Lecture-Experiments on Spectrum Analysis

This content has been downloaded from IOPscience. Please scroll down to see the full text.

1885 Proc. Phys. Soc. London 7 51

(<http://iopscience.iop.org/1478-7814/7/1/308>)

View [the table of contents for this issue](#), or go to the [journal homepage](#) for more

Download details:

IP Address: 137.207.120.173

This content was downloaded on 01/10/2015 at 23:47

Please note that [terms and conditions apply](#).

VII. *On the Second Law of Thermodynamics.*

By MR. J. MACFARLANE GRAY*.

MR. MACFARLANE GRAY gave an account of a most extended investigation upon the second law of thermodynamics. From considerations connected with the specific heats of liquids and gases, the author comes to the conclusion that the second law is not true. The experimental results used are chiefly those of Regnault, to which, however, Mr. Gray has applied some corrections.

VIII. *Lecture-Experiments on Spectrum Analysis.*

By E. CLEMINSHAW, M.A., F.C.S.†

I PROPOSE in the following paper to explain some processes by which all the phenomena in spectrum analysis, usually shown upon the screen in class-demonstrations, may be exhibited without the use of the electric light, which for various reasons is frequently not available. The methods employed depend upon the use of the limelight and the oxy-hydrogen flame : these of course do not give the same brilliant effects as the electric light, but all the phenomena may be shown upon the screen with much simpler apparatus ; and for some of my methods I think I may claim advantages over the usual method of demonstration.

i. *Spectra of the Alkalies and Alkaline Earths.*

Debray (*Ann. Ch. Phys.* [3] lxx. p. 331) proposed the use of the oxy-hydrogen flame for the volatilization of the alkalies and alkaline earths. By a modification of the ingenious method of Bunsen for procuring a monochromatic flame, the substances in question may be conveniently introduced into the flame. Bunsen made hydrogen in a bottle containing a strong solution of sodium chloride with zinc and hydrogen sulphate,

* Read February 28, 1885.

† Read March 14, 1885.

passed coal-gas into the bottle in order to increase the size of the flame, and to assist in the mechanical carrying-over of the spiritings of the sodium-chloride solution, and burnt the mixed gases in a description of Bunsen burner.

Instead of burning the mixed gases in air, I propose to burn them in an atmosphere of oxygen, by which I find a sufficiently bright flame can be obtained to show the spectra on the screen.

The mixed gases are burnt from a jet consisting of two concentric brass tubes, the inner of which passes into the gas-generating apparatus, and the outer is connected with a supply of oxygen; the inner tube is from $\frac{1}{8}$ – $\frac{3}{16}$ inch diameter, and may with advantage be wider at the bottom. A better result is obtained by passing hydrogen into the bottle, since it is not easy to render the coal-gas perfectly non-luminous by the oxygen.

A rapid evolution of hydrogen is necessary for a good result. The lens or lenses should be arranged so as to obtain as bright an image of the slit as possible, even at the expense of some spherical aberration.

The light obtained with sodium chloride is perfectly monochromatic and very bright. I venture to recommend this method of obtaining a bright monochromatic flame for lecture-demonstrations.

With a strong solution of lithium chloride the red band (Li α) can be shown, and on adding some strong solution of sodium chloride the yellow band of sodium.

For showing the spectra of the alkaline earths I use a saturated solution of the chlorides and generate hydrogen with zinc and hydrogen chloride. With two CS_2 -prism bottles a red, orange (Sr α), and blue (Sr δ) can be shown on the screen; and, if the slit is narrow, the yellow band of sodium is clearly shown as soon as some sodium-chloride solution is introduced into the gas-generator. If a strong solution of lithium, sodium, and calcium chlorides are used, with two CS_2 -prisms five bands can be shown on the screen, including the orange, green, and violet bands of Ca.

The above method is applicable for all compounds which can be volatilized in the oxy-hydrogen flame, and which are not reduced by the nascent hydrogen.

