The PH 203 course has covered a variety of topics. In order to prepare for the final exam, you may find the following problems helpful to review. The solutions will be posted to Boxsand on Saturday.

Problem 1.

Suppose you pass light from a He-Ne laser through two slits separated by 0.01 mm and find that the fourth bright fringe (m = 3) on a screen is formed at an angle of 10.95^o relative to the incident beam.

a. What is the wavelength of the light?
b. How many bright fringes are there?

Consider a similar set up with the same laser, but now with a single slit. The third dark spot is formed at an angle of 10.95^o relative to the incident beam.

c. What is the width of the single slit?
d. How many bright spots form on the screen?

Now consider white light incident on a diffraction grating with 10,000 slits/cm.

e. What is the distance between the violet (380 nm) and the red (760 nm) wavelength light on the m=1 bright fringe if the screen is 1.5 m away?

Problem 2.

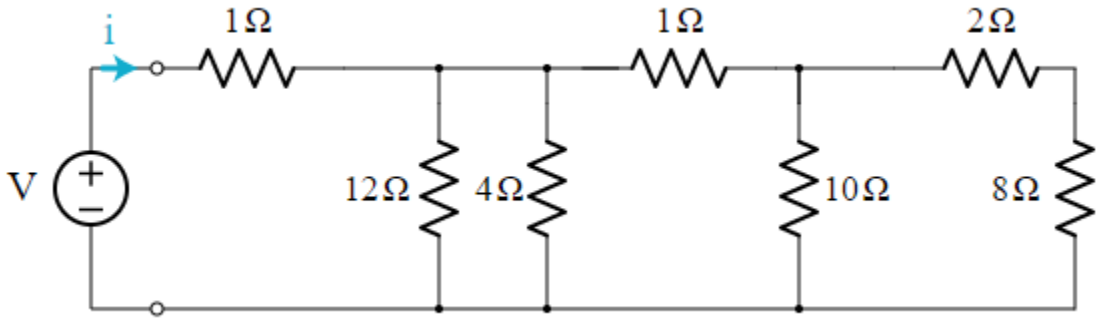
Some butterflies have a brilliant color to their wings. This color isn't produced by a pigment in their wings. We can explore this phenomenon with some of the physics we have done this term.

Consider the butterfly's wings to be made of two thin layers of keratin (a transparent substance that will not phase shift or otherwise affect the incoming light) with a 275 nm film with index of refraction n = 1.1.

a. What wavelength of light will be strongly reflected at nearly normal incidence on the butterfly's wings? Consider the butterfly to be in air.
b. What color light is this?

Problem 3.

Consider the following circuit.



a. What is the equivalent resistance of this circuit?
b. If the battery is 9V, what is the Power dissipated by the 4 Ω resistor?
c. What is the current going through the 2 Ω resistor?

Problem 4.

The transepithelial potential difference (TEPD) is the voltage across the inner and outer membrane of the skin. Consider the TEPD to be 50 mV (high potential on the outside, low potential on the inside). Consider the thickness between the layers to be 53.4 μm. For simplicity, we will model the skin as parallel plate capacitors.

a. Draw the electric field lines between the layers of the membranes.
b. What is the electric field (including direction) generated by the TEPD?
c. When the outside layer of the membrane is damaged, we can no longer model the TEPD as a parallel plate capacitor. Instead, the electric field changes orientation toward the wound site. Consider the electric field to be $940 < \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}} >$ N/C. How long would it take Sodium ion (Na^+) starting at rest to travel to the wound, given the diagram below? (The mass of a sodium ion is 3.817 x 10^-26 kg).

Problem 5.

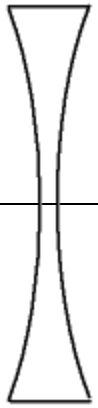
Consider an electron in a uniform magnetic field of 1 μT. We place the electron between two large, neutral plates. The electron hits the top of the plate after 2.6 seconds.

a. What direction is the magnetic field going?
b. What is the acceleration that the electron experiences?
c. How far from the electron's starting position does the electron travel?

Problem 6.

A cool looking rock is placed 5 cm in front of a diverging lens because I wanted you to get more practice with diverging lenses. The focal length of the diverging lens is 3 cm.

a. Using a ray tracing diagram, show where the image forms.



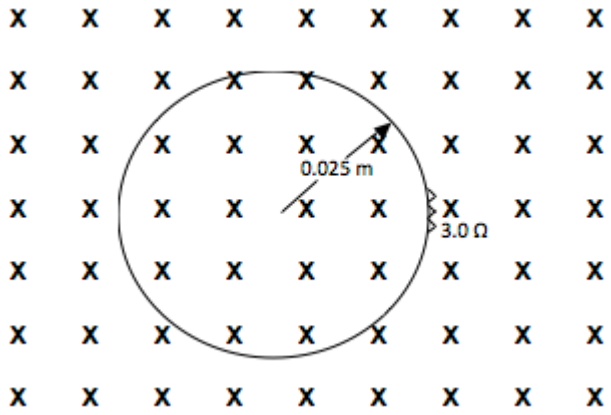
b. Is the image virtual or real?

c. What is the magnification of the image?

d. If the height of the cool looking rock is 1 cm, what is the height of the image?

Problem 7.

A circular loop of wire has a radius of 0.025 m. It's placed in a 1.6 T uniform magnetic field going into the page.



a. If an ammeter is used to measure the current in the wire, will it detect a current? Why?
b. Now the magnetic field is turned off uniformly over a period of 0.10 s. What direction is the induced magnetic field?
c. What is the EMF generated in the loop by the changing magnetic field?
d. What is the current in the loop, given that the wire has a resistance of 3.0 Ω?