

SOLUTION OF EXPERIMENT PROBLEM 2

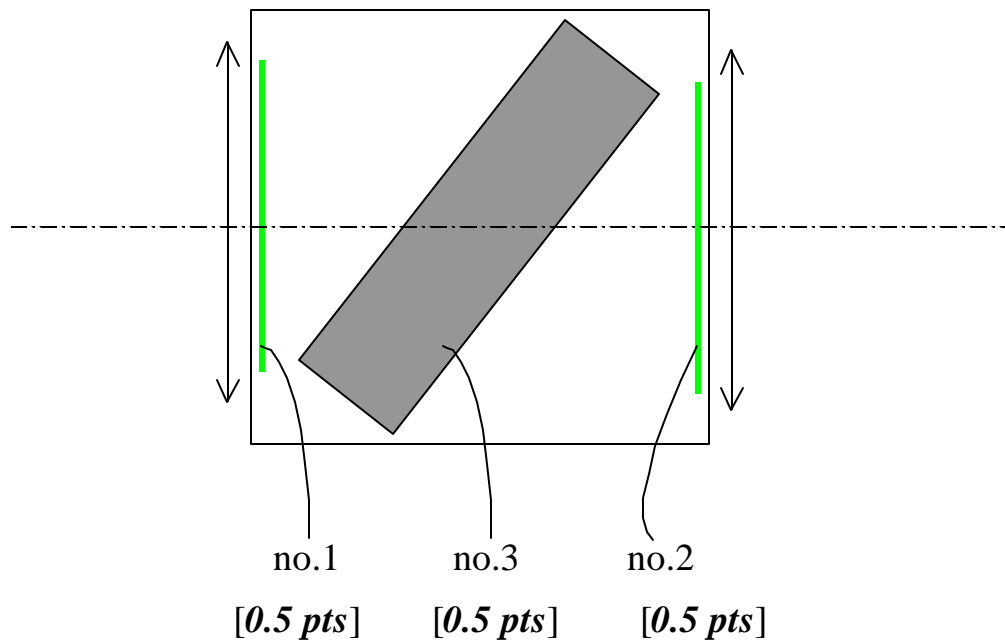
1. The optical components are **[total 1.5 pts]**:

no.1 Diffraction grating [0.5 pts]

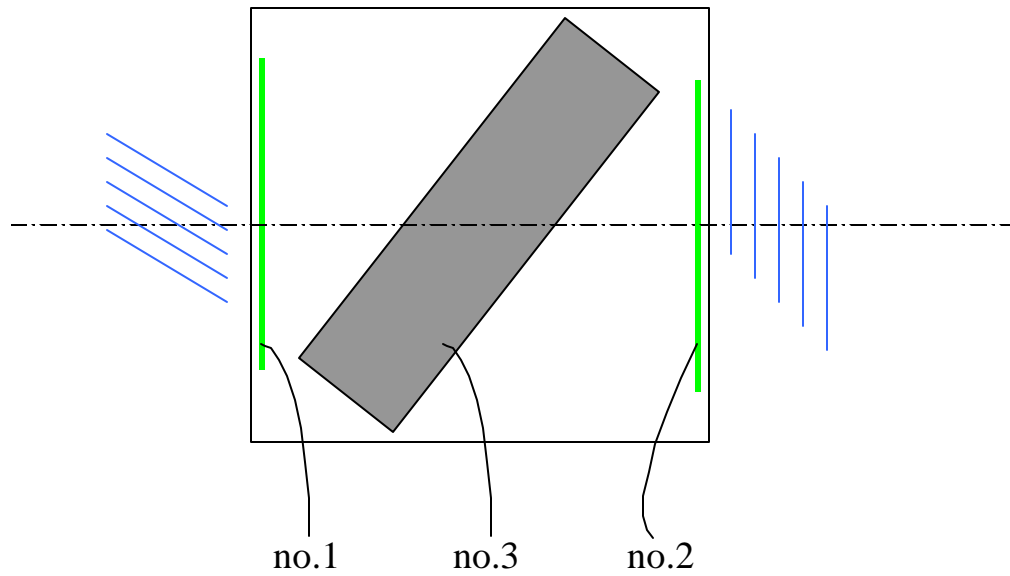
no.2 Diffraction grating [0.5 pts]

no.3 Plan-parallel plate [0.5 pts]

2. Cross section of the box **[total 1.5 pts]**:



3. Additional information [total 1.0 pts]:



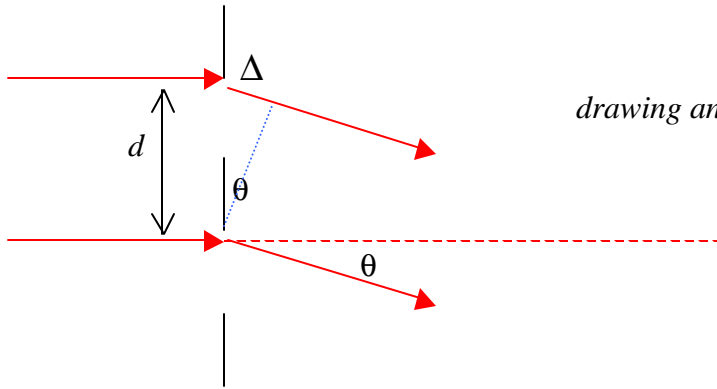
Distance of the grating (no.1)
to the left wall is practically zero
[0.2 pts]

