# Experiment

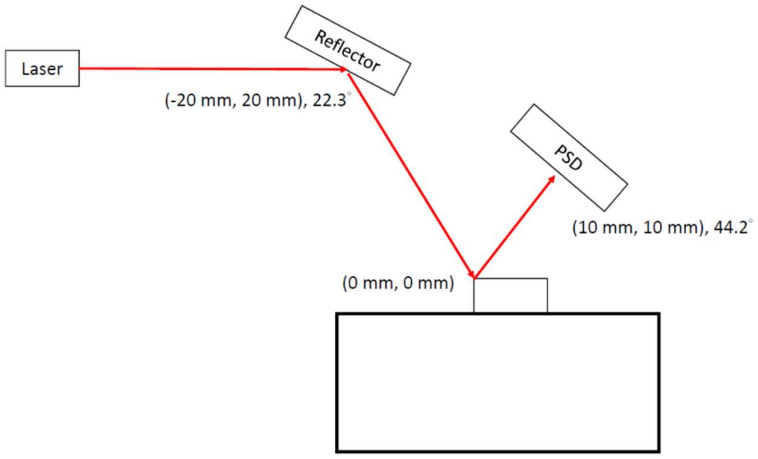
# A1-1

中文 (Official)

## Elasticity of cantilever

### Part A. Alignment of light path

A1. 0.6 pt




A2. 0.8 pt

| time (s) | position $d$ (m) | time (s) | position $d$ (m) | time (s) | position $d$ (m) |
|---|---|---|---|---|---|
| 3 | $-6.415 \times 10^{-4}$ | 48 | $1.198 \times 10^{-4}$ | 93 | $6.85 \times 10^{-5}$ |
| 6 | $5.261 \times 10^{-4}$ | 51 | $-4.46 \times 10^{-5}$ | 96 | $7.36 \times 10^{-5}$ |
| 9 | $4.843 \times 10^{-4}$ | 54 | $1.488 \times 10^{-4}$ | 99 | $8.73 \times 10^{-5}$ |
| 12 | $3.349 \times 10^{-4}$ | 57 | $-7.70 \times 10^{-5}$ | 102 | $7.93 \times 10^{-5}$ |
| 15 | $-5.386 \times 10^{-4}$ | 60 | $8.75 \times 10^{-5}$ | 105 | $6.39 \times 10^{-5}$ |
| 18 | $7.91 \times 10^{-5}$ | 63 | $1.604 \times 10^{-4}$ | 108 | $3.22 \times 10^{-5}$ |
| 21 | $-2.762 \times 10^{-4}$ | 66 | $-1.93 \times 10^{-5}$ | 111 | $6.05 \times 10^{-5}$ |
| 24 | $1.398 \times 10^{-4}$ | 69 | $1.159 \times 10^{-4}$ | 114 | $3.20 \times 10^{-5}$ |
| 27 | $-2.039 \times 10^{-4}$ | 72 | $7.10 \times 10^{-5}$ | 117 | $4.71 \times 10^{-5}$ |

| | | | | | |
|---|---|---|---|---|---|
| 30 | $-4.42 \times 10^{-5}$ | 75 | $3.6 \times 10^{-6}$ | 120 | $8.26 \times 10^{-5}$ |
| 33 | $-1.988 \times 10^{-4}$ | 78 | $-1.79 \times 10^{-5}$ | | |
| 36 | $-2.77 \times 10^{-5}$ | 81 | $9.21 \times 10^{-5}$ | | |
| 39 | $1.195 \times 10^{-4}$ | 84 | $6.00 \times 10^{-5}$ | | |
| 42 | $1.960 \times 10^{-4}$ | 87 | $1.361 \times 10^{-4}$ | | |
| 45 | $2.192 \times 10^{-4}$ | 90 | $5.72 \times 10^{-5}$ | | |

A3. 1.0 pt

| $d$ (m) | $\bar{d}$ (m) | $d - \bar{d}$ (m) | standard deviation |
|---|---|---|---|
| $6.85 \times 10^{-5}$ | $6.267 \times 10^{-5}$ | $5.5 \times 10^{-6}$ | $1.88 \times 10^{-5}$ |
| $7.36 \times 10^{-5}$ | | $1.09 \times 10^{-5}$ | |
| $8.73 \times 10^{-5}$ | | $2.46 \times 10^{-5}$ | |
| $7.93 \times 10^{-5}$ | | $1.66 \times 10^{-5}$ | |
| $6.39 \times 10^{-5}$ | | $1.2 \times 10^{-6}$ | |
| $3.22 \times 10^{-5}$ | | $-3.05 \times 10^{-5}$ | |
| $6.05 \times 10^{-5}$ | | $-2.2 \times 10^{-6}$ | |
| $3.20 \times 10^{-5}$ | | $-3.07 \times 10^{-5}$ | |
| $4.71 \times 10^{-5}$ | | $-1.56 \times 10^{-5}$ | |
| $8.26 \times 10^{-5}$ | | $1.99 \times 10^{-5}$ | |

reference value of measurement (with standard deviation)：

$6.267 \times 10^{-5} \pm 1.88 \times 10^{-5}$ m

# Experiment

# A1-3

中文 (Official)

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

B1. answer sheet. 1.0 pt

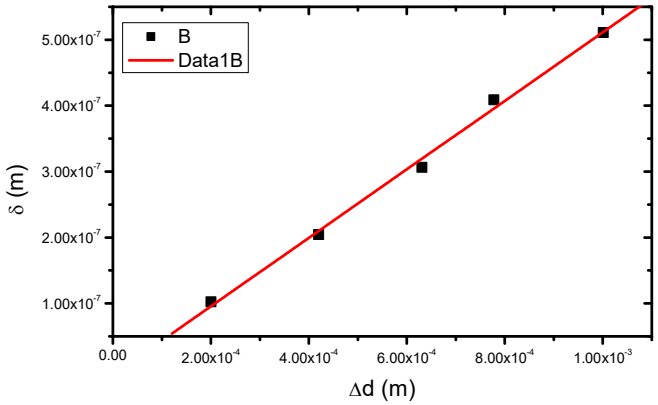
| $F$ (N) | $d$ (m) | $\bar{d} = d_0$ (m) |
|---|---|---|
| 0 | $-1.82 \times 10^{-5}$ | $-1.386 \times 10^{-5}$ |
| | $-1.09 \times 10^{-5}$ | |
| | $-6.69 \times 10^{-5}$ | |
| | $1.72 \times 10^{-5}$ | |
| | $9.5 \times 10^{-6}$ | |

