can be predicted from the dissociation pressure–temperature curve of NH_4-HS as determined by Walker and Lumsden.

4. The temperature–concentration phase diagram of the system NH_3–H_2S was determined.

5. The diagram indicates the existence of two compounds NH_4HS and $(NH_4)_2S$ and a eutectic mixture of 95% NH_3 and 5% H_2S.

6. Solid crystalline $(NH_4)_2S$ does not exist above $-18°$. On heating, at this temperature, it decomposes into solid crystalline NH_4HS and melt.

7. The melting point of NH_4HS agrees with the temperature as given by earlier investigators.

8. The vapor pressure curve in this work shows that probably only one compound, ammonium hydrosulfide, is stable above 0°.

SYRACUSE, NEW YORK

[CONTRIBUTION FROM THE LABORATORY OF PHYSICAL CHEMISTRY OF THE UNIVERSITY OF WISCONSIN]

INTERFERENCE OPTICAL LEVER FOR PRESSURE GAGES, GALVANOMETERS, ETC.

BY W. E. ROSEVEARE

RECEIVED OCTOBER 6, 1931 PUBLISHED JANUARY 7, 1932

It is possible, with a very simple optical system, to measure deflections with an average error corresponding to about 0.001 mm. for a meter optical arm. The optical system is shown in Fig. 1. The usual galvanometer lamp was replaced by a very narrow slit S and two slit apertures S″ were placed in front of the projection lens P. The projected image of the slit, viewed through an eyepiece or microscope, consisted of a number of straight interference bands with nearly all the light in the three center bands. The source of light L was a 100-watt frosted light bulb placed in a lamp house with a 1-cm. hole in the side to illuminate the slit. The collimator of an old spectroscope was used for the narrow slit and lens. The slit must be one that equally illuminates the two slit apertures when the former is made very narrow. Some spectroscope slits were found to be shaped like A and B of Fig. 1. They were unsuitable and were ground to the shape C or D on a fine oil stone. Projection lenses with a focal length of 15–17 cm. were found most convenient for use with a two or three meter optical lever. The slit apertures were 3 mm. wide and 3 mm. apart and about 20 cm. from the mirror M. A filar micrometer eyepiece was used for measuring deflections up to 1 cm., while a comparator was used for measuring deflections up to 10 cm. The cross hair was always set in the center of the most intense interference band. The mirror must be of good quality plate glass and should be $^3/_8$-inch size. Some galvanometer mirrors were not sufficiently plane and therefore it was necessary to select a good mirror. Five $^3/_8$-inch mirrors were tested and all were found to be satisfactory, while all $^1/_2$-inch mirrors tested were found to be useless.

By the following systematic procedure it was easy to set up and adjust the optical system. With the room dark and the slit open about 0.5 mm., an image of the latter was focused on a white paper in the position where the eyepiece was to be placed. A piece of paper was held in the path of the light a short distance from the mirror at the position indicated by the dotted line F. This showed two spots of light. The mirror or "collimator" was moved sidewise until the two spots were the same size. If the amount of light on both sides was not nearly the same, the interference bands were overcast by white light. The eyepiece was then put in place and the slit closed until 0.02 mm. wide. Two images of the slit appeared when the slit was not in focus and the slit was moved back and forth until these two images coincided. Interference bands were then usually observed. If sharp interference bands were not observed, it was due either to the slit being too wide or improperly shaped, or the mirror not being plane enough. In such a case, the mirror was replaced by a large plate glass mirror and the slit placed out of focus. The intensity of the two images of the slit should be the same when the slit is 0.02 mm. wide. If not, the slit should be ground to the proper shape. The galvanometer mirrors were then tested after it was known that the rest of the system was in good adjustment. During the adjustments, care had to be taken to keep the openings of the slit and slit apertures parallel. After the adjustments had been made, it was not necesary to have the room dark since the bands could easily be seen in a room with ordinary illumination. However, there should not be any lights shining directly on the eyepiece lens or it will obscure the interference bands. A telescope tube, attached in front of the eyepiece, cut down stray light and made observation much easier. A very much brighter image was obtained by using a point-o-light lamp with condensing lens to illuminate the slit, but more care was required to get equal intensity of light through the two slit apertures.

Sensitivity of Optical Lever.—In order to test the sensitivity of the optical lever, a series of twenty successive readings was taken with the mirror in a fixed position. Table I gives the results in terms of deviation

Table I

Results

−2	0	+6	−4
+7	−7	−1	+6
−4	−9	0	−1
−1	+4	+1	−1
−1	+5	−5	−1

from the mean reading in 10^{-3} mm. The average deviation from the mean is 0.0033 mm. for a 3-meter lever arm, which corresponds to 0.0011 mm. for a meter distance. The sensitivity may be increased by having the double slits farther apart, thus making the interference bands narrower. In that case, better lenses and a larger mirror are required to give good results.

