Umbra and penumbra with two point light sources

Principle and equipment

Principle

Show that, when using two point light sources, umbra and penumbra are formed behind opaque bodies.

Equipment

Position No.	Material	Order No.	Quantity
1	Demo Physics board with stand	02150-00	1
2	PHYWE Multitap transformer, DC: 2/4/6/8/10/12 V, 5 A / AC: 2/4/6/8/10/12/14 V, 5 A	13533-93	1
3	Lamp,halogen,mag.held,12V/50W	08270-20	1
4	Light box 12V/20W,w.magn.base	09804-00	1
5	Model earth/moon, magnet held	08270-07	1

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Set-up and procedure

- Using the magnetic lamp and the light box, generate two divergent light beams which cross each other.
- Place the model earth (the shading body) in the area which is lighted by both light beams in such a way that part of both light beams pass above and below the shading body (Fig. 1).
- Move the shading body toward and away from the light sources and observe the changes in the shadows.

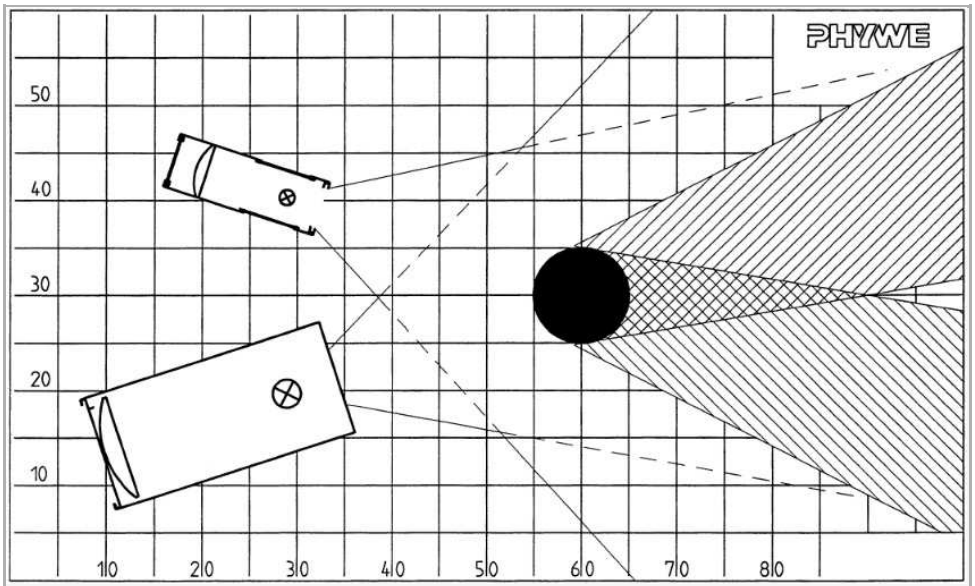

Fig. 1

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Observation and evaluation

Observation

Behind the shading body an area appears which is completely unlighted: the umbra (deep shadow).
The umbra is sharply delimited and ends in a point. Behind the umbra there is an area which is (about) as brightly lit as the area in front of the shading body, which is illuminated by both light beams. Above and below the umbra there are partly darkened areas which are also are sharply delimited: the penumbra (partial shadow). The shape of the shadows changes with the distance from the light sources.

Evaluation

When an opaque object is illuminated by two point light sources, umbral (deep shadow) and penumbra! (partial shadow) regions are formed behind it. These shaded areas are clearly defined. With increasing distance of the body from the light sources the umbra becomes longer and the penumbra, narrower. To characterise the shaded areas it is generally sufficient to construct the marginal rays. There have their origin in the point light sources.

Remark
This experiment could be expanded by changing the distance of the two point light sources with respect to each other. Then the following could be shown: The larger the distance between the light sources, the shorter the umbra and the more (with constant distance of the shading body from the light source) the constantly wide penumbras diverge.

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