| $F$ (N) | $d - d_0 = \Delta d$ (m) | $\overline{\Delta d}$ (m) |
|---|---|---|
| $2.00 \times 10^{-9}$ | $1.9136 \times 10^{-4}$ | $2.0046 \times 10^{-4}$ |
| | $2.0016 \times 10^{-4}$ | |
| | $1.9766 \times 10^{-4}$ | |
| | $2.0096 \times 10^{-4}$ | |
| | $2.1216 \times 10^{-4}$ | |
| $4.00 \times 10^{-9}$ | $4.2336 \times 10^{-4}$ | $4.2018 \times 10^{-4}$ |
| | $4.1536 \times 10^{-4}$ | |
| | $4.3526 \times 10^{-4}$ | |
| | $4.0346 \times 10^{-4}$ | |
| | $4.2346 \times 10^{-4}$ | |
| $6.00 \times 10^{-9}$ | $6.4136 \times 10^{-4}$ | $6.3112 \times 10^{-4}$ |
| | $6.4646 \times 10^{-4}$ | |
| | $6.4256 \times 10^{-4}$ | |
| | $6.2186 \times 10^{-4}$ | |
| | $6.0336 \times 10^{-4}$ | |
| $8.00 \times 10^{-9}$ | $7.1906 \times 10^{-4}$ | $7.7770 \times 10^{-4}$ |
| | $7.8006 \times 10^{-4}$ | |
| | $8.0506 \times 10^{-4}$ | |
| | $7.7736 \times 10^{-4}$ | |
| | $8.0696 \times 10^{-4}$ | |

| | | |
|---|---|---|
| $1.000 \times 10^{-8}$ | $1.01216 \times 10^{-3}$ | $1.00106 \times 10^{-3}$ |
| | $1.00076 \times 10^{-3}$ | |
| | $1.00336 \times 10^{-3}$ | |
| | $9.7846 \times 10^{-4}$ | |
| | $1.01076 \times 10^{-3}$ | |

B2. 1.0 pt

| $F$ (N) | $\delta$ (m) | $\overline{\Delta d}$ (m) |
|---|---|---|
| $2.00 \times 10^{-9}$ | $1.022 \times 10^{-7}$ | $2.0046 \times 10^{-4}$ |
| $4.00 \times 10^{-9}$ | $2.044 \times 10^{-7}$ | $4.2018 \times 10^{-4}$ |
| $6.00 \times 10^{-9}$ | $3.066 \times 10^{-7}$ | $6.3112 \times 10^{-4}$ |
| $8.00 \times 10^{-9}$ | $4.088 \times 10^{-7}$ | $7.7770 \times 10^{-4}$ |
| $1.000 \times 10^{-8}$ | $5.109 \times 10^{-7}$ | $1.00106 \times 10^{-3}$ |




B3. 0.4 pt

$C_1 = 5.196 \times 10^{-4}$

# Experiment

# A1-5

中文 (Official)

## Part C. Double layer cantilever beam

C1. 1.0 pt

| $T$ (K) | $d$ (m) | $\bar{d} = d_0$ (m) |
|---|---|---|
| *300* | $-2.28 \times 10^{-5}$ | $-2.836 \times 10^{-5}$ |
| | $-7.24 \times 10^{-5}$ | |
| | $-1.61 \times 10^{-5}$ | |
| | $-2.84 \times 10^{-5}$ | |
| | $-2.1 \times 10^{-6}$ | |

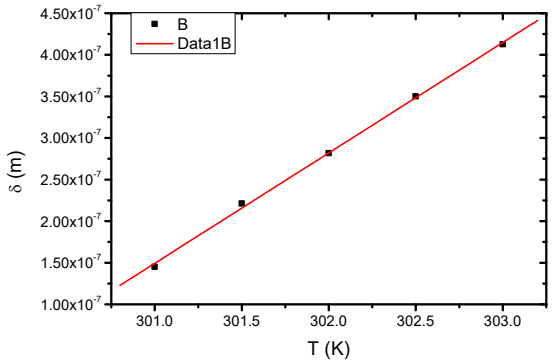
| $T$ (K) | $d - d_0 = \Delta d$ (m) | $\overline{\Delta d}$ (m) |
|---|---|---|
| 301 | $2.8506 \times 10^{-4}$ | $2.7928 \times 10^{-4}$ |
| | $2.7186 \times 10^{-4}$ | |
| | $2.7466 \times 10^{-4}$ | |
| | $2.7436 \times 10^{-4}$ | |
| | $2.9046 \times 10^{-4}$ | |
| 301.5 | $4.1276 \times 10^{-4}$ | $4.2568 \times 10^{-4}$ |
| | $4.1336 \times 10^{-4}$ | |
| | $4.6276 \times 10^{-4}$ | |
| | $4.3956 \times 10^{-4}$ | |
| | $3.9996 \times 10^{-4}$ | |
| 302 | $5.4146 \times 10^{-4}$ | $5.4186 \times 10^{-4}$ |
| | $5.4676 \times 10^{-4}$ | |
| | $5.3386 \times 10^{-4}$ | |
| | $5.6706 \times 10^{-4}$ | |
| | $5.2016 \times 10^{-4}$ | |
| 302.5 | $6.9866 \times 10^{-4}$ | $6.7330 \times 10^{-4}$ |
| | $6.6726 \times 10^{-4}$ | |
| | $6.6416 \times 10^{-4}$ | |
| | $6.8296 \times 10^{-4}$ | |
| | $6.5346 \times 10^{-4}$ | |
| 303 | $7.6026 \times 10^{-4}$ | $7.9410 \times 10^{-4}$ |

| | | |
|---|---|---|
| | $7.7046 \times 10^{-4}$ | |
| | $7.9706 \times 10^{-4}$ | |
| | $8.1346 \times 10^{-4}$ | |
| | $8.2926 \times 10^{-4}$ | |

