4729 Mechanics 2

1	75×9.8×40 (75×9.8×40)÷120 245 W	B1 M1 A1 **[3]**	Average Speed = 40÷120 (75×9.8)×(Average speed) **3**
2 (i)	$v^2 = 2\times9.8\times3$ or $2\times9.8\times1.8$ $v_1 = \sqrt{6g}$ or $\sqrt{58.8}$ or $\frac{7}{5}\sqrt{30}$ or 7.67 $v_2 = \sqrt{3.6g}$ or $\sqrt{35.28}$ or $\frac{21}{5}\sqrt{2}$ or 5.94 $I = \pm0.2(5.94+7.67)$ 2.72	M1 A1 A1 M1 A1ft **[5]**	Kinematics or energy Speed of impact (±) Speed of rebound (±) +ve, ft on v_1 and v_2
(ii)	e = 5.94/7.67 0.775 or $\frac{\sqrt{15}}{5}$	M1 A1ft **[2]**	Allow 0.774, ft on v_1 and v_2 **7**
3 (i)	$\bar{u}$ = 0.2 (from vertex) or 0.8 or 0.1 $0.5\bar{d} = 0.2\times\bar{u} + 0.3\times0.65$ $\bar{d}$ = 0.47	B1 M1 A1 A1 **[4]**	com of conical shell **AG**
(ii)	s = 0.5 Tsin80°× 0.5 = 0.47 × 0.5 × 9.8 T = 4.68 N	B1 M1 A1 A1 **[4]**	slant height, may be implied **8**
4 (i)	D – 400 = 700 × 0.5 D = 750 N	M1 A1 **[2]**	3 terms
(ii)	P = 750 × 12 9 000 W or 9 kW	M1 A1ft **[2]**	
(iii)	P/35 = 400 14 000 W or 14 kW	M1 A1 **[2]**	
(iv)	D = 14000/12 3500/3 = 400 + 700×9.8sinθ θ = 6.42°	B1ft M1 A1 A1 **[4]**	May be implied 3 terms Their P/12 **10**

5	$16 - 12 = 2x + 3y$	M1	
	$4 = 2x + 3y$	A1	aef
	$½.2(8)^2 + ½.3(4)^2$ or $½.2x^2 + ½..3y^2$ or $±½.2(8^2 - x^2)$ or $±½.3(4^2 - y^2)$	B1	
	$½.2(8)^2 + ½.3(4)^2 - ½.2x^2 - ½...3y^2 = 81$	M1	
	$2x^2 + 3y^2 = 14$	A1	aef
	Attempt to eliminate x or y from a linear and a quadratic equation	M1	
	$15y^2 - 24y - 12 = 0$ or $10x^2 - 16x - 26 = 0$	A1	aef
	Attempt to solve a three term quadratic	M1	
	$x = -1$ (or $x = 2.6$)	A1	
	$y = 2$ (or $y = -2/5$)	A1	
	$x = -1$ and $y = 2$ only	A1	
	speeds 1, 2 away from each other	A1 **[12]**	**12**
6 (i)	$30^2 = V_1^2 \sin^2 \theta_1 - 2×9.8×250$	M1	$½m\, V_1^2 = ½m\, 50^2 + m×9.8×250$
	$V_1^2 \sin^2 \theta_1 = 5800$ AEF	A1	
	$V_1 \cos \theta_1 = 40$	B1	
	$V_1 = 86.0$	A1	**AG**
	$\theta_1 = 62.3°$	A1 **[5]**	**AG**
(ii)	$0 = \sqrt{5800}\, t_p - 4.9t_p^2$	M1	$30 = V_1 \sin \theta_1 - 9.8t$
	$t_p = 15.5$	A1	$t = 4.71$
	$-\sqrt{5800} = 30 - 9.8t_q$	M1	
	$t_q = 10.8$	A1 **[4]**	
(iii)	R = 40×15.5	M1	
	R = 621	A1	(620, 622)
	$V_2 \cos \theta_2 × 10.8 = 621$	B1	$V_2 \cos \theta_2 = 57.4$
	$0 = V_2 \sin \theta_2 × 10.8 - 4.9 × 10.8^2$	M1	
	$V_2 \sin \theta_2 = 53.1$ or 53.0	A1	(52.9,53.1)
	Method to find a value of V_2 or θ_2	M1	
	$\theta_2 = 42.8°$	A1	42.6° to 42.9°
	$V_2 = 78.2$ m s^{-1} or 78.1 m s^{-1}	A1 **[8]**	or 78.1° **17**
7 (i)	$\cos\theta = 3/5$ or $\sin\theta = 4/5$ or $\tan\theta = 4/3$ or $\theta = 53.1°$	B1	θ = angle to vertical
	$R\cos\theta = 0.2×9.8$	M1	
	R = 3.27 N or 49/15	A1 **[3]**	
(ii)	r = 4	B1	
	$R\sin\theta = 0.2×4×\omega^2$	M1	
		A1	
	$\omega = 1.81$ rad s^{-1}	A1 **[4]**	

(iii)	φ = 26.6° or $\sin\varphi = \frac{1}{\sqrt{5}}$ or $\cos\varphi = \frac{2}{\sqrt{5}}$ or tan φ = 0.5	B1	φ = angle to horizontal
	T = 0.98 or 0.1g	B1	
	Ncosθ = Tsinφ + 0.2×9.8	M1	Vertically, 3 terms
	N×3/5 = 0.438 + 1.96	A1	
	N = 4.00	A1	may be implied
	Nsinθ + Tcosφ = 0.2×4×ω^2	M1	Horizontally, 3 terms
	4×4/5 + 0.98cos 26.6° = 0.8ω^2	A1	
	ω = 2.26 rad s^{-1}	A1 **[8]**	**15**