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Answers to "A Quiz on Electromagnetic Diffraction"

We published an interesting quiz on electromagnetic diffraction, specifically, on shadow radiation and Fresnel diffraction, in the "Testing Ourselves" column of *IEEE Antennas and Propagation Magazine*'s December 2020 issue [1]. Below we list the answers (in italics) and, in Table 1, we list the first four respondents and their scores.

1) Who discovered the diffraction phenomenon and when?
   Grimaldi (1665).
2) What is his definition of diffraction?
   Any deviation of the waves' behavior from the geometrical optics laws.
3) What experiments did he conduct to observe diffraction?
   He carried out optical experiments: in a dark room, he made a very small hole in the window curtain; a narrow beam of light passing through the hole illuminated an opaque object; and the object's shadow with surrounding light bands was observed on the white wall opposite the window.
4) What was the nature of light, in Grimaldi's opinion?
   Something like a fluid substance.
5) Who first proposed the wave concept of light propagation and when?
   Huygens (1690).
6) What was his concept?
   Each point of the wavefront generates elementary spherical waves. The envelope of these waves determines the following position of the wavefront.
7) Who proposed the concept of interference of the elementary Huygens waves and when?
   Fresnel (1818).
8) Who developed the exact mathematical formulation of Huygens' principle of wave propagation in free space and when?
   Helmholtz (1859).
9) Who proposed the first high-frequency approximation in the Helmholtz theory of diffractionby apertures in opaque screens and when?
   Kirchhoff (1882).
10) What is his approximation?
    The field and its normal derivative inside the aperture are the same as in the free space. On the shadow side of the screen, they are equal to zero.
11) Who first developed the physical optics approximation for electromagnetic waves and when?
    Macdonald (1912).
12) What is his approximation?
    The total electromagnetic field at each point on the illuminated surface of a scattering object is the same as on a tangential plane. On the shadow surface, the field equals zero.
13) Who developed a new formulation of the physical optics in terms of the shadow radiation and reflected waves and when?
    Ufimtsev [2].
14) Who first developed the exact solution to the diffraction theory and when?
    Sommerfeld (1896). He developed the exact solution for diffraction on a perfectly conducting half plane.
15) What specific functions describe Sommerfeld's solution?
    The Fresnel integrals. They show that diffraction on a half plane can be interpreted as a specific type of Fresnel diffraction.

Who first developed the physical optics approximation for electromagnetic waves and when?

TABLE 1. THE FIRST FOUR RESPONDENTS.

Name	Score
Stefano Selleri	13/15
Krishnasamy Selvan	12/15
Alper Uslu	12/15
Aysegul Pekmezci	11/15

REFERENCES

[1] L. Sevgi, "A quiz on electromagnetic diffraction," *IEEE Antennas Propag. Mag.*, vol. 62, no. 6, Dec. 2020, p. 91. doi: 10.1109/MAP.2020.3027276.
[2] P. Y. Ufimtsev, "New insight into the classical Macdonald physical optics approximation," *IEEE Antennas Propag. Mag.*, vol. 50, no. 3, pp. 11–20, June 2008. doi: 10.1109/MAP.2008.4563560.

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