C2. 1.0 pt

| $T$ (K) | $\overline{\Delta d}$ (m) | $\delta$ (m) |
|---|---|---|
| 301 | $2.7928 \times 10^{-4}$ | $1.451 \times 10^{-7}$ |
| 301.5 | $4.2568 \times 10^{-4}$ | $2.212 \times 10^{-7}$ |
| 302 | $5.4186 \times 10^{-4}$ | $2.816 \times 10^{-7}$ |
| 302.5 | $6.7330 \times 10^{-4}$ | $3.499 \times 10^{-7}$ |
| 303 | $7.9410 \times 10^{-4}$ | $4.127 \times 10^{-7}$ |

Slope: $1.337 \times 10^{-7}$




C3. 0.6 pt

$4.98 \times 10^{10}$ N/m$^2$ $(Pa)$

# Experiment

# A1-7

中文 (Official)

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

D1. 0.6 pt

| | $d$ (m) | $\bar{d} = d_0$ (m) |
|---|---|---|
| Sample 0 | $3.4 \times 10^{-6}$ | $-7.2 \times 10^{-6}$ |
| | $-1.15 \times 10^{-5}$ | |
| | $-1.61 \times 10^{-5}$ | |
| | $2.09 \times 10^{-5}$ | |
| | $-3.25 \times 10^{-5}$ | |

| | $d - d_0 = \Delta d$ (m) | $\overline{\Delta d}$ (m) |
|---|---|---|
| Sample 1 | $-8.2414 \times 10^{-4}$ | $-8.2552 \times 10^{-4}$ |
| | $-8.2884 \times 10^{-4}$ | |
| | $-8.2794 \times 10^{-4}$ | |
| | $-8.1934 \times 10^{-4}$ | |
| | $-8.2584 \times 10^{-4}$ | |

D2. Assume the function form of the displacement and coverage ratio (CR) 0.6 pt

can be expressed as： $\delta = C_2 \frac{CoverageRatio}{EI^*} L^4$. Estimate $C_2$ based on your data obtained in A9. You can use the correlation between $\delta$ and $\overline{\Delta d}$ in A6.

$-7.89 \times 10^{-2}$

# Experiment

# A1-8

中文 (Official)

D3. 0.8 pt

| | $d - d_0 = \Delta d$ (m) | $\overline{\Delta d}$ (m) |
|---|---|---|
| Sample 2 | $-6.1734 \times 10^{-4}$ | $-6.0866 \times 10^{-4}$ |
| | $-6.0434 \times 10^{-4}$ | |
| | $-6.0054 \times 10^{-4}$ | |
| | $-5.9884 \times 10^{-4}$ | |
| | $-6.2224 \times 10^{-4}$ | |
| | $d - d_0 = \Delta d$ (m) | $\overline{\Delta d}$ (m) |
| Sample 3 | $-2.4924 \times 10^{-4}$ | $-2.4588 \times 10^{-4}$ |
| | $-2.6224 \times 10^{-4}$ | |
| | $-2.4764 \times 10^{-4}$ | |
| | $-2.4854 \times 10^{-4}$ | |
| | $-2.2174 \times 10^{-4}$ | |

D4. 0.6 pt

Sample 2: 0.738%

Sample 3: 0.298%

# Experiment
# Solution

# A2

English

Q2 Exploring the spatial structure of the sample with optical methods

## Solution

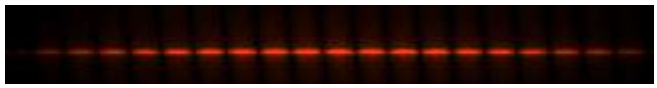
### Part A. Collimation of light and sample

A.1 0.5 pt

$(X_{sample}, Y_{sample})$= **(3700, -2900)**

A.2 0.5 pt

Interference pattern:



| Order, fringe | -2, Dark | -1, Dark | 1, Dark | 2, Dark |
|---|---|---|---|---|
| $(x, y)$ | **(-0.98 , 0)** | **(-0.38, 0)** | **(0.34, 0)** | **(0.98, 0)** |
| $S$ (cm) | **0.98** | **0.38** | **0.34** | **0.98** |
| $\Delta S$ (cm) | **0.65** | | | |

### Part B. Exploration of sample structure size

B.1 0.5 pt

$$d = \frac{m \times \lambda}{\sin\left(\tan^{-1}\left(\frac{S}{L}\right)\right)}$$

# Experiment
# Solution

# A2

English

B.2 1.5 pt

$L$ = **60 cm**

$\lambda$ = **488 nm**

| Data | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| (x, y) | (-4.04, 4.68) | (3.00, 5.50) | (4.08, -4.60) | (5.76, 0.48) | (-5.68, 0.56) |
| $S$ (cm) | **6.18** | **6.26** | **6.15** | **5.78** | **5.71** |
| $\bar{S}$ (cm) | $\mathbf{6.02 \pm 0.11}$ | | | | |
| $tan^{-1}\left(\frac{\bar{S}}{L}\right)$ | $\mathbf{0.0999 \pm 0.0019}$ | | | | |

$\lambda$ = **514 nm**

| Data | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $(x, y)$ | (3.32,5.64) | (6.16,0.48) | (4.46,-4.90) | (-3.12,-5.64) | (-6,-0.64) |
| $S$ (cm) | **6.54** | **6.18** | **6.63** | **6.45** | **6.03** |
| $\bar{S}$ (cm) | $\mathbf{6.37 \pm 0.11}$ | | | | |
| $tan^{-1}\left(\frac{\bar{S}}{L}\right)$ | $\mathbf{0.1057 \pm 0.0019}$ | | | | |

