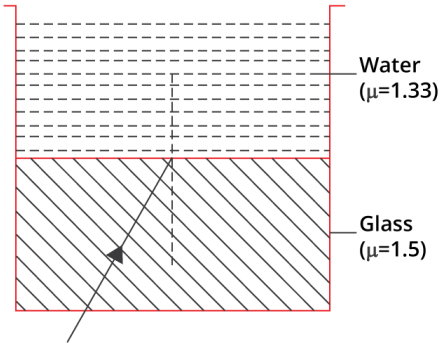
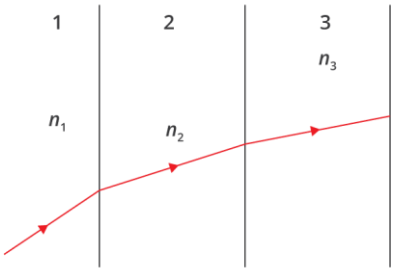
# QUIZ -REFRACTION OF LIGHT

**1.** Figure shows a vessel whose lower part is a glass slab. The remaining upper part is filled with water. A ray of light travels from glass and enters water. Which of the following statements is correct as the ray of light travels from glass to water?



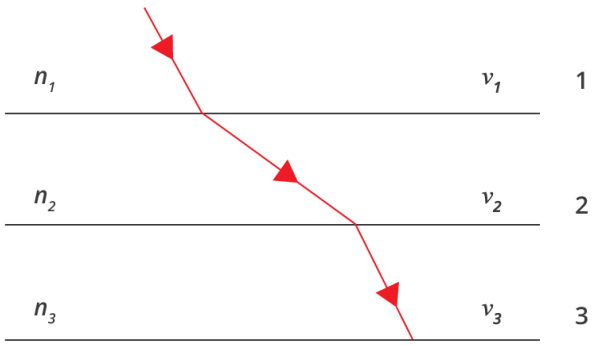

(a) It bends towards the normal and slows down.
(b) It bends away from the normal and slows down.
(c) It bends towards the normal and speeds up.
(d) It bends away from the normal and speeds up.

**2.** A ray of light travels through three mediums of refractive index $n_1$,$n_2$ and $n_3$ respectively, as shown in the figure.
The correct relation between $n_1$, $n_2$ and$n_3$ is given by




(a) $n_1 > n_2 > n_3$
(b) $n_2 > n_3 > n_1$
(c) $n_1 < n_2 < n_3$
(d) $n_3 < n_2 > n_1$

**3.** A ray of light travels through three mediums of refractive index $n_1$, $n_2$ and $n_3$, respectively, as shown is the figure. Let $v_1$, $v_2$ and $v_3$ represent the speed of light in these mediums as shown. The correct relation between $v_1$, $v_2$ and $v_3$ in the given context is




(a) $v_1 < v_2 < v_3$
(b) $v_2 < v_3 < v_1$
(c) $v_3 < v_2 < v_1$
(d) $v_3 < v_2 > v_1$

**4.** A 3 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 15 cm. The distance of the object from the lens is 20 cm. Which of the following correctly represents the image distance and magnification produced by the lens, as per New Cartesian sign convention?

(a) 60 cm, 3.0
(b) 60 cm, -3.0
(c) -60 cm, 3.0
(d) -60 cm, -3.0

**5.** A convex lens of focal length 15.0 cm is used to form image of a pencil. The pencil is placed perpendicular to the principal axis at such a distance that the height of the image formed (real and inverted) is twice the height of the pencil. Using new Cartesian sign convention, the object distance from the lens is

(a) 15.0 cm.
(b) -15.0 cm.
(c) -22.5 cm
(d) 22.5 cm

**Answers:**

**1. (d)**

**Options:**

(a) Light travels from glass (denser) to water (rarer) medium. Hence it bends away from the normal. This option is wrong.

(b) Light travels from glass (denser) to water (rarer) medium. Therefore, it bends away from the normal. This part is correct. However the speed of light in water (c/1.33) is more than the speed of light in glass (c/1.5). Thus in going form glass to water, light speeds up. Hence this option is wrong.

(c) Light ray bends away from the normal as it travel from glass to water as water is rarer compared to glass. Hence this option is wrong.

(d) Light ray bends away from the normal as light travel from glass to water as water is rarer as compared to the glass. However the speed of light in water (c/1.33) is more than the speed of light in glass (c/1.5). Thus in going form glass to water, light speeds up. Hence it speeds up. Hence this option is correct.

**Explanation:** With respect to glass, water is a rarer medium. So when light ray travels from denser to a rarer medium, it bends away from the normal. Further, speed of light in water (= c/1.33) is more than speed of light in glass (= c/1.5). Hence it speeds up. Therefore option (d) is correct.

