General Physics II - Spring 2019
Final Exam B

Show your work. Answers alone get no credit.

{4} **1** A bird has an internal temperature of 40℃ and a fluffy layer of down that is 0.006m thick with a thermal conductivity of $0.03\frac{\mathrm{W}}{\mathrm{m}\cdot C^\circ}$. The bird has a surface area of $0.016\mathrm{m}^2$. On a day that is 5.0℃ what is the metabolic power output to keep the bird from getting cold.

{4} **2** The temperature of your campfire is about 1300K. What surface area should you make the fire so that it has the same heating capacity as a 1613 watt space heater?

{4} **3** The average kinetic energy of the molecules in a gas is 1.908×10^{-20}J. What is the temperature of the gas?

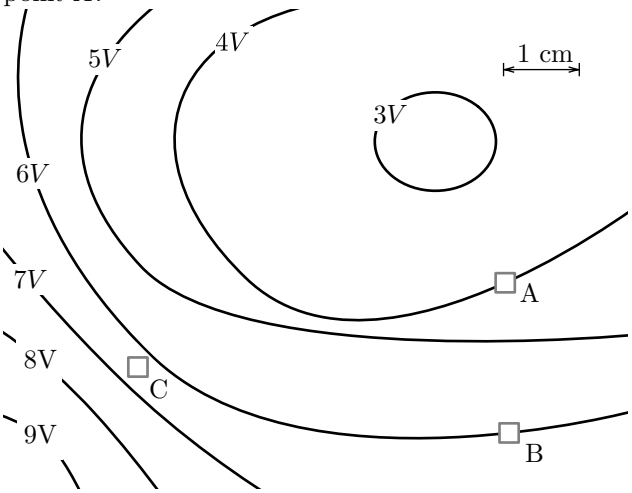
{4} **4** A current of 7.0 amps is going to the west in a wire that is 50 meters long. There is a magnetic field of 3.0 Tesla directed 31 degrees west of due north. What is the magnitude and direction of the force on the wire?

{4} **5** A laser emits a beam of light with a wavelength of 496 nm and a power of 4.0 mW.
(a) What is the momentum of one of the photons.
(b) What is the energy of one of the photons.
(c) How many photons per second are produced.

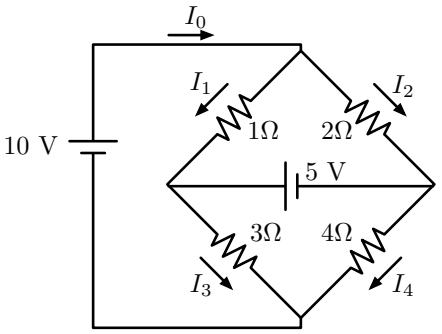
{4} **6** A electron gun emits a beam of electrons with a wavelength of 496 nm.
(a) What is the momentum of one of the electrons.
(b) What is the frequency of one of the electrons.

{4} **7** An atom has three possible energy levels, 3eV, 5eV, and 13eV. If this atom emits light what are the possible wavelengths for the light?

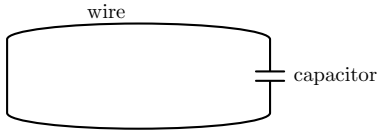
{8} **8** In the figure below is shown lines of equal electric potential. The figure is drawn to scale.
(a) Draw the direction of the electric field at point C.
(b) What is the field strength at point C?
(c) Label the location with the greatest field strength.
(d) If there is a region with $E = 0$, label it.
(e) A particle with charge -3.0C goes through this region passing through both points A and B. It had a kinetic energy of 11.0J when it passed point B. What was the particles kinetic energy when it passed through point A?



{4} **9** Write equations sufficient to find the five currents indicated.



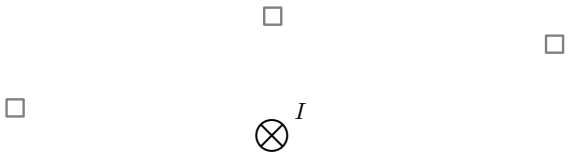
{8} **10** The two ends of a wire are connected to the two plates of a 3.0μF capacitor, forming a loop with an area of $0.50\mathrm{m}^2$ as shown in the figure.



