

Person's Optics Test **KEY**

SSSS 2017-18

Competitors' Names:

School Name: _____

All questions are worth one point unless otherwise stated. Show ALL WORK or you may not receive credit. Include correct units whenever possible.

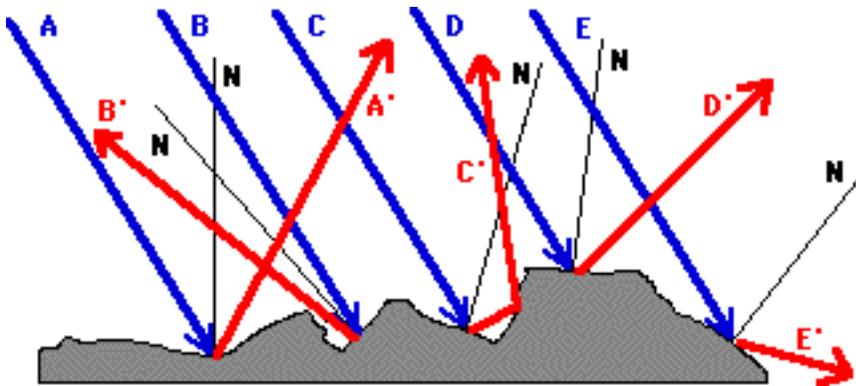
1. What are the two types of reflection?

Specular, Diffuse

1a. What type of reflection is present in a normal sheet of paper?

Diffuse

1b. Draw a diagram of the incident and reflected light rays for that reflection.



Should look something like this. Give credit if student shows a rough surface and the rays reflecting in different directions.

2. A ray of light passes from air into a block of the newly discovered material Entomologium. It refracts at an angle of 25° to the normal. Given that the refractive index of Entomologium equals 1.346, what is the incident angle?

About 34.670 degrees.

3. A triangular prism of Entomologium has an internal angle of 62° . What is the angle of minimum deviation?

About 25.774 degrees.

4. What is the angle of minimum deviation of rectangular slab of Entomologium?

0 degrees. The entering and exiting rays are parallel.

5. A convex thin lens made of Entomologium has surface radii $R_1 = 4\text{cm}$ and $R_2 = -2\text{ cm}$. What is the power of this lens in air, in diopters?

25.950 diopters

6. Calculate the critical angle for an Entomologium-Air boundary.

About 47.983 degrees.

7. What does the angle of deviation refer to in a prism?

The angle of deviation refers to the angle between incident ray entering the prism and the refracted ray exiting the prism. Also known as the overall angle of refraction of a light ray through a prism.

8. A ray of light traveling from air into an unknown material slows to 1.23×10^8 meters/second. What is the index of refraction of the material?

$n \sim 2.439$

9. If you are 1.4 meters tall, what is the smallest size a plane mirror can be in order for you to see your entire body?

0.7 meters tall: half the size of the mirror.

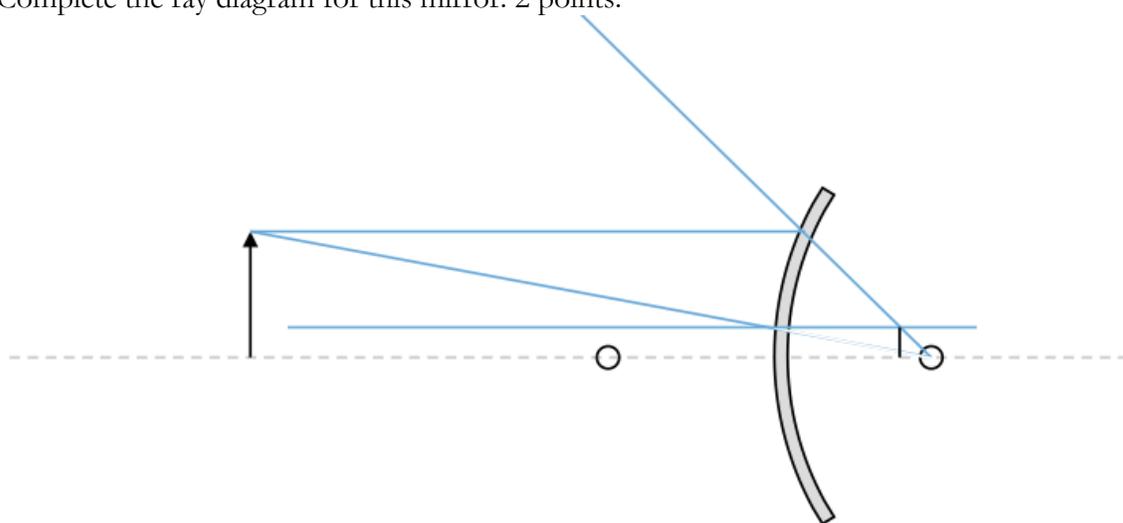
10. Fill out the following table for a concave mirror. 0.25 points per cell.

