1	c of m of arc = 20sin(π/2)/(π/2) (2 + 0.9) $\bar{x}$ = 2×20sin(π/2)/(π/2) Distance is 8.78cm	B1 M1 A1 A1 [4]	 For attempting to take moments about the diameter
2	**(i)** tan35° = r/7.5 r = 5.25	M1 A1ft A1 [3]	For using the idea that the c.m. is vertically above the lowest point of contact ft using their c of m from the base
	(ii) [μmgcos35° > mgsin35°] μ > tan35° → Coefficient is greater than 0.7	M1 A1 [2]	For using 'no sliding → μR > weight component' Do not allow $\mu \geqslant 0.7$ AG
3	**(i)** mg = Tcosθ ma = Tsinθ tanθ = a/g = 0.75 T = 0.24 × 10/cosθ = 3	B1 B1 B1 B1 [4]	SR B1 not B2 for tanθ = v^2/gr or a/g used AG For using Tcosθ = mg to find T
	(ii) [v^2 = 7.5 × 2sinθ] Speed is 3ms^{-1}	M1 A1 [2]	For using v^2 = ar to find v
4	Weight split is 9N:6N For lamina 9 × 0.75 + 6 × 0.5 = T × 1.5sin30° Tension is 13N **Alternatively** [(1.5^2+$\frac{1}{2}$ 1.5×2) $\bar{x}$ = 1.5^2×0.75+$\frac{1}{2}$ 1.5×2×0.5] $\bar{x}$ = 0.65 15 × 0.65 = T × 1.5sin30° Tension is 13N	B1 M1 A1ft A1 A1 [5] M1 A1 M1 A1ft A1 [5]	 For taking moments about A For using A$\bar{x}$ = $A_1x_1 + A_2x_2$ For taking moments about A

5	(i)	$7 = 16\tan\theta - 10\times16^2/(2\times20^2)\cos^2\theta$ $[7 = 16T - 3.2(1 + T^2)]$ $3.2T^2 - 16T + 10.2 = 0$ T = ¾, 17/4	B1 M1 A1 A1 [4]	 For using $\cos\theta = 1/\sec\theta$ and the given identity to obtain a quadratic in T($\tan\theta$) AEF AG
	(ii)	$[x = \tan\theta\cos^2\theta/0.0125$ or $x = 20^2\sin2\theta/g]$ For $\tan\theta = 0.75$, distance is 38.4 m For $\tan\theta = 4.25$, distance is 17.8 m	M1 A1 A1 [3]	For solving $y = 0$ for x or for using $R = V^2\sin2\theta/g$
	(iii)	For sketching two parabolic arcs which intersect once, both starting at the origin, each with y ⩾ 0 throughout, and each returning to the x-axis, the arc for which the angle of projection is smaller having the greater range. The ranges appear significantly greater than x at the intersection, and slightly greater, respectively.	B1 B1 [2]	
6	(i)	$[0.35g = 2T\{0.7/(2.4^2 + 0.7^2)^{1/2}\}]$ Tension is 6.25N $[6.25 = \lambda \times ¼]$ Modulus is 25N	M1 A1 M1 A1 [4]	For resolving forces on P vertically For using $T = \lambda x/L$ AG
	(ii)	 EE on release = $25\times2^2/(2\times4)$ EE when P is at M = $25\times0.8^2/(2\times4)$ $25\times2^2/(2\times4) = 0.35g\times1.8 + 25\times0.8^2/(2\times4) + \frac{1}{2}0.35v^2$ Speed is 4.90ms^{-1}	M1 A1 A1 M1 A1 A1 [6]	For using $EE = \lambda x^2/2L$ For using EE on release = mgh + EE when P is at M + $\frac{1}{2}mv^2$
7	(i)	$[0.25v(dv/dx) = -(5 - x)]$ $[\int v\,dv = 4\int(x - 5)dx]$ $v^2/2 = 4(x - 5)^2/2\ (+ A)$ $v^2 = 4(x - 5)^2$ Selects correct square root to obtain $v = 10 - 2x$	B1 M1 A1 M1 A1 A1 [6]	For using Newton's second law and a = v(dv/dx) For separating variables and attempting to integrate For using v(0) = 10 Any correct expression in x AG
	(ii)	$[\int\frac{dx}{10 - 2x} = \int dt]$ $-\frac{1}{2}\ln(10 - 2x) = t(-\frac{1}{2}\ln B)$ B = 10 (or equivalent) $x = 5(1 - e^{-2t})$ $0 < e^{-2t} < 1$ for all t $\to x < 5$ for all t	M1 A1 A1 B1ft B1 [5]	For using v = dx/dt and separating variables ft $x = (B/2)(1 - e^{-2t})$ AG