The diffraction grating

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Warm-up question

from Nelkon & Parker, *Advanced Level Physics*

A diffraction grating has 400 lines per mm and is illuminated normally by monochromatic light of wavelength 600 nm (6×10^{-7} m). Calculate (a) the grating spacing, (b) the angle away from the normal at which the first order maximum is seen, (c) the number of diffraction maxima obtained.

Lesson Objectives

1. To be able to answer questions on diffraction gratings.
2. To know one application of diffraction gratings.
3. To discuss revision for the summer exam in unit 2.

Textbook pp. 205–207

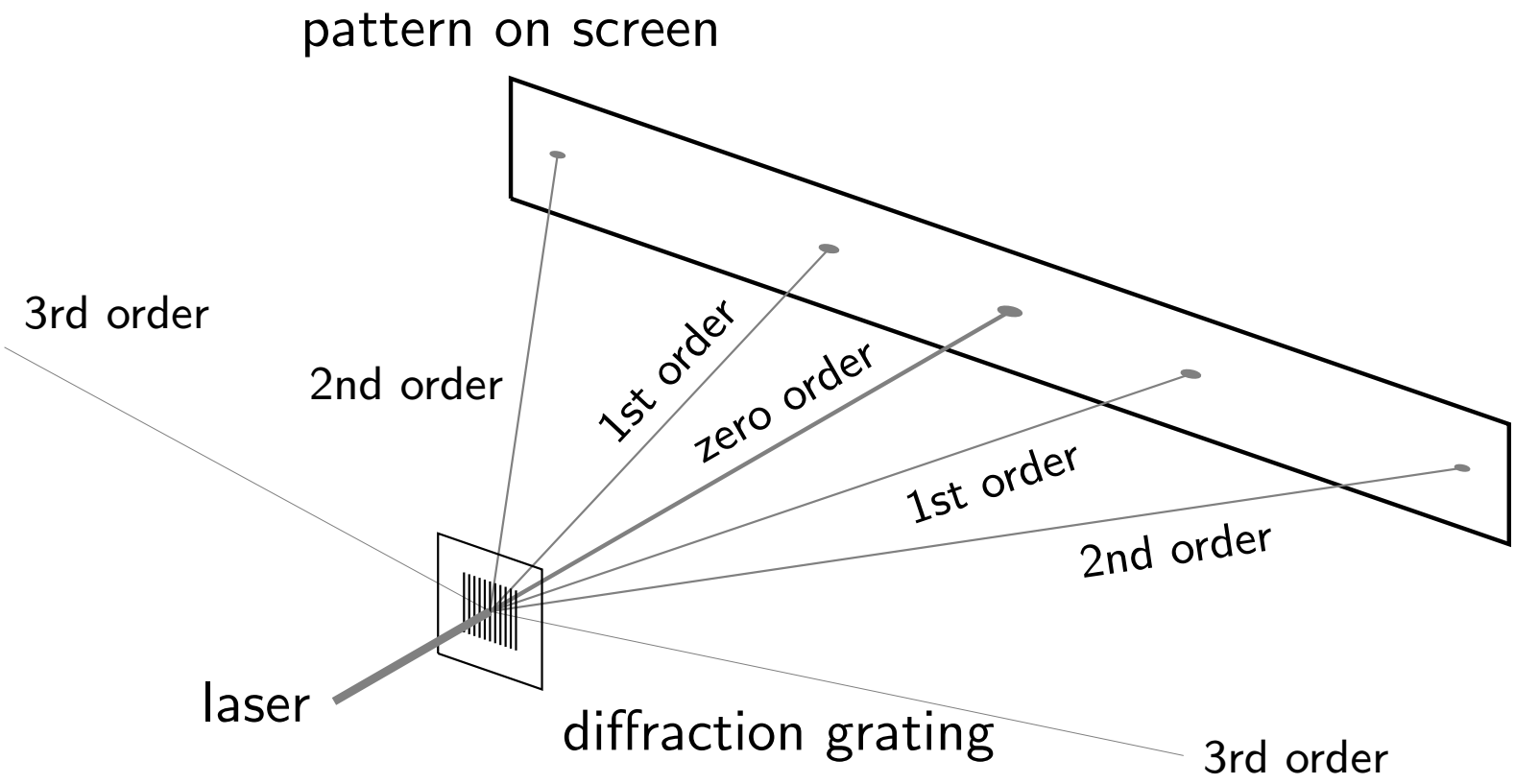
REMINDER: Office hours are week 2 Tuesdays 3.45–5.0 p.m. in room 19.
Next office hours: Tuesday 1 May 2012

Specification Requirement

Diffraction
The plane diffraction grating at normal incidence; optical details of the spectrometer will not be required.
Derivation of $d \sin\theta = n\lambda$,
where n is the order number.
Applications; e.g. to spectral analysis of light from stars.