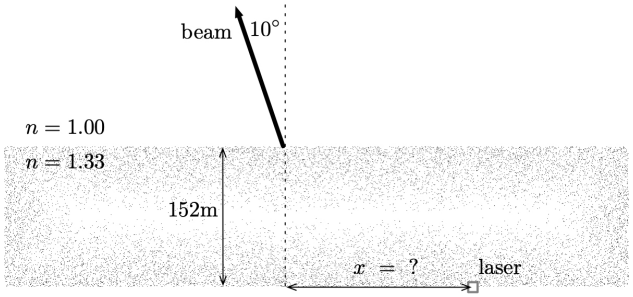
There is a magnetic field going through the loop. The field strength is $B = \alpha t^2$, where t is the time and $\alpha = 500\frac{\mathrm{A}\cdot\mathrm{V}}{\mathrm{m}^2\cdot\mathrm{C}}$.
(a) What is the charge on the capacitor at time t?
(b) How much current is running through the wire?

{4} **11** You hold a magnet over a bucket so that the magnetic field is pointing upward, then drop the magnet. There is a loop of wire around the rim of the bucket. What is the direction of the current in the wire when the magnet is half way between your hand and the bucket?

{4} **12** There is a current going into the paper at the location indicated. Draw a vector showing the direction of the magnetic field produced by this current at the three locations marked by squares.

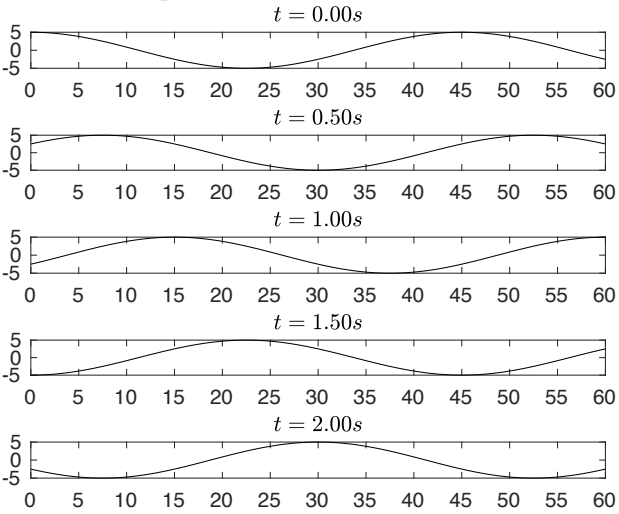


{4} **13** Your laser has fallen to the bottom of a lake which is 152 meters deep. The laser beam is coming out of the water at an angle of 10 degrees from the normal. How far horizontally x from the point where the beam comes out of the water is the laser?

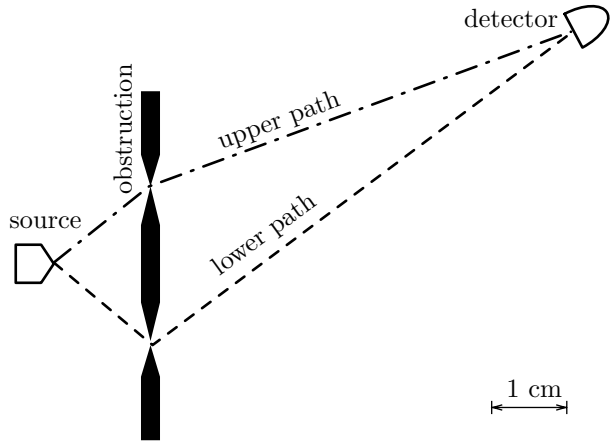


{4} **14** An electron is know to be trapped in a region that is 10 nm long. What is the least possible uncertainty in the velocity of the electron?

{4} **15** In the following graphs are snapshots of a wave at different times. The distances are in meters.
(a) What is the wavelength of the wave?
(b) What is the period of the wave?
(c) What is the speed of the wave?
(d) Write a function that gives the height of the wave at time t and position x.

