PHOTOMETER EXPERIMENTS

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(Class of 1900.)

A photometer is an instrument used for comparing the amount of light given off from a source of known candle power with that given off from a source of unknown candle power.

The instrument consists of three parts, a standard source of light, an optical bench and a screen. The standard source of light is sometimes an argand gas burner, set behind a metal slab. The metal slab has two perforations through which light of known candle power passes. This form is known as the Methoen Standard. The optical bench is made up of two bars of iron, four or five meters long, set five centimeters apart and mounted on standards about fifteen centimeters high. Along one bar is a standard scale of length. Constructed so as to move back and forth, on the optical bench, is the screen or sight box. This consists of two mirrors, a white surface and two prisms, parts of whose faces are ground so as to reflect light, the whole being properly arranged in a small metal box, into which a telescope projects. Light enters the metal box from sources of light placed at each end of the optical bench. The sight-box here described is called the Lummer-Brodhien. Light from the standard enters the box where, on account of the ground part of the prism through which it passes, a shadow is cast upon part of the white surface or screen, the remainder being illuminated. From the source of unknown candle power at the opposite end of the bench, light enters the other side of the box and passes through the other prism, which has such a part of its face ground that it lights up the shadow cast by the first prism, and casts a shadow where the first prism throws light. Move the sight-box back and forth on the bench until a point is reached where the light from each source lights up the shadow cast by the other, or until, as seen by the telescope, the white screen is evenly lighted. Then the candle power of the known source is to the candle power of the other source, as the square of the distance from the screen to the known source is to the square of the distance from the screen to the unknown source.

The following experiments must be performed in a perfectly dark room, so no light can reach the white screen excepting that from the two sources of light. These experiments were all performed in the Physical Laboratories of the University of Iowa, at Iowa City.

EXPERIMENT I.

Comparison of our standard source of light with a standard candle.

Distance from standard candle to screen....125½ centimeters
Distance from standard source of light to the screen....................................174½ centimeters

Standard candle.......................1 candle power
Source of light.........................x candle power

$$x : 1 :: (174\tfrac{1}{2})^2 : (125\tfrac{1}{2})^2$$

x is 2.003

Therefore our standard source of light is practically two candle power.

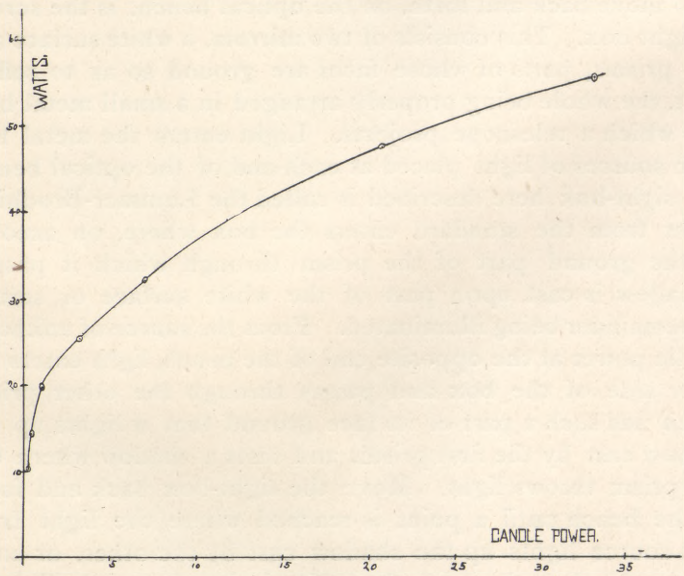

FIGURE 1.
CANDLE POWER OF COMMON INCANDESCENT LIGHT AT DIFFERENT VOLTAGES.

EXPERIMENT 2.

To show the candle power of a common incandescent lamp when run at different voltages.

VOLTS.	AMPERES.	WATTS.	CANDLE POWER.
25	0.41	10.25	0.16
30	0.48	14.4	0.49
35	0.555	19.425	1.232
40	0.64	25.6	3.315
45	0.715	32.175	7.103
50	0.8	40.	11.83
55	0.87	47.85	21.59
60	0.933	56.	33.074

EXPERIMENT 3.

Revolving the incandescent lamp about a horizontal axis. Lamp set side ways at all times. At zero degrees the bulb is up, at ninety degrees it is turned away from the photometer. Voltage fifty and constant.

DEGREES.	CANDLE POWER.
0	12.1
30	10.7
60	5.1
90	0.42
120	4.19
150	10.51
180	12.1
210	12.4
240	9.1
270	6.1
300	6.3
330	11.2
360	12.1

EXPERIMENT 4.

Revolving the incandescent lamp about a perpendicular axis, keeping the voltage constant. Lamp is always perpendicular and at zero degrees is set edge wise.

DEGREES.	CANDLE POWER.
0	9.9
30	10.8
60	11.1
90	11.5
120	11.1
150	10.8
180	9.9

EXPERIMENT 5.

Measuring the candle power of an arc lamp, inclined at various angles. The incandescent lamp used in the previous experiments is here used as the standard, and the arc lamp is set 1034 centimeters from the standard. To find the distance from the standard to the screen subtract the readings in the second column from 300 centimeters. An interrupter consisting of a disk, one-fourth of which has been cut out, is revolved between the arc and the photometer, thus allowing but one-fourth of the light from the arc to reach the photometer. The arc is run at one hundred volts and thirteen amperes, and the standard is run with storage batteries. The arc lamp is set horizontal, the crater facing the screen at the start.

DEGREES.	PHOTO. READING.	VOLTS ON STANDARD.	CANDLE POWER OF ARC.
0	63	30	53.
45	210	45	3124.4
90	200	45	2476.
135	190	45	200.2
180	10	35	31.2

From these five experiments we may deduce the following facts, which are of practical use:

In burning a system of incandescent lamps, experiment two shows us the necessity of keeping the voltage constant and at the required point. For at twenty-five volts our lamp gave one-sixth candle power, while at double the voltage the candle power was multiplied by seventy. We see that if a system of incandescent lamps is connected to run one hundred volts, and for some reason the voltage drops to ninety-five or ninety-six, then lamps designed to give thirty-two candle power at one hundred volts will give considerably less than this. The opposite would occur if the voltage were raised to one hundred and five, for then the lamps would give more than thirty-two candle power. This would not be desirable, however, as the life of the lamp would be considerably shortened.

Experiment three shows us how necessary a reflector is for lighting a table, window display or other similar place by lamps suspended above it. For a lamp giving from ten to twelve candle power laterally will of itself throw but six directly under it.

In lighting such a place as a stage, where light is thrown sideways from the lamp, experiment four shows us that the greatest efficiency is derived from a given number of lamps when they are set sideways toward the stage. For a lamp giving ten candle power edgewise gives one and one-half more candle power when set sideways amounting in the case of forty lamps to sixty candle power— the equivalent of several lights.

The last, or arc light experiment, tells us how important it is in the case of a search light or like apparatus, that the carbons supplying the light should be hung at the proper angle to the reflector, for otherwise the efficiency of the lamp may be cut down to a half or evèn a third of its proper efficiency. This is important just now when such lights are being used for so many purposes — signaling in war, light-house purposes, headlights on locomotives, etc. In this last adaptation, if the lamp is so placed as to yield the maximum efficiency, and a proper reflector used, a beam of light may easily be thrown a mile ahead of the locomotive, or a greater distance than the noise of the train can be heard. And though the light may not, due to the curves in the track, be thrown on the road crossings, the beam may easily be seen, as it illuminates the the country toward which the reflector is pointing.