

4729 Mechanics 2

1 (i)	$\frac{1}{2} \times 75 \times 12^2$ or $\frac{1}{2} \times 75 \times 3^2$ (either KE) $75 \times 9.8 \times 40$ (PE) $R \times 180$ (change in energy = 24337) $\frac{1}{2} \times 75 \times 12^2 = \frac{1}{2} \times 75 \times 3^2 + 75 \times 9.8 \times 40 - R \times 180$ $R = 135 \text{ N}$	B1 B1 B1 M1 A1 5	$M1 \quad 12^2 = 3^2 + 2a \times 180$ $A1 \quad a = 0.375 \quad (3/8)$ $M1 \quad 75 \times 9.8 \times \sin\theta - R = 75a$ $A1 \quad R = 135$ (max 4 for no energy)	5
2 (i)	$R = F = P/v = 44\,000/v = 1400$ $v = 31.4 \text{ m s}^{-1}$	M1 A1 2		
(ii)	$44\,000/v = 1400 + 1100 \times 9.8 \times 0.05$ $v = 22.7 \text{ m s}^{-1}$	M1 A1 A1 3	must have g	
(iii)	$22\,000/10 + 1100 \times 9.8 \times 0.05 - 1400$ $= 1100a$ $a = 1.22 \text{ m s}^{-2}$	M1 A1 A1 3		8
3 (i)	$\cos\theta = 5/13$ or $\sin\theta = 12/13$ or $\theta = 67.4^\circ$ $0.5 \times F \sin\theta = 70 \times 1.4 + 50 \times 2.8$ $F = 516 \text{ N}$	B1 M1 A1 A1 4	any one of these moments about A (ok without 70) $0.5 \sin\theta = 0.4615$ SR 1 for 303 (omission of beam)	
(ii)	$F \sin\theta = 120 + Y$ (resolving vertically) $Y = 356$ ✓ their $F \times 12/13 - 120$ $X = F \cos\theta$ (resolving horizontally) $X = 198$ ✓ their $F \times 5/13$ Force = $\sqrt{(356^2 + 198^2)}$ 407 or 408 N	M1 A1 ✓ M1 A1 ✓ M1 A1 6	M1/A1 for moments (B) $Y \times 2.8 + 1.4 \times 70 = 2.3 \times 516 \times 12/13$ (C) $0.5 \times Y = 0.9 \times 70 + 2.3 \times 50$ (D) $1.2X = 1.4 \times 70 + 2.8 \times 50$	10
4 (i)	$T = 0.4 \times 0.6 \times 2^2$ $T = 0.96 \text{ N}$	M1 A1 2		
(ii)	$S - T$ $S - T = 0.1 \times 0.3 \times 2^2$ $S = 1.08$	B1 M1 A1 A1 4	may be implied	
(iii)	$v = r\omega$ $v_P = 0.6$ $v_B = 1.2$ $\frac{1}{2} \times 0.1 \times 0.6^2 + \frac{1}{2} \times 0.4 \times 1.2^2$ 0.306	M1 A1 A1 M1 A1 5	(0.018 + 0.288) separate speeds	11

5 (i)	$\bar{d} = (2 \times 6 \sin \pi/4) / 3\pi/4$ $\bar{d} = 3.60$	M1 A1 2	must be correct formula with rads AG
(ii)	$\bar{d} \cos 45^\circ = "2.55"$ $5 \bar{x} = 3 \times 3 + 2 \times "2.55"$ $\bar{x} = 2.82$ $5 \bar{y} = 3 \times 6 + 2 \times (12 + "2.55")$ $\bar{y} = 9.42$	B1 M1 A1 A1 M1 A1 A1 7	may be implied moments must not have areas 2kg/3kg misread (swap) gives (2.73, 11.13) $\theta = 21.7^\circ$ (MR - 2) (max 7 for (ii) + (iii)) SR -1 for \bar{x} , \bar{y} swap
(iii)	$\tan \theta = 2.82/8.58$ $\theta = 18.2^\circ$ ✓	M1 A1 2	M0 for their \bar{x} / \bar{y} ✓ their $\bar{x} / (18 - \bar{y})$ 11

6 (i)	$I = 0.9 = 6 \times 0.2 - v \times 0.2$ $v = 1.5$	M1 A1 A1 3	needs to be mass 0.2
(ii)	$0.6 = (c - b) / 6$ $6 \times 0.2 = 0.2b + 0.1c$ $b = 2.8$ $0.4 \times 5 + 0.2 \times 1.5 = 0.4a + 0.2 \times 6$ or $I = 0.9 = -0.4a - 0.4 \times 5$ $a = 2.75$ $2.75 < 2.8$ no further collision	M1 A1 M1 A1 A1 M1 A1 M1 A1 10	restitution (allow 1.5 for M1) momentum (allow 1.5 for M1) 1st collision (needs their 1.5 for M1) compare v's of A and B (calculated) 13

7(i)	$9 = 17 \cos 25^\circ \times t$ $t = 0.584$ (or $9/17 \cos 25^\circ$) $d = 17 \sin 25^\circ \times 0.584 + \frac{1}{2} \times 9.8 \times 0.584^2$ (d = ht lost (5.87)) $h = 2.13$	M1 A1 M1 A1 A1 5	B1 $y = x \tan \theta - 4.9x^2/v^2 \cos^2 \theta$ M1/A1 $y = 9 \tan(-25^\circ) - 4.9 \times 9^2 / 17^2 \cos^2 25^\circ$ A1 $y = -5.87$ 2.13
(ii)	$v_h = 17 \cos 25^\circ$ (15.4) $v_v = 17 \sin 25^\circ + 9.8 \times 0.584$ or $v_v^2 = (17 \sin 25^\circ)^2 + 2 \times 9.8 \times 5.87$ $v_v = 12.9$ $\tan \theta = 12.9/15.4$ $\theta = 40.0^\circ$ below horizontal	B1 M1 A1 M1 A1 5	M1/A1 $dy/dx = \tan \theta - 9.8x/v^2 \cos^2 \theta$ A1 $dy/dx = -0.838$ M1 $\tan^{-1}(-0.838)$ or 50.0° to vertical
(iii)	speed = $\sqrt{(12.9^2 + 15.4^2)}$ $\frac{1}{2} m v^2 = \frac{1}{2} m \times 20.1^2 \times 0.7$ $v = 16.8 \text{ m s}^{-1}$	M1 A1 ✓ M1 A1 4	(20.1) NB 0.3 instead of 0.7 gives 11.0 (M0) 14