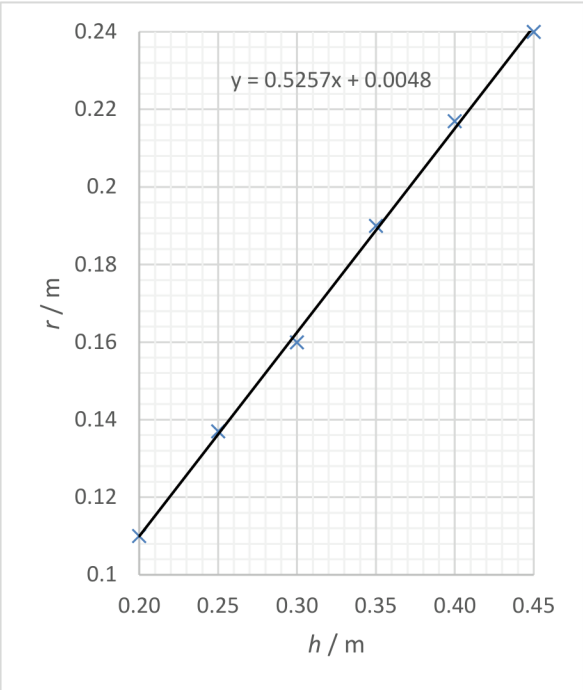
| Question Number | Answer | Mark |
|---|---|---|
| **4(a)(i)** | **Max 2 from**<br>• Inconsistent d.p. in *r* (1)<br>• No repeat readings (for *r*) (1)<br>• All values (of *h* and *r*) should be to the nearest mm<br>**Or** all values (of *h* and *r*) should be to 3 d.p. (1) | **2** |
| **4(a)(ii)** | • Labels axes with quantities and units (1)<br>• Sensible scales (1)<br>• Plotting (2)<br>• Line of best fit (1)<br>  <br>\| ***h* / m** \| ***r* / m** \|<br>\|---\|---\|<br>\| 0.20 \| 0.11 \|<br>\| 0.25 \| 0.137 \|<br>\| 0.30 \| 0.16 \|<br>\| 0.35 \| 0.19 \|<br>\| 0.40 \| 0.217 \|<br>\| 0.45 \| 0.24 \| | **5** |
| **4(b)(i)** | • $mgh = ½mv^2$ (1)<br>• Algebra steps shown leading to $u = \sqrt{2gh}$ (1)<br>Do not accept use of $v^2 = u^2 + 2as$ | **2** |
| **4(b)(ii)** | • See $v = \sqrt{2gr}$ (1)<br>• Shows that $e = \frac{\sqrt{r}}{\sqrt{h}}$ (1)<br>• Gradient = $\frac{\Delta r}{\Delta h}$ therefore gradient = $e^2$ (1)<br>Accept substitution of $u = \sqrt{2gh}$ and v= $\sqrt{2gr}$ into $e = v/u$ and re-arrangement into $y = mx$ format for MP2 and 3 | **3** |
| **4(c)** | • Calculates gradient using large triangle (allow use of $e^2 = \frac{r}{h}$) (1)<br>• Gradient / $e^2$ value between 0.51 and 0.56<br>**Or** *e* value between 0.71 and 0.75 (1)<br>• Correct choice of metal for value of *e* calculated (1)<br><u>Example of Calculation</u><br>$e^2 = (0.22 – 0.12)/(0.41 – 0.22)$ | **3** |

| | | |
|---|---|---|
| | $e^2 = 0.53$<br>$e = 0.73$ so stainless steel | |
| **4(d)** | • Acceleration along the ramp would be smaller, so $r$ would be lower (for a given $h$)<br>**Or** friction would reduce velocity, so $r$ would be lower (for a given $h$)<br>**Or** friction would dissipate energy, so $r$ would be lower (for a given $h$) (1)<br>• (The gradient and) the value obtained for $e$ would be smaller [dependent on MP1] (1) | **2** |
| | **Total for question 4** | **17** |