

CAMBRIDGE INTERNATIONAL AS & A LEVEL

MATHEMATICS
9709/42

Paper 4 Mechanics

October/November 2025

MARK SCHEME

Mark Scheme Notes:

- **M1:** Method mark, awarded for a valid method applied to the problem.
- **A1:** Accuracy mark, awarded for a correct answer or intermediate step following a correct method.
- **B1:** Independent mark, awarded for a correct result or statement without needing a method.

Q	Answer	Marks	Guidance
1(a)	Uses Newton's Second Law: $F - 600 = 1400 \times 0.25$ $\Rightarrow F = 350 + 600 = 950 \text{ N}$ Power $P = Fv = 950 \times 20 = 19000 \text{ W}$ (or 19 kW)	M1	Correct unsimplified equation.
		A1	Correct final answer.
		[2]	
1(b)	Weight component down the hill = $1400 \times 10 \times 0.05 = 700 \text{ N}$ Equates driving force to total resistance: $\frac{25000}{v} = 600 + 700$ $v = \frac{25000}{1300} = 19.2 \text{ m s}^{-1}$	B1	May be seen in equation.
		M1	Must include both R and weight component.
		A1	Accept $\frac{250}{13}$ or AWRT 19.2.
		[3]	
2(a)	Uses conservation of momentum: $m(u) + 2(-2u) = m(-0.5u) + 2v$ $1.5mu - 4u = 2v \Rightarrow v = (0.75m - 2)u$	M1	Correct signs reflecting opposite directions.
		A1	Accept equivalent forms e.g. $\frac{3m-8}{4}u$.
		[2]	
2(b)	Sets up kinetic energy inequality: $\frac{1}{2}(2)(v^2) < \frac{1}{2}(2)(2u)^2 \Rightarrow v^2 < 4u^2$ Since direction reversed, $v > 0$: $0 < (0.75m - 2)u < 2u$	M1	Correct unsimplified inequality.
		M1	Recognises $v > 0$ boundary for reversal.

Q	Answer	Marks	Guidance
	$0 < 0.75m - 2 < 2 \Rightarrow 2 < 0.75m < 4$ $\Rightarrow \frac{8}{3} < m < \frac{16}{3}$	A1 [3]	Correct exact boundaries.
3	Uses $v = u + at$ for P to max height: $0 = 25 - 10t \Rightarrow t = 2.5$ s Distance P travels: $s_P = 25(2.5) - 0.5(10)(2.5)^2 = 31.25$ m OR Q travels: $s_Q = 0.5(10)(2.5)^2 = 31.25$ m $H = s_P + s_Q = 31.25 + 31.25$ $H = 62.5$ m	M1 A1 M1 M1 A1 [5]	Correct method for time. Correct time. Correct method for either displacement. Sums displacements. (Or uses relative velocity $H = 25 \times 2.5$). Exact correct value.
4	Recognises triangle APB is right-angled ($0.9^2 + 1.2^2 = 1.5^2$). Let $\angle BAP = \theta$ and $\angle ABP = \phi$. $\sin \theta = 0.8$, $\cos \theta = 0.6$, and $\sin \phi = 0.6$, $\cos \phi = 0.8$. Resolves vertically: $T_A \sin \theta + T_B \sin \phi = 1.5 \times 10$ $0.8T_A + 0.6T_B = 15$ Uses $T_A = 2T_B$: $1.6T_B + 0.6T_B = 15 \Rightarrow 2.2T_B = 15$ $T_B = \frac{75}{11}$ N and $T_A = \frac{150}{11}$ N Resolves horizontally: $F + T_B \cos \phi = T_A \cos \theta$ $F = \frac{150}{11}(0.6) - \frac{75}{11}(0.8) = \frac{90}{11} - \frac{60}{11} = \frac{30}{11}$ $F = 2.73$ N (to 3 s.f.)	M1 M1 A1 M1 A1 A1 [6]	Finds correct angles/trig ratios with horizontal. Resolves vertically. Obtains correct exact values for tensions. Resolving equation with F . Correct equation structure. Accept 2.73 or $\frac{30}{11}$.
5(a)	Differentiates to find v : $v = 0.3t^2 - 2.4t + 4.5$ Sets $v = 0$: $t^2 - 8t + 15 = 0 \Rightarrow (t - 3)(t - 5) = 0$ $t = 3$ s and $t = 5$ s $a = \frac{dv}{dt} = 0.6t - 2.4$ At $t = 3$, $a = -0.6$ m s ⁻² . At $t = 5$, $a = 0.6$ m s ⁻² .	M1 A1 M1 A1	Attempt at differentiation. Correct times. Attempt at second derivative. Both accelerations correct.