**NOTE FOR TEACHERS:** One can generate similar questions by taking pair of material with different refractive indices.

**2. (c)**

**Options:**

(a) As the ray goes from medium 1 to 2 the ray bends towards the normal. Thus $n_2 > n_1$.
Hence this option is wrong.

(b) As the ray goes from medium 2 to 3, the ray bends towards the normal. Thus $n_3 > n_2$.
Hence this option is wrong.

(c) Since the ray bends towards the normal in going from medium 1 to medium 2 thus $n_2 > n_1$. This is also true for ray travelling from medium 2 to 3, thus $n_3 > n_2$.
Hence this option is correct.

(d) As the ray bends towards the normal in going from medium 2 to 3, thus $n_3 > n_2$. Hence this option is wrong.

**Explanation:** We know that when a ray of light travels from rarer to denser medium it bends towards the normal. As ray travels from $n_1$ to $n_2$ in the given situation, it bends towards the normal. Hence $n_1<n_2$. Similarly, $n_2<n_3$. Hence $n_1<n_2<n_3$. Hence option (c) is correct.

**3. (d)**

**Options:**

(a) In going from medium 1 to medium 2, the ray bends away from the normal. Thus $n_1>n_2$. Since $v = \frac{c}{n}$, therefore $v_2>v_1$. Similarly in going from medium 2 to medium 3, the ray bends towards the normal. Hence $n_3> n_2$. Since $v = \frac{c}{n}$, thus $v_3<v_2$.Hence this option is wrong.

(b) In going from medium 2 to medium 3, the ray bends towards the normal. Hence $n_3> n_2$. Since $v = \frac{c}{n}$, thus $v_3<v_2$. Hence this option is wrong.

(c) In going from medium 1 to medium 2, the ray bends away from the normal, thus $n_2< n_1$. And since $v = \frac{c}{n}$, thus $v_2>v_1$.Hence this option is wrong.

(d) The ray bends away from the normal in going from medium 1 to medium 2. And it bends towards the normal in going from medium 2 to medium 3. Therefore $n_2< n_1$ and $n_3> n_2$. Since $v = \frac{c}{n}$, thus $v_2>v_1$ *and* $v_3<v_2$.

Hence this option is correct.

**Explanation:** The light ray bends away from the normal in going from medium 1 to 2, thus$v_2>v_1$. In going from medium 2 to 3, the ray bends towards normal thus$v_3<v_2$. Hence option (d) is correct.

**4. (b)**

**Options:**

(a) $u$= -20cm, $f$= +15cm. Using Lens formula $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ we get $v$= +60cm. Now $m = \frac{h^1}{h} = \frac{v}{u} = \frac{60}{-20} = -3.0$. Hence this option is wrong

(b) $u$= -20cm, $f$= +15cm Lens formula $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ gives $v$= +60cm. Magnification $m = \frac{h^1}{h} = \frac{v}{u} = \frac{60}{-20} = -3.0$

Hence this option is correct.

(c) Using Lens formula $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ with $u$= -20cm, $f$= +15cm for the present case, we get $v$= +60cm and $m = \frac{v}{u} = \frac{60}{-20} = -3.0$

Hence this option is wrong.

(d) $u$= -20cm, $f$= +15cm, using $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ $v$=+60cm.

Hence this option is wrong.

**Explanation:** $u$=-20 cm, $f$= +15 cm, using New Cartesian sign convention in lens formula $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$, we get $v$= + 60 cm, and magnification $m = \frac{h^1}{h} = \frac{v}{u} = \frac{60cm}{-20cm} = -3.0$

**5. (c)**

**Options:**

(a) Image formed is real, inverted and twice the height of the object.

Hence $m$=-2 = $\frac{v}{u}$ so $v$= -2$u$, $f$= +15.0cm. Using Lens formula $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ we get $u$= -22.5cm.

Hence this option is wrong.

(b) $m$= -2 = $\frac{v}{u}$ so, $v$= -2$u$ also $f$= +15.0cm

Using Lens formula, $u$ = -22.5cm.

Hence this option is wrong.

(c) $m$= -2 =$\frac{v}{u}$, $f$= +15.0 cm, using Lens formula, $u$= -22.5 cm.

Hence this option is correct.

(d) $m$= -2 = $\frac{v}{u}$, $f$= +15.0 cm, using Lens formula, $u$= -22.5 cm

Hence this option is wrong.

**Explanation:** Image is real, inverted and twice as tall as the object.

Hence $m = -2 = \frac{v}{u}$, so, $v = -2u$.

Using $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$, we have

$$\frac{1}{-2u} - \frac{1}{u} = \frac{1}{15}$$

$$\frac{-3}{2u} = \frac{1}{15}$$

Thus $u$ =-22.5 cm. So the object is placed at a distance of 22.5 cm left of the lens i.e. $u$ =-22.5 cm.