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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	3	
6 Momentum and Impulse Conservation of momentum, impulse	10	81	own PDF	
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.



5

Chapter 5: Forces and Friction

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

Question 1

6 marks

Part	Scheme	Marks
(a)	Resolving vertically: $R + P \sin 30^\circ = 20g$ $R = 196 - 0.5P$ <i>Jan 2021 report: adding the vertical component of the pull to the weight is M0.</i>	M1 A1 (2)
(b)	Horizontally: $P \cos 30^\circ - F = 20 \times 0.5$ $F = 0.4R = 0.4(196 - 0.5P)$ $P \cos 30^\circ - 78.4 + 0.2P = 10$ $P = 82.9$ (83)	M1 M1 A1 A1 (4)
Total for Question 1: 6 marks		

Question 2

6 marks

Part	Scheme	Marks
(a)	Parallel to the plane: $P \cos 20^\circ - 2g \sin 20^\circ = 2 \times 1.5$ Correct equation $P = 10.3$	M1 A1 A1 (3)
(b)	Perpendicular: $R = 2g \cos 20^\circ + P \sin 20^\circ$ Correct with their P 21.9 N (22) <i>The horizontal force has a component into the plane, so $R \neq mg \cos 20^\circ$.</i>	M1 A1 A1 (3)
Total for Question 2: 6 marks		



Question 3

6 marks

Part	Scheme	Marks
(a)	$0 = 8^2 - 2a \times 10$ 3.2 ms^{-2}	M1 A1 (2)
(b)	$\mu mg = m \times 3.2$ $\mu = 0.33$ (0.327)	M1 A1 (2)
(c)	$\frac{8}{3.2} = 2.5 \text{ s}$	B1 (1)
(d)	Friction μmg and ma are both proportional to m , so m cancels	B1 (1)
Total for Question 3: 6 marks		

Question 4

6 marks

Part	Scheme	Marks
(a)	$R = 15g + 60 \sin 25^\circ$ 172 N (172.4)	M1 A1 (2)
(b)	Constant speed: $F = 60 \cos 25^\circ$ and $F = \mu R$ $\mu = 0.32$ (0.315)	M1 A1 (2)
(c)	$R = 15g$ now: $60 - \mu \times 15g = 15a$ 0.91 ms^{-2} (0.908)	M1 A1 (2)
Total for Question 4: 6 marks		



Question 5

6 marks

Part	Scheme	Marks
(a)	$R = mg \cos \alpha = \frac{12}{13}mg$ and the greatest friction is $0.3 \times \frac{12}{13}mg = 0.277mg$ Component of weight down the plane $mg \sin \alpha = \frac{5}{13}mg = 0.385mg$ $0.385mg > 0.277mg$, so friction cannot hold it: it slides * <i>Jan 2025 report: a comparison with a conclusion is needed; friction cannot move a particle up the plane.</i>	M1 A1 A1* (3)
(b)	$mg \sin \alpha - 0.3mg \cos \alpha = ma$ 1.06 ms^{-2} (1.055)	M1 A1 (2)
(c)	$\mu = \tan \alpha = \frac{5}{12}$	B1 (1)
Total for Question 5: 6 marks		



Question 6

12 marks

Part	Scheme	Marks
(a)	Perpendicular: $R + 30 \sin 20^\circ = 3g \cos 25^\circ$ $R = 16.38$ Parallel: $30 \cos 20^\circ - 3g \sin 25^\circ - 0.4R = 3a$ Correct equation 3.07 ms^{-2} <i>Jan 2023 Q8 was worth 8 marks on this structure. $R = 3g \cos 25^\circ$ (ignoring the pull) loses the first A mark and the final A mark.</i>	M1 A1 M1 A1 A1 (5)
(b)	$v^2 = 2^2 + 2 \times 3.07 \times 5$ 5.89 ms^{-1}	M1 A1 (2)
(c)	Force removed: $R = 3g \cos 25^\circ$, friction $0.4R$ now acts down the plane with the weight component Deceleration $g \sin 25^\circ + 0.4g \cos 25^\circ = 7.69$ $BC = \frac{5.89^2}{2 \times 7.69} = 2.26 \text{ m}$ (2.3)	M1 A1 A1 (3)
(d)	Compares $3g \sin 25^\circ = 12.4$ with the greatest friction $0.4 \times 3g \cos 25^\circ = 10.7$ (or $\tan 25^\circ = 0.466 > 0.4$) Weight component is larger, so the parcel does not remain at rest : it slides down	M1 A1 (2)
Total for Question 6: 12 marks		



