Physics 132-01 Test 2

I pledge that I have neither given nor received unauthorized assistance during the completion of this work.

Name ________________________ Signature ________________________

Questions (5 for 8 pts. apiece) Answer in complete, well-written sentences WITHIN the spaces provided.

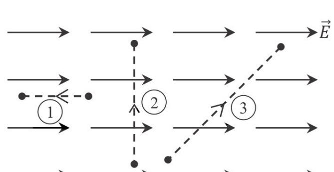
1. Suppose that you were to try the following with an electroscope, a rubber rod, and a wool cloth.

   a. Charge up the rubber rod by rubbing it.
   b. Touch it to the ball of the electroscope.
   c. Pull the rod away and charge it up with the wool cloth by rubbing it again.
   d. Bring it close to the ball of the electroscope, without touching it.

   What do you think will happen when you do the last step? (Will the foil move up, down, or neither?) Explain.

2. Why do we usually not experience electrical forces in our everyday lives?

3. One of the three paths in the figure below is an equipotential meaning that every point along the path has the same electric potential V. Which one is it? Explain your reasoning.

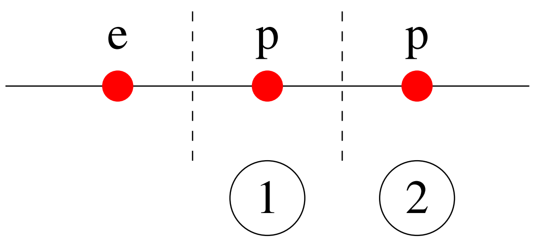


DO NOT WRITE ON THIS PAGE BELOW THE LINE.

Questions continued. Answer in complete, well-written sentences WITHIN the spaces provided.

4. Recall the oscilloscope we used to study the effect of magnetic fields on moving electrons. Suppose the beam spot from the electrons is visible on the screen and you bring the S-pole of a vertical bar magnet near to, but not touching the bottom of the case of the oscilloscope just beneath the spot. Does the spot move as the magnet gets closer? If it does, in what direction? Explain your reasoning.

5. The figure below shows an electron and two protons evenly spaced along a line. The protons are labelled with the numbers. The vertical lines mark the midpoint between two adjacent particles. Where on the line (except infinitely far away) is the net electric field zero? Mark that point. Explain your reasoning.



Problems (3). Clearly show all reasoning for full credit. Use a separate sheet to show your work.

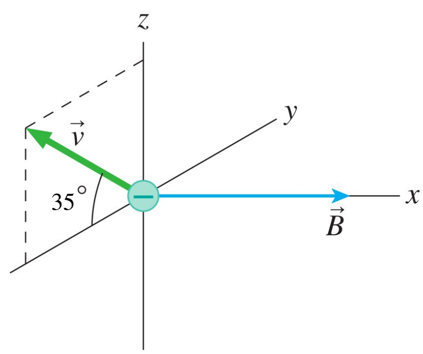
1. 16 pts. Two infinite lines of charge, each with linear charge density λ, lie along the $x-$ and $y-$axes, crossing at the origin. The magnitude of the field strength for a single line of charge is

$$E_{line} = k_e \frac{2|\lambda|}{r}$$

where r is the perpendicular distance from the line of charge, λ is the linear charge density, and k_e is the Coulomb constant. What is the electric field strength vector at position (x, y)?

DO NOT WRITE ON THIS PAGE BELOW THE LINE.

2. 20 pts. An electron moves in the magnetic field $\vec{B} = 0.7\hat{\imath}\ T$ with a speed $v = 5 \times 10^6\ m/s$ as shown in the figure. The y axis in the figure is going into the plane of the paper. What is the magnetic force $\vec{F}_B$ on the electron? Give your answer in component form.



3. 24 pts. Consider the electron orbiting a proton in the hydrogen atom as a classical point particle. The electron orbits in a circle centered on the proton at a radius $r = 5.29 \times 10^{-11}\ m$. What is the potential energy of the electron in terms of the electronic charge e, the radius r, and any other constants? What is the kinetic energy of the electron in terms of the electronic charge e, the radius r, and any other constants? How much energy is required to ionize hydrogen (*i.e.*, remove the electron from the proton so their separation is effectively infinite and their kinetic energies are zero)?

Physics 132-1 Constants

k_B	$1.38 \times 10^{-23}\ J/K$	proton/neutron mass	$1.67 \times 10^{-27}\ kg$
$1\ u$	$1.67 \times 10^{-27}\ kg$	g	$9.8\ m/s^2$
Gravitation constant	$6.67 \times 10^{-11}\ N - m^2/kg^2$	Earth's radius	$6.37 \times 10^6\ m$
Coulomb constant (k_e)	$8.99 \times 10^9 \frac{N-m^2}{C^2}$	Earth's mass	$5.97 \times 10^{24}\ kg$
Elementary charge (e)	$1.60 \times 10^{-19}\ C$	Electron mass	$9.11 \times 10^{-31}\ kg$
Permittivity constant (ϵ_0)	$8.85 \times 10^{-12} \frac{kg^2}{N-m^2}$	1.0 eV	$1.6 \times 10^{-19}\ J$
Permeability constant (μ)	$4\pi \times 10^{-7}\ Tm/A$	1 MeV	$10^6\ eV$