Object Location	Image Location	Image Size (Larger/Smaller than object)	Image Type (Real/Virtual)	Upright/Inverted
Beyond center of curvature	Between center of curvature (C) and focal point (F)	Smaller	Real	Inverted
At center of curvature	Center of curvature	Same size	Real	Inverted
Between center of curvature and focal point	Beyond C	Larger	Real	Inverted
At focal point	No image is formed	No image	No image	No image
In front of focal point	Opposite side of mirror	Larger	Virtual	Upright

11. Is spherical aberration present in a concave mirror? If so, how can it be reduced? 2 points.

Yes, spherical aberration is present in a concave mirror. Covering the outer edges of the mirror or using a differently shaped mirror, like a parabolic one, can reduce its effects.

12. Complete the ray diagram for this mirror. 2 points.



Very rough drawing done on a computer, lines should be straight + intersect correctly on students' drawings.

13. List 3 differences each between compound and stereoscopic microscopes (3 in compound, 3 in stereoscopic). 1 point each.

Accept any of these.

Compound	Stereoscopic
Contains both coarse and fine adjustment knob Specimens must be transparent/translucent View smaller specimens such as cells 2D view Higher magnification power Typically has one eyepiece	Contains only one focus knob Specimens can be transparent or opaque View larger specimens such as insects 3D view Lower magnification power Typically has two eyepieces

14. List 2 advantages each of refractor and reflector telescopes. (Two in refractor, two in reflector) 1 point each.

Refractor	Reflector
More resistant to misalignment Tube is sealed so it requires less cleaning, and air and temperature effects are reduced Images are steadier+sharper than a reflector of the same size	Can have a large size because it is supported at all points No chromatic aberration Only one side of the objective needs to be perfectly constructed Cheaper to make

