

# Experiment



# A1-1

中文 (Official)

## Elasticity of cantilever (10 points) (Marking scheme)

### Part A. Alignment of light path

A1 (marking scheme)	Total 0.6 pt
1. Draw 4 devices (laser, reflector, cantilever, and PSD) with relatively correct positions	0.2 pt
Draw 2 or 3 devices (from laser, reflector, cantilever, and PSD) with relatively correct positions	0.1 pt
2. Correctly plot the path of laser beam.	0.2 pt
3. Correctly mark the coordinates and angle of the reflector.	0.1 pt
4. Correctly mark the coordinates and angle of the PSD.	0.1 pt

A2. (marking scheme)	Total 0.8 pt
1. Fill in at least 40 sets of data.	0.2 pt
Fill in 20-39 sets of data.	0.1 pt
2. There are 10 data in the second column for $d$ with fluctuation around $1.0000 \times 10^{-3}$ .	0.2 pt
There are 5 data in the second column for $d$ with fluctuation around $1.0000 \times 10^{-3}$ .	0.1 pt
3. There are 10 data in the fourth column for $d$ with fluctuation around $1.000 \times 10^{-4}$ .	0.2 pt
There are 5 data in the fourth column for $d$ with fluctuation around $1.000 \times 10^{-4}$ .	0.1 pt
4. There are 10 data in the sixth column for $d$ with fluctuation around $1.00 \times 10^{-5}$ .	0.2 pt
There are 5 data in the sixth column for $d$ with fluctuation around $1.00 \times 10^{-5}$ .	0.1 pt

A3. (marking scheme)	Total 1.0 pt
1. Fill in 10 data in the first column $d$ (m).	0.1 pt
2. The value in the second column $\bar{d}$ (m) is within $\pm$ two standard	0.2 pt

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<p>deviations.</p> <p>The value in the second column <math>\bar{d}</math> (m) is reasonable (order of magnitudes).</p>	0.1 pt
3. Fill in 10 data in the third column $d - \bar{d}$ (m).	0.1 pt
4. The value in the fourth column “standard deviations” is within $1.00 \times 10^{-5} \leq x \leq 5.00 \times 10^{-5}$ .	0.4 pt
The value in the fourth column “standard deviation” is within $1.0 \times 10^{-6} \leq x < 1.00 \times 10^{-5}$ or $5.00 \times 10^{-5} < x \leq 5.000 \times 10^{-4}$ .	0.2 pt
5. Correctly write down the reference value of measurement (with standard deviation) as $\bar{d} \pm \text{standard deviation}$ (m).	0.2 pt

## Part B. Deformation of cantilever beam and deduction of Young’s modulus

B1. (marking scheme)	Total 1.0 pt
1. In the first table, the third column for $\bar{d} = d_0$ (m) is within $-3.0 \times 10^{-5} \leq x \leq 3.0 \times 10^{-5}$ .	0.5 pt
In the first table, the third column for $\bar{d} = d_0$ (m) is within $-6.0 \times 10^{-5} \leq x < -3.0 \times 10^{-5}$ or $3.0 \times 10^{-5} < x \leq 6.0 \times 10^{-5}$ .	0.2 pt
2. In the second table, completely and reasonably fill in five rows.	0.5 pt
In the second table, completely and reasonably fill in four rows.	0.4 pt
In the second table, completely and reasonably fill in three rows.	0.3 pt
In the second table, completely and reasonably fill in two rows.	0.2 pt
In the second table, completely and reasonably fill in one row.	0.1 pt

B2. (marking scheme)	Total 1.0 pt
1. The ratio of data in the second column $\delta$ and that in the first column F is $5.12 \times 10^1$ .	0.4 pt
2. Correctly mark x-axis as $\overline{\Delta d}$ (m)	0.2 pt
3. Correctly mark y-axis as $\delta$ (m)	0.2 pt
4. Correctly mark the data points on the plot.	0.2 pt

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B3. (marking scheme)	Total 0.4 pt
1. The value of $C_1$ is within $4.6 \times 10^{-4} \leq x \leq 5.4 \times 10^{-4}$ .	0.4 pt
The value of $C_1$ is within $4.2 \times 10^{-4} \leq x < 4.6 \times 10^{-4}$ or $5.4 \times 10^{-4} < x \leq 5.8 \times 10^{-4}$ .	0.2 pt

