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|---|---|---|---|
| 1a | Equation of motion | M1 | Dimensionally correct. Condone sign error. |
| | $F - R = 1500a$ | A1 | Correct unsimplified equation in $F$ or $P$ |
| | Use of $P = Fv$ : $\left(\frac{30\,000}{20} - R = 1500 \times 0.6\right)$ | M1 | Must be trying to use 30 kW but condone error in zeros |
| | $R = 600$ | A1 | Correct answer only |
| | | **4** | |
| 1b | Equation of motion | M1 | Dimensionally correct. Need all relevant terms.<br>Condone sign errors and sin/cos confusion.<br>Allow with $F$. |
| | $\frac{30\,000}{V} - 1500g \times \frac{1}{8} - 500 = -1500 \times 0.2$ | A1<br><br>A1 | Unsimplified equation with $F$ substituted and at most one error<br>Correct unsimplified equation with $F$ substituted.<br>If $F$ is never substituted, A0A0 |
| | $V = 14.7 \quad (15)$ | A1 | 3 sf or 2 sf |
| | | **4** | |
| | | **(8)** | |
| 2 | 1st equation e.g. Equation for change in KE | M1 | Dimensionally correct. Must be subtracting but condone sign error. |
| | $\frac{1}{2} \times 0.5\left(x^2 + y^2 - \left(5^2 + 3^2\right)\right) = 22$<br>$\left(x^2 + y^2 = 122\right) \ \left(1^2 + (2\lambda + 3)^2 = 122\right)$ | A1 | Correct unsimplified equation seen or implied (They might have used impulse-momentum first and done some work before substituting $x$ and $y$.) |
| | 2nd equation e.g. Impulse-momentum equation | M1 | Dimensionally correct. Must be subtracting but condone sign error. |
| | $0.5(x\mathbf{i} + y\mathbf{j}) - 0.5(5\mathbf{i} + 3\mathbf{j}) = (-2\mathbf{i} + \lambda\mathbf{j})$<br><br>$\left((x-5)\mathbf{i} + (y-3)\mathbf{j} = -4\mathbf{i} + 2\lambda\mathbf{j}\right)$ | A1 | Correct unsimplified equation |
| | **NB: epen has M1A1A1 for the final 3 marks but this should be marked DM1DM1A1** | | |
| | Form a quadratic equation in $\lambda$ | DM1 | e.g. $1^2 + (3 + 2\lambda)^2 = 122$<br>Dependent on the 2 preceding M marks |
| | Solve for 2 values of $\lambda$ | DM1 | e.g. solve $4\lambda^2 + 12\lambda - 112 = 0$ or $(3 + 2\lambda)^2 = 121$<br>Dependent on the preceding M1 |
| | $\Rightarrow \lambda = 4 \quad \text{or} \quad \lambda = -7$ | A1 | Correct only and no errors seen (watch out for $x = -1$ used) |
| alt | Form a quadratic in $y$ | DM1 | e.g. $1 + y^2 = 122 \quad \left(y^2 = 121\right)$ Dependent on the 2 preceding M marks |
| | Solve for 2 values of $y$ and use these to obtain 2 values of $\lambda$ | DM1 | Dependent on the preceding M1 |
| | $\Rightarrow \lambda = 4 \quad \text{or} \quad \lambda = -7$ | A1 | |
| | | **7** | |