College of Engineering and Technology
Department of Basic and Applied Sciences
PHYSICS I – Sheet

Suggested Problems

1 Vectors

2 Coulomb's Law and Electric Field
23.13, 23.17, 23.23, 23.25, 23.26, 23.27, 23.62, 23.77, 23.78

3 Electric Flux and Gauss's Law
24.15, 24.19, 24.23, 24.30, 24.47, 24.48, 24.60, 24.61, 24.64

4 Electric Potential Energy and Electric Potential
25.3, 25.12, 25.13, 25.16, 25.18, 25.23, 25.27, 25.31, 25.59

5 Capacitance
26.23, 26.28, 26.29, 26.48, 26.53, 26.57, 26.61, 26.65, 26.67, 26.72

6 DC Circuits
28.25, 28.27, 28.31

7 Magnetic Force and Magnetic Torque
29.8, 29.11, 29.12, 29.22, 29.31, 29.39, 29.44, 29.47

8 Sources of Magnetic Field

9 Faraday's Law of Induction
31.46, 31.53, 31.55

Additional Exercises

1 Vectors

Question 1.1. If a person moves from the origin to point A with $x = 4$, $y = 3$, $z = 5$:

a) Write down the displacement vector in cartesian form.

b) What is the unit vector in the direction of the displacement ?

Question 1.2. For the following vectors:

- Find the unit vector $\hat{\boldsymbol{A}}$ in cartesian form.
- Find the polar forms of the vectors.

a) $\vec{\boldsymbol{A}} = 3\hat{\boldsymbol{i}} - 5\hat{\boldsymbol{j}}$ [**Ans:** $\hat{\boldsymbol{A}} = 0.5145\hat{\boldsymbol{i}} - 0.8575\hat{\boldsymbol{j}}$, $\vec{\boldsymbol{A}} = 5.831, \angle -59.04°$]

b) $\vec{\boldsymbol{A}} = -7\hat{\boldsymbol{i}} - 15\hat{\boldsymbol{j}}$ [**Ans:** $\hat{\boldsymbol{A}} = -0.423\hat{\boldsymbol{i}} - 0.906\hat{\boldsymbol{j}}$, $\vec{\boldsymbol{A}} = 16.553, \angle -115.02°$]

c) $\vec{\boldsymbol{A}} = -3\hat{\boldsymbol{i}} + 4\hat{\boldsymbol{j}}$ [**Ans:** $\hat{\boldsymbol{A}} = -0.6\hat{\boldsymbol{i}} + 0.8\hat{\boldsymbol{j}}$, $\vec{\boldsymbol{A}} = 5, \angle 126.87°$]

Question 1.3. Find the cartesian forms of the following vectors:

a) $\vec{\boldsymbol{A}} = 5,\ 30°$ [**Ans:** $\vec{\boldsymbol{A}} = 4.33\hat{\boldsymbol{i}} + 2.5\hat{\boldsymbol{j}}$]

b) $\vec{\boldsymbol{A}} = 10,\ 257°$ [**Ans:** $\vec{\boldsymbol{A}} = -2.25\hat{\boldsymbol{i}} - 9.74\hat{\boldsymbol{j}}$]

c) $\vec{\boldsymbol{A}} = 34,\ 55°$ with the y-axis in the fourth-quadrant [**Ans:** $\vec{\boldsymbol{A}} = 27.85\hat{\boldsymbol{i}} - 19.50\hat{\boldsymbol{j}}$]

d) $\vec{\boldsymbol{A}} = 55,\ 25°$ with the x-axis in the third-quadrant [**Ans:** $\vec{\boldsymbol{A}} = -49.85\hat{\boldsymbol{i}} - 23.24\hat{\boldsymbol{j}}$]

Question 1.4. A person moves from point $A(-2, 1, 7)$ to point $B(4, -3, -5)$.

a) Find the displacement vector in cartesian form. [**Ans:** $6\hat{\boldsymbol{i}} - 4\hat{\boldsymbol{j}} - 12\hat{\boldsymbol{k}}$]

b) What is the magnitude of the displacement vector ? [**Ans:** 14]

c) Find the unit vector in the direction of the displacement. [**Ans:** $0.428\hat{\boldsymbol{i}} - 0.286\hat{\boldsymbol{j}} - 0.857\hat{\boldsymbol{k}}$]

