of waves in unit length. *Purity.—*The unit purity of a spectrum is that purity which allows the separation of two lines differing by the thousandth part of their own wave-length or wave-number. We speak of the resolving power of a spectroscope and of the purity of a spectrum. The resolving power is a constant for each spectroscope, and independent of the width of the slit. The purity of a spectrum, on the other hand, depends on the width of the slit, unless that width is small compared to a certain quantity presently to be mentioned. The resolving power of a spectroscope is numerically equal to the greatest purity of spectrum obtainable by it.

Adopting these definitions, we get from Lord Rayleigh’s equations for the resolving power *R* of a grating

1000 *R=mn,*

where *n* is the total number of lines used on the grating and *m* the order of the spectrum. For a spectroscope with simple prisms we get

1000*R*=-(*t*2-*t*1)*δμ*/*δλ*,

where *t*2 and *t*1 are the greatest and smallest lengths of paths in the dispersive medium. If we put for the re­fractive index of the medium *μ = A + B*/λ2 we may write

1000*R*=2*B*(*t*2-*t*1)/*λ*3∙

It will be seen that, while the resolving power of a spectro­scope with grating depends only on the order of the spec­trum and is independent of the wave-length for each order, the resolving power of a spectroscope with prism will vary inversely as the third power of the wave-length λ, so that the resolving power will be about eight times as great in the violet as in the red (see Optics). If compound prisms are used we must write

1000*R*=2(*B*2*t*2-*B*1*t*1)∕λ3,

where *t*2 is the greatest effective length of path in one medium, *t*1 in the other medium, *B*2 and *B*1 being the dis­persive constants for the two media.

The purity *P* of a spectrum is given by the equation

*P*=*λ*/*dψ + λR*,

where *d* denotes the width of slit and *ψ* is the angle sub­tended by the collimator lens at the slit. If the slit is sufficiently narrowed, *d ψ* may be made small compared to λ, and in that case the purity of the spectrum is independ­ent of the width of slit and equal to the resolving power. If, on the other hand, a wide slit is used, so that *d ψ* is large compared to λ, the purity becomes inversely pro­portional to the width of slit. In actual work the slit is generally of such width that neither term in the denomi­nator of the expression for purity can be neglected.

There is a necessary limit to the resolving power of all optical instruments, depending on the fact that light con­sists of a series of groups of waves incapable of interfering with each other. If it is true, as is generally believed, but without sufficient reason, that a retardation of 50,000 wave­lengths is sufficient to destroy the capability of interfer­ence—that is to say, that the groups consist on the average of approximately 50,000 waves—the maximum purity ob­tainable in any spectroscope is 50. The closest line resolved with a grating, as far as the present writer is aware, requires a resolving power of about 100. Professor Piazzi Smyth has with prisms realized a purity of 50. It would seem, therefore, that the theoretical limit of purity has very nearly been reached, for, though the estimate of 50,000 waves to the group is in all probability too small, there are other considerations which render it highly improbable that the total number of waves to the group should, for sunlight at any rate, be more than two or three times larger. The limit of possible purity will very likely depend on the temperature of the luminous body.

Almost the greatest practical difficulty which the spectroscopist has to contend with generally is the want of suffi­cient light. The following remarks apply to line spectra principally, but they hold also almost entirely for the spectra of fluted bands, which break up into lines under high resolving power. The maximum illumination for any line is obtained when the angular width of the slit is equal to the angle subtended by one wave-length at a distance equal to the collimator aperture. In that case *dψ = λ* and the purity is half the resolving power. Hence when light is a consideration we shall not, as a rule, realize more than half the resolving power of the spectroscope. If the visual impression depended only on the intensity of illumination, a further widening of the slit should not increase the visi­bility of a line. As a matter of fact spectroscopists gener­ally work with slits wider than that which theoretically gives full illumination. The explanation of the fact is physiological, visibility depending on the apparent width of the object. If different spectroscopes have their slits of such width that the apparent width of a line as seen by the eye is the same, and if the magnifying power is such that the pupil is just filled with light, the purity of the spectrum is directly proportional to the resolving power. We come to the conclusion, therefore, that for both narrow and wide slits the efficiency of a spectroscope depends ex­clusively on its resolving power. It has been pointed out by Lord Rayleigh that, owing to the want of definition in the optical images on the retina when the full aperture of the pupil is used, the pencil must be contracted to a third or a quarter of its natural width, if full resolving power is to be obtained. This is accompanied with a serious loss of light, which can be partly obviated by contracting the horizontal aperture only (the refracting edge being supposed vertical). There are two ways of doing this. One con­sists in the use of magnifying half prisms. But the loss of light by reflexion in simple half prisms more than counterbalances the advantage ; compound half prisms like those used by Christie may, however, be employed. We may also use prisms of three or four times the height of the effective horizontal aperture, with correspondingly large telescopes, and then by the eye-piece contract the beam until its vertical section fills the pupil. The latter plan, though theoretically best, involves more expensive appa­ratus and prisms of very homogeneous material.

The question of illumination is important also when photography is used for spectroscopic analysis. For a given intensity of the source of light the intensity of the image on the sensitive film will be directly proportional to the solid angle of the cone of light forming the last image, and will be independent of the arrangement of inter­mediate lenses. Hence lenses with as short a focus com­pared to aperture as is consistent with good definition should be used in the camera.

The methods of recording and reducing spectroscopic observations are described in all books and treatises on the subject and may therefore be passed over here.

A lens is often used to concentrate the light of the source on the slit. There is some loss of light due to reflexion from the surface of the lens, but its position, aperture, and focal length do not affect the luminosity of the spectrum seen as long as the whole collimator is filled with light.

Bodies are rendered luminous for spectroscopic investi­gation either by being placed in the Bunsen flame or by the help of the electric current. A little difficulty may arise where the body is given in solution and does not show its characteristic lines in the flame. Lecoq de Bois- baudran takes the spark from the surface of the solution. The present writer has found the tube sketched in the figure on the next page a great improvement on those commonly used, if a sufficient quantity of the solution is at