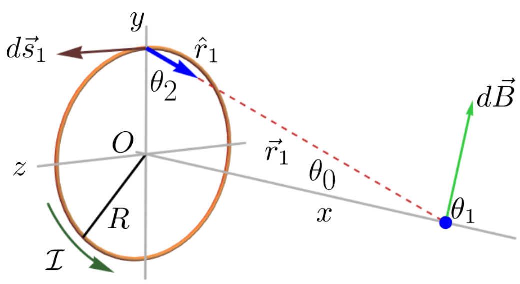
Physics 132-01 Test 2

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

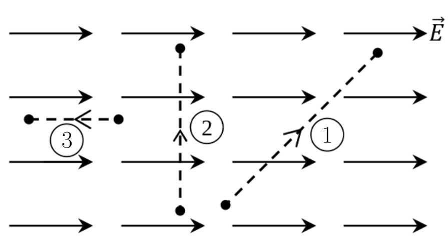
Name ______________________________ Signature ______________________________

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

1. Consider the figure of a ring of electric current and the $\vec{B}$ field produced by the point current in $d\vec{s}_1$ on the ring's axis. How is θ_2 related to θ_1? Prove your assertion.



2. The figure below shows electric field vectors in a region of space. In traveling along each of the dotted-line paths below, is the change in electric potential ΔV positive, negative, or zero? (Think: if pushing a positive charge $+q$ along the path with your hand would require doing positive work, then you would be increasing the potential energy of the system.) Explain your reasoning.

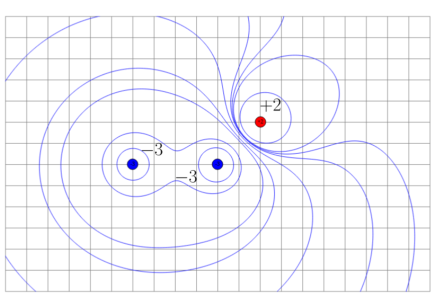


ΔV_1: ____________

ΔV_2: ____________

ΔV_3: ____________

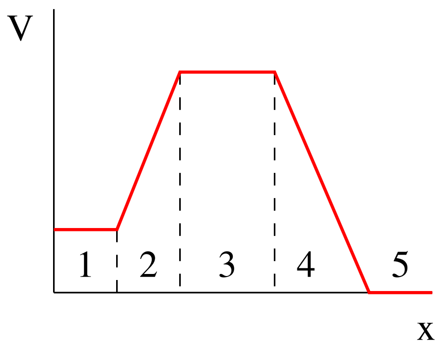
3. Consider the figure below of three charges (red is positive, blue is negative) and their equipotential lines. Draw a representative set of field lines including directions for each of the charges. What reasoning did you apply to draw the field lines?



DO NOT WRITE BELOW THIS LINE.

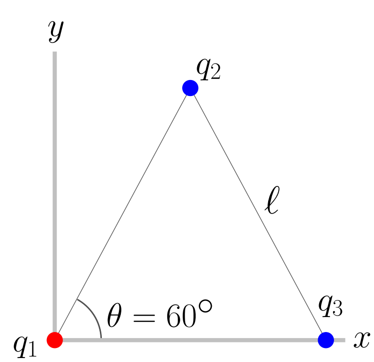
4. When we turn the lights on in a room the lights come on essentially instantaneously. In our study of circuits and current flow we found the drift velocity of the electrons in the wire was slow - usually $\approx 10^{-5}\ m/s$. Explain why these slow moving electrons can cause the lights to come on so quickly.

5. The figure below shows the electric potential V as a function of x. Which region along the x axis has the largest electric field? Which region has the lowest? Explain your reasoning.



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

1. 15 pts. Three point charges are located at the corners of an equilateral triangle as shown in the figure with the values $q_1 > 0$, $q_2 < 0$, $q_3 < 0$, and ℓ. What is the vector force on q_2 in terms of the charges, ℓ, θ, and any other constants? Explain how you arrive at the angles you used.



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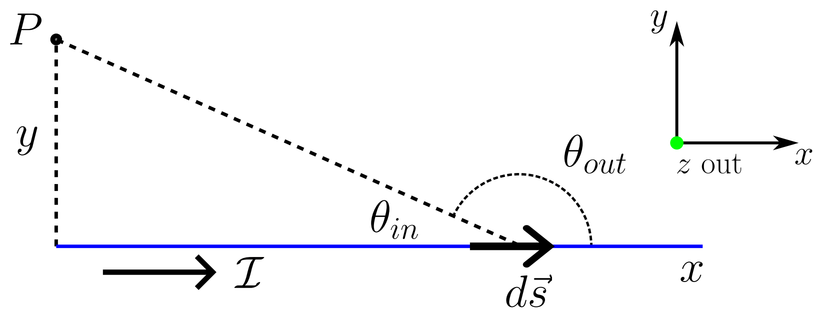
Problems (3). Clearly show all reasoning for full credit. Use a separate sheet to show your work.

2. 20 pts. What is the magnetic field $\vec{B}$ at a point P which is a distance y away from the end of a thin wire of length $\mathcal{L}$ carrying current $\mathcal{I}$ as shown in the figure? Start from the Biot-Savart Law and get your answer in terms of $\mathcal{L}$, y, $\mathcal{I}$, and any other necessary quantities.