Question 7

11 marks

Part	Scheme	Marks
(a)	$R = 4g \cos \alpha = 3.2g$ and $F = 0.25R$ $0.8g = 7.84 \text{ N}$	M1 A1 (2)
(b)	$A: T - 4g \sin \alpha - 0.8g = 4a$ $B: 5g - T = 5a$ Adding: $5g - 2.4g - 0.8g = 9a$, so $a = 0.2g$ * $T = 5(g - 0.2g) = 4g = 39.2 \text{ N}$	M1 M1 A1* A1 (4)
(c)	Angle between the two parts of the string $= 90^\circ - \alpha = 53.1^\circ$; force $= 2T \cos 26.6^\circ$ 70.1 N <i>Jan 2022 report: the angle between the string on the plane and the vertical string causes difficulty. The cosine rule on a triangle with sides T, T is equally valid.</i>	M1 A1 (2)
(d)	Speed when B lands: $v^2 = 2 \times 0.2g \times 1 = 3.92$ A now decelerates at $g \sin \alpha + 0.25g \cos \alpha = 0.8g$ $s = \frac{3.92}{2 \times 7.84} = 0.25 \text{ m}$	M1 M1 A1 (3)
Total for Question 7: 11 marks		



Question 8

11 marks

Part	Scheme	Marks
(a)	$A: T - 0.3 \times 2g = 2a; B: 3g - T = 3a$ Both correct ($R = 2g$ for A) $a = 4.7 \text{ ms}^{-2}$ (4.704) $T = 15 \text{ N}$ (15.3)	M1 A1 A1 A1 (4)
(b)	$v^2 = 2 \times 4.704 \times 1$ 3.07 ms^{-1}	M1 A1 (2)
(c)	After B lands the string is slack; friction alone decelerates A: $0.3 \times 2g = 2a, a = 2.94$ $0 = 9.408 - 2 \times 2.94s$ $s = 1.6 \text{ m}$ A travels $1 + 1.6 = 2.6 \text{ m} < 3 \text{ m}$, so it does not reach the pulley * <i>Jan 2021 report: the final inequality (the correct way round) with a conclusion is needed; using the old acceleration after B lands is M0.</i>	M1 M1 A1 A1* (4)
(d)	e.g. friction at the pulley; the mass of the string; the size of A (not a particle); the string stretching	B1 (1)
Total for Question 8: 11 marks		



Question 9

10 marks

Part	Scheme	Marks
(a)	Whole system: $2500 - 400 - 150 - 1300g \sin \alpha = 1300a$ $1300a = 1313$ 1.01 ms^{-2} <i>Oct 2019 report: omitting the weight components is M0 even if it happens to give a correct later value.</i>	M1 A1 A1 (3)
(b)	Trailer: $T - 150 - 300g \sin \alpha = 300 \times 1.01$ Correct equation 600 N	M1 A1 A1 (3)
(c)	Trailer: $150 + 300g \times \frac{1}{20} = 300d, d = 0.99 \text{ ms}^{-2}$ $0 = 20^2 - 2 \times 0.99 \times s$ 202 m (200)	M1 M1 A1 (3)
(d)	e.g. resistances such as air resistance increase with speed, so they are unlikely to be constant	B1 (1)
Total for Question 9: 10 marks		



Question 10

12 marks

Part	Scheme	Marks
(a)	$\sin \alpha = \frac{3}{5}, \cos \alpha = \frac{4}{5}; R = \frac{4}{5}mg$ Up the plane: $-mg \sin \alpha - 0.5R = ma$ $-\frac{3}{5}mg - \frac{2}{5}mg = ma$ Deceleration $g \text{ ms}^{-2}$ *	B1 M1 A1 A1* (4)
(b)	$\frac{14^2}{2g} = \boxed{10 \text{ m}}$	B1 (1)
(c)	Compares $mg \sin \alpha = 0.6mg$ with the greatest friction $0.5 \times 0.8mg = 0.4mg$ (or $\tan \alpha = 0.75 > 0.5$) $0.6mg > 0.4mg$, so P slides down *	M1 A1* (2)
(d)	Down the plane, friction now acts up: $mg \sin \alpha - 0.4mg = ma$ $a = 0.2g = 1.96$ $v^2 = 2 \times 1.96 \times 10$: $\boxed{6.26 \text{ ms}^{-1}}$	M1 A1 A1 (3)
(e)	Straight line from 14 down to 0 at $t = \frac{10}{7} \approx 1.43$, then a less steep straight line to -6.26 at $t \approx 1.43 + 3.19 = 4.62$ Values marked; the second line is less steep and continues below the axis with no vertical jump	B1 B1 (2)
Total for Question 10: 12 marks		

