At length the Foord Pit was won out, and, with its great pumps and engines, formed one of the finest coal-mining establishments in America. The ventilation was effected by a large Guibal fan, similar to those used in the Pennsylvania Mines, and capable of circulating 120,000 cubic feet of air per minute through the ramifications of the mine. The workings of the Foord Pit, which is nearly 1,000 feet deep, extend about 1,800 yards to the north, and 1,700 yards to the south, having an average breadth of 350 yards. The galleries varied in height from 9 to 15 feet, being driven in the upper part of the seam, the lower part being left for later operations. The ventilation through the south side was maintained at the average rate of 25,000 cubic feet per minute. Shortly before the accident referred to, I went entirely through the colliery, in company with Mr. Gilpin and the overman, and we remarked the perfection of the ventilation, and the consequent absence of deleterious gases, even in the remotest bords.

On the morning of the disaster the night watchmen reported the mine to be free from gas, except in small and harmless quantities. From what source, then, originated the series of explosions that began within an hour from the time this report of entire safety was made, and continued at intervals until the mine became a furnace, whose flames could be subdued only by emptying into its burning chambers the waters of the adjacent river? Was there some sudden exudation of gas from the solid coal, or was this explosion due to the firing of coal dust from a safety-lamp or the flame of a blast?

None of the forty-four men who witnessed the beginning of the catastrophe escaped to tell the story or explain the mystery, and those rescued from more distant galleries had but conjectures to offer. The workmen on receiving the assurance that the mine was free from gas, received their orders, descended the drawing shaft, received their safety-lamps at the lamp cabin and a part of them went into the north side workings and the rest went into the south side dips and waited for their tools to be sent in for distribution. At this moment the explosion took place that was first noticed at the fan-shaft, where it blew the cover of the fan-drift off, and about one minute later it was apparent at the drawing shaft, having traveled in the one case *with* and in the other *against* the ventilating current.

The only additional facts definitely ascertained were gathered by an exploring part led by Mr. Gilpin, who, shortly after the original explosion and at the risk of life, descended into the pit and penetrated as far as the after-damp would allow them to go. The locality where the unfortunate workmen whom they tried to save were known to be was 1,200 yards south of the shaft; and the point reached by the party was only about 600 yards in that direction.

It was evident that the flame of the explosion had not reached as far as this, for there were no marks of fire on the dead bodies of men and horses found, nor was the splintered wood-work charred. They carried two corpses to the surface for examination, and it was found that one of these died of the after-damp, and the other from being dashed against some timber.

The walls of the galleries had been swept clear of timber, and presented the appearance of having been brushed with a broom. This was due to the passage of great volumes of dust which lay on the floor of the level in waves and drifts, into which the party often sank up to their knees. A similar effect was visible in the mine level, but not to so great a degree; as it was damper about the floor, and from the effects observed it would appear that, while the explosion passed along each level simultaneously, it had greater power in the lower one, as the doors were blown toward the upper, or main level. Clouds of the finer particles were carried up the shaft, and were swept on into the North-side levels.

At the lamp-cabin, where the safety lamps were cleaned and given to the men after being examined by the shot-firers, an open light had been kept burning for years, as it was considered a safe place, being within a few feet of the bottom of the shaft. But here a *secondary* explosion took place, demolishing the cabin, burning the horses between the shaft and the cabin, and fatally injuring the lamp-man by igniting his oil-soaked clothing, so that he died in a few days. The effect of the explosion did not extend far into the north side, and some of the men there were ignorant of the disaster until warned by the over-man to leave the pit.

Secondary explosions caused by extracted, or generated gas, are nearly always in the vicinity of the primary one; but here is a case where the second was half a mile from the first, with an intervening space of at least a quarter of a mile known to be free from gas, because men were in it with lamps which showed no indications of its presence.

The ignition of these volumes of dust would, no doubt, have done serious injury to the shafting, had not the latter been wet and indeed saturated with water oozing under pressure through the upper strata into the shaft, and then falling to the bottom; so that, although elsewhere the mine was a very dry one, it was here in such a condition that the flame would be extinguished as soon as it touched the damp walls. The necessity of watering dusty mines has been pointed out by Inspector Gilpin, and this is said to be practised in some of the Belgian collieries. The present instance shows that such a precaution would tend to reduce the range of the explosion of the dust.