$\lambda$ = **632.8 nm**

| Data | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $(x, y)$ | (4.04,7.00) | (7.44,0.68) | (5.24,-5.96) | (-3.96,-7.04) | (-7.44,-0.68) |
| $S$ (cm) | **8.08** | **7.47** | **7.94** | **8.08** | **7.47** |
| $\bar{S}$ (cm) | $\mathbf{7.81 \pm 0.14}$ | | | | |
| $tan^{-1}\left(\frac{\bar{S}}{L}\right)$ | $\mathbf{0.1294 \pm 0.0023}$ | | | | |

$\lambda$ = **694.3 nm**

| Data | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $(x, y)$ | (-5.84,6.50) | (8.20,0.76) | (-4.28,-7.72) | (5.96,-6.60) | (4.48,7.72) |
| $S$ (cm) | **8.74** | **8.24** | **8.83** | **8.89** | **8.93** |

| | |
|---|---|
| $\bar{S}$ (cm) | $\mathbf{8.73 \pm 0.13}$ |
| $tan^{-1}\left(\frac{\bar{S}}{L}\right)$ | $\mathbf{0.1444 \pm 0.0021}$ |

B.3 1.0 pt

$$a = 5.627\ \mu m$$

| $\lambda$ (nm) | $d$ (µm) | $a$ (µm) |
|---|---|---|
| 488 | 4.89 | 5.65 |
| 514 | 4.87 | 5.63 |
| 632.8 | 4.90 | 5.66 |
| $\bar{a}$ (µm) | $\mathbf{5.627 \pm 0.020}$ | |

# Experiment
# Solution

# A2

English

## Part C. Exploration of sample structure size

C.1 0.8 pt

$\lambda$ = **488 nm**

| L=90 cm, Axis1 | | | | |
|---|---|---|---|---|
| Order, fringe | 4, Bright | 5, Bright | 6, Bright | 7, Bright |
| $(x, y)$ | **(3.01, 1.46)** | **(3.67, 1.91)** | **(4.30, 2.24)** | **(5.00, 2.50)** |
| $S$ (cm) | **3.35** | **4.14** | **4.85** | **5.59** |
| $tan^{-1}\left(\frac{S}{L}\right)$ | **0.0372** | **0.0459** | **0.0538** | **0.0620** |

| L=90 cm, Axis 2 | | | | |
|---|---|---|---|---|
| Order, fringe | 4, Bright | 5, Bright | 6, Bright | 7, Bright |
| $(x, y)$ | **(-1.64, 3.46)** | **(-2.07, 4.19)** | **(-2.41, 4.95)** | **(-2.87, 5.73)** |
| $S$ (cm) | **3.83** | **4.67** | **5.51** | **6.41** |
| $tan^{-1}\left(\frac{S}{L}\right)$ | **0.0425** | **0.0519** | **0.0611** | **0.0711** |

$\lambda$ = **514 nm**

| L=90 cm, Axis1 | | | | |
|---|---|---|---|---|
| Order, fringe | 4, Bright | 5, Bright | 6, Bright | 7, Bright |
| $(x, y)$ | **(3.08, 1.56)** | **(3.76, 1.92)** | **(4.44, 2.28)** | **(5.20, 2.60)** |
| $S$ (cm) | **3.45** | **4.22** | **4.99** | **5.81** |
| $tan^{-1}\left(\frac{S}{L}\right)$ | **0.0383** | **0.0469** | **0.0554** | **0.0645** |

| L=90 cm, Axis 2 | | | | |
|---|---|---|---|---|
| Order, fringe | 4, Bright | 5, Bright | 6, Bright | 7, Bright |
| $(x, y)$ | **(-1.76, 3.68)** | **(-2.26, 4.38)** | **(-2.58, 5.34)** | **(-3.22, 6.04)** |
| $S$ (cm) | **4.09** | **4.92** | **5.93** | **6.84** |
| $tan^{-1}\left(\frac{S}{L}\right)$ | **0.0454** | **0.0547** | **0.0658** | **0.0759** |

$\lambda =$ **632.8 nm**

| L=90 cm, Axis1 | | | | |
|---|---|---|---|---|
| Order, fringe | 4, Bright | 5, Bright | 6, Bright | 7, Bright |
| $(x, y)$ | **(3.84, 1.96)** | **(4.68, 2.44)** | **(5.48, 2.88)** | **(6.44, 3.32)** |
| $S$ (cm) | **4.31** | **5.28** | **6.19** | **7.25** |
| $tan^{-1}\left(\frac{S}{L}\right)$ | **0.0479** | **0.0586** | **0.0687** | **0.0803** |

| L=90 cm, Axis 2 | | | | |
|---|---|---|---|---|
| Order, fringe | 4, Bright | 5, Bright | 6, Bright | 7, Bright |
| $(x, y)$ | **(-2.28, 4.56)** | **(-2.84, 5.48)** | **(-3.36, 6.52)** | **(-3.84, 7.52)** |
| $S$ (cm) | **5.10** | **6.17** | **7.33** | **8.44** |
| $tan^{-1}\left(\frac{S}{L}\right)$ | **0.0566** | **0.0685** | **0.0813** | **0.0935** |

# Experiment
# Solution

# A2

English

$\lambda$ = **694.3 nm**

| L=90 cm, Axis 1 | | | | |
|---|---|---|---|---|
| Order, fringe | 4, Bright | 5, Bright | 6, Bright | 7, Bright |
| $(x, y)$ | **(4.24, 2.12)** | **(5.08, 2.80)** | **(6.04, 3.20)** | **(7.04, 3.68)** |
| $S$ (cm) | **4.74** | **5.80** | **6.84** | **7.96** |
| $tan^{-1}\left(\frac{S}{L}\right)$ | **0.0526** | **0.0644** | **0.0758** | **0.0882** |

| L=90 cm, Axis 2 | | | | |
|---|---|---|---|---|
| Order, fringe | 4, Bright | 5, Bright | 6, Bright | 7, Bright |
| $(x, y)$ | **(-2.48, 5.00)** | **(-3.08, 6.04)** | **(-3.60, 7.16)** | **(-4.16, 8.28)** |
| $S$ (cm) | **5.58** | **6.78** | **8.01** | **9.27** |
| $tan^{-1}\left(\frac{S}{L}\right)$ | **0.0619** | **0.0752** | **0.0888** | **0.103** |

