# Workshop module 10 - Physics 123, Spring 2013

**P114 - 1999**

**Many fish, such as herring, have a brilliant silvery appearance in the ocean. This is due to platelets that are attached to the surfaces of the fish. Each platelet is made up of several alternating layers of crystalline guanine (n=1.8) and cytoplasm (n=1.33). The outer layer is guanine. In a typical platelet, guanine layers are 74 nm thick on average, while the cytoplasm layers are 100 nm thick.**

**(a) For the typical platelet (shown in the diagram), determine the visible (400-700 nm) wavelength(s) that are most strongly reflected?**

**The surface of a herring has many platelets, side by side, with varying layer thicknesses so that all visible wavelengths are reflected strongly … thus, the silver color! … Is that cool, or what? And to think you took this course just to satisfy a requirement for your major.**

**(b) The color most strongly reflected by a platelet depends on the angle at which it is viewed. *Briefly* explain why this is so.**

**P114 – 2000**

You lounge on the beach a week from now. Bored with looking at all the skin on the neighboring towels, you pick up a pair of eyeglasses belonging to a friend and dream of the good ol' days back in physics class …

(a) 3 pts - Your friend is nearsighted. Are the lenses in the eyeglasses converging or diverging?

(b) 3 pts - The absolute value of the focal length of each lens is 10 cm. For an object located 6 cm in front of the lens, where is the image located?

(c) 3 pts - Is the image upright or inverted?

(d) 3 pts - What is the magnification of the lens?

**P114 – 2000**

For a given light source, if the photoelectric effect is observed to occur for one metal, can you conclude that the effect will also be observed for a different metal under the same conditions? Why or why not?

**P114 – 2003**

**An object is located 4 cm from a converging lens of focal length 3 cm. The magnitude of the magnification of the image is**

a) 3
b) 4
c) 9
d) 12
e) 16

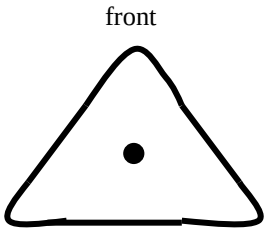
**P114-2003**

**A ray of light passes from air into water, striking the surface of the water with an angle of incidence of 45°. Which of the following quantities change as the light enters the water: (1) wavelength, (2) frequency, (3) speed of propagation, and (4) direction of propagation?**

a) 1 and 2 only
b) 2, 3, and 4 only
c) 1, 3, and 4 only
d) 3 and 4 only
e) 1, 2, 3, and 4

**P114-2003**

**Below is a sketch of the cross section of an ordinary glass thermometer for use in a doctor's office. In the middle is a small tube containing a thin "stream" of mercury (or some other substance) that expands with increasing temperature. Surrounding that small tube is glass with a triangular cross section, rounded at the corners. Briefly explain why thermometers are designed with the curved surface on the front.**



**P114-2003**

**Judy Goodall decided to study bats instead of monkeys, much to the chagrin of her famous sister Jane. During a recent field study she made a number of observations that puzzled her. Knowing you were a physics star in college, Judy comes to you and asks you to help explain her observations.**

**Judy observed the following things about a particular species of bats:**

- **This species eats insects.**
- **They "see" by emitting and detecting sound waves at a frequency of 170 kHz.**
- **They only eat insects larger than 2 mm in size.**
- **The speed of sound in air is 343 m/s.**

**Please explain briefly, using the physics principles we have discussed recently in this course, why insects smaller than 2 mm are safe from being consumed by the bats.**

**P114-2004**

**A real object is 42 cm from a negative lens with f=-21cm. The image is**

**a) real and 14 cm from the lens.**
**b) real and 42 cm from the lens.**
**c) virtual and 42 cm from the lens.**
**d) virtual and 21 cm from the lens.**
**e) virtual and 14 cm from the lens.**

**P114-2004**

**Tarzan gets his tail hauled to the eye doctor when he sees Jane at a distance and calls her Cheetah. It may have been a bad hair day, but she was not amused. The eye doctor measures Tarzan's far point to be 30 cm. Assume the lens of Tarzan's new glasses will be held 1.5 cm from the eye by the eyeglass frames. What power spectacle lens is needed to correct Tarzan's vision?**

**P114-2006**

**A ray of light travels at an angle of 52 degrees with respect to the normal of an air-liquid interface. The light is totally reflected at the interface. The liquid has index of refraction n, which is greater than 1.**
**a) Given this information, is the light traveling in liquid or air just before it strikes the interface? Justify your answer.**

**b) Given the information in this problem, what do you know about the index of refraction of the liquid? That is to say, mathematically constrain the value of n as much as possible.**

P114-2006

**Two thin lenses of focal length $f_1$ and $f_2$, respectively, are aligned along the same axis and placed very close together. (Here "close together" means you can treat the two lenses as being at the same point. This is not a bad approximation if the focal lengths are long.) Determine the correct expression for the focal length, f, of the lens combination. You must justify your answer with an argument or mathematical proof to get credit.**
**A) $f = f_1 + f_2$**
**B) $f = f_1 - f_2$**
**C) $f = 1/f_1 + 1/f_2$**
**D) $f = 1/f_1 - 1/f_2$**
**E) $1/f = 1/f_1 + 1/f_2$**
**F) $1/f = 1/f_1 - 1/f_2$**

P114-2010

A ray of light is traveling in a glass cube that is totally immersed in water. You find that if the ray is incident on the glass-water interface at an angle to the normal greater that 48.7 degrees, no light passes from the glass to the water (no light is refracted into the water in physics-speak). What is the refractive index of the glass. (Assume the refractive index of water is 1.33.)

