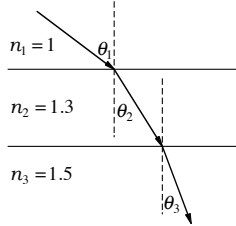


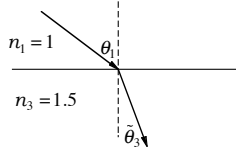
Quizzes Section 3

Snell's Law

1. Consider refraction through three materials.



Now remove the middle material.



- (a) Angle $\tilde{\theta}_3$ is less than θ_3 .
- (b) Angle $\tilde{\theta}_3$ is the same as θ_3 .
- (c) Angle $\tilde{\theta}_3$ is greater than θ_3 .

Brewster's Angle

2. When light is incident upon a material interface at Brewster's angle

- (a) only one polarization component of the field is transmitted.
- (b) both polarization components of the field are transmitted, but more of one than the other.
- (c) both polarization components of the field are reflected from the surface.

Image Formation

3. An object is located in front of a concave mirror. The image formed can occur

- (a) at the same location as the object with any desired magnification.
- (b) behind the mirror, but only if it is upright.
- (c) in front of the mirror and be virtual.
- (d) in front of the mirror and be upright.

4. It is possible to have a real image formed by a convex mirror (i.e. f is negative).

- (a) True.
- (b) False.

5. An object placed before a lens causes an image to be formed after the lens. If an opaque paper is pressed against the lower half of the lens, what part of the image will disappear?

- (a) The lower part.
- (b) The upper part.
- (c) The whole image will still be there.

Camera

6. If the f -number of a camera is doubled with the same lighting, the shutter speed should be

- (a) reduced by four.
- (b) halved.
- (c) left the same.
- (d) increased.

Eye

7. To correct the vision of a near-sighted person, a lens should be chosen which has
- (a) a negative focal length with magnitude equal to the distance to the near point.
 - (b) a negative focal length with magnitude equal to the distance to the far point.
 - (c) a positive focal length with magnitude equal to the distance to the near point.
 - (d) a positive focal length with magnitude equal to the distance to the far point.
8. A near-sighted person has an advantage over a person with 20/20 vision when looking at tiny objects brought up close to the eye.
- (a) True
 - (b) False
9. A far-sighted person has an advantage over a person with 20/20 vision when looking at very distant objects.
- (a) True.
 - (b) False.

Double Slit

10. Monochromatic light is sent through a Young's double-slit setup. The slit separation is increased. The fringe pattern on a distant screen
- (a) narrows.
 - (b) remains the same.
 - (c) broadens.
11. When a single laser beam illuminates two slits, an interference pattern is seen on a distant screen. Now suppose that each slit is illuminated by a separate laser. Suppose that the two lasers have almost the same wavelength, but differ by as much as $\Delta\lambda = 0.001nm$.
- (a) The interference pattern will be similar to that created when a single laser illuminates both slits.
 - (b) The interference pattern will shift very rapidly in time so that no fringes are seen.

Thin Film

12. An oil film on water reflects different colors more or less brightly owing to interference, depending on the film thickness. In an outer region where the film is thinnest (thin compared to visible wavelengths), all colors reflect brightly. From this information, we can tell that the index of refraction of the oil is
- (a) less than that of water.
 - (b) the same as that of water.
 - (c) greater than that of water.

Diffraction

13. Consider the central peak in a diffraction pattern that appears on a far-away screen. Which has the widest width?
- (a) The pattern formed by two narrow slits separated by spacing d .
 - (b) The pattern formed by a single slit with width d .
 - (c) The pattern formed by a circular hole with diameter d .
 - (d) They all have the same widths.
14. A circular aperture forms a pattern on a far-away screen. A lens is placed just after the aperture, which causes an image of the far-away pattern to appear at the focal plane. The angular width of the pattern with the lens in place is:
- (a) greater than the angular width without the lens.
 - (b) the same as the angular width without the lens.
 - (c) less than the angular width without the lens.

Miscellaneous

15. Choose the incorrect statement regarding Snell's law for light:

- (a) From above the surface of water, it is always possible to see objects in the water.
- (b) From beneath the surface of water, it is always possible to see objects above the water.
- (c) The critical angle for total internal reflection exists on both sides of a material interface.
- (d) none of the statements is incorrect.