Question 1.5. For the following force vectors acting on a body:

$$\vec{\boldsymbol{F}}_{\mathbf{1}} = 5\hat{\boldsymbol{i}} - 10\hat{\boldsymbol{j}}\,(N) \qquad \vec{\boldsymbol{F}}_{\mathbf{2}} = -15\hat{\boldsymbol{i}} + 5\hat{\boldsymbol{j}}\,(N) \qquad \vec{\boldsymbol{F}}_{\mathbf{3}} = 4,\ \angle 45°\,(N),$$

what is the resultant force vector. [**Ans:** $-7.17\hat{\boldsymbol{i}} - 2.17\hat{\boldsymbol{j}}\,(N)$]

Question 1.6. The vectors $\vec{\boldsymbol{A}}$ and $\vec{\boldsymbol{B}}$ are given as:

$$\vec{\boldsymbol{A}} = -3\hat{\boldsymbol{i}} + 4\hat{\boldsymbol{j}} \qquad \vec{\boldsymbol{B}} = 4\hat{\boldsymbol{i}} - 3\hat{\boldsymbol{j}}$$

a) Find the magnitudes of both $\vec{\boldsymbol{A}}$ and $\vec{\boldsymbol{B}}$. [**Ans:** $|\vec{\boldsymbol{A}}| = 5$,$|\vec{\boldsymbol{B}}| = 5$]

b) Put the following vectors in polar forms:

$$\vec{\boldsymbol{C}} = \vec{\boldsymbol{A}} - 5\vec{\boldsymbol{B}}$$

[**Ans:** $29.83, \angle 140.44°$]

$$\vec{\boldsymbol{D}} = 2\vec{\boldsymbol{A}} + \vec{\boldsymbol{B}}$$

[**Ans:** $5.385, \angle 111.8°$]

Question 1.7. [**Scalar Product**] Find the angle between the following vectors:

a) $\vec{\boldsymbol{A}} = 12\hat{\boldsymbol{i}} - 15\hat{\boldsymbol{j}} + 25\hat{\boldsymbol{k}}$, $\vec{\boldsymbol{B}} = -12\hat{\boldsymbol{i}} + 20\hat{\boldsymbol{j}} + 30\hat{\boldsymbol{k}}$ [**Ans:** $75.201°$]

b) $\vec{\boldsymbol{A}} = -10\hat{\boldsymbol{i}} - 25\hat{\boldsymbol{j}} - 50\hat{\boldsymbol{k}}$, $\vec{\boldsymbol{B}} = -12\hat{\boldsymbol{i}} + 20\hat{\boldsymbol{j}}$ [**Ans:** $106.67°$]

c) $\vec{\boldsymbol{A}} = -10\hat{\boldsymbol{i}} - 50\hat{\boldsymbol{k}}$, $\vec{\boldsymbol{B}} = -12\hat{\boldsymbol{i}}$ [**Ans:** $78.69°$]

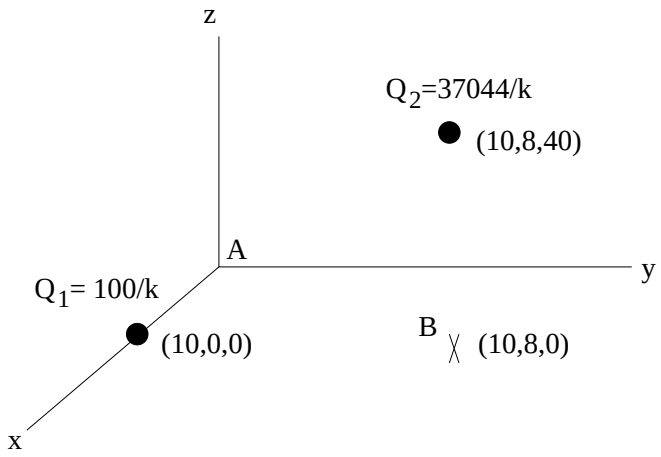
2 Coulomb's Law and Electric Field

Question 2.1. Three charges, each of magnitude $3\,nC$, are at separate corners of a square of side $5\,cm$. The two charges at opposite corners are positive, and the other charge is negative. Find the magnitude of the force exerted by these charges on a fourth charge $q = 3\,nC$ at the remaining corner. [**Ans:** $29.6\,\mu N$]