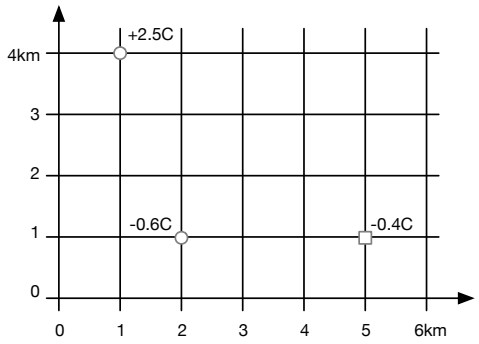


{4} **16** A source is emitting particles. They are counted at a detector at the location shown. When just the lower path is open 900 particles are detected per second. When just the upper path is open 1600 particles are detected per second. When both paths are open 2500 particle are detected per second. What is one possible wavelength for the particles?



It is a scale diagram so you can measure distances.

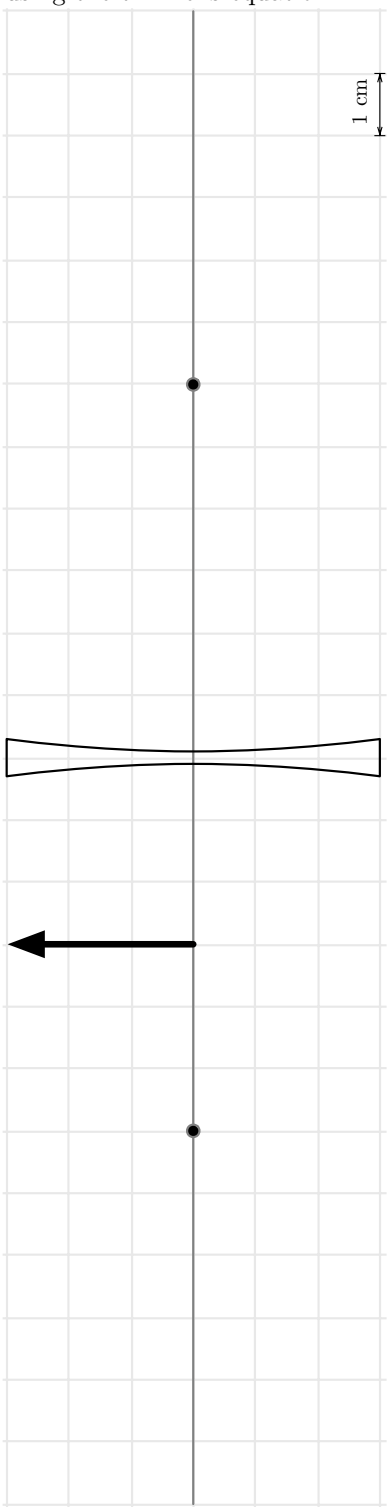
{8} **17** Compute the force on the -0.4 C charge. The distances in the diagram are in km, use $k = 9000\text{N}\frac{\text{km}^2}{\text{C}^2}$.



{4} **18** What are alpha, beta and gamma radiation?

{4} **19** You have a sample of radioactive material. You set up a detector to count the emission of radiation. You measure the emission rate and find that you get 1000 emissions per second. You measure the emission rate 32.2 day later and find the emission rate is 800 per second. What is the half life of the radioactive material?

{8} **20** Using principle rays construct the image for the object shown in this diagram. Also compute the location of the image using the thin lens equation.



$$\sigma = 5.67 \times 10^{-8}\ \mathrm{W/m^2 \cdot K^4}$$
$$k = 1.38 \times 10^{-23}\,\frac{\mathrm{J}}{\mathrm{K}}$$
$$c = 3.00 \times 10^{8}\ \frac{\mathrm{m}}{\mathrm{s}}$$
$$\hbar = 1.054 \times 10^{-34}\mathrm{J \cdot s}$$
$$h = 6.626 \times 10^{-34}\mathrm{J \cdot s}$$
$$hc = 1240\mathrm{eV \cdot nm}$$
$$hc = 1.99 \times 10^{-16}\mathrm{J \cdot nm}$$
$$m_e = 9.11 \times 10^{-31}\mathrm{kg} \quad \text{electron mass}$$