Further Mechanics 1 Mark Scheme

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **1(a)** | Using the model and $v^2 = u^2 + 2as$ to find $v$ | M1 | 3.4 |
| | $v^2 = 2as = 2g \times 2.4 = 4.8g \Rightarrow v = \sqrt{(4.8g)}$ | A1 | 1.1b |
| | Using the model and $v^2 = u^2 + 2as$ to find $u$ | M1 | 3.4 |
| | $0^2 = u^2 - 2g \times 0.6 \Rightarrow u = \sqrt{(1.2g)}$ | A1 | 1.1b |
| | Using the correct strategy to solve the problem by finding the sep. speed and app. speed and applying NLR | M1 | 3.1b |
| | $e = \sqrt{(1.2g)} / \sqrt{(4.8g)} = 0.5$ * | A1* | 1.1b |
| | | **(6)** | |
| **(b)** | Using the model and $e$ = sep. speed / app. speed, $v = 0.5\sqrt{(1.2g)}$ | M1 | 3.4 |
| | Using the model and $v^2 = u^2 + 2as$ | M1 | 3.4 |
| | $0^2 = 0.25\,(1.2g) - 2gh \Rightarrow h = 0.15$ (m) | A1 | 1.1b |
| | | **(3)** | |
| **(c)** | Ball continues to bounce with the height of each bounce being a quarter of the previous one | B1 | 2.2b |
| | | **(1)** | |
| | | | **(10 marks)** |

Notes:

**(a)**
**M1:** For a complete method to find $v$
**A1:** For a correct value (may be numerical)
**M1:** For a complete method to find $u$
**A1:** For a correct value (may be numerical)
**M1:** For finding both $v$ and $u$ and use of Newton's Law of Restitution
**A1*:** For the given answer

**(b)**
**M1:** For use of Newton's Law of Restitution to find rebound speed
**M1:** For a complete method to find $h$
**A1:** For 0.15 (m) oe

**(c)**
**B1:** For a clear description including reference to a quarter

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **2(a)** | Energy Loss = KE Loss – PE Gain | M1 | 3.3 |
| | $= \frac{1}{2} \times 0.5 \times 25^2 - 0.5g \times 20$ | A1 | 1.1b |
| | $= 58.25 = 58$ (J ) or 58.3 (J) | A1 | 1.1b |
| | | **(3)** | |
| **(b)** | Using work-energy principle, $20R = 58.25$ | M1 | 3.3 |
| | $R = 2.9125 = 2.9$ or 2.91 | A1ft | 1.1b |
| | | **(2)** | |
| **(c)** | Make resistance variable (dependent on speed) | B1 | 3.5c |
| | | **(1)** | |
| | | | **(6 marks)** |

Notes:

**(a)**
**M1:** For a difference in KE and PE
**A1:** For a correct expression
**A1:** For either 58 (2sf) or 58.3(3sf)

**(b)**
**M1:** For use of work-energy principle
**A1ft:** For either 2.9 (2sf) or 2.91 (3sf) follow through on their answer to (a)

**(c)**
**B1:** For variable resistance oe

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **3(a)** | Force = Resistance (since no acceleration) = 30 | B1 | 3.1b |
| | Power = Force $\times$ Speed = $30 \times 4$ | M1 | 1.1b |
| | = 120 W | A1 **ft** | 1.1b |
| | | **(3)** | |
| **(b)** | Resolving parallel to the slope | M1 | 3.1b |
| | $F - 60g\sin\alpha - 30 = 0$ | A1 | 1.1b |
| | $F = 70$ | A1 | 1.1b |
| | Power = Force $\times$ Speed = $70 \times 3$ | M1 | 1.1b |
| | = 210 W | A1 **ft** | 1.1b |
| | | **(5)** | |
| | | | **(8 marks)** |

Notes:

**(a)**
**B1:** For force = 30 seen
**M1:** For use of $P = Fv$
**A1ft:** For 120 (W), follow through on their '30'

**(b)**
**M1:** For resolving parallel to the slope with correct no. of terms and 60*g* resolved
**A1:** For a correct equation
**A1:** For $F = 70$
**M1:** For use of $P = Fv$
**A1ft:** For 210 (W), follow through on their '70'

| Question | Scheme | Marks | AOs |
|---|---|---|---|
| **4(a)** | Use of conservation of momentum | M1 | 3.1a |
| | $3mu - 2mu = 3mv + mw$ | A1 | 1.1b |
| | Use of NLR | M1 | 3.1a |
| | $3ue = -v + w$ | A1 | 1.1b |
| | Using a correct strategy to solve the problem by setting up two equations (need both) in $u$ and $v$ and solving for $v$ | M1 | 3.1b |
| | $v=\frac{u}{4}(1-3e)$ | A1 | 1.1b |
| | | **(6)** | |
| **(b)** | $\frac{u}{4}(1-3e)<0$ | M1 | 3.1b |
| | $\frac{1}{3}< e\leq 1$ | A1 | 1.1b |
| | | **(2)** | |
| **(c)** | Solving for $w$ | M1 | 2.1 |
| | $w=\frac{u}{4}(1+9e)$ * | A1 * | 1.1b |
| | | **(2)** | |
| **(d)** | Substitute $e=\frac{5}{9}$ | M1 | 1.1b |
| | $v=-\frac{u}{6}, w=\frac{3u}{2}$ | A1 | 1.1b |
| | Use NLR for impact with wall, $x=fw$ | M1 | 1.1b |
| | Further collision if $x>-v$ | M1 | 3.4 |
| | $f\frac{3u}{2}>\frac{u}{6}$ | A1 | 1.1b |
| | $1\geq f>\frac{1}{9}$ | A1 | 1.1b |
| | | **(6)** | |
| | | | **(16 marks)** |

Notes:

**(a)**
**M1:** For use of CLM, with correct no. of terms, condone sign errors
**A1:** For a correct equation
**M1:** For use of Newton's Law of Restitution, with $e$ on the correct side
**A1:** For a correct equation
**M1:** For setting up *two* equations and solving their equations for $v$
**A1:** For a correct expression for $v$

**(b)**
**M1:** For use of an appropriate inequality
**A1:** For a complete range of values of $e$

**(c)**
**M1:** For solving their equations for $w$
**A1:** For the given answer

| Question 4 notes continued: |
|---|
| **(d)** |
| **M1:** For substituting $e = \frac{5}{9}$ into their $v$ and $w$ |
| **A1:** For correct expressions for $v$ and $w$ |
| **M1:** For use of Newton's Law of Restitution, with $e$ on the correct side |
| **M1:** For use of appropriate inequality |
| **A1:** For a correct inequality |
| **A1:** For a correct range |