# Experiment
# Solution

# A2

English

C.2 0.7 pt

| $\lambda$ (nm) | $\Delta S_\ell$ (cm) | $\ell$ (µm) | $\Delta S_w$ (cm) | $w$ (µm) |
|---|---|---|---|---|
| 488 | 0.748 | 58.7 | 0.860 | 51.1 |
| | 0.750 | 58.5 | 0.842 | 52.1 |
| 514 | 0.787 | 58.8 | 0.920 | 50.3 |
| | 0.794 | 58.3 | 0.891 | 51.9 |
| 632.8 | 0.978 | 58.2 | 1.12 | 51.1 |
| | 0.960 | 59.3 | 1.11 | 51.4 |
| 694.3 | 1.07 | 58.2 | 1.23 | 50.9 |
| | 1.07 | 58.2 | 1.22 | 51.4 |

$$\ell = 58.59\ \mu\text{m}$$
$$w = 50.78\ \mu\text{m}$$

# Experiment

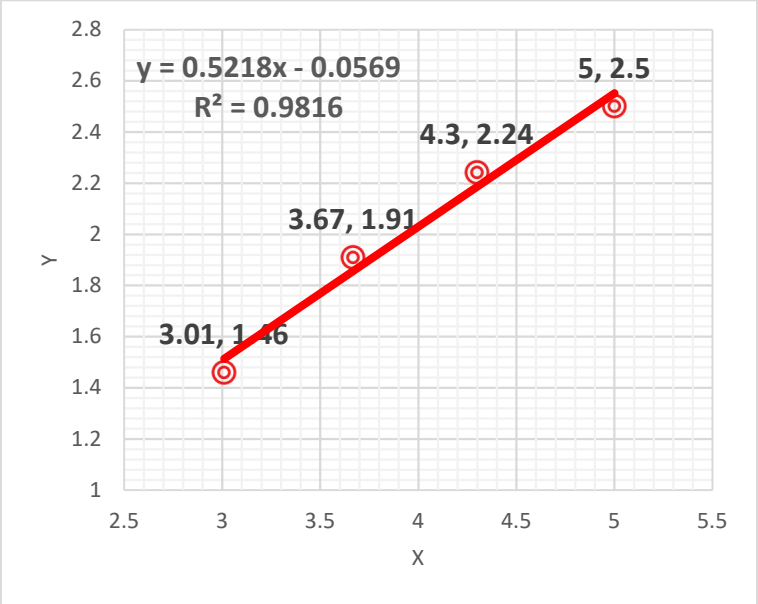
# Solution

# A2

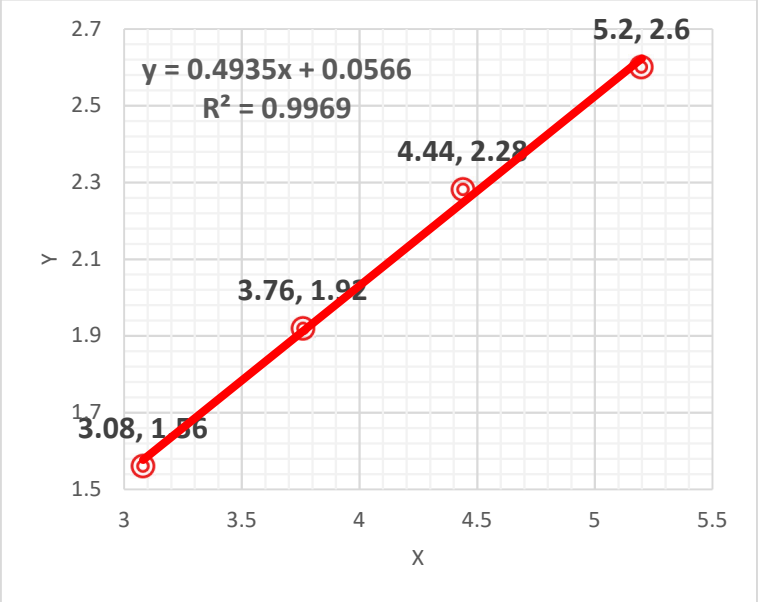
English

C.3 $\phi = 27°$ 1.0 pt

$\lambda =$ **488 nm** Axis 1 (long) $\phi =$ **27.6°**




$\lambda =$ **514 nm** Axis 1 (long) $\phi =$ **26.2°**

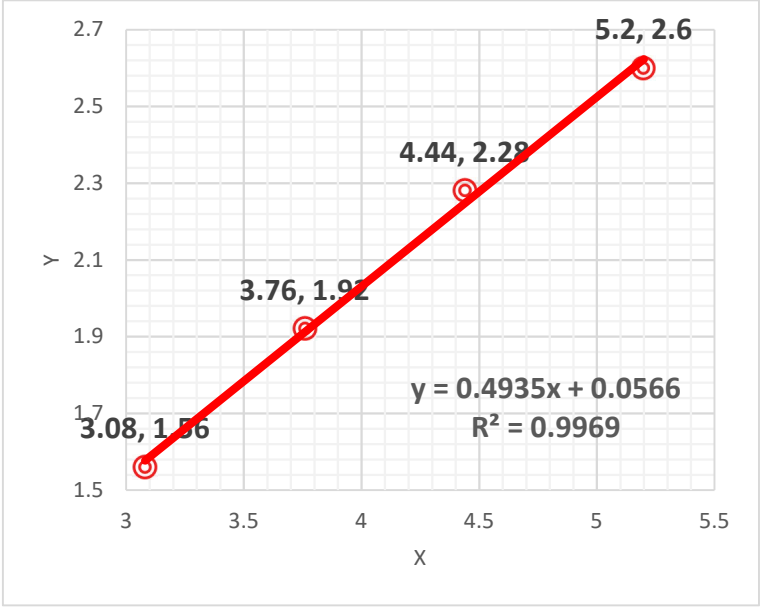


# Experiment Solution

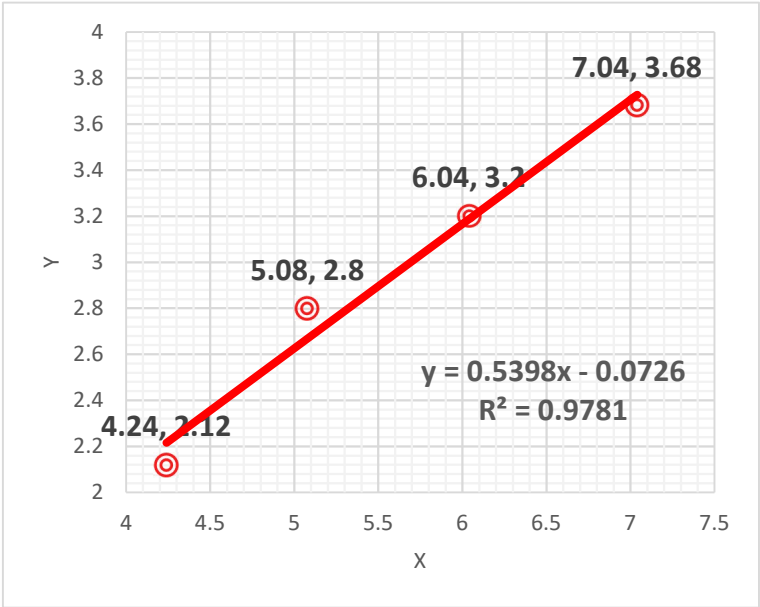
# A2

English

$\lambda =$ **632.8 nm** Axis 1 (long) $\phi =$ **27.7**




$\lambda =$ **694.3 nm** Axis 1 (long) $\phi =$ **28.4**



# Experiment

# Solution

# A2

English

## Part D. Exploration of sample structure size

D.1 1.9 pt

| Laser wavelength $\lambda$ = **914 nm** | | | |
