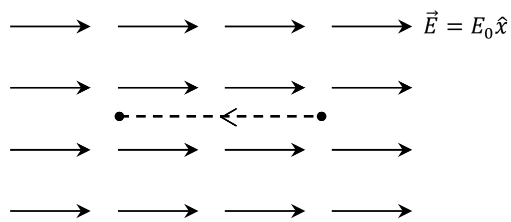
Physics 132-01 Test 2

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

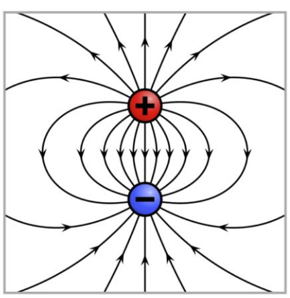
Name ______________________________ Signature ______________________________

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

1. The figure below shows a region of uniform electric field E_0. If a *positively* charged particle $+q$ moves along the path shown with the dashed line, is the change in potential energy of the system *positive*, *negative*, or *zero?* Explain.



2. The figure below shows either the field lines or equipotentials for an electric dipole. Are they field lines or equipotentials? Whatever you answered in the previous question draw the other type of curve. Explain your reasoning for how you draw those curves.



3. The magnitude of the magnetic force on a charged particle in a uniform magnetic field is $|\vec{F}_B| = qvB$ and it moves in a circle. What is the magnitude of the centripetal force $|\vec{F}_c|$ in terms of v, r (the radius of the circular motion) and m (the particle mass)? Equate the expressions for the magnitudes of $|\vec{F}_B|$ and $|\vec{F}_c|$. Solve for the mass m in terms of the radius r of the particles path, $|q|$, v, and B.

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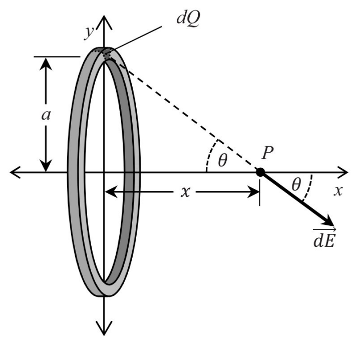
Questions continued. Answer in complete, well-written sentences WITHIN the spaces provided.

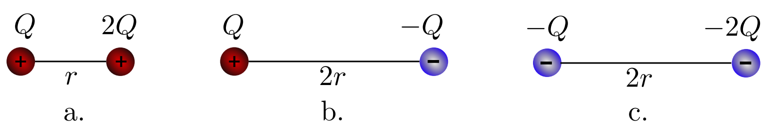
4. Referring to the figure, the magnitude of the electric field $d\vec{E}$ due to just a single bit of charge dQ on the ring is

$$|d\vec{E}| = k_e \frac{dQ}{r^2}$$

where k_e is a constant and r is the distance from dQ to a point on the axis as shown. What is dE_x in terms of x, a, and any other known constants?



5. Rank the potential energies of the three systems of particles shown in the figure from largest to smallest. Include equalities if appropriate. Explain your reasoning.



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

1. 15 pts. Four 1.50-V AA batteries in series are used to power a transistor radio. If the batteries can move a charge of $Q = 240\ C$, how long will they last if the radio has a resistance of $R = 150\ \Omega$?

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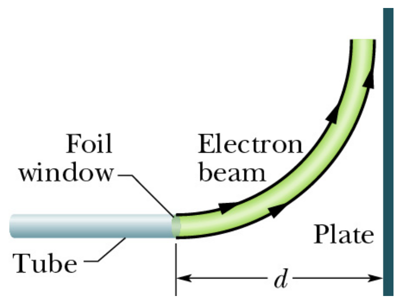
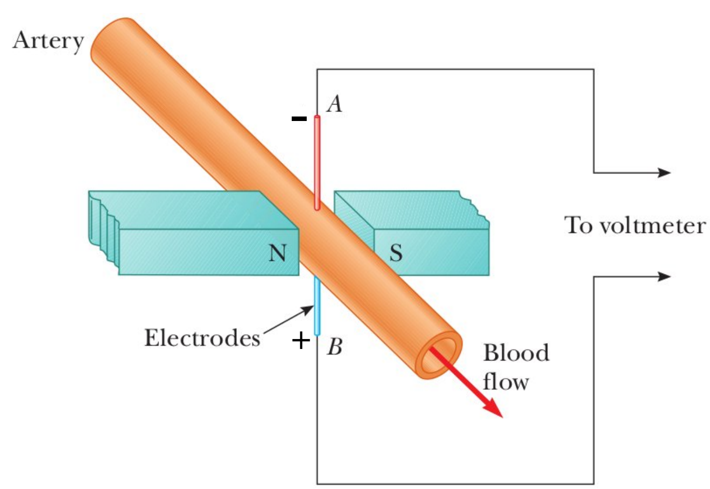
2. 20 pts. A beam of particles of charge q and mass m is accelerated across a potential difference V_0 and emerges with kinetic energy KE after passing through a thin-foil 'window' at the end of an accelerator tube. There is a metal plate a distance d from the window and perpendicular to the beam direction. See the figure below. What is the minimum magnetic field $\vec{B}$ needed to deflect the beam and prevent it from hitting the plate? How should $\vec{B}$ be oriented? If you measured this magnetic field B, then what would be the mass of the beam particles? Get your answers in terms of V_0, d, q, B, m and any other necessary constants.



3. 25 pts. Surgeons use the following device to check on blood flow during an operation. Two electrodes A and B are in contact with the outer surface of an artery, which has an interior diameter $d = 3.0\ mm$. When a magnetic field of magnitude $B_0 = 0.04\ T$ is applied as shown, a voltage $V_0 = 1.60 \times 10^{-4}\ V$ is measured. Some of the blood constituents are positively charged and are deflected to one side of the vessel by the B field creating an electric field E_0 in the artery. Assume the electric field/force in the artery is constant and in equilibrium with the magnetic force. How are the voltage and the electric field related? What is the speed of the blood? Is electrode A negative as shown? Explain.



Physics 132-01 Equation Sheet Test 2

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

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

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

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

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

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

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

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

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

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

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

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

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

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	$10^{6}\ eV$

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.