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INTERNATIONAL A LEVEL MATHEMATICS • MECHANICS 1

Mechanics 1

Exam Questions by Topic: Mark Scheme

Pearson Edexcel International Advanced Level (WME01/01) • Calculator allowed • Take $g = 9.8 \text{ ms}^{-2}$

Every question in the booklet, marked line by line the way an examiner marks it

Chapters (tap a chapter to jump to it)	Qs	Marks	Page	My score
1 Mathematical Models in Mechanics Not examined on its own: modelling ideas are tested within Chapters 2 to 8	—	—	Not applicable	
2 Constant Acceleration Motion graphs, the suvat formulae, vertical motion under gravity	10	82	own PDF	
3 Vectors in Mechanics Resultants, velocity and position vectors, $\mathbf{r} = \mathbf{r}_0 + \mathbf{v}t$	10	81	own PDF	
4 Dynamics of a Particle Moving in a Straight Line $F = ma$, connected particles, pulleys, lifts	10	82	own PDF	
5 Forces and Friction Resolving forces, friction, inclined planes	10	86	own PDF	
6 Momentum and Impulse Conservation of momentum, impulse	10	81	3	
7 Statics of a Particle Equilibrium, limiting friction	10	82	own PDF	
8 Moments Beams and rods, tilting, non-uniform rods	10	82	own PDF	

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How to use this mark scheme

The same marking rules Pearson examiners use for WME01.

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 can only be given if the method mark it depends on has been given.
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	Correct answer only.
cso	Correct solution only: no errors anywhere in the working.
ft	Follow through: the mark can be given for correct work using your own earlier (wrong) answer.
oe	Or equivalent: any correct equivalent form is accepted.

Accuracy after using $g = 9.8$. When $g = 9.8 \text{ ms}^{-2}$ has been substituted, the final answer must be given to 2 or 3 significant figures: more accurate answers (and fractions) lose the final A mark. Exact multiples of g are usually accepted. Using $g = 9.81$ loses accuracy marks.

Marking a sketch. Graph marks are given for the correct shape (straight lines for constant acceleration, no solid vertical lines) and for the key values marked on the axes. An equation of motion or a suvat equation must have the correct number of terms and be dimensionally correct to earn its method mark.



6

Chapter 6: Momentum and Impulse

Mark scheme. Marks are shown on the right of each line.

Question 1

6 marks

Part	Scheme	Marks
(a)	$25\,000 \times 3 - 15\,000 \times 1 = 40\,000$ 1.5ms^{-1} in the original direction of A	M1 A1 A1 (3)
(b)	Impulse on B: $15\,000(1.5 - (-1))$ 37 500 $37\,500\text{Ns}$ <i>Oct 2022 report: the units are required. Using $1.5 - 1$ (ignoring the change of direction) is M0.</i>	M1 A1 A1 (3)
Total for Question 1: 6 marks		

Question 2

6 marks

Part	Scheme	Marks
(a)	$I = 0.2(8 - (-12))$ (towards the wall negative) Correct 4Ns <i>0.2(12 - 8) = 0.8 ignores the change of direction: M0.</i>	M1 A1 A1 (3)
(b)	$4 = F \times 0.05$ 80N	M1 A1 (2)
(c)	$4\text{Ns towards the wall}$ (Newton's third law)	B1 (1)
Total for Question 2: 6 marks		



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Question 3

6 marks

Part	Scheme	Marks
(a)	$3 \times 5 - 2 \times 2 = 3 \times 1 + 2v$ 4 ms^{-1} Direction reversed (now in the original direction of P) <i>Jan 2021 report: failing to account for the opposite initial directions.</i>	M1 A1 A1 (3)
(b)	$3(5 - 1)$ 12 N s	M1 A1 (2)
(c)	12 N s : equal and opposite to the impulse on P (or $2(4 - (-2)) = 12$)	B1 (1)
Total for Question 3: 6 marks		

Question 4

6 marks

Part	Scheme	Marks
(a)	The string is inextensible, so once taut A and B must move together $2 \times 6 = 5v$ 2.4 ms^{-1} <i>Oct 2019 report: not realising that the particles move with the same speed in the same direction.</i>	B1 M1 A1 (3)
(b)	3×2.4 7.2 N s	M1 A1 (2)
(c)	No friction, so the speed of A is still 6 ms^{-1} when the string becomes taut (no external impulse)	B1 (1)
Total for Question 4: 6 marks		



