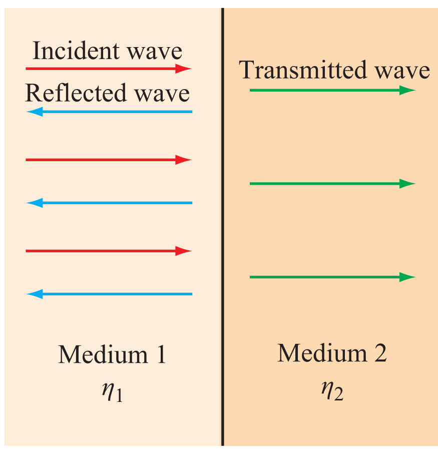
Test 8.1: Normal Incidence

When a plane wave in medium 1 is incident upon a plane boundary of a different medium at normal incidence, the **E** and **H** fields of the reflected and transmitted waves can be related to those of the incident wave by applying:

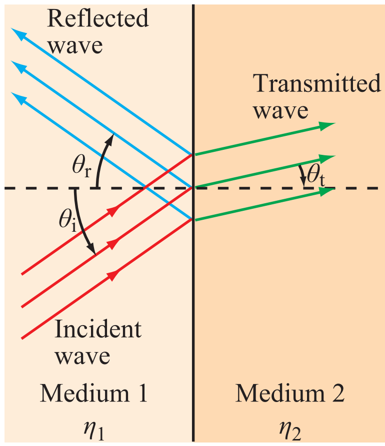
(a) Only the boundary condition for **E**.
(b) Only the boundary condition for **H**.
(c) The boundary conditions for both **E** and **H**.
(d) Snell's laws.



Test 8.2: Oblique Incidence

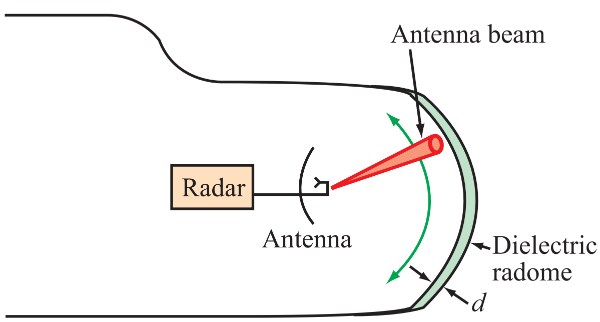
When a plane wave in medium 1 is incident upon a plane boundary of a different medium at oblique incidence, the **E** and **H** fields and the directions of propagation of the reflected and transmitted waves can be related to those of the incident wave by applying:

(a) Only Snell's laws.
(b) The boundary conditions for both **E** and **H**.
(c) The phase-matching condition.
(d) The boundary conditions for both **E** and **H** plus the phase-matching condition.



Test 8.3: Radar Radome

The aircraft radome shown in the figure has $\varepsilon_r = 16$ and the radar operates at 5 GHz. How thick should the radome be so that it is structurally strong ($d > 2$ cm) and simultaneously "transparent" to the radar signal?



(a) $d = 3$ cm
(b) $d = 2.25$ cm
(c) $d = 2.5$ cm
(d) $d = 2.1$ cm

Test 8.4: Normal Incidence on Conductor

A 7.5 GHz plane wave in air is normally incident upon the plane surface of a very good conductor. At what distance from the boundary in the air medium is the **E** field at its first maximum?

(a) $l_{\max} = 1$ cm
(b) $l_{\max} = 2$ cm
(c) $l_{\max} = 4$ cm
(d) $l_{\max} = 0.5$ cm

Test 8.5: Modal Dispersion

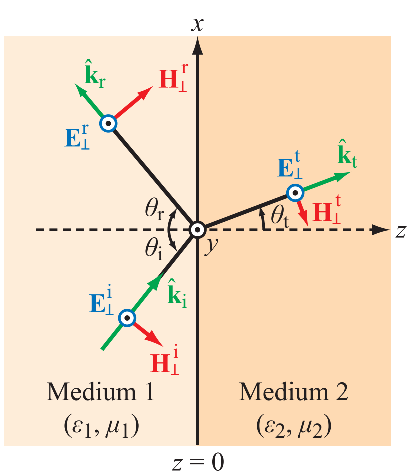
The term "modal dispersion" in optical fibers refers to:

(a) Light rays dispersing out of the fiber.
(b) Light modes that cause the fiber to act like a short circuit.
(c) Different light modes having different transit times between the two ends.
(d) None of the above.

Test 8.6: Plane of Incidence

Transverse electric (TE) and transverse magnetic (TM) polarizations are defined in terms of the direction of the electric field relative to the *plane of incidence*. For the configuration shown, the plane of incidence is:

(a) The x–y plane.
(b) The plane containing $\hat{\mathbf{k}}_\mathrm{i}$ and $\hat{\mathbf{z}}$.
(c) The x–z plane.
(d) The y–z plane.

