4729 Mechanics 2

1 (i)	½×75×12² or ½×75×3² (either KE) 75×9.8×40 (PE) R×180 (change in energy = 24337) ½×75×12²=½×75×3²+75×9.8×40–R×180 R = 135 N	B1 B1 B1 M1 A1 **5**	M1 $12^2 = 3^2 + 2a \times 180$ A1 $a = 0.375$ (3/8) M1 $75 \times 9.8 \times \sin\theta - R = 75a$ A1 $R = 135$ (max 4 for no energy) **5**

2 (i)	$R = F = P/v = 44\,000/v = 1400$ v = 31.4 m s^{-1}	M1 A1 **2**	
(ii)	$44\,000/v = 1400 + 1100 \times 9.8 \times 0.05$ v = 22.7 m s^{-1}	M1 A1 A1 **3**	must have g
(iii)	22 000/10 + 1100×9.8×0.05 – 1400 = 1100a a = 1.22 m s^{-2}	M1 A1 A1 **3**	**8**

3 (i)	$\cos\theta = 5/13$ or $\sin\theta = 12/13$ or $\theta = 67.4°$ 0.5×$F\sin\theta$ = 70×1.4 + 50 × 2.8 F = 516 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 × 12/13 – 120 $X = F\cos\theta$ (resolving horizontally) X = 198 ✓ their F × 5/13 Force = √(356² + 198²) 407 or 408 N	M1 A1 ✓ M1 A1 ✓ M1 A1 **6**	M1/A1 for moments (B)Y×2.8+1.4×70=2.3×516✓×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 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 ½×0.1×0.6² + ½×0.4×1.2² 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)	$\bar{d}\cos 45° =$ "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) $\theta = 21.7°$ (MR – 2) (max 7 for (ii) + (iii)) SR -1 for $\bar{x}$, $\bar{y}$ swap
(iii)	$\tan\theta = 2.82/8.58$ $\theta = 18.2°$ ✓	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 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)	$9 = 17\cos 25°\times t$ $t = 0.584$ (or $9/17\cos 25°$) $d = 17\sin 25°\times 0.584 + \frac{1}{2}\times 9.8\text{x}\times 0.584^2$ (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 $y = 9\tan(-25°) - 4.9\times 9^2/17^2\cos^2 25°$ A1 y = -5.87 2.13
(ii)	$v_h = 17\cos 25°$ (15.4) $v_v = 17\sin 25° + 9.8\times 0.584$ or $v_v^{\ 2} = (17\sin 25°)^2 + 2\times 9.8\times 5.87$ $v_v = 12.9$ $\tan\theta = 12.9/15.4$ $\theta = 40.0°$ 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 $\tan^{-1}(-.838)$ or 50.0° to vertical
(iii)	speed = $\sqrt{(12.9^2 + 15.4^2)}$ $\frac{1}{2}mv^2 = \frac{1}{2}m\times 20.1^2\times 0.7$ $v = 16.8$ m s^{-1}	M1 A1 ✓ M1 A1 **4**	(20.1) NB 0.3 instead of 0.7 gives 11.0 (M0) **14**