

Question Number	Answer	Mark
4(a)(i)	<ul style="list-style-type: none"> Calculation of mean (1) Mean $t = 3.56$ (s) to 3 s.f. (1) <p>Example of calculation</p> <p>Mean value of time = $(3.57 \text{ s} + 3.61 \text{ s} + 3.54 \text{ s} + 3.51 \text{ s}) / 4 = 3.5575 = 3.56 \text{ s}$</p>	2
4(a)(ii)	<ul style="list-style-type: none"> Use of half range for uncertainty (1) Or uncertainty = max distance from the mean (1) Percentage uncertainty = 1.4% (1) <p>Allow e.c.f. from 4(a)(i)</p> <p>Example of calculation</p> <p>Uncertainty = half range = $(3.61 \text{ s} - 3.51 \text{ s}) / 2 = 0.05 \text{ s}$</p> <p>Percentage uncertainty = $0.05 \text{ s} / 3.56 \text{ s} \times 100\% = 1.4 \%$</p>	2
4(b)	<ul style="list-style-type: none"> Place a light gate (at each marker) (1) To (start and) stop an electronic/digital timer (1) Or use a datalogger/computer to determine the time (1) <p>OR</p> <ul style="list-style-type: none"> Use video camera (1) Valid method to find time (e.g., count the number of frames) (1) 	2
4(c)(i)	<ul style="list-style-type: none"> Rearranges equation to $F = (M / t) v$ and compares with $y = mx (+ c)$ (1) So, the gradient = M / t (1) <p>OR</p> <ul style="list-style-type: none"> Rearranges equation to $F / v = M / t$ (1) States that gradient of graph = F / v (1) <p>OR</p> <ul style="list-style-type: none"> Rearranges equation to $t = M v / F$ (1) States that gradient of graph = F / v (1) Or states that $1/\text{gradient of graph} = v / F$ (1) 	2

4(c)(ii)	<ul style="list-style-type: none">Labels axes with quantities and unitsSensible scalesPlottingLine of best fit	(1) (1) (2) (1)	5												
	<div><table><thead><tr><th>F/N</th><th>$v/\text{m s}^{-1}$</th></tr></thead><tbody><tr><td>0.5</td><td>0.28</td></tr><tr><td>1.5</td><td>0.84</td></tr><tr><td>2.5</td><td>1.40</td></tr><tr><td>3.5</td><td>1.97</td></tr><tr><td>4.5</td><td>2.52</td></tr></tbody></table></div>	F/N	$v/\text{m s}^{-1}$	0.5	0.28	1.5	0.84	2.5	1.40	3.5	1.97	4.5	2.52		
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4(c)(iii)	<ul style="list-style-type: none">Calculates gradient using large triangleUse of gradient = M / tt in the range of 0.068 to 0.072 s <p>Example of calculation</p> <p>Gradient = $\frac{4.0-1.0}{2.25-0.55} = 1.76$</p> <p>$t = \frac{0.125 \text{ kg}}{1.76 \text{ N m}^{-1}\text{s}} = 0.07 \text{ s}$</p>	(1) (1) (1)	3												
Total for question 4			16												