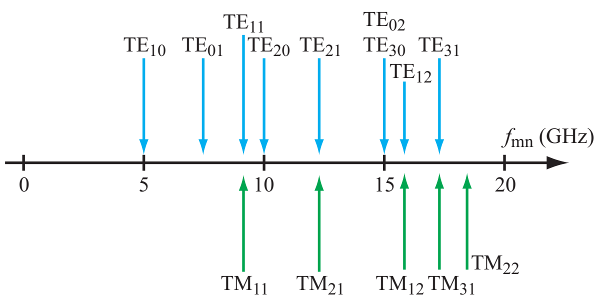


Test 8.7: Brewster Angle

For nonmagnetic materials the Brewster angle does not exist:

(a) For perpendicular polarization.
(b) For parallel polarization.
(c) For any polarization.
(d) For low dielectric media.

Test 8.8: Rectangular Waveguide



Cutoff frequencies for TE and TM modes in a hollow rectangular waveguide with $a = 3$ cm and $b = 2$ cm.

In a rectangular waveguide, the cutoff frequency associated with a given mode defines:

(a) The frequency above which the wave will not propagate.
(b) The frequency at which the group velocity is a maximum.
(c) The frequency at which the zigzag angle is zero.
(d) The frequency below which the wave will not propagate.

Test 8.9: Resonant Cavity

One of the modes of a metallic resonant cavity has a resonant frequency of 10 GHz and a quality factor $Q = 10^4$. What is the bandwidth of the spectrum supportable by that cavity at that mode?

(a) $\Delta f = 100$ MHz
(b) $\Delta f = 1$ MHz
(c) $\Delta f = 30$ MHz
(d) $\Delta f = 3$ MHz

Test 8.10: Wave Power

A plane wave in air with an electric field amplitude of 40 V/m is incident normally upon the surface of a lossless, nonmagnetic medium with $\varepsilon_r = 25$. Determine the average power density of the transmitted wave.

(a) $S^t_{av} = 0.28$ W/m^2
(b) $S^t_{av} = 2.92$ W/m^2
(c) $S^t_{av} = 1.12$ W/m^2
(d) $S^t_{av} = 0.56$ W/m^2

Test 8.11: Minima and Maxima

A 25-MHz plane wave with electric field amplitude of 25 V/m is normally incident in air onto a semi-infinite, perfect dielectric medium with $\varepsilon_r = 36$. Determine the distance in the air medium from the boundary to the nearest minimum of the electric field intensity, $|\mathbf{E}|$.

(a) $l_{min} = 1$ m
(b) $l_{min} = 1.5$ m
(c) $l_{min} = 3$ m
(d) $l_{min} = 0$

Test 8.12: Light Color

Orange light of wavelength 0.61 μm in air enters a block of glass with $\varepsilon_r = 1.68$. What color would it appear to a sensor embedded in the glass? The wavelength ranges of colors are violet (0.39 to 0.45 μm), blue (0.45 to 0.49 μm), green (0.49 to 0.58 μm), yellow (0.58 to 0.60 μm), orange (0.60 to 0.62 μm), and red (0.62 to 0.78 μm).

(a) blue
(b) orange
(c) green
(d) red

Test 8.13: Incidence Angle

A plane wave in air with

$$\widetilde{\mathbf{E}}^i = (\hat{\mathbf{x}}6 - \hat{\mathbf{y}}4 - \hat{\mathbf{z}}6)e^{-j(4x+6z)} \qquad \text{(V/m)}$$

is incident upon the planar surface of a dielectric material, with $\varepsilon_r = 2.25$, occupying the half-space $z \geq 0$. Determine the incidence angle θ_i.

(a) $\theta_i = 45.4°$
(b) $\theta_i = 33.7°$
(c) $\theta_i = 28.4°$
(d) $\theta_i = 62.7°$

Test 8.14: Refraction Angle

A parallel-polarized plane wave is incident from air onto a dielectric medium with $\varepsilon_r = 4$ at the Brewster angle. What is the refraction angle?

(a) $\theta_2 = 18.44°$
(b) $\theta_2 = 36.22°$
(c) $\theta_2 = 19.32°$
(d) $\theta_2 = 26.57°$

Test 8.15: Waveguide

A TE wave propagating in a dielectric-filled waveguide of unknown permittivity has dimensions $a = 5$ cm and $b = 3$ cm. If the x-component of its electric field is given by

$$E_x = -36\cos(20\pi x)\sin(100\pi y)\sin(2.4\pi \times 10^{10} t - 52.9\pi z), \qquad \text{(V/m)}$$

determine the mode number.

(a) TE_{13}
(b) TE_{31}
(c) TE_{23}
(d) TE_{12}