Attempts were made to restore the ventilation of the workings in the Albion Mines, when the presence of a large fire was discovered, and this made it necessary to flood the galleries. In about 48 hours after the explosion, a trench had been cut through to East River, and the water was let in at the rate of 15,000 gallons per minute, until, within a week, all the workings were filled. This, of course, made further investigations impossible, and nothing will be known beyond what has here been told.

The subject is one of acknowledged importance. There have been frequent explosions in flouring mills, said to be attributable to the ignition of flour dust. At a late meeting of the Manchester Geological Society, (in England), experiments were made to show that even finely powdered slate will spread the flame of gas explosions. Since the preparation of the present paper, a report has been made before the royal commission on accidents in mines, by Mr. F. A. Abel, Chemist to the British War Department, in which it is claimed, as demonstrated, that coal-dust is not only a fiercely burning agent, but when suspended in air currents may operate as an exploding agent. It operates, aside from its inflammability, as a finely divided solid, in "determining the ignition of only small proportions of fire-damp and air, and consequently in developing explosive effects," *i.e.*, under circumstances which, in the absence of the dust, would be attended by no danger.

HISTORY OF ALHAZEN'S PROBLEM.

Abstract of a paper read before the American Association for the Advancement of Science, Cincinnati, August, 1881, by MARCUS BAKER, U. S. COAST AND GEODETIC SURVEY, Washington, D. C.

Alhazen's problem is an optical one and was thus stated by the Arabian Alhazen for whom the problem is named. "*Given a luminous point and a point of vision unequally distant from the center of a convex spherical mirror, determine the point of reflexion.*" The solution of this problem involves the solution of the following geometrical problem now generally known among mathematicians as Alhazen's problem. *From two given points in the plane of a given circle draw lines meeting in the circumference and making equal angles with the tangent drawn at that point.*

This problem was first solved by Alhazen, a learned Arabian of the 11th century, and published at Basle, in Latin, in 1572. Since that time it has been studied by several distinguished mathematicians and a variety of solutions given. The paper presented contained a collection of these solutions aiming to be complete. Eleven solutions were contained in this collection, beginning with Alhazen and ending with a solution by E. B. Seitz, in 1881.

The first five solutions are by geometrical constructions, in which the points sought are determined by the intersections of a circle and hyperbola. The sixth solution, also a geometrical construction, is by means of the intersection of a circle and parabola. The seventh, eighth, ninth and eleventh solutions are by analytical or algebraical methods, while the tenth is a trigonometrical solution.

Among the people who have studied and solved the problem are Alhazen, Barrow, Hutton, Huyghens, Kaestner, Leybourn, L'Hospital, Robins, Seitz, Sluse and Wales. A complete list of bibliographical references was appended to the paper.

The paper contained further, an extension of the problem, *first*, to the surface of a sphere, and *second*, to an ellipse. The first case was illustrated by the following practical example:

The great circle track between San Francisco, Cal., and Yokohama, Japan, reaches nearly to latitude 52° N. The Pacific mail steamers plying between these ports usually avoid going north of latitude 45° N. Now, if the 45th parallel of latitude be designated as one north of which the steamer is not to go, in what longitude must this parallel be reached in order that the steamers' path between the ports shall be the shortest possible? The extension of Alhazen's problem to the surface of the sphere solves this problem and the longitude required is 168° W. from Greenwich.

The extension of the problem to the case in which an ellipse replaces the circle gives rise to a very complex equation of no special value.

WASHINGTON, D. C., Sept. 13, 1881.

ROTATION OF REDUCING POWER, AS MEASURED BY FEHLING'S SOLUTION TO THE ROTATORY POWER OF COMMERCIAL AMYLOSE (GLUCOSE AND GRAPE SUGAR).

SECOND PAPER.*

BY PROF. H. W. WILEY, Lafayette, Ind.

In a paper read at the Boston meeting of this Association [1] I called attention to the fact that the reducing power of Amylose, measured by Fehling's Sol., could be readily determined by the polariscope. Since that time I have extended the series of observation then reported, and with such results as justify the conclusions at which I arrived.

