Speed of light in $\frac{m}{s}$

vacuum	$2.998 \cdot 10^8$	water	$2.25 \cdot 10^8$	ice	$1.90 \cdot 10^8$
air	$2.997 \cdot 10^8$	diamond	$1.24 \cdot 10^8$	PMMA (Plexiglass)	$2.01 \cdot 10^8$

Indices of refraction

ethanol	1.36	water	1.33	salt	1.54
methanol	1.33	diamond	2.42	window glass	1.52

1. Calculate the absolute indices of refraction for
a) ice
b) PMMA (plexiglass)

2. Calculate the speed of light in
a) salt
b) ethanol

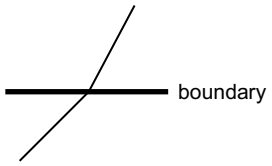
3. Choose the correct option:

a) In a medium with a higher index of refraction, the light travels (*faster/slower*) than in a medium with a lower index of refraction.

b) Consider a light ray passing obliquely from one medium to another. In the material with the higher index of refraction the angle between the light ray and the normal is (*greater*/*smaller*) than in the material with the lower index of refraction.

c) Total internal reflection only occurs in materials in which the speed of light is (*more*/*less*) than the outside material. Furthermore, the angle of incidence needs to be (*smaller*/*larger*) than the critical angle.

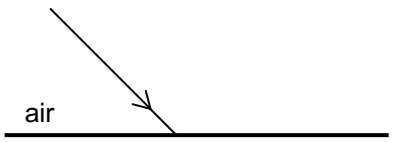
4. A light ray passes from air into glass.
Which side of the boundary is of glass? Give reasons for your answer.



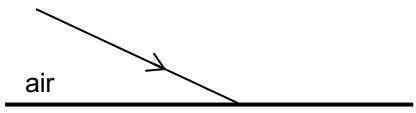
5. A light ray travelling in air strikes the surface of an unknown transparent material. The angle of incidence is 45 ° and the angle of refraction is 17 °.
What is the unknown material?

6. Draw the normal and measure the angle of incidence. Calculate the angle of refraction. Draw the reflected and the refracted light rays.

a)



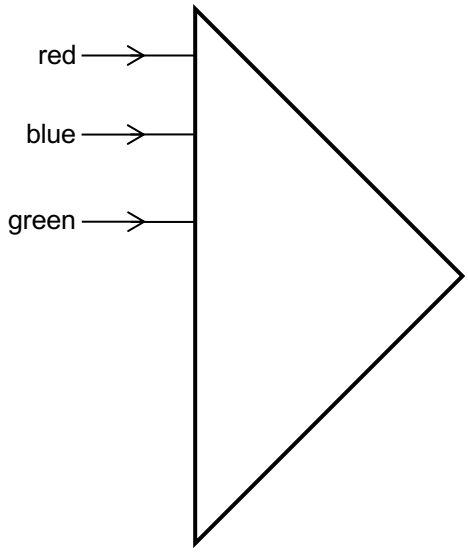
b)



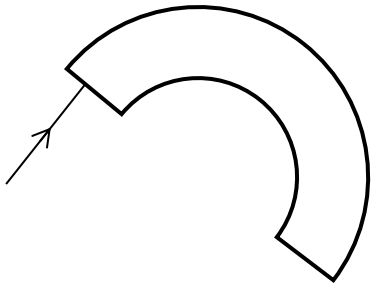
7. Calculate the critical angle for
a) window glass in vacuum
b) diamond in ethanol
c) ice in water

8. In which ones of the following cases is it possible for total internal reflection to occur? Give reasons for your answer. Calculate the critical angle for those cases where it's possible for total internal reflection to occur.
a) A light ray travelling in diamond strikes the boundary between diamond and air.
b) A light ray travelling in air strikes the boundary between air and water.
c) A light ray travelling in window glass strikes the boundary between window glass and ethanol.

9. Draw the paths of the three light rays, as they pass from air into the prism (window glass), and travel on. Continue until they pass into air again. Label the light rays "red", "blue" and "green".



10. A light ray passes into a glass rod. Draw the approximate path of the light ray until it moves out into air.



Solutions

1. a) 1.58 b) 1.49

2. a) $1.94 \cdot 10^8 \frac{m}{s}$ b) $2.20 \cdot 10^8 \frac{m}{s}$

5. diamond

6. a) 28.3 ° b) 43.0°

7. a) 41.1° b) 34.2° c) 57.6°

8. a) 24.4° b) no c) 63.5°