Distance of the grating (no.2)
to the right wall is practically zero
[0.2 pts]

Lines of grating no.1 is at
right angle to the slit
[0.3 pts]

Lines of grating no. 2
is parallel to the slit
[0.3 pts]

4. Diffraction grating [total 2.0 pts]:



drawing and labels should be complete
[0.6 pts]

Path length difference:

$$\Delta = d \sin \theta , \quad d = \text{spacing of the grating}$$

Diffraction order:

$$\Delta = m \lambda , \quad m = \text{order number}$$

Hence, for the first order ($m = 1$):

$$\sin \theta = \lambda / d \quad [0.4 \text{ pts}]$$

Observation data:

$\tan \theta$	θ	$\sin \theta$	
0.34	18.78°	0.3219	
0.32	17.74°	0.3048	<i>number of data</i> ³³
0.32	17.74°	0.3048	

[0.5 pts]

Name of component no.1	Specification
Diffraction grating	Spacing = $2.16 \mu\text{m}$
	Lines at right angle to the slit

[0.4 pts]

[0.1 pts]

Note: true value of grating spacing is $2.0 \mu\text{m}$, deviation of the result $\leq 10\%$

5. Diffraction grating **[total 2.0 pts]**:

For the derivation of the formula, see nr.4 above.

[1.0 pts]

Observation data:

$\tan\theta$	θ	$\sin\theta$
1.04	46.12°	0.7208
0.96	43.83°	0.6925
1.08	47.20°	0.7330

number of data ³³

[0.5 pts]

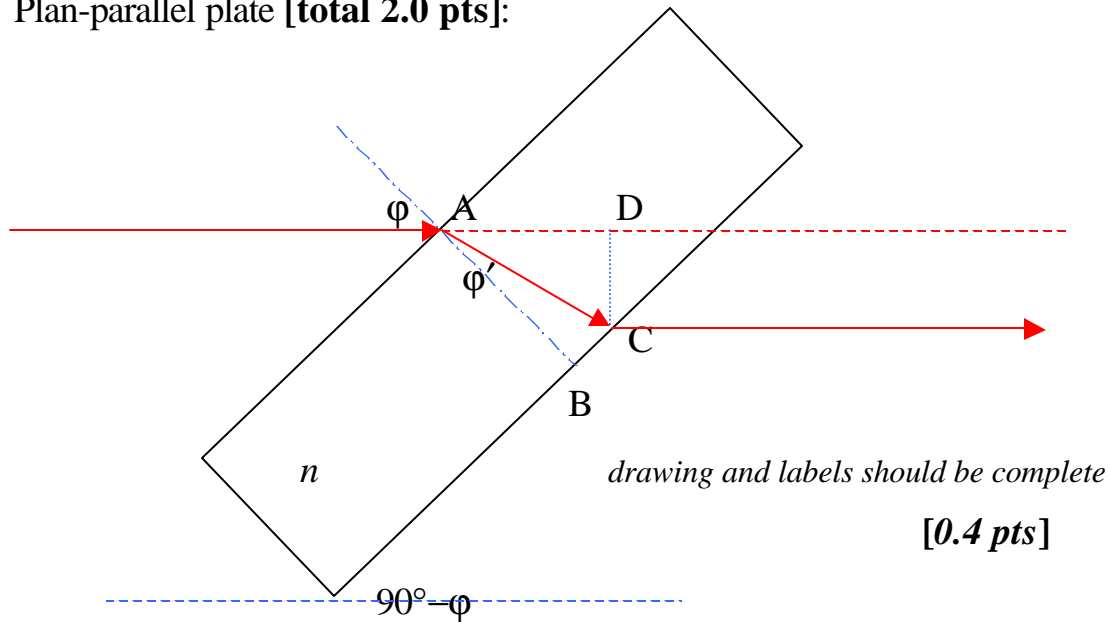
Name of component no.2	Specification
Diffraction grating	Spacing = 0.936 μm Lines parallel to the slit

[0.4 pts]

[0.1 pts]

Note: true value of grating spacing is 1.0 μm , deviation of the result $\leq 10\%$

6. Plan-parallel plate [total 2.0 pts]:



Snell's law:

$$\sin \phi = n \sin \phi' , \quad \phi' = \angle BAC$$

Path length inside the plate:

$$AC = AB / \cos \phi' , \quad AB = h = \text{plate thickness}$$

Beam displacement:

$$CD = t = AC \sin \angle CAD , \quad \angle CAD = \phi - \phi'$$

Hence:

$$t = h \sin \phi \left[1 - \cos \phi / (n^2 - \sin^2 \phi)^{1/2} \right] \quad [0.6 \text{ pts}]$$

Observation data:

ϕ	t	
0	0	(angle between beam and axis 49°)
49°	7.3 arbitrary scale	[0.5 pts]

Name of component no.3	Specification	
Plane-parallel plate	Thickness = 17.9 mm	[0.2 pts]
	Angle to the axis of the box 49°	[0.3 pts]

Note: - true value of plate thickness is 20 mm
 - true value of angle to the axis of the box is 52°
 - deviation of the results $\leq 20\%$.