|---|---|---|---|
| The center coordinates of the fine diffraction bright spot $(x, y)$ long | | | |
| **(1.98, 0.40)** | **(2.36, 1.62)** | **(2.64, 1.68)** | **(3.02, 1.68)** |
| **(1.96, 0.82)** | **(2.32, 1.22)** | **(2.70, 1.28)** | **(3.02, 1.30)** |
| **(1.98, 1.24)** | **(2.32, 0.84)** | **(2.66, 0.84)** | **(3.04, 1.66)** |
| **(1.98, 1.66)** | **(2.36, 0.42)** | **(2.62, 0.40)** | **(2.98, 0.50)** |
| The center coordinates of the fine diffraction bright spot $(x, y)$ short | | | |
| **(-2.06, 3.48)** | **(-1.72, 3.48)** | **(-1.38, 3.46)** | **(-1.06, 3.46)** |
| **(-2.08, 3.08)** | **(-1.74, 3.08)** | **(-1.40, 3.14)** | **(-1.00, 3.12)** |
| **(-2.08, 2.64)** | **(-1.74, 2.65)** | **(-1.38, 2.62)** | **(-1.02, 2.62)** |
| **(-2.06, 2.16)** | **(-1.68, 2.22)** | **(-1.36, 2.22)** | **(-1.02, 2.14)** |
| Calculate the distances between adjacent spots $\Delta S_x$ 、$\Delta S_y$ | | | |

| | $\Delta S_x$ (cm) | $\Delta S_y$ (cm) |
|---|---|---|
| long | **0.346** | **0.410** |
| short | **0.348** | **0.428** |

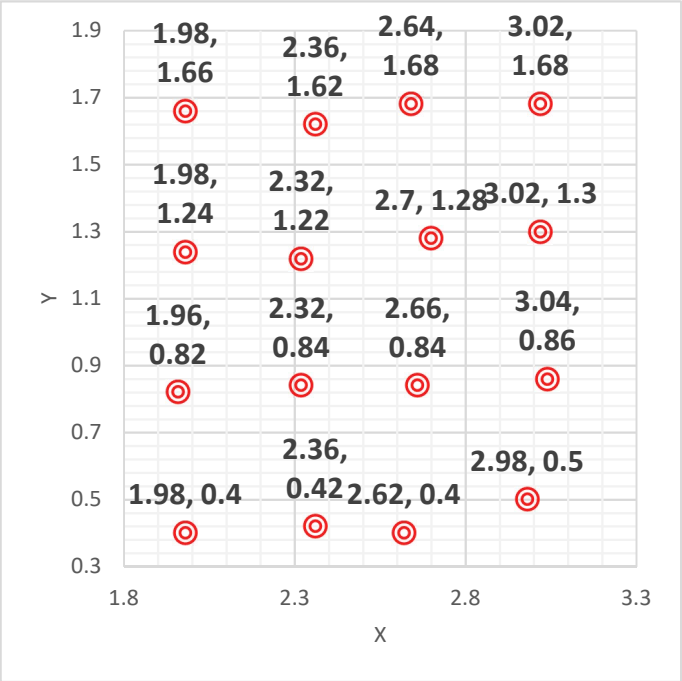
# Experiment
# Solution

# A2

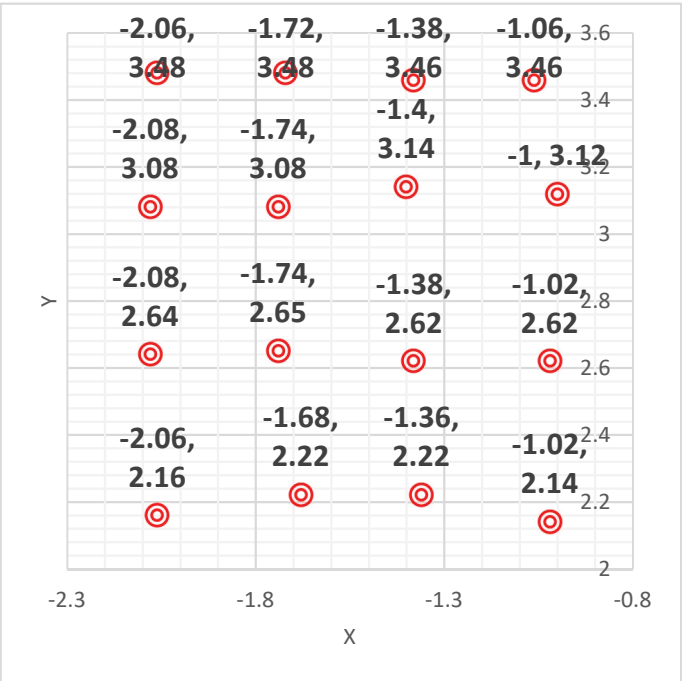
English

D.1.