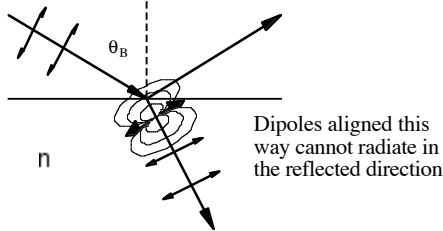
16. Choose the correct definition of dispersion:

- (a) The bending of transmitted rays as they enter into a material with a different index of refraction.
- (b) The separation of colors as they refract (or diffract) differently depending on wavelength.
- (c) The interference between different portions of a wavefront as light bends around corners and forms fringe patterns.
- (d) all of the above.
- (e) none of the above.

Answers

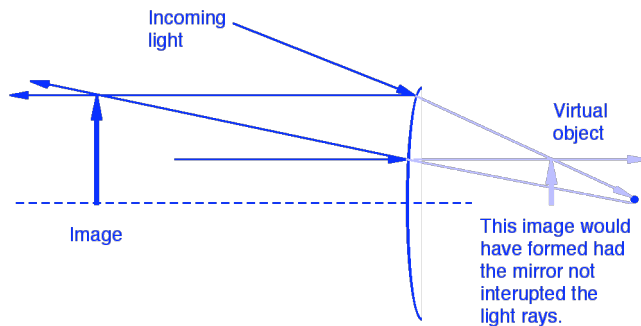
1. (b) Same angle: $n_1 \sin \theta_1 = n_2 \sin \theta_2 = n_3 \sin \theta_3$.

2. (b) At Brewster's angle, the component of polarization in the plane of the figure stimulates dipoles along the direction of reflected rays. Since dipoles cannot radiate along their axes, there is no reflection for this polarization, only transmission. The other polarization component (in and out of the page) reflects and transmits as usual.



3. (b) If p is less than $f=R/2$, then q is negative or behind the mirror so magnification is positive, indicating upright. Not (a) because fixing p and q fixes magnification. Not (c) or (d) since an image in front of the mirror will be real and inverted.

4. (a) A convex mirror can form a real image, but only if the *object is virtual*.



5. (c) All rays from a particular point on the object converge to a corresponding point on the image. It doesn't matter what part of the lens they pass through.

6. (a) The f -number is the ratio of the focal length to the diameter of the aperture. If the f -number is doubled, it means that the aperture has been closed to one half, allowing a quarter of the original light. Therefore, the shutter speed should be four times slower.

7. (b) A near-sighted person complains that the far point (obtained when the eye is relaxed) is not infinity. A negative lens is needed to re-image far-away objects () to the person's far-point.

8. (a) A near-sighted person's lens has too short a focal length. This means that the fixed distance from the lens to the screen at the back of the eye is appropriate to form images of objects that are unusually close to the eye.

9. (b) A person with 20/20 vision is able to bring far-away objects into focus by relaxing the eye. A far-sighted person can do no better but must have the ciliary muscle slightly tensed to bring far-away objects into focus.

10. (a) A wider slit separation gives a narrower pattern.

11. (b) The small separation in wavelength corresponds to a beat frequency as high as $\Delta f = 10^9$ Hz. This means that the pattern will jitter very rapidly in time. The two laser sources are not coherent.

12. (a) When the oil film is much thinner than a wavelength, constructive interference results when the phase shift upon reflection at the top of the film is the same as at the bottom. Since the index for oil is greater than air, the index for water must be greater than for the oil.

13. (c) The central peak of the single-slit diffraction pattern is twice as wide as the peaks of the double-slit setup. The central peak for the circular hole is 1.22 times wider than that of the single slit.

14. (b) Before installing the lens, the angular width is $\theta = h/|p|$. After installing the lens, the image subtends angle $\tilde{\theta} = \tilde{h}/q$, where \tilde{h} is the height of the image determined from $\tilde{h} = Mh = -qh/p = qh/|p|$, which gives $\tilde{\theta} = \theta$.

15. (c) It is impossible to force the sine function on both sides of Snell's law to exceed 1. Total internal reflection occurs only on the higher-index side. The entire 180-degree hemisphere above the water is mapped into angles within the cone defined by the critical angle.
16. (b) Dispersion is the separation of colors as they refract (or diffract) at different rates depending on wavelength.