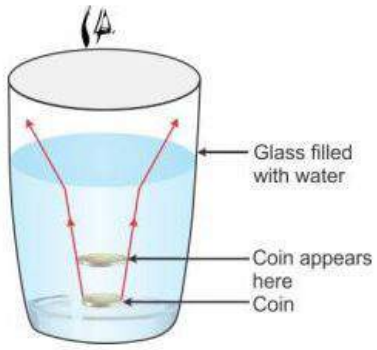
Refraction of Light

Exercise 81:

Solution 1(a):

We cannot see the coin when the glass is held slightly below the eye level. At this level, when water is being poured in the glass, the surface of the water keeps increasing and rises above the eyes. The light rays coming from the coin have to travel from two different mediums, that is, from water to air. Thus, they bend away from the normal. These rays cannot enter our eyes and hence the coin is not seen.

Solution 1(b):



The coin is seen inside the glass and appears to be slightly raised. This is due to the refraction of light. The light rays coming from the coin placed at the bottom of the glass travel from two different media, that is, from water to air. Due to this the light rays get refracted and bend away from the normal. Thus, the coin in the glass appears to be slightly raised than its original position.

Exercise 82:

Solution 1(a):

Pencil in glass filled with water

When a pencil is partly immersed in a glass half filled with water, it appears to bend at the water surface when viewed from the side. Also, the part of the pencil immersed in water appears to be slightly thick. This apparent bending is due to the refraction light rays travelling from water to air.

Exercise 84:

Solution 1(a):

1. For the surface PQ of the glass slab, ∠ABE is the angle of incidence.
2. For the surface PQ of the glass slab, ∠CBF is the angle of refraction.

Exercise 85:

Solution 1(a):

1. For the surface RS of the glass slab, ∠BCG is the angle of incidence.
2. For the surface RS of the glass slab, ∠HCD is the angle of refraction.

Exercise 87:

Solution 1(a):

We know that,

$$\text{Refractive index of water with respect to the air} = \frac{\text{Velocity of light in air}}{\text{Velocity of light in water}}$$

$$\text{So, air } (\mu) \text{ water} = \frac{3 \times 10^8 \text{m/s}}{2.66 \times 10^8 \text{m/s}}$$
$$= 1.25$$

Thus, the refractive index of water with respect to air is 1.25.

Exercise 88:

Solution 1(a):

We can see that refraction of light takes place in all the different shaped glass slabs. But, there is a difference in the path of refraction in each slab. In some glass slabs the direction of the incident and the emergent ray changes while in some it does not change.

Exercise 89:

Solution 1(a):

1. Ray PQ is the incident ray.
2. Ray QR is the refracted ray.

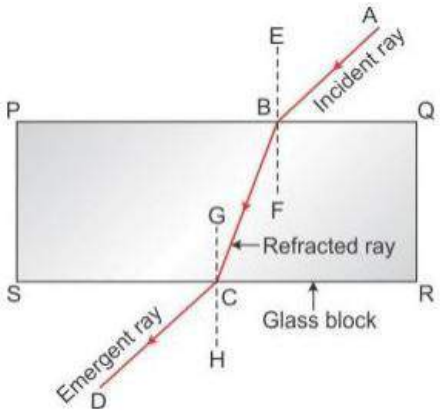
Exercise 90:

Solution 1(a):

1. Ray RS is the emergent ray.
2. For the surface AC of the prism, ∠PQE is the angle of incidence.
3. For the surface AC of the prism, ∠FQR is the angle of refraction
4. The emergent ray bends downwards towards the base of the prism.

Solution 1:

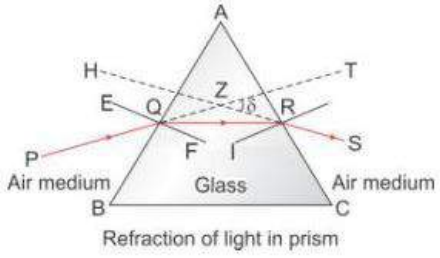
Refraction of light through a rectangular glass slab:



Place a rectangular glass slab on a white paper board. Mark the boundaries of the slab as PQRS. Now project a laser beam obliquely on the surface, PQ of the glass. Trace the incident ray and mark a point, A on it. Mark the point where the incident ray touches the surface, PQ as point B. Now observe the obliquely bend ray passing through the rectangular glass slab. The rays emerges out of the slab from the surface, SR. Trace the emergent ray and mark the point on the opposite surface RS from where it emerges out as point C. Mark one more point on the ray coming out from the point C and name it as point, D. Remove the rectangular glass slab and connect the points A, B, C and D.

Thus, we obtain the incident ray AB, refracted ray BC and the emergent ray CD. The path, ABCD in the figure is the path of refraction of light through the glass slab. The incident ray, AB bends towards the normal as it travels from air (rarer medium) to glass (denser medium) and gets refracted. The ray BC travels away from the normal as it travels from glass (denser medium) to air (rarer medium).

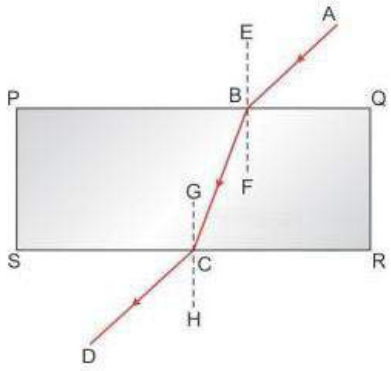
Refraction of light through a glass prism:



Refraction of light in prism

Place a glass prism with its triangular surface on a white paper board. Mark the boundaries of the prism as ABC. Now project a laser beam obliquely on the surface, AB. Trace the incident ray and mark the points P and Q. Observe the ray coming out of the prism from the surface AC. Mark the points R and S. Remove the prism and join the points P, Q, R and S. Thus, we obtain the incident ray PQ, refracted ray QR and the emergent ray Rs. As the incident ray PQ travels from air (rarer medium) to glass (denser medium), it refracts and bends towards the normal. The refracted ray QR bends away from the normal as it travels from glass (denser medium) to air (rarer medium). Thus, the emergent ray bends towards to the base of the prism. If the rays PQ and ray RS are extended such that they meet at a point Z then the ∠TZR is called the angle of deviation and is denoted as d (delta). Thus, we can say that PQ deviates by an angle d (delta).

Solution 2:



For refraction when a light ray enters from air to glass, that is at the surface PR:

Ray AB: Incident ray
Ray BC: Refracted ray
∠ABE: Angle of incidence
∠FBC: Angle of refraction

For refraction when a light ray enters from glass to air, that is at the surface RS:
Ray BC: Incident ray
Ray CD: Refracted ray
∠BCG: Angle of incidence