

## 4729 Mechanics 2

<b>1</b>	$75 \times 9.8 \times 40$ $(75 \times 9.8 \times 40) \div 120$ 245 W	B1 M1 A1 [3]	Average Speed = $40 \div 120$ $(75 \times 9.8) \times (\text{Average speed})$	<b>3</b>
<b>2 (i)</b>	$v^2 = 2 \times 9.8 \times 3$ or $2 \times 9.8 \times 1.8$ $v_1 = \sqrt{6g}$ 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 $I = \pm 0.2(5.94 + 7.67)$ 2.72	M1 A1 A1 M1 A1ft [5]	Kinematics or energy Speed of impact ( $\pm$ ) Speed of rebound ( $\pm$ ) +ve, ft on $v_1$ and $v_2$	
<b>(ii)</b>	$e = 5.94/7.67$ $0.775$ or $\frac{\sqrt{15}}{5}$	M1 A1ft [2]	Allow 0.774, ft on $v_1$ and $v_2$	<b>7</b>
<b>3 (i)</b>	$\bar{u} = 0.2$ (from vertex) or 0.8 or 0.1 $0.5\bar{d} = 0.2 \times \bar{u} + 0.3 \times 0.65$ $\bar{d} = 0.47$	B1 M1 A1 A1 [4]	com of conical shell <b>AG</b>	
<b>(ii)</b>	$s = 0.5$ $T \sin 80^\circ \times 0.5 = 0.47 \times 0.5 \times 9.8$ $T = 4.68 \text{ N}$	B1 M1 A1 A1 [4]	slant height, may be implied	<b>8</b>
<b>4 (i)</b>	$D - 400 = 700 \times 0.5$ $D = 750 \text{ N}$	M1 A1 [2]	3 terms	
<b>(ii)</b>	$P = 750 \times 12$ 9 000 W or 9 kW	M1 A1ft [2]		
<b>(iii)</b>	$P/35 = 400$ 14 000 W or 14 kW	M1 A1 [2]		
<b>(iv)</b>	$D = 14000/12$ $3500/3 = 400 + 700 \times 9.8 \sin \theta$ $\theta = 6.42^\circ$	B1ft M1 A1 A1 [4]	May be implied 3 terms Their P/12	<b>10</b>

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

(iii)	$\varphi = 26.6^\circ$ or $\sin \varphi = \frac{1}{\sqrt{5}}$ or $\cos \varphi = \frac{2}{\sqrt{5}}$ or $\tan \varphi = 0.5$ $T = 0.98$ or $0.1g$ $N \cos \theta = T \sin \varphi + 0.2 \times 9.8$ $N \times 3/5 = 0.438 + 1.96$ $N = 4.00$ $N \sin \theta + T \cos \varphi = 0.2 \times 4 \times \omega^2$ $4 \times 4/5 + 0.98 \cos 26.6^\circ = 0.8 \omega^2$ $\omega = 2.26 \text{ rad s}^{-1}$	B1  B1 M1 A1 A1 M1 A1 A1 [8]	$\varphi = \text{angle to horizontal}$  Vertically, 3 terms may be implied Horizontally, 3 terms  <b>15</b>
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