

1. Find the index of refraction of a substance if the speed of light through it is  $2 \times 10^8$  m/s.
2. The index of refraction of water is 1.33. Find the speed of light through water.
3. Find the time it would take a ray of light to pass through a glass fiber 3.00 km long. The index of refraction of glass is 1.52.
4. If it takes light  $5.0 \times 10^{-9}$  s to travel through a fish tank filled with water, find the length of the tank. The index of water is 1.33.
5. A ray of light passes from diamond to glass. How many times faster does the light travel in glass than diamond.
6. A ray of light passes from air into glass with an incident angle of  $40^\circ$ . Find the angle of refraction.
7. A ray of light passes from water into a transparent crystal with an incident angle of  $30^\circ$ . If the angle of refraction is  $24^\circ$ , find the index of refraction of the crystal and the speed of light through the crystal.
8. A ray of light passes from water into diamond such that the angle of refraction is  $20^\circ$ . Find the angle of incidence.
9. A ray of light in water strikes the surface with an incident angle of  $60^\circ$ . Find the refraction angle in air.
10. Find the critical angle for glass to air.
11. Find the critical angle for glass to water.
12. Find the critical angle for diamond to air.
13. Find the critical angle for diamond to water.
14. A fish tank is resting on a horizontal surface. The tank is filled with water to a depth of 10 cm and the bottom is 2.0 cm (glass) thick. Find the time it would take light to pass through the tank if the incident angle was  $0^\circ$ .
15. A ray of light enters an equilateral (all angles are  $60^\circ$ ) glass prism with an incident angle of  $55^\circ$ . Find the angle that it exits the prism.
16. A ray of light enters an equilateral (all angles are  $60^\circ$ ) diamond prism with an incident angle of  $55^\circ$ . Find the angle that it exits the prism.
17. A ray of light enters an equilateral glass prism with an incident angle of  $10^\circ$ . Find the angle that it exits the prism.
18. REDO questions 15-17 assuming the prisms are 10.0 cm along each side and the ray of light enters the prism 5.0 cm along one

side. Find the exact point that the ray exits the prism.

19. REDO questions 15-17 assuming that the prisms are made of diamond. Find the exit points and the angle at which the ray exits.

20. A scuba diver is sitting motionless on the bottom of a swimming pool such that his head is exactly 2.0 m below the (calm) surface. Find the diameter of the circle that allows him to see a complete  $360^\circ$  view above the surface.

21. A coin is at the bottom of an empty container and water is poured into the container to a depth of 50.0 cm. How far below the water surface would the coin appear to be to a person looking at it through the water at an angle of incidence of  $40^\circ$ .

22. At what angle must a diver submersed in a lake look to see the setting sun?

23. A ray of light is incident upon a rectangular piece of glass with an incident angle of  $40^\circ$ . If the glass is 3.00 cm thick, calculate the distance the exiting ray has been deflected from the incident beam (see diagram).