[AQA GCE AS and A Level Specification Physics A, 2009/10 onwards]

Diffraction grating



Diffraction grating question

from Nelkon & Parker, *Advanced Level Physics*, adapted

A diffraction grating having 500 lines per mm is used to determine the wavelength of a spectral line. When the light is incident normally on the grating the third order spectrum, measured using a spectrometer, occurs at an angle of 60.32° to the normal.
Calculate the wavelength of the spectral line.
Why is the value obtained by using the third order maximum likely to be more accurate than if the first order were used?

Diffraction grating question

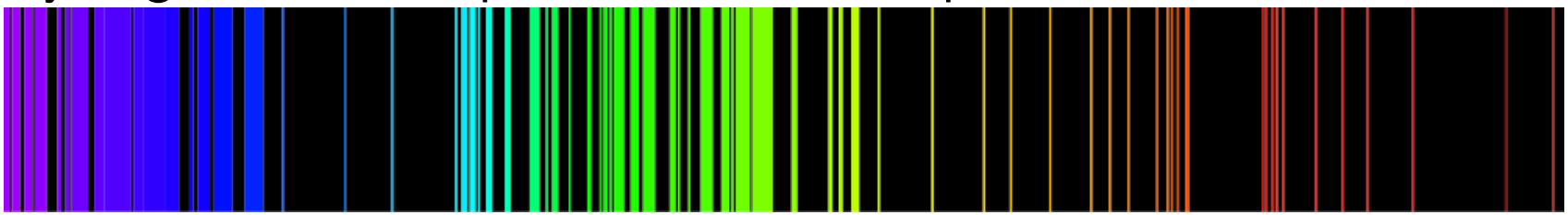
from Nelkon & Parker, *Advanced Level Physics*, adapted

A parallel beam of sodium light is incident normally on a diffraction grating. A telescope is used to view the diffraction spectra, which is 20 cm from the grating. The angle between the two first order spectra on either side of the normal is 27°. Assuming that the temperature in the room is 18 °C, and wavelength of the sodium light is 5.893×10^{-7} m, find the number of rulings per mm on the grating.

Use of diffraction gratings: spectrometer

Diffraction gratings can be used in a spectrometer, a device which can measure wavelengths very accurately and can be used to study the spectrum of light from any light source.

Hydrogen emission spectrum, with few spectral lines in the visible.



Iron emission spectrum, showing the many spectral lines (think about iron glowing red / yellow / 'white' hot).

