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INTERNATIONAL A LEVEL MATHEMATICS • MECHANICS 1 (WME01)

Mechanics 1 Practice Paper 1

Mark Scheme

AIMING FOR B

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 **60** • B **52** • C **44**

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	Conservation of momentum and impulse in a direct collision	7	Ch 6 Momentum and Impulse	
2	Vertical motion under gravity with constant acceleration	8	Ch 2 Constant Acceleration	
3	Forces as vectors, Newton's second law and velocity	9	Ch 3 Vectors in Mechanics Ch 4 Dynamics of a Particle	
4	Equilibrium of a particle: resolving two tensions	9	Ch 7 Statics of a Particle	
5	Moments on a plank; the point of tilting	9	Ch 8 Moments	
6	A speed-time graph: areas, times and deceleration	10	Ch 2 Constant Acceleration	
7	Friction on a rough slope; motion after the force is removed	10	Ch 5 Forces and Friction Ch 4 Dynamics of a Particle	
8	Connected particles over a pulley; motion after the string goes slack	13	Ch 4 Dynamics of a Particle Ch 5 Forces and Friction	
	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 sign, a missing g, a force left out of an equation, or a change of stage in the motion. A clear force diagram before every equation stops most of these.

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Question 1

7 marks

Part	Scheme	Marks
(a)	Conservation of momentum, taking P's original direction as positive	**M1**
	$2\times 6-3\times 2=2\times(-1.5)+3v$	**A1**
	$\boxed{v=3}$ (m s^{-1})	**A1**
	Q moves in the direction that P was originally moving (its direction is reversed)	**B1**
	The velocities before and after must have consistent signs. Using +2 for Q before the collision gives $v=7$: M1 A0 A0.	
		(4)
(b)	Impulse on Q = change in momentum of Q: $3(3-(-2))$, or on P: $2(6-(-1.5))$	**M1**
	Correct difference of momenta	**A1**
	$\boxed{15\,\text{N s}}$	**A1**
		(3)
		Total for Question 1: 7 marks

Question 2

8 marks

Part	Scheme	Marks
(a)	At the top $v=0$: $0=14.7^2-2\times 9.8\times s$	**M1**
	$s=11.025$	**A1**
	Height above the sea $=24.5+11.025=\boxed{35.5\,\text{m}}$ (or 36 m)	**A1**
		(3)
(b)	Up positive: $-24.5=14.7t-4.9t^2$	**M1**
	$t^2-3t-5=0$, solved	**M1**
	$\boxed{4.19\,\text{s}}$ (or 4.2 s)	**A1**
	The displacement is -24.5, not $+24.5$: the sea is below O. The negative root is rejected.	
		(3)
(c)	$v^2=14.7^2+2\times 9.8\times 24.5$ (or $v=14.7-9.8t$)	**M1**
	$\boxed{26.4\,\text{m s}^{-1}}$ (or 26)	**A1**
		(2)
		Total for Question 2: 8 marks

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Question 3

9 marks

Part	Scheme	Marks
(a)	Resultant $= (2+3+1)\mathbf{i}+(5-1+4)\mathbf{j} = 6\mathbf{i}+8\mathbf{j}$	M1
	$\mathbf{F} = m\mathbf{a}$: $\mathbf{a} = 3\mathbf{i}+4\mathbf{j}$	A1
	$\lvert\mathbf{a}\rvert = \sqrt{3^2+4^2}$	M1
	$\boxed{5\,\text{m s}^{-2}}$	A1
		(4)
(b)	$\tan\theta = \frac{4}{3}$	M1
	$\boxed{53.1^\circ}$ (or 53°)	A1
		(2)
(c)	$\mathbf{v} = (-3\mathbf{i}+2\mathbf{j})+2(3\mathbf{i}+4\mathbf{j})$	M1
	$= 3\mathbf{i}+10\mathbf{j}$	A1
	Speed $= \sqrt{109} = \boxed{10.4\,\text{m s}^{-1}}$ (or 10)	A1
	Speed is a magnitude. Leaving the answer as $3\mathbf{i}+10\mathbf{j}$ scores A0 for the last mark.	
		(3)
		Total for Question 3: 9 marks

Question 4

9 marks

Part	Scheme	Marks
(a)	Resolve horizontally	M1
	$T_A\cos 30^\circ = T_B\cos 45^\circ$	A1
	Resolve vertically	M1
	$T_A\sin 30^\circ + T_B\sin 45^\circ = 3g$	A1
	Solves the two equations	dM1
	$\boxed{T_{AC} = 21.5\,\text{N}}$, $\boxed{T_{BC} = 26.4\,\text{N}}$ (or 22 N and 26 N)	A1
		(6)
(b)	BC has the larger tension, so it reaches 40 N first; both tensions are proportional to the mass	M1
	$m = \frac{40}{26.36\ldots}\times 3$	M1
	$\boxed{4.55\,\text{kg}}$ (or 4.6 kg)	A1
	Using $AC = 40$ gives 5.58 kg, but then BC would have a tension of 49 N and break.	
		(3)
		Total for Question 4: 9 marks

