf{j}$	M1
	$d^2 = (12-6t)^2+(2t-2)^2$	M1
	$\boxed{d^2 = 40t^2-152t+148}$	A1
		(3)
(d)	$d^2 = 40(t-1.9)^2+3.6$, or the least value of the quadratic at $t = \frac{152}{80} = 1.9$	M1
	$d = \sqrt{3.6} = \boxed{1.90\,\text{km}}$ (or 1.9)	A1
	The question asks for the distance, not the time. Giving $t = 1.9$ alone scores M1 A0.	
		(2)
		Total for Question 2: 10 marks

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Question 3

10 marks

Part	Scheme	Marks
(a)	$R_A + R_B = W$ and $R_A = 2R_B$, so $R_B = \frac{W}{3}$	M1
	Moments about A: $W \times AG = \frac{W}{3} \times 4$	M1
	$AG = \frac{4}{3}$ m	A1*
		(3)
(b)	Moments about C: $mg\left(2 - \frac{4}{3}\right) = 3g \times 2$	M1
	Correct equation, with G on the A side of C	A1
	9 kg	A1
		(3)
(c)	On the point of tilting about the support 1 m from B: the reaction at the other support is zero	B1
	Moments about that support (3 m from A): $9g\left(3 - \frac{4}{3}\right) = Mg \times 1$	M1
	Correct equation	A1
	$M = 15$	A1
	The centre of mass is $\frac{5}{3}$ m from the right-hand support, not 1 m: the rod is not uniform.	
		(4)
		Total for Question 3: 10 marks

Question 4

11 marks

Part	Scheme	Marks
(a)	Perpendicular to the plane: $R = 2g\cos\alpha + P\sin\alpha$	M1
	$R = 15.68 + 0.6P$	A1
	Least P: about to slide down, so friction acts up the plane: $P\cos\alpha + 0.2R = 2g\sin\alpha$	M1
	$0.8P + 0.2(15.68 + 0.6P) = 11.76$	A1
	9.37 (or 9.4)	A1
	The horizontal force has a component into the plane, so $R \neq 2g\cos\alpha$. Missing $P\sin\alpha$ loses the A marks.	
		(5)
(b)	Greatest P: about to slide up, so friction acts down the plane: $P\cos\alpha = 2g\sin\alpha + 0.2R$	M1
	$0.8P = 11.76 + 0.2(15.68 + 0.6P)$	A1
	Solves: $0.68P = 14.896$	dM1
	21.9 (or 22)	A1
		(4)
(c)	$15\cos\alpha - 2g\sin\alpha = 12 - 11.76$	M1
	0.24 N acting down the plane	A1
		(2)
		Total for Question 4: 11 marks

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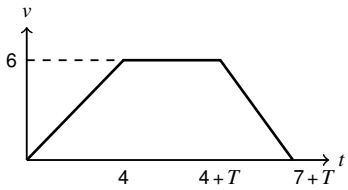
Question 5

11 marks

Part	Scheme	Marks
(a)	 Three straight-line stages, starting and ending at speed 0 Top speed 6, and times 4, $4+T$, $7+T$ (or equivalent) marked	B1 B1 (2)
(b)	Top speed = $1.5 \times 4 = 6\,\text{m s}^{-1}$ Area: $\frac{1}{2} \times 4 \times 6 + 6T + \frac{1}{2} \times 3 \times 6 = 45$ $\boxed{T = 4}$	B1 M1 A1 (3)
(c)	Lift and box together: $T_c - 640g = 640 \times 1.5$ Correct equation, with the total mass 640 kg $\boxed{7230\,\text{N}}$ (accept 7232 N or 7200 N)	M1 A1 A1 (3)
(d)	Deceleration = $\frac{6}{3} = 2\,\text{m s}^{-2}$ Box: $40g - R = 40 \times 2$ $\boxed{312\,\text{N}}$ (or 310 N) *While the lift slows on the way up, its acceleration is downwards, so the reaction is less than the weight of the box.*	M1 M1 A1 (3)
		Total for Question 5: 11 marks

Question 6

12 marks

Part	Scheme	Marks
(a)	$R = 4g\cos 30^\circ$ and $F = 0.25R = 8.49\,\text{N}$	**M1**
	P: $T - 4g\sin 30^\circ - F = 4a$	**M1**
	Q: $5g - T = 5a$	**M1**
	Both equations correct	**A1**
	$\boxed{a = 2.32\,\text{m s}^{-2}}$ (or 2.3)	**A1**
	$\boxed{T = 37.4\,\text{N}}$ (or 37)	**A1**
		(6)
(b)	$v^2 = 2 \times 2.32\ldots \times 2$	**M1**
	$\boxed{3.05\,\text{m s}^{-1}}$ (or 3.0)	**A1**
		(2)
(c)	String slack: P decelerates at $g\sin 30^\circ + 0.25g\cos 30^\circ$	**M1**
	$= 7.02\,\text{m s}^{-2}$, so a further $\dfrac{3.05^2}{2 \times 7.02} = 0.662\,\text{m}$	**A1**
	Total $= 2 + 0.662 = \boxed{2.66\,\text{m}}$ (or 2.7)	**A1**
	P moved 2 m with Q before the string went slack. Giving only 0.662 scores M1 A1 A0.	
		(3)
(d)	No: $\tan 30^\circ = 0.577 > 0.25$ (or $4g\sin 30^\circ = 19.6\,\text{N} >$ greatest friction 8.49 N), so P slides back down	**B1**
		(1)
		Total for Question 6: 12 marks

Question 7

12 marks

Part	Scheme	Marks
(a)	Whole system: $2100 - 300 - 200 = 1600a$	**M1**
	$a = 1\,\text{m s}^{-2}$	**A1**
	Trailer: $T - 200 = 400a$	**M1**
	Correct equation	**A1**
	$T = 600\,\text{N}$	**A1**
		(5)
(b)	Whole system: $B + 300 + 200 = 1600 \times 2.5$	**M1**
	$B = 3500$	**A1**
	Trailer: $200 + F = 400 \times 2.5$, where F is the backward force from the towbar	**M1**
	$F = 800$	**A1**
	800 N, a thrust	**A1**
	The trailer's own resistance gives only $0.5\,\text{m s}^{-2}$ of deceleration, so the towbar must push back on it: a thrust.	**(5)**
(c)	$\frac{15^2}{2 \times 2.5} = 45\,\text{m}$	**B1**
		(1)
(d)	The force in the towbar is the same at both ends (it has no mass, so it needs no resultant force)	**B1**
		(1)
		Total for Question 7: 12 marks

TOTAL FOR PAPER: 75 MARKS

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