**P142-2005**

**A real object is placed 9.00 cm from a converging lens that has a focal length of 24.0 cm. The image is**

**a) 0.119 cm from the lens, real and smaller than the object.**
**b) 0.119 cm from the lens, virtual, and smaller than the object.**
**c) 14.4 cm from the lens, real and enlarged.**
**d) 14.4 cm from the lens, virtual and enlarged.**
**e) 11.7 cm from the lens, virtual and enlarged.**

**P142-2005**

**Krok's cavemate is annoyed with how he leaves his loincloth on the floor all the time. To get him out of the way while she picks lice off the kids, she tells him to go spear some fish in the local stream. Krok is happy to go since he's tired of his mate's nagging and grunting. Krok goes down the hill and stands in the midst of the stream. The water is crystal clear. It comes up to his chin. He stands still with his spear in his hand. He feels a fish brush his leg at a depth of approximately one meter. As the fish swims away from Krok (staying at the same depth), he readies his spear. Just before jabbing his spear at the fish, it disappears from view. How far away from Krok is the fish when it disappears? ($n_w$=1.33)**

**P142-2008**

Biff goes diving and shines an underwater searchlight at the surface of the water (index of refraction 1.33) with an angle of incidence of 32 degrees relative to the normal to the surface of the water. Does Buffy, sitting in a boat nearby (on a foggy night) see the beam emerge from the water? If so, what angle does the emerging beam make with the normal to the surface of the water?

**P142-2008**

An object to the left of a lens is imaged by the lens on a screen 15.0 cm to the right of the lens. When the lens is moved 2.00 cm to the right, the screen must be moved 2.00 cm to the left to refocus the image. Determine the focal length of the lens.

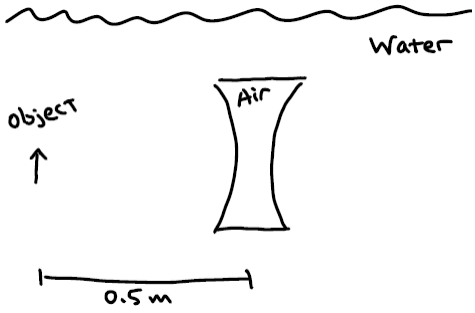
**P142-2008**

After graduation the President calls you to Washington. With knees knocking you enter the oval office and discover why you've been summoned. The President says, "Because of your extreme physics prowess, I want you to help me evaluate a pet project of mine. You see, I love to watch *Star Wars* and other science fiction movies. You know how the characters in these movies have laser blasters that have the power to knock people back as if they were struck by a bullet? I really want one of those. I need your help in evaluating the feasibility of building a blaster like that."

Briefly estimate here (for the President) the minimum power necessary for a blaster to emit (assume it emits light) in order that when the ray is incident on a person, it causes an acceleration of the person away from the blaster at 0.1g. Assume the blaster beam does not diverge significantly before hitting the target and also assume the cross section of the beam is much smaller than a human body. Finally, assume for now that the beam does not immediately blast a hole through the target.

**P142-2010**

An object in water is 0.5 meters from a concave "air lens" with a focal length 0.3 meters. Assume the index of refraction of air is 1 and the index of refraction of water is 1.33. The air lens is a shaped cavity of air immersed in the water.




a) Is the image of the object real or virtual?

b) Where is the image located?

**P142-2010**

a) Pure water is colorless and transparent, yet you can easily see water drops if you spill several onto a glass table. Briefly explain why this is so.

b) Would you expect a diamond to have more or less sparkle when immersed in water relative to air? Briefly explain your answer. *Assume the thickness of the water is not a factor. That is to say assume the same amount of light is incident on the diamond in air or in water.*

**P142-2010**

A beam of polarized light is sent through a system of two polarizing sheets. Relative to the polarization direction of that incident light, the polarizing directions fo the sheets are at angles $\theta$ for the first sheet and 90 degrees for the second sheet. If 10% of the incident intensity is transmitted by the two sheets, what is $\theta$?

**P142-2010**

The large radio telescope in Arecibo, Puerto Rico has been used to search for extra-terrestrial intelligence. The radio telescope has a diameter of 1000 feet = 304.8 meters. According to one of the researchers in Arecibo, the telescope can detect a signal that lays down over the surface of the Earth a power of 1 picowatt ($1 \times 10^{-12}$ Watts). If a signal emanating from the center of our galaxy ($2.2 \times 10^4$ light years distant) were detected, what is the minimum power of the source of the signal (assuming the source radiates equally in all directions)? *The radius of the Earth is $6.4 \times 10^6$ m and the speed of light is $3 \times 10^8$ m/s.*