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Question 5

9 marks

Part	Scheme	Marks
(a)	Moments about C: $3R_D = 30g \times 2 + 70g \times 1$	**M1**
	$R_D = \dfrac{130g}{3}$	**A1**
	Resolve vertically: $R_C + R_D = 100g$ (or moments about D)	**M1**
	$\boxed{R_C = 555\,\text{N}}$, $\boxed{R_D = 425\,\text{N}}$ (or 560 N and 420 N)	**A1**
		(4)
(b)	About to tilt about D: the reaction at C is zero	**B1**
	Moments about D: $30g \times 1 = 70g \times x$	**M1**
	$x = \dfrac{3}{7}$ m beyond D	**A1**
	Distance from $B = 2 - \dfrac{3}{7} = \boxed{1.57\,\text{m}}$ (or 1.6 m)	**A1**
		(4)
(c)	The weight of the plank acts at its midpoint, 3 m from A	**B1**
		(1)
		Total for Question 5: 9 marks

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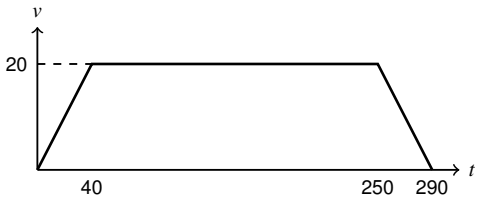
Question 6

10 marks

Part	Scheme	Marks
(a)	 Trapezium starting and ending on the t-axis 20 marked on the speed axis, and 40 (or the times) on the time axis	B1 B1 (2)
(b)	Deceleration time $= \dfrac{20}{0.5} = 40$ s Area: $\frac{1}{2} \times 40 \times 20 + 20T + \frac{1}{2} \times 40 \times 20 = 5000$ $400 + 20T + 400 = 5000$, so $T = 210$ *The 5 km must be converted to 5000 m before equating to the area.*	B1 M1 A1* (3)
(c)	$40 + 210 + 40 =$ 290 s	B1 (1)
(d)	$400 + 20t' = 2500$, so $t' = 105$ $40 + 105 =$ 145 s	M1 A1 (2)
(e)	$300 = \frac{1}{2} \times 0.5 \times t^2$ (or $v^2 = 2 \times 0.5 \times 300$, then $t = \frac{v}{0.5}$) 34.6 s (or 35 s)	M1 A1 (2)
		Total for Question 6: 10 marks

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Question 7

10 marks

Part	Scheme	Marks
(a)	$\sin\alpha = 0.6$, $\cos\alpha = 0.8$	**B1**
	Perpendicular to the plane: $R = 5g\cos\alpha = 39.2$	**M1**
	Along the plane: $50 - F - 5g\sin\alpha = 5 \times 2.16$	**M1**
	$F = 9.8$	**A1**
	$\mu = \dfrac{9.8}{39.2} = 0.25$	**A1***
		(5)
(b)	Speed after 5 s: $v = 2.16 \times 5 = 10.8$	**M1**
	New motion: $5g\sin\alpha + 0.25 \times 39.2 = 5a$	**M1**
	$a = 7.84$ (deceleration)	**A1**
	$0 = 10.8^2 - 2 \times 7.84 \times s$: $\boxed{7.44\,\text{m}}$ (or 7.4 m)	**A1**
	Friction still acts down the plane while the box is moving up. Leaving it out gives a deceleration of 5.88.	
		(4)
(c)	No: $5g\sin\alpha = 29.4$ N is greater than the greatest friction $\mu R = 9.8$ N (or $\tan\alpha > \mu$), so it slides back down	**B1**
		(1)
		Total for Question 7: 10 marks

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Question 8

13 marks

Part	Scheme	Marks
(a)	$F = \mu R = \frac{1}{3} \times 3g = g$	**M1**
	Equation of motion for A, including the friction: $T - F = 3a$	**M1**
	$T - g = 3a$	**A1**
	Equation of motion for B: $2g - T = 2a$	**M1**
	Both equations correct (or the whole system: $2g - g = 5a$)	**A1**
	$\boxed{a = 1.96\,\text{m s}^{-2}}$ $\left(= \frac{g}{5}\right)$, $\boxed{T = 15.7\,\text{N}}$ (or 16 N)	**A1**
		(6)
(b)	$v^2 = 2 \times 1.96 \times 1.2$	**M1**
	$\boxed{2.17\,\text{m s}^{-1}}$ (or 2.2)	**A1**
		(2)
(c)	The string is slack, so only friction acts on A: deceleration μg	**M1**
	$\frac{g}{3} = 3.27\,\text{m s}^{-2}$	**A1**
	$0 = 2.17^2 - 2 \times \frac{g}{3} \times s$, so $s = 0.72$	**M1**
	$1.2 + 0.72 = 1.92 < 2$, so A stops before the pulley	**A1***
	A has already moved 1.2 m with B. Comparing 0.72 with 2 scores M1 A1 M1 A0.	
		(4)
(d)	A and B have the same acceleration (and the same speed) while the string is taut	**B1**
		(1)
		Total for Question 8: 13 marks

TOTAL FOR PAPER: 75 MARKS

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