

4728 Mechanics 1

1 i	$x^2 + (3x)^2 = 6^2$ $10x^2 = 36$ $x = 1.9(0) \quad (1.8973..)$	M1 A1 A1 [3]	Using Pythagoras, 2 squared terms May be implied Not surd form unless rationalised $(3\sqrt{10})/5$, $(6\sqrt{10})/10$
ii	$\tan\theta = 3x/x (= 3 \times 1.9/1.9) = 3$ $\theta = 71.6^\circ \quad (71.565..)$	M1 A2 [3]	Must target correct angle. Accept $\sin\theta = 3 \times 1.9/6$ or $\cos\theta = 1.9/6$ which give $\theta=71.8^\circ$, $\theta=71.5^\circ$ respectively, A1. SR $\theta = 71.6^\circ$ from $\tan\theta = 3x/x$ if x is incorrect; x used A1, no evidence of x used A2
2 i		B1 B1 [2]	Inverted V shape with straight lines. Starts at origin, ends on t -axis, or horizontal axis if no labelling evident
ii	$6 = 3v/2$ $v = 4 \text{ ms}^{-1}$	M1 A1 A1 [3]	Not awarded if special (right angled, isosceles) triangle assumed, or $s = (u+v)t/2$, or max v at specific t .
iii	T accn = $4/2.4$ or s accn = $16/(2 \times 2.4)$ T accn = $1 \frac{2}{3}$ s or s accn = $10/3$ Deceleration = $4/(3 - 1 \frac{2}{3})$ or $16/2(6-10/3)$ Deceleration = 3 ms^{-2}	M1* A1 D*M1 A1 [4]	Uses $t = v/a$ or $s = v^2/2a$. May be implied Accept $4/(3 - 1.67)$ or $16/2(6-3.33)$ Accept 3.01; award however $v = 4$ obtained in (ii). $a = -3$ gets A0.
3 i	$0.8g\sin 30$ 0.8×0.2 $0.8 \times 9.8\sin 30 - T = 0.8 \times 0.2$ $T = 3.76 \text{ N}$	B1 B1 M1 A1 [4]	Not for 3.92 stated without justification Or 0.16 Uses N2L // to slope, 3 non-zero terms, inc ma Not awarded if initial B1 withheld.
ii	$3.76 - F = 3 \times 0.2$ $F = 3.16$ $3.16 = \mu \times 3 \times 9.8$ $\mu = 0.107 \quad (0.10748)$	M1 A1 A1 M1 A1 [5]	Uses N2L, B alone, 3 non-zero terms Needs <i>correct value</i> of T . May be implied. Uses $F = \mu R$ (Accept with $R = 3$, but not with $R = 0.8g(\cos 30)$, $F = 0.6$, $F = 3.76$, $F = f(\text{mass } P)$) Not 0.11, 0.108 (unless it comes from using $g = 9.81$ consistently through question.