Question 5

6 marks

Part	Scheme	Marks
(a)	$-\lambda mu = 2m(-u) - 2m(3u)$ $\lambda mu = 8mu$ $\lambda = 8$	M1 A1 A1 (3)
(b)	$-4mu = 2mv - 6mu, v = u$ speed u , in the original direction	M1 A1 (2)
(c)	$2m(3u) - \lambda mu < 0: \lambda > 6$	B1 (1)
Total for Question 5: 6 marks		

Question 6

10 marks

Part	Scheme	Marks
(a)	Friction deceleration $0.25g = 2.45 \text{ ms}^{-2}$ $v^2 = 6^2 - 2 \times 2.45 \times 2$ 5.12 ms^{-1} <i>Jan 2025 report: the initial speed must be used in $v^2 = u^2 + 2as$.</i>	B1 M1 A1 (3)
(b)	$0.4 \times 5.119 = 0.4 \times 0.5 + 0.6v$ 3.08 ms^{-1}	M1 A1 (2)
(c)	0.6×3.079 (or $0.4(5.119 - 0.5)$) 1.85 N s	M1 A1 (2)
(d)	Both decelerate at 2.45 ms^{-2} : A travels $\frac{0.5^2}{4.9} = 0.051 \text{ m}$ B travels $\frac{3.079^2}{4.9} = 1.935 \text{ m}$ Distance apart = 1.88 m	M1 M1 A1 (3)
Total for Question 6: 10 marks		



Question 7

10 marks

Part	Scheme	Marks
(a)	$2m \times 4u = 2m \times u + mv$ $6u$	M1 A1 (2)
(b)	$2m(4u - u)$ $6mu$	M1 A1 (2)
(c)	$m \times 6u = m \times ku + 3mw$ $w = \frac{(6-k)u}{3}$	M1 A1 (2)
(d)	B does not catch C: $ku \leq \frac{(6-k)u}{3}$, so $k \leq \frac{3}{2}$ A does not catch B: $u \leq ku$, so $k \geq 1$ Both conditions, with the correct inequalities $1 \leq k \leq \frac{3}{2}$ <i>Equal speeds give no further collision (the particles stay a fixed distance apart), so the inequalities include equality.</i>	M1 M1 A1 A1 (4)
Total for Question 7: 10 marks		



Question 8

10 marks

Part	Scheme	Marks
(a)	$v^2 = 2 \times 9.8 \times 5$ 9.9 ms^{-1} ($7\sqrt{2}$)	M1 A1 (2)
(b)	$400 \times 9.9 = 500V$ 7.9 ms^{-1} (7.92)	M1 A1 (2)
(c)	100×7.92 792 N s (790)	M1 A1 (2)
(d)	$0 = 7.92^2 - 2a \times 0.2$, $a = 156.8$ (deceleration) Equation of motion for hammer and pile: $R - 500g = 500 \times 156.8$ Correct equation 83300 N ($8.33 \times 10^4 \text{ N}$) <i>Omitting the weight 500g is the common error; the resistance must stop the weight as well as the motion.</i>	M1 M1 A1 A1 (4)
Total for Question 8: 10 marks		



Question 9

10 marks

Part	Scheme	Marks
(a)	$3 \times 4 = 3 \times 2 + 1 \times v$ 6 ms^{-1}	M1 A1 (2)
(b)	$1(3 - (-6))$ 9 N s	M1 A1 (2)
(c)	<i>B</i> reaches the wall after 1.5 s, when <i>A</i> is 3 m from the first collision point (6 m from the wall) After that: $6 = 2t + 3t$, so $t = 1.2 \text{ s}$ Time between collisions $1.5 + 1.2 = 2.7 \text{ s}$ Distance from the wall $3 \times 1.2 = 3.6 \text{ m}$	M1 M1 A1 A1 (4)
(d)	$3 \times 2 + 1 \times (-3) = 4V$ 0.75 ms^{-1} towards the wall	M1 A1 (2)
Total for Question 9: 10 marks		



Question 10

11 marks

Part	Scheme	Marks
(a)	$2m(3u - (-u)) = 8mu$ It depends only on the mass and velocities of P , which are all known	B1 B1 (2)
(b)	$2m(3u) - km(u) = 2m(-u) + kmv$ Correct equation $v = \frac{(8-k)u}{k}$ Or: the impulse on Q is $8mu$ in the positive direction, so $km(v+u) = 8mu$.	M1 A1 A1 (3)
(c)	Reversed means $v > 0$: $8 - k > 0$ $0 < k < 8$	M1 A1 (2)
(d)	$\frac{8-k}{k} = 3$ $k = 2$	M1 A1 (2)
(e)	Deceleration $0.5g$; $0 = (3u)^2 - 2(0.5g)s$ $\frac{9u^2}{g}$	M1 A1 (2)
Total for Question 10: 11 marks		