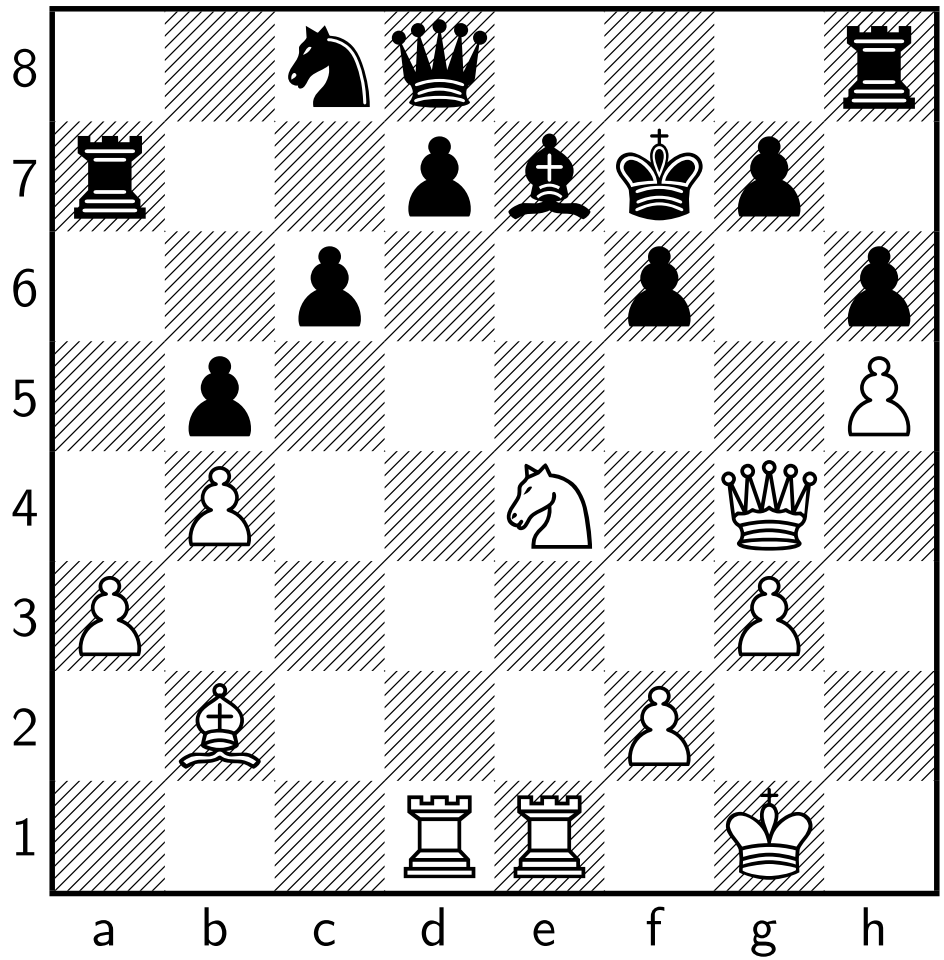
Advantages / disadvantages of diffraction gratings

- Diffraction gratings produce a longer spectrum: it separates the light much more than a prism.
- The spectrum in a diffraction grating is linear with wavelength (a prism 'stretches' the violet end of the spectrum, losing definition)
- Some light can be permanently lost in a diffraction grating, depending on how it is made. A prism normally has higher transmission.
- Diffraction gratings' output can be highly polarization dependent (a prism is polarization independent).
- Diffraction gratings have a maximum efficiency at a single wavelength, prisms tend to be more sensitive over an extended wavelength.

Revision: How to be good at physics

Hopefully you should have started revision by now!
You can either view it as dull, or really interesting – it is your chance to become the expert in the physics topics we have been studying!
So what is the secret of how to be good at physics?
It's the same as being good at anything, and to illustrate this, I'm going to show you a chess position.