long




short



# Experiment Solution

# A2

English

| Laser wavelength $\lambda$ = **1152 nm** | | | |
|---|---|---|---|
| The center coordinates of the fine diffraction bright spot $(x, y)$ long | | | |
| **(2.16, 0.56)** | **(2.60, 0.56)** | **(3.04, 0.56)** | **(3.48, 0.56)** |
| **(2.12, 1.16)** | **(2.58, 1.16)** | **(3.06, 1.14)** | **(3.48, 1.12)** |
| **(2.12, 1.64)** | **(2.60, 1.66)** | **(3.04, 1.68)** | **(3.48, 1.66)** |
| **(2.14, 2.26)** | **(2.62, 2.22)** | **(3.08, 2.18)** | **(3.48, 2.24)** |
| The center coordinates of the fine diffraction bright spot $(x, y)$ **short** | | | |
| **(-3.44, 4.44)** | **(-2.68, 4.42)** | **(-2.20, 4.42)** | **(-1.78, 4.42)** |
| **(-3.10, 3.86)** | **(-2.70, 3.88)** | **(-2.24, 3.84)** | **(-1.82, 3.88)** |
| **(-3.20, 3.38)** | **(-2.74, 3.38)** | **(-2.22, 3.34)** | **(-1.76, 3.34)** |
| **(-3.14, 2.78)** | **(-2.68, 2.78)** | **(-2.22, 2.78)** | **(-1.76, 2.76)** |

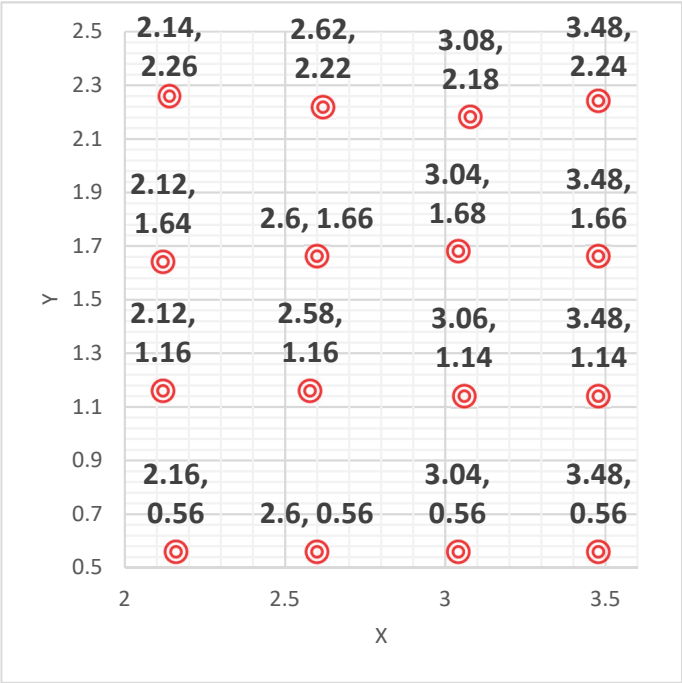
| | $\Delta S_x$ (cm) | $\Delta S_y$ (cm) |
|---|---|---|
| long | **0.448** | **0.555** |
| short | **0.452** | **0.550** |

# Experiment
# Solution

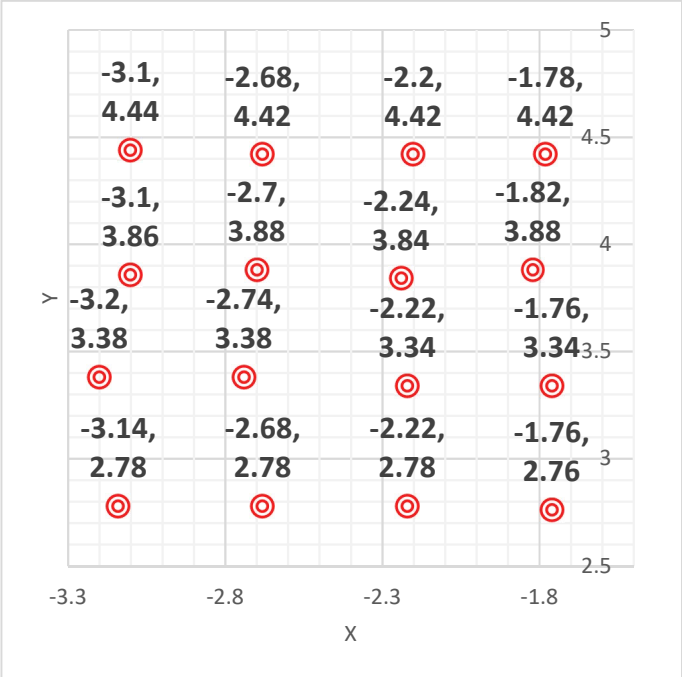
# A2

English

long




short



# Experiment Solution

# A2

English

Laser wavelength $\lambda$ = **1444 nm**

The center coordinates of the fine diffraction bright spot $(x, y)$ long

| | | | |
|---|---|---|---|
| **(3.34, 0.02)** | **(3.86, 0.02)** | **(4.42, 0.02)** | **(4.94, 0.04)** |
| **(3.34, 0.70)** | **(3.84, 0.72)** | **(4.42, 0.70)** | **(4.94, 0.74)** |
| **(3.36, 1.42)** | **(3.86, 1.42)** | **(4.44, 1.40)** | **(5.00, 1.46)** |
| **(3.34, 2.08)** | **(3.86, 2.08)** | **(4.48, 2.08)** | **(5.00, 2.10)** |