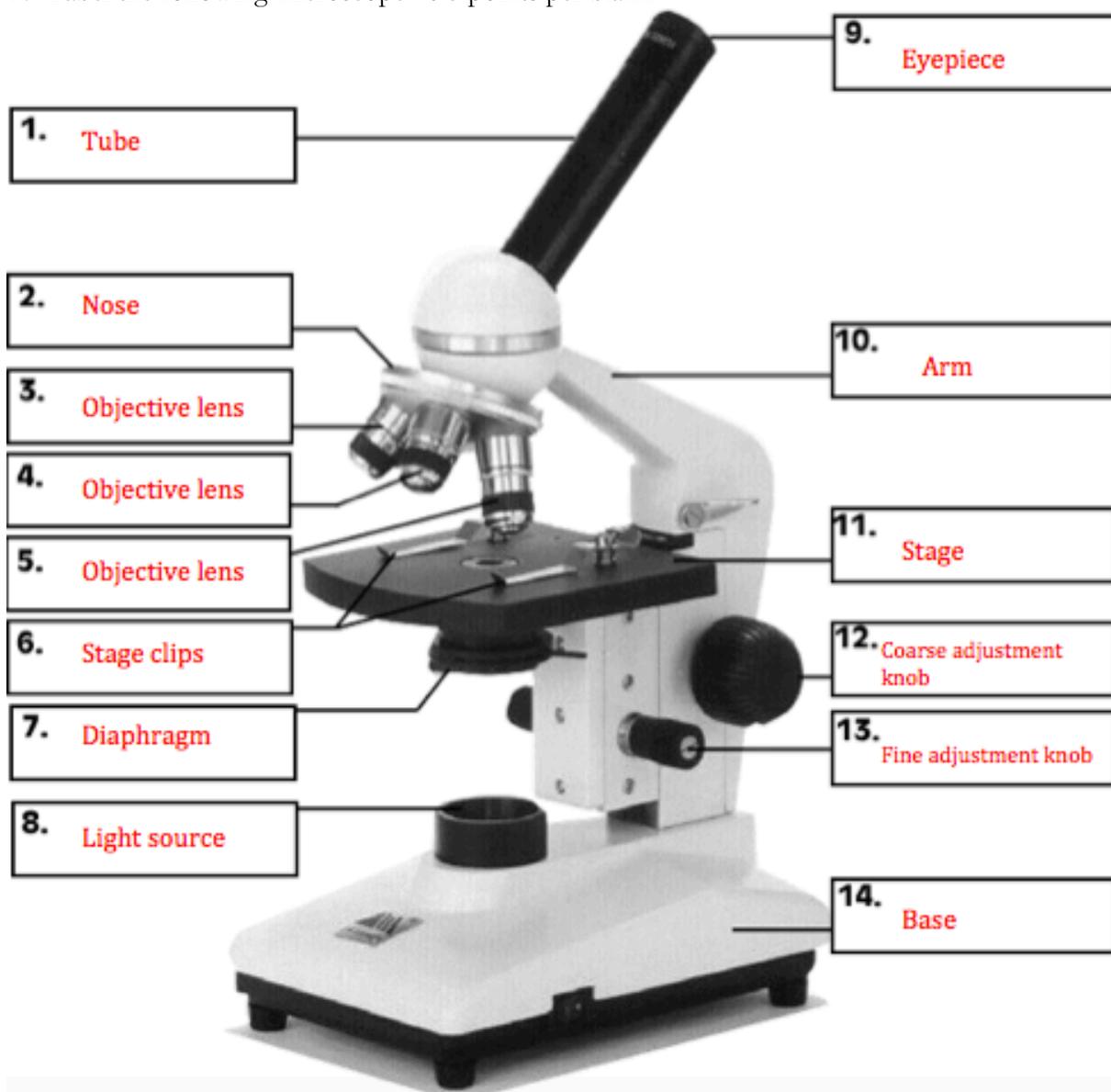
15. What kind of telescopes are all modern research telescopes?

Reflector telescopes – see advantages listed above.

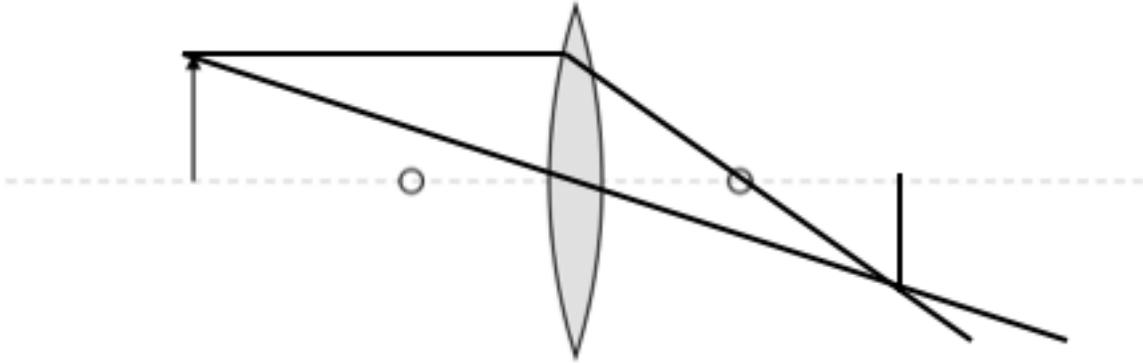
16. What happens to the aperture on a camera as the f-stop gets larger?