## Part C. Double layer cantilever beam

C1. (marking scheme)	Total 1.0 pt
1. In the first table, the third column for $\bar{d} = d_0$ (m) is within $-3.0 \times 10^{-5} \leq x \leq 3.0 \times 10^{-5}$ .	0.5 pt
In the first table, the third column for $\bar{d} = d_0$ (m) is within $-6.0 \times 10^{-5} \leq x < -3.0 \times 10^{-5}$ or $3.0 \times 10^{-5} < x \leq 6.0 \times 10^{-5}$ .	0.2 pt
2. In the second table, completely and reasonably fill in five rows.	0.5 pt
In the second table, completely and reasonably fill in four rows.	0.4 pt
In the second table, completely and reasonably fill in three rows.	0.3 pt
In the second table, completely and reasonably fill in two rows.	0.2 pt
In the second table, completely and reasonably fill in one row.	0.1 pt

C2. (marking scheme)	Total 1.0 pt
1. The ratio of data in the third column $\delta$ and the second column $\overline{\Delta d}$ is the same as the value of $C_1$ in B3.	0.2 pt
2. Correctly mark x-axis as $T$ (K) .	0.2 pt
3. Correctly mark y-axis as $\delta$ (m) .	0.2 pt
4. Correctly mark the data points on the plot.	0.2 pt
5. Slope is within $1.0 \times 10^{-7} \leq x \leq 1.5 \times 10^{-7}$ (m/K)	0.2 pt

C3. (marking scheme)	Total 0.6 pt
1. Young's modulus is within $3.0 \times 10^{10} \leq x \leq 6.0 \times 10^{10}$	0.4 pt
Young's modulus is within $1.0 \times 10^{10} \leq x < 3.0 \times 10^{10}$ or $6.0 \times 10^{10} < x \leq 9.0 \times 10^{10}$	0.2 pt
2. Unit: $\text{N/m}^2$ or (Pa)	0.2 pt

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## Part D. Test of molecular-absorption-induced bending of a cantilever beam

D1. (marking scheme)		Total 0.6 pt
1. Sample 0: the third column for $d_0$ is within $-3.0 \times 10^{-5} \leq x \leq 3.0 \times 10^{-5}$		0.2 pt
Sample 0: the third column for $d_0$ is within $-6.0 \times 10^{-5} \leq x < -3.0 \times 10^{-5}$ or $3.0 \times 10^{-5} < x \leq 6.0 \times 10^{-5}$		0.1 pt
2. Completely and reasonably fill in the table for Sample 0.		0.2 pt
3. Completely and reasonably fill in the table for Sample 1.		0.2 pt

D2. (marking scheme)		Total 0.6 pt
1. $C_2$ is within $-7.0 \times 10^{-2} \leq x \leq -8.0 \times 10^{-2}$ (N/m)		0.6 pt
$C_2$ 在 $-5.0 \times 10^{-2} \leq x \leq -7.0 \times 10^{-2}$ or $-8.0 \times 10^{-2} \leq x \leq -10.0 \times 10^{-2}$ (N/m)		0.3 pt

D3. (marking scheme)		Total 0.8 pt
1. Sample 2: value of $\overline{\Delta d}$ (m) within $-6.3 \times 10^{-4} \leq x \leq -5.7 \times 10^{-4}$		0.4 pt
Sample 2: value of $\overline{\Delta d}$ (m) within $-6.6 \times 10^{-4} \leq x < -6.3 \times 10^{-4}$ or $-5.7 \times 10^{-4} < x \leq -5.4 \times 10^{-4}$ .		0.2 pt
2. Sample 3: value of $\overline{\Delta d}$ (m) within $-2.7 \times 10^{-4} \leq x \leq -2.1 \times 10^{-4}$		0.4 pt
Sample 3: value of $\overline{\Delta d}$ (m) within $-3.0 \times 10^{-4} \leq x < -2.7 \times 10^{-4}$ or $-2.1 \times 10^{-4} < x \leq -1.8 \times 10^{-4}$ .		0.2 pt

D4. (marking scheme)		Total 0.6 pt
1. Sample 2: coverage ratio within $0.6\% \leq x \leq 0.8\%$		0.3 pt
Sample 2: coverage ratio within $0.4\% \leq x \leq 0.6\%$ or $0.8\% \leq x \leq 10.0\%$		0.1 pt
2. Sample 3: coverage ratio within $0.25\% \leq x \leq 0.35\%$		0.3 pt
Sample 3: coverage ratio within $0.15\% \leq x \leq 0.25\%$ or $0.35\% \leq x \leq 0.45\%$		0.1 pt