4 i	$v^2 = 7^2 - 2 \times 9.8 \times 2.1$ $v = 2.8 \text{ ms}^{-1}$	M1 A1 A1 [3]	Uses $v^2 = u^2 - 2gs$. Accept $7^2 = u^2 + 2gs$
ii	$v = 0$ $0^2 = 7^2 - 2 \times 9.8s$ $s = 2.5 \text{ m}$	B1 M1 A1 [3]	Velocity = 0 at greatest height Uses $0 = u^2 - 2gs$. Accept $7^2 = 2 \times 9.8s$.
iii	$v = -5.7$ (or $t = 0.71$ oef to reach greatest height) $-5.7 = 7 - 9.8t$ or $5.7 = (0+) 9.8T$ $t = 1.3(0) \text{ s}$ (1.2959..)	B1 M1 A1 [3]	Allows for change of direction Uses $v = u$ or $-gt$. Not 1.29 unless obtained from $g=9.81$ consistently
5 i	$0.5 \times 6 = 0.5v + m(v+1)$ $3 = 0.5v + mv + m$ $v(m + 0.5) = -m + 3$	M1 A1 A1 [3] AG	Uses CoLM. Includes g throughout MR-1
ii	Momentum before = +/- $(4m - 0.5 \times 2)$ +/- $(4m - 0.5 \times 2) = mv + 0.5(v+1)$ $4m - 0.5 \times 2 = mv + 0.5(v+1)$ $v(m+0.5) = 4m - 1.5$	B1 M1 A1 A1 [4]	Includes g throughout MR-1 Needs opposite directions in CoLM on "before" side only. RHS in format $am + b$ or $b + am$. Ignore values for a and b if quoted.
iii	$4m - 1.5 = -m + 3$ $5m = 4.5$ $m = 0.9 \text{ kg}$ $0.9 + v(0.9+0.5) = 3$ or $4 \times 0.9 - 1.5 = v(0.9+0.5)$ $v = (3-0.9)/(0.9+0.5) = 2.1/1.4$ $v = 1.5 \text{ ms}^{-1}$	M1 A1 M1 A1 [4] AG	Attempts to obtain eqn in 1 variable from answers in (i) and (ii) Ignore $m = -0.5$ if seen Substitutes for $m=0.9$ in any m, v equation obtained earlier.
6 ia	Perp = $10\cos 20$ (= 9.3967 or 9.4) // = $10\sin 20$ (= 3.4202)	B1 B1 [2]	Includes g , MR -1 in part (i). Accept $-ve$ values.
b	$\mu = 10\sin 20 / 10\cos 20 = \tan 20$ (= 3.42/9.4) $\mu = 0.364$ (0.36397..)	M1 A1 [2] AG	Must use $ F = \mu R $ Accept after inclusion of g twice
ii	No misread, and resolving of 10 and T required $R = 10\cos 20 + T\cos 45$ $F = T\cos 45 - 10\sin 20$ or $T\cos 45 = \mu R + 10\sin 20$ $T\cos 45 - 3.42 = 0.364(9.4 + T\cos 45)$ $0.707T - 3.42 = 3.42 + 0.257T$ $0.45T = 6.84$ $T = 15.2 \text{ N}$ (15.209..)	M1* A1 M1* A1 D*M1 A1 A1 [7]	3 term equation perp plane, 2 unknowns $9.4 + 0.707T$ (accept $9.4 + .71T$) 3 term equation // plane, 2 unknowns $0.707T - 3.42$ (accept $0.71T - 3.4$) Substitutes for F and R in $F=0.364R$ Award final A1 only for $T = 149 \text{ N}$ after using $10g$ for weight

7 i	$a = dv/dt$ $a = 6 - 2t \text{ ms}^{-2}$	M1 A1 [2]	Differentiation attempt. Answer $6-t$ implies division by t
ii	$s = \int v dt$ $s = \int 6t - t^2 dt$ $s = 3t^2 - t^3/3 (+c)$ $t = 0, v = 0, c = 0$ $t = 3, s = 3 \times 3^2 - 3^3/3$ $s = 18 \text{ m}$	M1* A1 B1 D*M1 A1 [5]	Integration attempt on v Award if limits 0,3 used Requires earlier integration Does not require B1 to be earned.
iii	Distance remaining $(= 100 - 18) = 82$ Total time $= 3 + 82/9$ $T = 12.1 \text{ s}$ (12 1/9)	B1 M1 A1 [3]	Numerator not 100 Not 109/9
iv	Distance before slows $= 18 + (22 - 3) \times 9$ Distance while decelerating $= 200 - 189 = 11$ $11 = 9t - 0.3t^2$ or $11 = (9+8.23)t/2$ or $8.23 = 9 - 0.6t$ $t = 1.28$ (1.2765..., accept 1.3) $T = 23.3 \text{ s}$ (23.276..)	M1* A1 D*M1 A1 D*M1 A1 A1 [7]	(=189 m) Two sub-regions considered Accept 10.99. 10.9 penalise -1PA. Uses $s = ut - 0.5 \times 0.6t^2$, or $v^2 = u^2 - 2 \times 0.6s$ with $s = (u+v)t/2$ or $v = u + at$ Finds t . (If QE, it must have 3 terms and smaller positive root chosen.)