Question 2.2. A charge $Q_1 = \dfrac{100}{k}\,C$ is located at $x = 10$, $y = 0$, $z = 0$. A charge $Q_2 = \dfrac{37044}{k}\,C$ is located at $x = 10$, $y = 8$, $z = 40$. Let the coordinates of a point B be $x = 10$, $y = 8$, $z = 0$. Let A be the origin.

a) Calculate the electric field vector at the point A: $\vec{\boldsymbol{E}}_{\boldsymbol{A}}$. [**Ans:** $\vec{\boldsymbol{E}}_{\boldsymbol{A}} = -6\hat{\boldsymbol{i}} - 4\hat{\boldsymbol{j}} - 20\hat{\boldsymbol{k}}\,(N/C)$]

b) If a charge of $Q_3 = 2\,nC$ is placed at the origin A, what is the electric force vector $\vec{\boldsymbol{F}}$ on Q_3 ? [**Ans:** $\vec{\boldsymbol{F}}_{\boldsymbol{Q_3}} = -12\hat{\boldsymbol{i}} - 8\hat{\boldsymbol{j}} - 40\hat{\boldsymbol{k}}\,(nN)$]



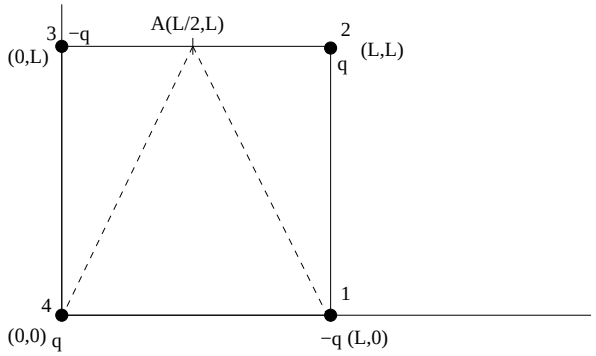
Question 2.3. A point charge of $5\mu C$ is located at $x = -3\,cm$ and a second point charge of $-8\mu C$ is located at $x = 4\,cm$. Where should a third charge of $6\mu C$ be placed so that the electric field at $x = 0$ is zero ? [**Ans:** $(2.38\,cm, 0)$]

Question 2.4. Four charges of equal magnitude are arranged at the corners of a square of side L as shown in the figure.

a) Find the magnitude and direction of the force exerted on the charge in the lower left corner by the other charges. [**Ans:** $k\frac{q^2}{L^2}\left(1 - \frac{1}{2\sqrt{2}}\right)(\hat{\boldsymbol{i}} + \hat{\boldsymbol{j}})$]

b) Show that the electric field at the midpoint of one of the sides of the square is directed along that side toward the negative charge and has a magnitude E given by:

$$E = k\frac{8q}{L^2}\left(1 - \frac{\sqrt{5}}{25}\right)$$



Question 2.5. A point charge of $-2.5\mu C$ is located at the origin. A second point charge of $6\mu C$ is at $x = 1\,m$, $y = 0.5\,m$.

