1. A runner wants to get from P to Q as fast as he can. He can run faster on pavement than on sand. Which path should he take?

A.  
B.  
C.  
*  D.  
E.  

2. A runner wants to get from Q to P as fast as he can. He can run faster on pavement than on sand. Which path should he take?
3. A converging lens forms a real image on a screen. If the right half of the lens is covered up,

A. the left half of the image disappears
B. the right half of the image disappears
C. the entire image disappears
D. the image becomes blurry
* E. the image becomes fainter
4. An overhead projector forms an image of P at P'.

If the screen is moved closer to the projector, the lens has to be refocused by moving it:

* A. upward
B. downward
C. It doesn't need to be moved.

5.

Where does an observer at O perceive the mirror image of S to be located?
6. The observer O views two parallel lines through an angled plastic slab. The lines appear to be:

A. position 1
B. 2
C. 3
* D. 4
A. shifted to the right
B. shifted to the left
C. spaced farther apart
D. spaced closer together
E. unchanged in any way

7.

The observer sees the fish at:
A. a greater depth than it really is

B. the same depth

C. a shallower depth than it really is

The observer sees the fish at:
9. Compared to the focal length in air, a convex lens in water focuses a flashlight beam:

A. a greater depth than it really is  
B. the same depth  
C. a shallower depth than it really is
10. A corner cube is made of 3 plane mirrors at right angles, forming the corner of a cube. How many images can be seen of an object within the corner cube?

A. 1
B. 3
C. 5
* D. 7
E. 8
11. The magnification of any convex mirror is:
   A. negative
   B. zero
   * C. between zero and one
   D. greater than one
   E. More than one of the above answers is possible.

12. The magnification of any concave mirror is:
   A. negative
   B. zero
   C. between zero and one
   D. greater than one
   * E. More than one of the above answers is possible.

13. A real object on one side of a lens forms a real image on the other side. Which statement is false?
   A. The image is inverted.
   B. The diverging object rays are converged by the lens.
   * C. The focal length of the lens is negative.
   D. The focal length of the lens is less than the object distance.
14. What can be said about the image of a virtual object by a converging lens?
   A. It is located beyond the position of the virtual object.
   * B. It is real.
   C. Both of the above.
   D. Neither of the above.

15. A magnifying glass is placed a focal length away from an object. Where is the image located?
   A. at the lens
   B. at the focal point on the other side
   C. wherever the observer stands
   * D. at infinity

16. What kind of glasses does a near-sighted person need?
   A. positive lenses
   * B. negative lenses

17. Dispersion occurs when:
   A. there is total internal reflection
* B. the index of refraction is wavelength dependent
C. there is a virtual image
D. the incident beam is not refracted

18. For large enough angles of incidence, light traveling from a medium of high refractive index toward one of low index is:
   A. totally polarized
   * B. totally reflected
   C. totally dispersed
   D. totally absorbed

19. The reflected rays from a mirror appear to diverge from a point behind the mirror. This is called:
   A. a real image
   B. a focal point
   * C. a virtual image
   D. spherical aberration

20. Which of the following rays cannot normally be used to locate an image by ray tracing?
   A. a ray traveling toward the center of curvature of the mirror
   B. a ray incident parallel to the principal axis
C. a ray traveling toward the focal point
D. a ray incident on the apex of the mirror on its axis
E. All of the above rays can be.

21. A single lens for which $m > 1$ makes an image that is:
A. virtual and upright
B. virtual and inverted
C. real and upright
D. real and inverted