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| **1** | | $F = 0.6 \times 3^2 \times 0.4$ | M1 | | Uses $a = \omega^2 r$ |
| | | $F = 2.16\,\text{N}$ | A1 | | |
| | | Radial, direction PO | B1 | 3 | Do not allow direction OP |
| **2** | **(i)** | $mg = 30(0.8 - 0.5)/0.5$ | M1 | | |
| | | $m = 1.8\,\text{kg}$ AG | A1 | 2 | |
| | **(ii)** | EE = $30\,(1.2 - 0.5)^2/(2 \times 0.5)$ | B1 | | |
| | | $1.8v^2/2 = 30(1.2–0.5)^2/(2 \times 0.5) - 1.8 \times (1.2 - 0.5)g$ | M1 | | KE/EE/PE equation, 3 terms<br>RHS = 2.1 |
| | | $v = 1.53\ \text{ms}^{-1}$ | A1 | 3 | |
| **3** | **(i)** | $d(3+3+4) = 3 \times 0.4\sin 30 \times 2$ | M1<br>A1 | | Taking moments about AC |
| | | $d = 0.12$ m | A1 | 3 | |
| | **(ii)** | $(3+3+4) \times 0.12 = F \times 0.8\sin 30$ | M1 | | Taking moments about A, allow candidate's $d$ |
| | | $F = 3$ | A1 | | |
| | | At hinge, 7 N upwards | B1√ | 3 | Ft 10 – candidate's value ($F$) (downwards if negative) |
| **4** | **(i)** | $r = 0.3$ m | B1 | | Can be implied |
| | | $0.4T/0.5 - 2(0.4/0.5) = 6$ | M1 | | Resolving vertically for the particle |
| | | $T = 9.5$ N | A1 | | |
| | | $9.5(0.3/0.5)+2(0.3/0.5)=6v^2/(0.3g)$ | M1 | | Newton's Second Law radially for P |
| | | $v = 1.86\ \text{ms}^{-1}$ | A1 | 5 | |
| | **(ii)** | $[0.4T/0.5 = 6]$, $T = 7.5$ | B1 | | Uses tension in BP = 0 and resolves vertically |
| | | $7.5(0.3/0.5) = (6/g)\ \omega^2\ (0.3)$ | M1 | | Newton's Second Law radially for P |
| | | $\omega = 5\ \text{rad s}^{-1}$ AG | A1 | 3 | |
| **5** | **(i)** | CP = 0.8 | B1 | | P is the point where the string is attached to the plane |
| | | $T = 12 \times (0.8–0.4)/0.4$ | M1 | | Uses $T = \lambda x/l$ |
| | | $T = 12$ N | A1 | 3 | |

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| | **(ii)** | Moment of $T$ at B = $0.4 \times 12\cos30$ | B1 | | ft for their $T$ in (i) |
| | | $0.4 \times 12\cos30 =$<br>$0.2W\cos30 - 0.2W\sin30$ | M1<br>A1 | | Moments about B<br>Or RHS = $0.2\sqrt{2}\cos75W$ or<br>$W(0.2–0.2\tan30)\cos30$ |
| | | $W = 56.8$ N | A1 | 4 | |
| **6** | **(i)** | $U\cos\theta = 18\cos30$ $(=9\sqrt{3} = 15.588..)$ | B1 | | |
| | | $U\sin\theta - 2g = -18\sin30$ | B1 | | $U\sin\theta = 11$ |
| | | $U^2 = 15.588^2 + 11^2$ | M1 | | Pythagoras or $\tan\theta = 11/15.588$ |
| | | $U = 19.1$ | A1 | | |
| | | $\theta = 35.2$ | A1 | 5 | |
| | **(ii)** | $X = 0.8V\cos30$ | B1 | | Horizontal displacement |
| | | $Y = -0.8V\sin30 + g0.8^2/2$ | B1 | | Vertical displacement |
| | | $(3.2–0.4V)/(0.8V\cos30) = \tan60$ | M1 | | Or $0.8V\cos30/(3.2–0.4V) = \tan30$ |
| | | $V = 2$ | A1 | 4 | |
| | | OR working perpendicular to the wall | B1* | | |
| | | $a = g\cos60$ | DB1* | | |
| | | $0 = 0.8V - g\cos60(0.8)^2/2$ | M1 | | Uses $s = 0$ |
| | | $V = 2$ | A1 | | |
| **7** | **(i)** | $R = 0.2g - 0.4 \times 2\sin30$ | M1 | | Resolving vertically, 3 terms |
| | | $F_R = 0.4 \times 2\cos30$ | M1 | | Use $F = \mu R$ |
| | | $\mu = 0.433$ | A1 | | |
| | | $0.2g = 0.4\ t\sin30$ | M1 | | Solves for $t$ when $R = 0$ |
| | | $t = 10$ | A1 | 5 | |
| | **(ii)** | $0.2\mathrm{d}v/\mathrm{d}t =$<br>$0.4t\cos30 - 0.433(0.2g - 0.4\ t\sin30)$ | M1<br>A1 | | Newton's Second Law<br>with both forces f(t) |
| | | $\mathrm{d}v/\mathrm{d}t = 2.165t - 4.33(0)$ AG | A1 | 3 | |

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| **(iii)** | $\int dv = \int (2.165t - 4.33)dt$ | M1 | | Attempts to integrate |
| | $v = 2.165t^2/2 - 4.33t\ (+c)$ | A1 | | |
| | $v = 0,\ t = 2\ \ [c = 4.33]$ | M1 | | Must use $t = 2$ |
| | $v = 2.165 \times 10^2/2 - 4.33 \times 10 + 4.33$<br>$v = 69.3$ | A1 | 4 | Puts $t$ (i) in integrand |