3. 25 pts. A neutral particle is at rest in a uniform magnetic field of magnitude $|\vec{B}|$. At time $t = 0$ it decays into two charged particles each with mass m and with charges $+q$ and $-q$. The two particles move off on separate paths with opposite velocities. Both paths lie in a plane perpendicular to $\vec{B}$. At a later time they collide.

   1. Why are the velocities opposite to one another?

   2. What is the time from the decay to the collision? Express your answer in terms of m, q and B and any other constants.

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Physics 132-01 Equations Test 2

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

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

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

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

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

The algebraic sum of the potential changes across all the elements of a closed loop is zero. $\qquad I = nqv_dA$

$$\vec{F}_B = q\vec{v}\times\vec{B} \quad |\vec{F}_B| = |qvB\sin\alpha| \quad \vec{B} = k_m\int\frac{Id\vec{s}\times\hat{r}}{r^2} \quad k_m = \frac{\mu_0}{4\pi} \quad \vec{B}_{ring} = \frac{\mu_o IR^2}{2}\frac{1}{(x^2+R^2)^{3/2}}\hat{i}$$

$$\vec{p}_0 = \vec{p}_1 \quad KE_0 + PE_0 = KE_1 + PE_1 \quad KE = \frac{1}{2}mv^2 \quad PE = qV$$

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

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

$$\langle x\rangle = \frac{1}{N}\sum_i x_i \quad \sigma = \sqrt{\frac{\sum_i(x_i-\langle x\rangle)^2}{N-1}} \quad \Delta x_{total} = \sqrt{\Delta x_1^2 + \Delta x_2^2 + ...} \quad A = 4\pi r^2 \quad V = Ah \quad V = \frac{4}{3}\pi r^3$$

$$\vec{A}\cdot\vec{B} = A_xB_x + A_yB_y + A_zB_z \quad \vec{A}\times\vec{B} = |\vec{A}||\vec{B}||\sin\alpha| \to rhr$$

$$\ln(ab) = \ln a + \ln b \quad \ln\left(\frac{a}{b}\right) = \ln a - \ln b \quad \ln x^n = n\ln x \quad x = e^{\ln x} = \ln(e^x)$$

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

$$\int \frac{1}{x}dx = \ln x \quad \int x^n dx = \frac{x^{n+1}}{n+1} \quad \int e^{ax}dx = \frac{e^{ax}}{a} \quad \int \frac{1}{\sqrt{x^2+a^2}}dx = \ln\left[x+\sqrt{x^2+a^2}\right]$$

$$\int \frac{x}{\sqrt{x^2+a^2}}dx = \sqrt{x^2+a^2} \quad \int \frac{x^2}{\sqrt{x^2+a^2}}dx = \frac{1}{2}x\sqrt{x^2+a^2} - \frac{1}{2}a^2 \ln\left[x+\sqrt{x^2+a^2}\right]$$

$$\int \frac{x^3}{\sqrt{x^2+a^2}}dx = \frac{1}{3}(-2a^2+x^2)\sqrt{x^2+a^2} \quad \int \frac{1}{(x^2+a^2)^{3/2}}dx = \frac{x}{a^2\sqrt{x^2+a^2}}$$

$$\int \frac{x}{(x^2+a^2)^{3/2}}dx = \frac{-1}{\sqrt{x^2+a^2}} \quad \int \frac{1}{x^2+a^2}dx = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right)$$

Physics 132-01 Constants

$T_{boiling}$ (N_2)	$77\ K$	$T_{freezing}$ (N_2)	$63\ K$
$T_{boiling}$ (water)	$373\ K$ or 100°C	$T_{freezing}$ (water)	$273\ K$ or 0°C
L_v(water)	$2.26 \times 10^6\ J/kg$	L_f (water)	$3.33 \times 10^5\ J/kg$
L_v(N_2)	$2.01 \times 10^5\ J/kg$	c (copper)	$3.87 \times 10^2\ J/kg -^\circ$ C
c (water)	$4.19 \times 10^3\ J/kg - K$	c (steam)	$0.69\ J/kg - K$
c (iron)	$4.5 \times 10^2\ J/kg - k$	c (aluminum)	$9.0 \times 10^2\ J/kg - K$
ρ (water)	$1.0 \times 10^3 kg/m^3$	P_{atm}	$1.01 \times 10^5\ N/m^2$
R	$8.31 J/K - mole$	g	$9.8\ m/s^2$
$0\ K$	-273° C	Speed of light (c)	$3.0 \times 10^8\ m/s$
proton/neutron mass	$1.67 \times 10^{-27}\ kg$	k_B	$1.38 \times 10^{-23}\ J/K$
Gravitation constant	$6.67 \times 10^{-11}\ N - m^2/kg^2$	1.0 eV	$1.6 \times 10^{-19}\ J$
e electronic charge	$1.6 \times 10^{-19}\ C$	Electron mass	$9.11 \times 10^{-31}\ kg$
Permittivity constant (ϵ_0)	$8.85 \times 10^{-12} \frac{kg^2}{N-m^2}$	$1\ u$	$1.67 \times 10^{-27}\ kg$
Permeability constant (μ_0)	$4\pi \times 10^{-7}\ Tm/A$	Earth-Sun distance	$1.5 \times 10^{11}\ m$
$k_e = 1/4\pi\epsilon_0$	$8.99 \times 10^9\ N - m^2/C^2$	Earth's mass	$5.97 \times 10^{24}\ kg$
$k_m = \mu_o/4\pi$	$10^{-7}\ Tm/A$	Earth's radius	$6.37 \times 10^6\ m$

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.