As the f-stop gets larger, the aperture becomes smaller.

17. Label the following microscope. 0.5 points per blank.



18. Complete the ray diagram. 2 points.



*Very rough drawing done on a computer – the lines should line up in the students' drawings.

19. What is the focal length of a convex lens when the object is 10 cm away and the image is 30 centimeters away?

7.5 cm

20. Where is rhodopsin stored, and what happens once it is exposed to light? 2 points.

Rhodopsin is stored in the rods of the eyes. When exposed to light, it bleaches.

21. In a dark room, a yellow light is shined on a paper containing blue pigment. What color does the paper appear to be when the light shines?

Appears to be black.

22. What are the three conditions necessary in order to view a rainbow? 3 points: 1 for each condition.

Bright sunlight, water drops suspended in air, and proper angle of viewing (~40 degrees, exact number is not necessary for credit)

23. Explain why the sky appears blue. 2 points.

The sky appears blue due to Rayleigh scattering. The atmospheric gases like nitrogen and oxygen scatter higher frequency portions of the visible spectrum like violet and blue easily, and do not scatter red/orange/yellow that much. The blue/violet light is scattered more so we see the sky as blue.

24. What is the focal length of a concave mirror given that its radius of curvature is 123 cm?

$$123/2 = 61.5 \text{ cm focal length}$$

25a. Where is the macula located and what is it responsible for?

The macula is located in the area near the center of the retina. It is responsible for sharp, straight vision.

25b. Give three SPECIFIC examples of its usage. 1 point for each example (3 points total).

Seeing fine detail, reading, driving, and recognizing faces.

26. What type of spectrum is the light from the Sun an example of?

Absorption spectrum

27. A 0.32 m tall lamp is placed 46.0 centimeters away from a concave mirror with focal length of 12.0 cm. What is the image distance and size? Two points: one each for distance and size.

Note that the lamp height is in meters. The centimeter equivalent would be 32 cm. Distance ~ 12.235 cm. Size ~ -11.294 cm.

28. Light reflects off of a lake. What is the relation between the polarized light and the lake's surface?

The polarized rays are parallel to the lake's surface.

29. A transparent piece of plastic is placed between two polarizing plates. What do the concentrated areas of colored bands signify?

These colored bands show where there is stress on the plastic.

30. What condition does a bulging or elongated eyeball typically result in?

Myopia/Nearsightedness

Complete the following statements.

31. Yellow, magenta, and cyan combine to form _____ **black** _____.

32. The side mirrors in a car are examples of _____ **convex** _____ mirrors.

33. _____ **ciliary** _____ muscles contract during lens accommodation.

34. Light traveling _____ **perpendicular** _____ to a film's polarizing axis is blocked.

35. In a convex mirror, as the object distance decreases, the image size _____ **increases** _____.

True/False. 0.5 points each.

___ **F** ___ 36. Light rays bend towards the normal when traveling into a medium with a lower refractive index.

___ **F** ___ 37. Total internal reflection occurs when the light ray travels from a denser medium to a less dense medium and the angle of incidence is smaller than the critical angle.

___ **F** ___ 38. Convex mirrors produce both real and virtual images.

___ **F** ___ 39. Diverging lenses reduce the effects of hyperopia.

___ **T** ___ 40. In a plane mirror, your dimensions are the same as the image's dimensions.

___ **F** ___ 41. Reflector telescopes suffer from chromatic aberrations.

___ **T** ___ 42. Red, green, and blue light can be combined to form white light.

___ **F** ___ 43. Magnifying glasses utilize concave lenses.

___ **F** ___ 44. The rods in the eye are sensitive to color.

___ **F** ___ 45. Red and blue are complementary colors of light.