Pressure Gage.—A Pyrex diaphragm gage was constructed of the type shown in Fig. 1 by flattening a thin blown bulb. Before the diaphragm had cooled, the hot end of a 1.5-mm. Pyrex rod was stuck to the diaphragm half-way between the center and a side. This was melted off about 5 mm. from the diaphragm and flattened on the end. A $^3/_8$-inch galvanometer mirror was attached to this rod with sealing wax. When the sealing wax was permitted to spread over a large part of the mirror,

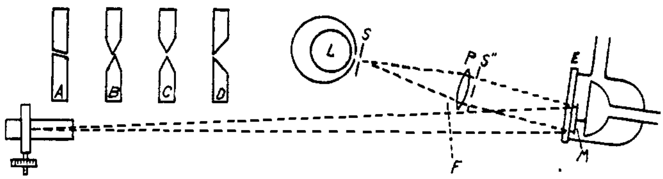

Fig. 1.

it warped the mirror on cooling. Therefore, care had to be taken to use as little sealing wax as possible. The diaphragm was 1 cm. in diameter and withstood one atmosphere pressure in either direction. It was found to have a sensitivity of 0.018 mm. of mercury per 0.01 mm. deflection at 3 meters. The average observational error in reading the pressure then was 0.006 mm. pressure. Another gage was constructed which withstood 10 cm. pressure. The average observational error for it was 0.00044 mm. pressure.

When a still more sensitive gage was constructed with an average observational error of 0.0002 mm. pressure, the mirror vibrated continuously, giving a band of light about 2 mm. wide in the eyepiece. This difficulty was overcome by placing the mirror M almost in contact with the plate glass E. This completely damped the oscillations of the mirror when the pressure was about atmospheric, but it vibrated when evacuated. This gage could only be used for measuring small changes of pressure. It had to be calibrated with a light liquid manometer instead of a McLeod gage.

In order to be certain that the gage had not moved before reading the pressure, a second mirror was attached to a rigid arm directly below the mirror on the diaphragm. The light from the double slits fell on both mirrors. The latter were adjusted until the two sets of interference bands fell in the field of view of the eyepiece. Thus one could check the "zero" point at any time by taking the reading of the position of the interference bands from the fixed mirror. As a reference point, it was found to be almost as convenient to use the interference bands reflected from the surface of the plate glass covering the gage. However, they were less intense than those reflected from the silvered mirror. If the gage cannot be mounted rigidly in a fixed position, two mirrors may be attached to opposite sides of the diaphragm so that they rotate in opposite directions. If the mirrors are so attached that the line joining the centers of the mirrors is perpendicular to the line joining the points of attachment to the diaphragm, then one optical system will do for both mirrors. The pressure, then, may be measured in terms of the distance between the two sets of interference bands.

Summary and Conclusions

A very simple optical system was constructed, by means of which it was possible to measure deflections of a three-meter optical lever with an average error of about 0.003 mm. An all-glass optical lever pressure gage was constructed. It had an average observational error of 0.006 mm. pressure and withstood an atmosphere pressure in either direction. A much more delicate gage had an average observational error of 0.0002 mm. pressure.

MADISON, WISCONSIN

[CONTRIBUTION FROM THE RICE INSTITUTE, HOUSTON, TEXAS]

THE PREPARATION OF NEPHELOMETRIC TEST SOLUTIONS

BY ARTHUR F. SCOTT AND JOHN L. MOILLIET

RECEIVED OCTOBER 10, 1931 PUBLISHED JANUARY 7, 1932

The nephelometer, devised by Richards[1] and now employed in many atomic weight determinations, serves to compare the light reflected by two silver halide suspensions. These suspensions are formed in measured samples of the supernatant analytical solution, which is saturated with respect to the silver halide, by the addition of a known excess of silver ion in one case and an equivalent amount of the halide ion in the other. That the chief source of error in these nephelometric measurements resides in the preparation of the suspensions was fully recognized by Richards,[2] who laid great stress on the necessity of precipitating the two suspensions under conditions as nearly identical as possible.

No systematic study[3] has been made of the effect on the reproducibility

[1] Richards, *Proc. Am. Acad. Arts Sci.*, **30**, 385 (1894); Richards and Wells, *Am. Chem. J.*, **31**, 235 (1904); THIS JOURNAL, **27**, 502 (1905).

[2] Richards, *Am. Chem. J.*, **35**, 511 (1906).

[3] See P. V. Wells, "The Present Status of Turbidity Measurements," *Chem. Reviews*, **3**, 331 (1927).