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		[4]	
5(b)	Evaluates s at critical points: $s(0) = 0$ $s(3) = 0.1(27) - 1.2(9) + 4.5(3) = 5.4 \text{ m}$ $s(5) = 0.1(125) - 1.2(25) + 4.5(5) = 5.0 \text{ m}$ Total distance = $ s(3) - s(0) + s(5) - s(3) $ $= 5.4 + 5.0 - 5.4 $ $= 5.4 + 0.4 = 5.8 \text{ m}$	M1 A1 M1 A1 [4]	Substitutes $t = 3$ and $t = 5$. Both displacements correct. Sums absolute changes in intervals. Correct total distance.
6(a)	Work-Energy from A to B : $\frac{1}{2}(0.4)v_B^2 = 0.4 \times 10 \times 2.0 - 4.8$ $0.2v_B^2 = 8 - 4.8 = 3.2 \Rightarrow v_B = 4 \text{ m s}^{-1}$ Free fall B to C : $v_C^2 = v_B^2 + 2g(1.0) = 16 + 20 = 36$ $v_C = 6 \text{ m s}^{-1}$	M1 A1 M1 A1 [4]	Uses work-energy principle correctly. Correct speed at B . Conserves energy or uses SUVAT.
6(b)	Time B to C : $v_C = v_B + gt \Rightarrow 6 = 4 + 10t \Rightarrow t = 0.2 \text{ s}$ Time C to D is 0.2 s . Uses SUVAT: $s = \frac{u+v}{2}t \Rightarrow s = \frac{6+0}{2}(0.2)$ Distance $CD = 0.6 \text{ m}$	M1 M1 A1 [3]	Correct method for time. Applies SUVAT in liquid with $v = 0$.
6(c)	Loss in KE + Loss in PE = Work done by R $\frac{1}{2}(0.4)(6^2) + 0.4 \times 10 \times 0.6 = R \times 0.6$ $7.2 + 2.4 = 0.6R \Rightarrow 9.6 = 0.6R \Rightarrow R = 16$	M1 A1 A1 [3]	Sets up work-energy equation. Correct substitution.
7(a)	Frictional force $F_{max} = \mu mg \cos 30^\circ = \frac{\sqrt{3}}{6} \times 100 \times \frac{\sqrt{3}}{2} = 25 \text{ N}$ Equations of motion: For A : $120 - T_A = 12a$ For B : $T_B - 20 = 2a$ For P : $T_A - T_B - 50 - 25 = 10a$	B1 M1 A1	Evaluates limiting friction. Valid Newton's 2nd law for components or system. Fully correct equations.

Q	Answer	Marks	Guidance
	Adding gives: $120 - 20 - 75 = 24a \Rightarrow 25 = 24a \Rightarrow a = \frac{25}{24}$ $a \approx 1.04 \text{ m s}^{-2}$ $T_A = 120 - 12(25/24) = 120 - 12.5 = 107.5 \text{ N}$	A1 A1 [5]	Correct acceleration. Correct tension.
7(b)	For equilibrium, $T_A = 10m$ and $T_B = 20$. Equates forces on P along plane without friction: Net force (ignoring friction) = $10m - 20 - 50 = 10m - 70$ Limits of friction: $-25 \leq 10m - 70 \leq 25$ Upper bound (impending motion UP): $10m = 70 + 25 = 95 \Rightarrow m = 9.5$ Lower bound (impending motion DOWN): $10m = 70 - 25 = 45 \Rightarrow m = 4.5$ Final range: $4.5 \leq m \leq 9.5$	B1 M1 M1 A1 A1 A1 [6]	Sets up limiting bounds using F_{max} . Correct fully bounded set.