The center coordinates of the fine diffraction bright spot $(x, y)$ **short**

| | | | |
|---|---|---|---|
| **(-3.86, 4.16)** | **(-3.32, 4.18)** | **(-2.74, 4.18)** | **(-2.14, 4.16)** |
| **(-3.84, 3.48)** | **(-3.28, 3.48)** | **(-2.72, 3.48)** | **(-2.12, 3.48)** |
| **(-3.80, 2.78)** | **(-3.26, 2.78)** | **(-2.72, 2.78)** | **(-2.12, 2.80)** |
| **(-3.78, 2.02)** | **(-3.26, 2.06)** | **(-2.70, 2.06)** | **(-2.00, 1.98)** |

計算圖形斑點間距$\Delta S_x$、$\Delta S_y$ **0.5 pt**

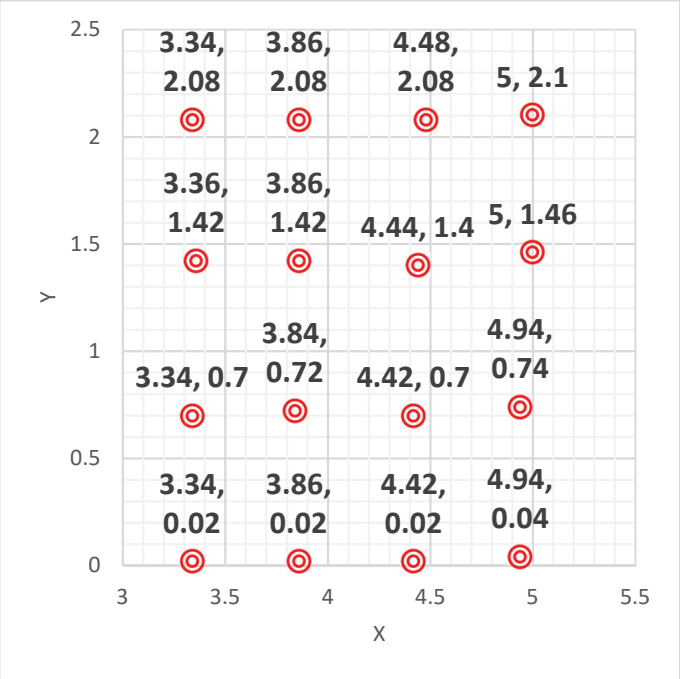
| | $\Delta S_x$ (cm) | $\Delta S_y$ (cm) |
|---|---|---|
| long | **0.542** | **0.687** |
| short | **0.575** | **0.713** |

# Experiment Solution

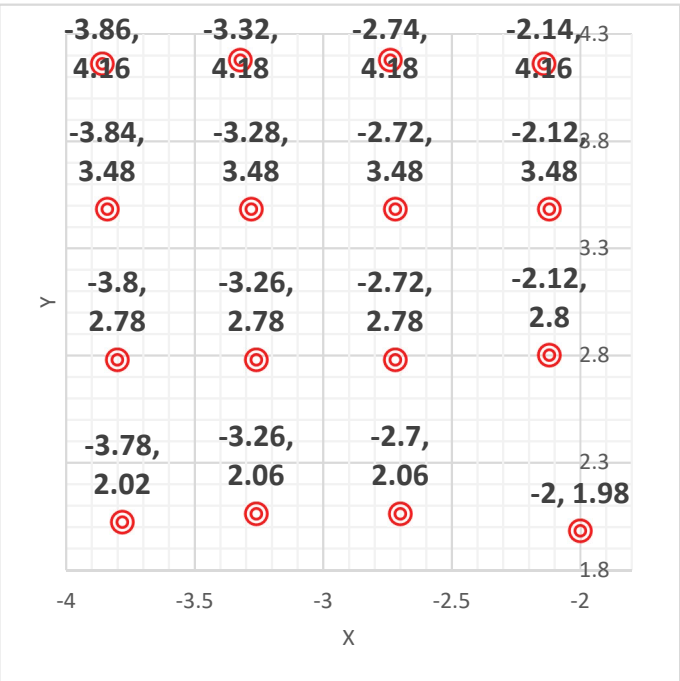
# A2

English

long




short



# Experiment

# Solution

# A2

English

D.2 0.6 pt

$d_x = 249.3\ \mu m$ $d_y = 198.2\ \mu m$

| λ (nm) | | $d_x$ (µm) | $d_y$ (µm) |
|---|---|---|---|
| 914 | long Axis | 251 | 211 |
| | short Axis | 250 | 203 |
| 1152 | long Axis | 244 | 197 |
| | short Axis | 242 | 199 |
| 1444 | long Axis | 253 | 199 |
| | short Axis | 239 | 192 |

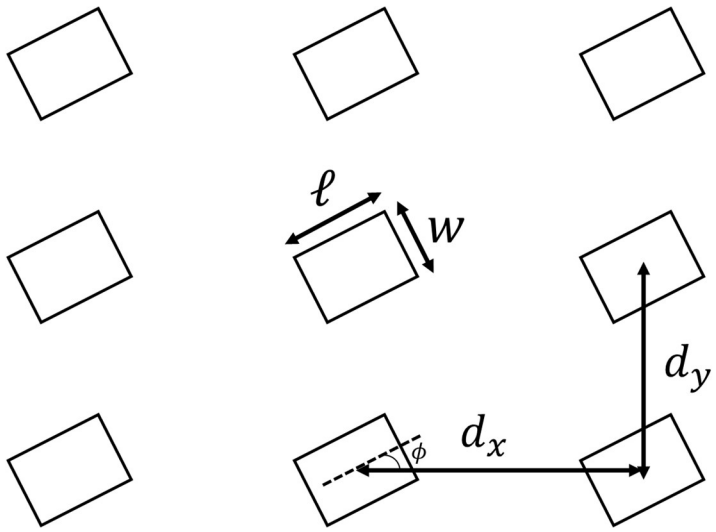
# Experiment
# Solution

# A2

English

## Part E. Exploration of sample structure size

E.1. 1.0 pt




$(a, \ell, w, d_x, d_y, \phi) =$

(5.627 um, 58.59 um, 50.78 um, 249.3 um, 198.2 um, 27 degree)