In commercial Amyloses, whose specific gravities do not vary much from 1.410, the reducing power is reliably calculated from the reading of the polariscope. The average percentage of water in these Amyloses is nearly thirteen. If we allow one per cent for optically inactive substances present, we may safely place the optically active matter at 86 per cent. By prolonged boiling with acids, even if they be quite concentrated, only about 82 per cent of reducing matter is obtained.[2] Further boiling causes the mass to turn brown, and may even cause a decrease in the amount of reducing matter found. Since there is so much difference of opinion respecting the reliability of Fehling's solution, and since there is no other reducing mixture that works as well, it would, perhaps, be better to use the polariscope for the determination of the amount of substances present in an Amylose capable of reducing the various solutions used for grape sugar measurements

In the following table the calculation of the reducing power was made by the formulæ, [3] which I have already explained. Although, in a few cases, the specific gravity varied by a few thousandths from 1.410, the difference has not been of sufficient importance to make any correction[4].

Since the ordinary Amyloses, called grape sugars, of commerce differ from those called glucoses only in having the processes of conversion carried further, it is found that the same rule applies to them also. In fact, I believe it will be found true with all varieties of Amylose made by use of sulphuric acid, provided 8.6 grammes of the anhydrous substance be used in each 100 c.c. of the mixture to be examined.

Following are the results of my observations:

TABLE I.

No.	Sp. gravity.	Reducing matter by Fehling's Solution.	Rotation of 10 g. in 100 c.c. cone sugar scale.	Reducing matter calculated from Polariscope.	Difference.		Date of Manufacture.	
					+	—	1880.	
1	1.414	52.1	53.04	52.05	0.04	...	September	15
2	1.419	52.2	53.00	53.00	0.08	...	"	14
3	1.410	53.8	51.00	55.05	1.07	...	"	15
4	.....	53.2	55.05	49.09	....	3.3	October	12
5	1.412	51.0	54.01	51.06	0.06	...	"	18
6	1.413	51.1	53.02	52.75	1.65	...	"	19
7	1.417	51.6	53.45	52.44	0.84	...	"	19
8	1.417	49.7	55.02	50.03	0.6	...	"	20
9	1.408	49.0	55.05	49.09	0.09	...	"	21
10	1.413	49.5	55.04	50.00	0.05	...	"	21
11	1.411	48.1	56.06	48.05	0.04	...	"	17
12	1.421	48.8	56.04	48.08	0.00	0.0	"	16
13	1.417	50.0	57.00	48.00	....	2.0	"	16
14	1.413	46.4	56.07	48.04	2.00	...	"	14
15	1.417	48 1	56.05	48.06	0.05	...	"	14
16	1.418	46.3	58.02	46.05	0.02	...	"	13
17	1.412	47.2	57.00	48.00	0.08	...	"	12
18	.....	72.0	37.03	72.63	0.63	...	Unknown.	

The above analyses were of samples sent by the manufacturers, the Peoria Grape Sugar Company. They represent the whole number of samples examined and in the order in which the analyses were made. Seventeen of them were of syrups, and the eighteenth of a solid sugar. Only four out of the eighteen show discordant results. In one of these the specific gravity was not determined. It was my intention to make these four analyses in duplicate, but a press of other business prevented. In general, it appears that the results given by the polariscope, by the above method of calculation, are a little too high. If they were diminished by 5 the agreement would be better. That the reducing power of Amylose can be correctly calculated from its rotatory power is certainly established from the thirty-eight unselected instances which have been presented.

ELECTRIC LIGHT FOR LIGHTHOUSES.—The first of the series of lighthouses round the French coast which are to be henceforth illuminated by electricity, has, with all its necessary machinery, been completed. It is called the "Phare de Planier," and is situated at the mouth of the Rhone, near Marseilles.

* Read before A. A. A. S., Cincinnati, 1881.

[1] Proceedings of this Association, 1880, p. 308; Journal Am. Chem. Soc., Vol. II., p. 387.

[2] Proceedings A. A. A. S., 1880, p. 320. Journal Am. Chem. Soc., Vol. II., p. 399.

[3] Proceedings A. A. A. S., 1880, p. 313. Journal Am. Chem. Soc. Vol. II., p. 393.

[4] Proceedings A. A. A. S., 1880, p. 316. Journal Am. Chem. Soc., Vol. II., p. 395.