Physics 132-01 Equation Sheet

Test 2

$$\vec{F}_G = -G\frac{m_1 m_2}{r_{12}^2}\hat{r} \qquad \vec{F}_C = k_e\frac{q_1 q_2}{r_{12}^2}\hat{r} \qquad \vec{E} \equiv \frac{\vec{F}}{q_0} \qquad \vec{E} = k_e\sum_i \frac{q_i}{r_i^2}\hat{r}_i \qquad \vec{E} = k_e\int\frac{dq}{r^2}\hat{r} \quad k_e = \frac{1}{4\pi\epsilon_0}$$

$$\vec{E}_{dipole} = k_e\frac{q(2a)}{(x^2+a^2)^{3/2}}\hat{j} \quad \vec{E}_{ring} = k_e\frac{qx}{(x^2+R^2)^{3/2}}\hat{i} \quad \vec{E}_{plane} = 2\pi k_e\eta\hat{k} = \frac{\eta}{2\epsilon_0}\hat{k}$$

$$\vec{E}_{disk} = 2\pi k_e\eta\left[1 - \frac{z}{\sqrt{z^2+R^2}}\right]\hat{k} = \frac{\eta}{2\epsilon_0}\left[1 - \frac{z}{\sqrt{z^2+R^2}}\right]\hat{k}$$

$$W \equiv \int\vec{F}\cdot d\vec{s} \quad \Delta V \equiv \frac{\Delta PE}{q_0} = -\int_A^B \vec{E}\cdot d\vec{s} \quad V = k_e\frac{q}{r} \quad V = k_e\sum_i\frac{q_i}{r_i}$$

$$V = k_e\int\frac{dq}{r} \quad V = Ed \quad I \equiv \frac{dQ}{dt} \qquad V = IR \qquad P = IV \qquad R_{equiv} = \sum R_i$$

The algebraic sum of the potential changes across all the elements of a closed loop is zero.

$$I = nev_dA \qquad \vec{F}_B = q\vec{v}\times\vec{B} \qquad |\vec{F}_B| = |qvB\sin\theta| \qquad |\vec{F}_c| = m\frac{v^2}{r}$$

$$KE_0 + PE_0 = KE_1 + PE_1 \quad KE = \frac{1}{2}mv^2 \quad PE = qV$$

$$\vec{F} = m\vec{a} \qquad x = \frac{a}{2}t^2 + v_0t + x_0 \qquad v = at + v_0$$

$$\frac{dx^n}{dx} = nx^{n-1} \qquad \frac{df(u)}{dx} = \frac{df}{du}\frac{du}{dx} \qquad \frac{d}{dx}f(x)\cdot g(x) = f\frac{dg}{dx} + g\frac{df}{dx}$$

$$\langle x\rangle = \frac{1}{N}\sum_i x_i \quad \sigma = \sqrt{\frac{\sum_i\left(x_i - \langle x\rangle\right)^2}{N-1}} \quad A = 4\pi r^2 \quad V = Ah \quad V = \frac{4}{3}\pi r^3$$

$$\frac{df(x)}{dx} = \lim_{\Delta x\to 0}\frac{f(x+\Delta x) - f(x)}{\Delta x} \quad \int_a^b f(x)dx = \lim_{\Delta x\to 0}\sum_{n=1}^N f(x)\Delta x \quad \frac{df(y)}{dx} = \frac{df(y)}{dy}\frac{dy}{dx}$$

$$\int\frac{1}{x}dx = \ln x \quad \int x^n dx = \frac{x^{n+1}}{n+1} \quad \int e^x dx = e^x$$

hydrogen 1 **H** 1.0079																		helium 2 **He** 4.0026
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.0122												boron 5 **B** 10.811	carbon 6 **C** 12.011	nitrogen 7 **N** 14.007	oxygen 8 **O** 15.999	fluorine 9 **F** 18.998	neon 10 **Ne** 20.180
sodium 11 **Na** 22.990	magnesium 12 **Mg** 24.305												aluminium 13 **Al** 26.982	silicon 14 **Si** 28.086	phosphorus 15 **P** 30.974	sulfur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.948
potassium 19 **K** 39.098	calcium 20 **Ca** 40.078		scandium 21 **Sc** 44.956	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.942	chromium 24 **Cr** 51.996	manganese 25 **Mn** 54.938	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.933	nickel 28 **Ni** 58.693	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.39	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.61	arsenic 33 **As** 74.922	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.468	strontium 38 **Sr** 87.62		yttrium 39 **Y** 88.906	zirconium 40 **Zr** 91.224	niobium 41 **Nb** 92.906	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.91	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.87	cadmium 48 **Cd** 112.41	indium 49 **In** 114.82	tin 50 **Sn** 118.71	antimony 51 **Sb** 121.76	tellurium 52 **Te** 127.60	iodine 53 **I** 126.90	xenon 54 **Xe** 131.29
caesium 55 **Cs** 132.91	barium 56 **Ba** 137.33	57-70 *	lutetium 71 **Lu** 174.97	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.95	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.21	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.22	platinum 78 **Pt** 195.08	gold 79 **Au** 196.97	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.38	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.98	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	89-102 * *	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	ununnilium 110 **Uun** [271]	unununium 111 **Uuu** [272]	ununbium 112 **Uub** [277]		ununquadium 114 **Uuq** [289]				

*Lanthanide series	lanthanum 57 **La** 138.91	cerium 58 **Ce** 140.12	praseodymium 59 **Pr** 140.91	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.96	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.93	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.93	erbium 68 **Er** 167.26	thulium 69 **Tm** 168.93	ytterbium 70 **Yb** 173.04
* *Actinide series	actinium 89 **Ac** [227]	thorium 90 **Th** 232.04	protactinium 91 **Pa** 231.04	uranium 92 **U** 238.03	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]

The Periodic Chart.