If hydrogen gas is passed into the bottle, or sufficient oxygen used to destroy the luminosity of the coal-gas, no trace of a continuous spectrum can be seen. An occasional addition of acid, to maintain the evolution of hydrogen, keeps the flame burning brilliantly for some time; this method might, therefore, be useful for spectroscopic observations for comparison.

ii. *Continuous Spectrum showing Bright Bands.*

If the slit is narrow, the orange and green bands of calcium may often be seen on the spectrum obtained with the lime-light. If the chlorides of the alkalis or alkaline earths are previously melted upon the surface of the lime-cylinder, the bands of these compounds become very bright. Four different compounds might be melted upon different portions, and the spectra of each shown in turn by turning the cylinder. The lime-cylinder should be a "hardlime;" the softer cylinders are too porous.

iii. *Reversed Spectra.*

The important fact that the light emitted by incandescent sodium vapour is opaque to light from the same source, is easily shown in a striking manner upon the screen by placing the apparatus used for showing the yellow band of sodium in § i. in the centre of an ordinary optical lantern; a bright disk of monochromatic sodium-light may be obtained on the screen from 4-5 feet in diameter. A small Bunsen burner is then placed as near as possible to the condensing lens, with the top of the tube projecting $\frac{1}{2}$ inch above the edge of the lens, which shows the shadow of the tube at the top of the disk upon the screen. When a platinum wire containing a quantity of sodium chloride is introduced into the flame of the Bunsen burner, the dark appearance of the cooler flame is clearly seen on the screen.

Reversal of D line.

Mr. Lewis Wright states that this can be done with the limelight by burning sodium in a Bunsen burner placed as close to the slit as possible. I have not been able to obtain

very satisfactory results by this method ; the flame is too hot. I have been more successful with the following methods :—The sodium is burnt in a small spoon placed between the lens and prism, *just* below the focus of the rays from the lens, which must be made as small as possible, so that all the rays are made to pass through the flame where the sodium vapour is densest, and none of the light from the sodium vapour is focused on the screen, and a much smaller flame may be used. Or the spoon may be placed a little in front of or beyond the focus in the path of the rays ; a shadow of the spoon is seen across the spectrum, and with a small flame a marked thickening of the dark line is seen just above the spoon. The sodium may be burnt in a Bunsen burner or in the flame of a spirit-lamp.

If the sodium-flame is placed between the slit and the lime-light, I have obtained a good result by using a Bunsen burner, the flame of which is cooled down to a proper temperature by a mixture of air and carbon dioxide. Care must be taken not to pass carbon dioxide into the flame to excess, otherwise too great a lowering of its temperature takes place. I have, for instance, obtained in this manner a bluish flame which did not show the slightest trace of sodium in a room where sufficient sodium had been burnt to make every gas-flame give a strong sodium reaction.

The supply of carbon dioxide to the Bunsen burner may be adjusted in the following manner :—A cork is attached to the movable cover which closes the two holes for admitting air, and two holes made in it opposite the air-holes ; to one a glass tube is attached which is connected with a bottle, into which carbon dioxide is passed, fitted with three openings. By opening clamps the carbon dioxide may be all passed into the Bunsen burner, or passed directly out from the bottle. The sodium is first brought into vivid combustion, and then the flame cooled down by admission of the proper supply of carbon dioxide.

The reversed line may also be shown by burning sodium in a spirit-lamp with four wicks, in the centre of which is a jet for the admission of oxygen. This is placed between the slit and the limelight. On passing oxygen into the flame, the heat may be raised sufficiently high to produce a bright

Na band upon the screen, especially if the light from the incandescent lime is somewhat moderated, and turned into a dark band when the oxygen is shut off, proving that the production of a dark or bright sodium-band depends upon the temperature of the absorbent vapour.

IX. *On the Characteristic Curves and Surfaces of Incandescence Lamps.* By J. A. FLEMING, M.A., D.Sc. (Lond.), Fellow of St. John's College, Cambridge*.

RECENT issues of a scientific journal† have contained some interesting letters and notes on the life of incandescence lamps, and on resulting deductions to be made therefrom. The difficulty of the full and complete discussion of this subject is the absence of sufficiently prolonged experiments to give statistics reliable for this purpose. These can only be obtained at great expense and by experiments lasting over a considerable time; but the results to hand make a preliminary investigation interesting on the connection which exists between the life of incandescence lamps and other correlated quantities.

The manufacture of incandescence lamps has now advanced to such a condition that the accidents of manufacture are greatly under control. The conditions necessary to get a good lamp are fairly well understood, and the physical actions going on in the lamp are also to a great extent known. We now know that the expectations of earlier investigators of getting an absolutely unalterable carbon incandescence lamp are not destined to be fulfilled; but we know that the gradual destruction of the filament is an operation dependent upon several causes, which may be greatly delayed by attention to, and success in, certain operations of manufacture.

The gradual destruction of the carbon filament in a vacuum lamp is a kind of erosion taking place at one or more points. Observation seems to show that in a single loop-filament this cutting through takes place most generally near the negative

* Read March 14, 1885.

† 'The Electrician,' vol. xiv. (1885), pp. 246, 294, 311, 347.