Chess position

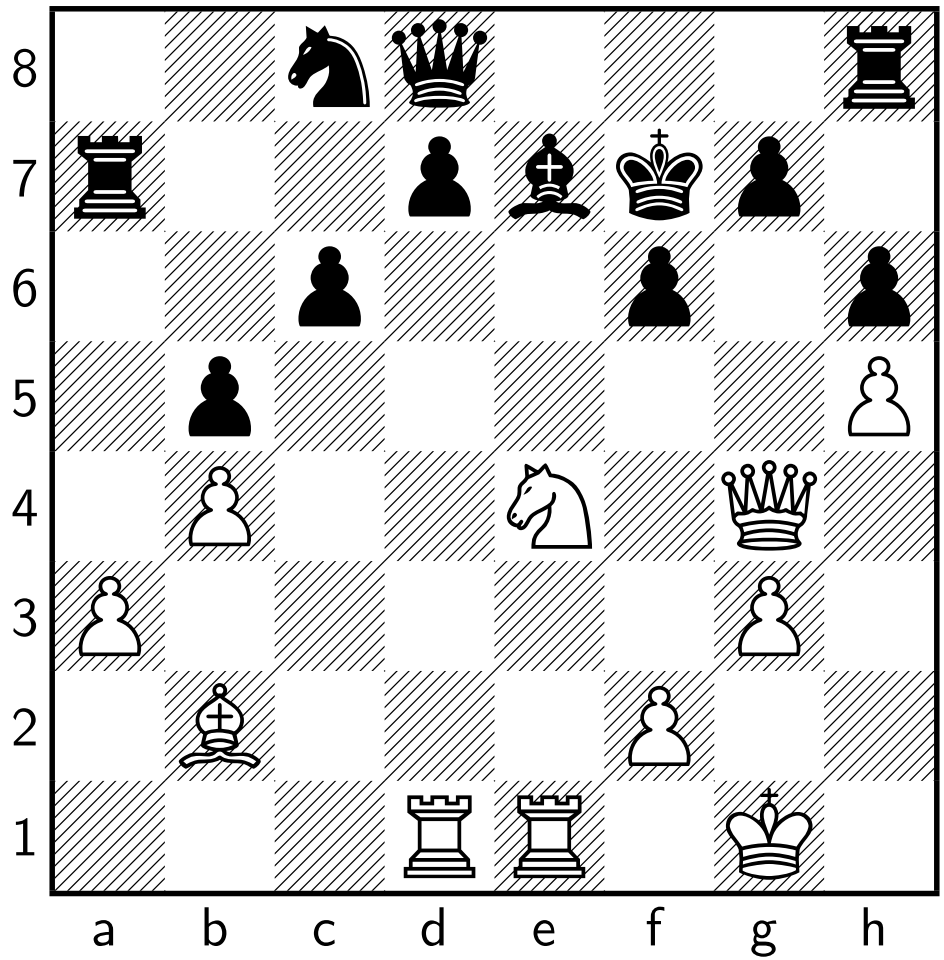


Quiz

How many total pawns were there?

- 7
- 9
- 11
- 13
- none of the above

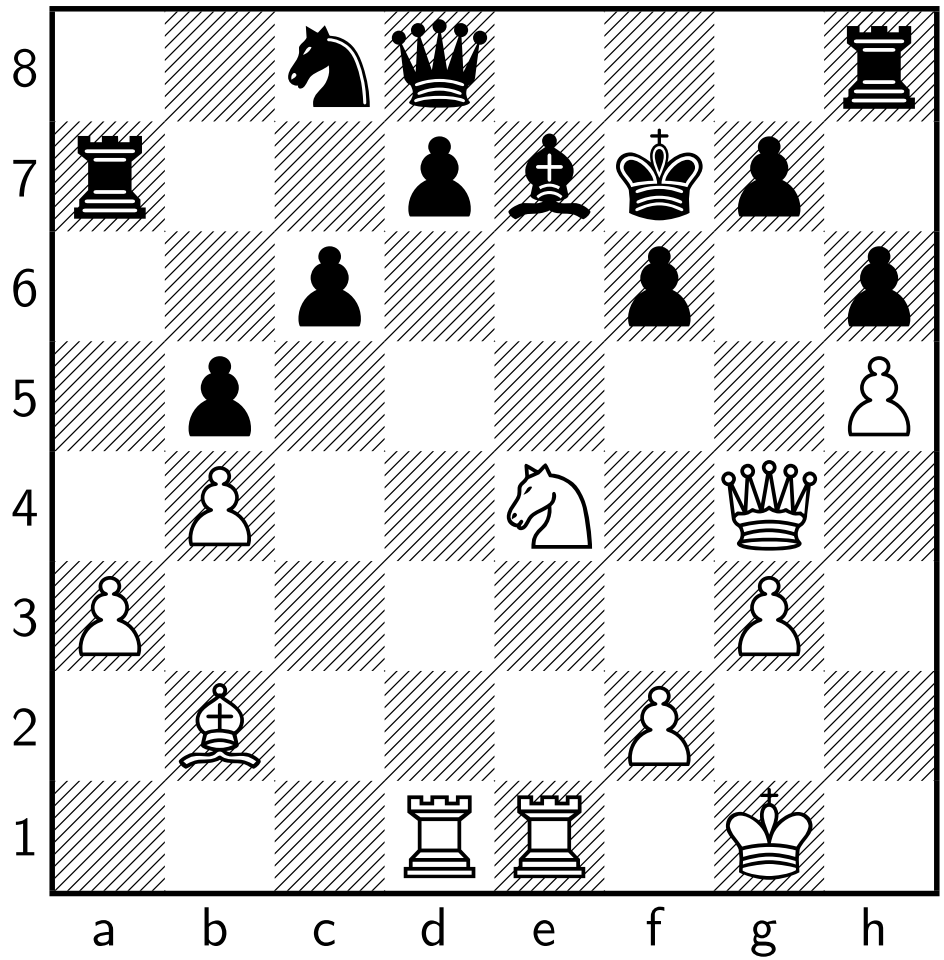
Chess position



How did others fare?

Level	% Correct
Class A	51
Experts	72
GM / M	93

How did others fare (2)?

Level	% Correct	Random positions
Class A	51	$\approx 12\%$
Experts	72	$\approx 12\%$
GM / M	93	$\approx 12\%$

Chess position