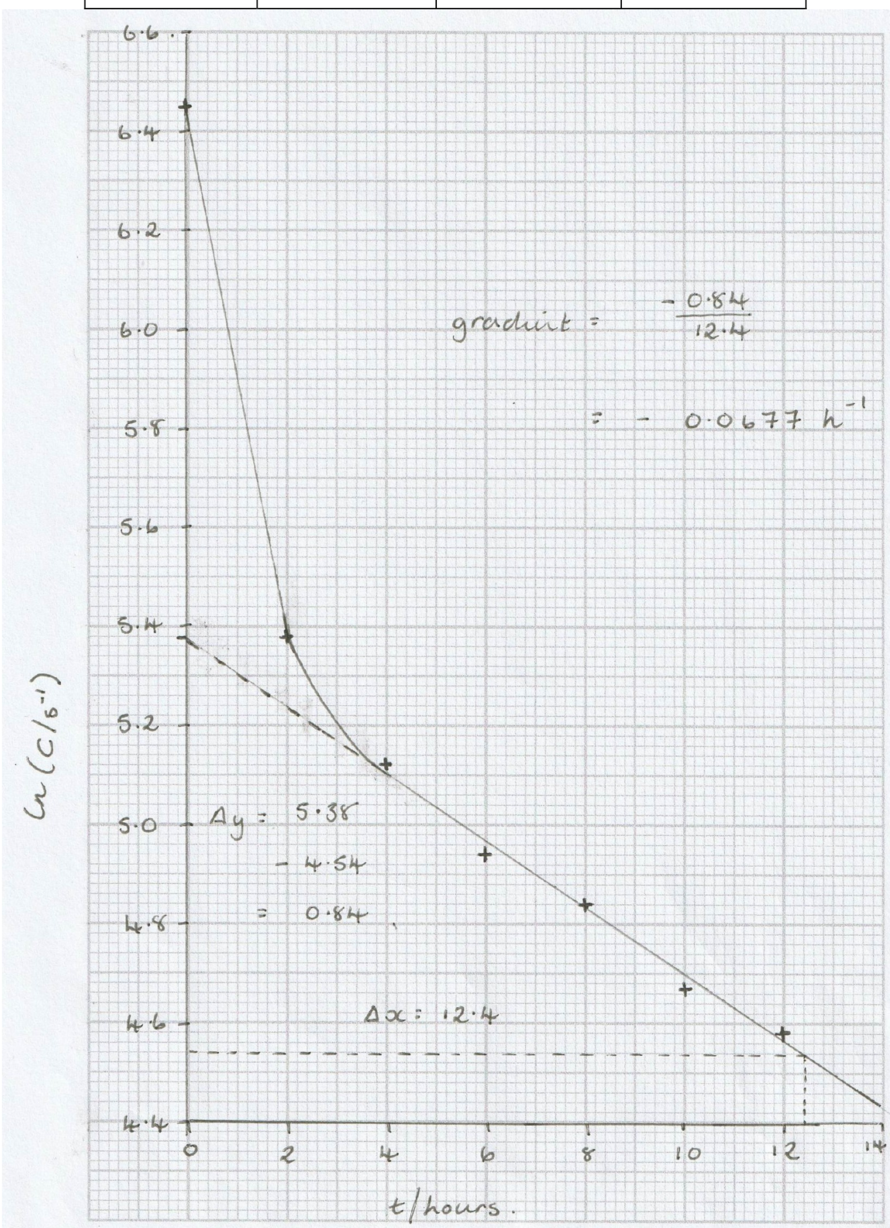
t / hours	C / s^{-1}	ln (C / s^{-1})	ln (C / s^{-1})
0	633	6.45	6.450
2	217	5.38	5.380
4	167	5.12	5.118
6	140	4.94	4.942
8	126	4.84	4.836
10	107	4.67	4.673
12	98	4.58	4.585



Question Number	Answer	Mark
4 (a)(i)	Any **TWO** from Place the rule as close as possible to the ramp (1) Use a set square to ensure the rule is vertical **Or** Use a spirit level to ensure the rule is vertical (1) Ensure the rule reads zero at the bench (1) Read the scale perpendicularly **Or** Use a set square to read value from the scale (1)	**2**
4 (a)(ii)	The uncertainty of each measurement is half the resolution of the ruler (which is 0.5 mm) **Or** The resolution of the ruler is 1 mm so the uncertainty is 0.5 mm (1) As values of h are subtracted the uncertainty is 0.5 mm + 0.5 mm = 1 mm (1) Accept 2×0.5mm = 1 mm	**2**
4 (b)(i)	Mean value of t = <u>1.95 </u>s (1) Correct uncertainty from half range shown **Or** Correct uncertainty from furthest from the mean shown (1) <u>Example of calculation</u> Mean t = (2.10 + 1.86 + 1.94 + 1.89) s / 4 = 7.79 s / 4 = 1.95 s Uncertainty = (2.10 – 1.86) s /2 = 0.12 s	**2**
4 (b)(ii)	The values of t will increase **Or** The cylinder will move more slowly (1) So the percentage uncertainty in t will reduce **Or** It will be easier to judge when the cylinder crosses the finish line **Or** The effect of reaction time will be reduced (1)	**2**
4 (c)	Both have the same level of accuracy as the means are the same (1) But cannot tell if they are close to the true value (1) Student B has a smaller range than Student A (1) Therefore Student B is more precise (1) Accept converse, MP4 dependent MP3	**4**

4 (d)(i)	Use of $t^2 = 4s^2/gh$ shown $g = 10.0$ m s^2 Accept 10 m s^{-2}, dependent MP1 <u>Example of calculation</u> $g = 4s^2 / t^2h = (4 \times 0.8^2\text{m}^2)/(2.44^2\text{s}^2 \times 0.043\text{m}) = 2.56\text{m}^2 / 0.256\text{m s}^2 = 10.0$ m s^{-2}	(1) (1)	**2**
4 (d)(ii)	Use of 2× %U in s **and** 2 × %U in t %U = 5.9 % Accept 6% or 5.85 % <u>Example of calculation</u> %U = 2 × (0.1 / 80) × 100% + 2 × (0.04 / 2.44) × 100% + (1 / 43) × 100% = 0.25% + 3.28% + 2.33% = 5.9 %	(1) (1)	**2**
4 (d)(iii)	Correct value of relevant limit e.c.f. (d)(i) and (d)(ii) Valid conclusion based on comparison of limit to $g = 9.81$ m s^{-2} MP2 dependent MP1 <u>Example of calculation</u> %U = 5.9% Lower limit = 10.0 × (100 – 5.9)/100 = 9.4 m s^{-2} As the accepted value of g of 9.81 m s^{-2} lies within the lower limit then the value is accurate. **Or** Correct calculation of %D shown e.c.f. (d)(i) Valid conclusion based on comparison of %D to %U e.c.f. (d)(ii) MP2 dependent MP1 <u>Example of calculation</u> %U = 5.9% %D = (10.0 – 9.81)/9.81 ×100% = 1.9% As the %D is less than %U then the value of g is accurate. Accept comparisons to $g = 9.8$ m s^{-2}	(1) (1)	**2**
	Total for question		**18**