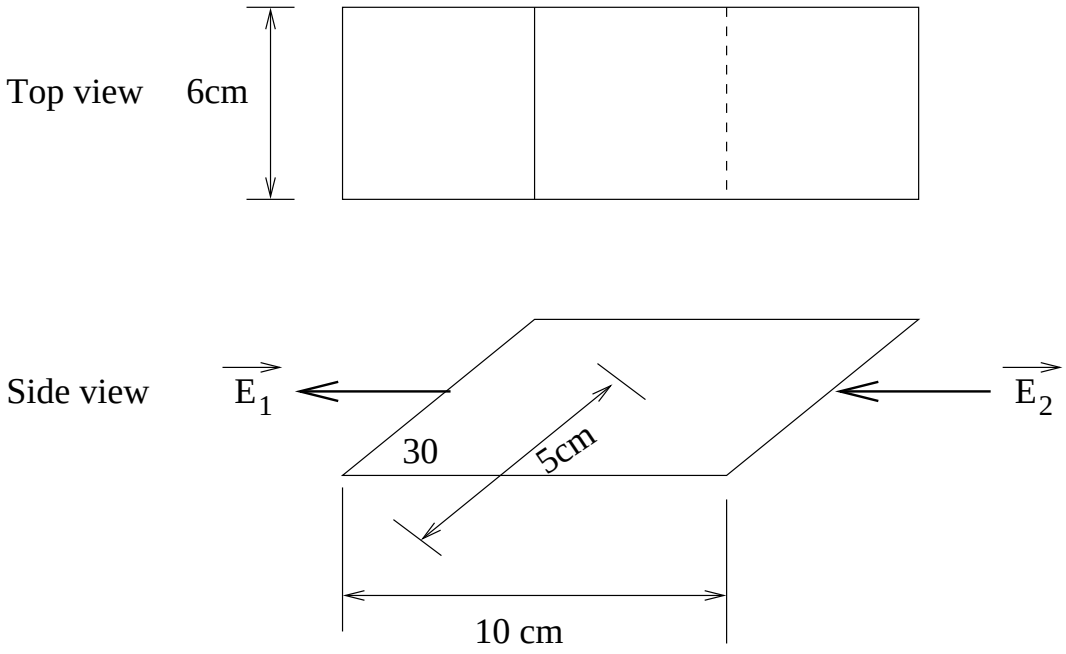
a) Find the x and y coordinates of the position where the electric field is zero. [**Ans:** $(-1.82\,m, -0.91\,m)$]

b) Find the x and y coordinates where the force on an: electron, proton, is zero. [**Ans:** $(-1.82\,m, -0.91\,m)$]

3 Electric Flux and Gauss's Law

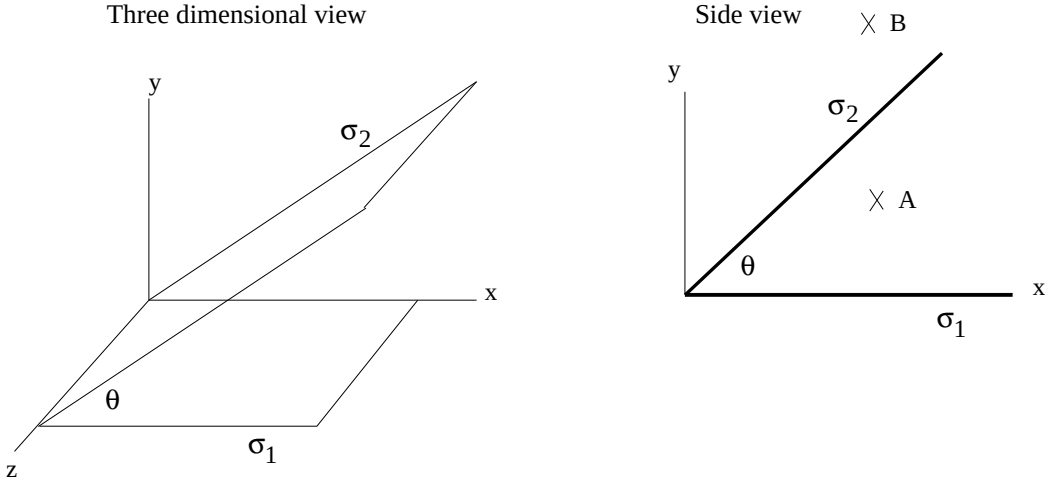
Question 3.1. Consider a uniform electric field $\vec{\boldsymbol{E}} = 2\hat{\boldsymbol{i}} - 3\hat{\boldsymbol{j}} + 5\hat{\boldsymbol{k}}\,(kN/C)$. What is the flux of this field through an area of $5\,cm^2$ with a normal vector of $7\hat{\boldsymbol{i}} - 12\hat{\boldsymbol{j}} + 17\hat{\boldsymbol{k}}$? [**Ans:** $3.07 \times 10^{-3}\,N.m^2/C$]

Question 3.2. A uniform electric field $\vec{\boldsymbol{E}}_{\mathbf{1}} = -9 \times 10^4 N/C\hat{\boldsymbol{i}}$, is directed out of one face of a parallelopiped, and another uniform electric field, $\vec{\boldsymbol{E}}_{\mathbf{2}} = -11 \times 10^4 N/C\hat{\boldsymbol{i}}$, is directed into the opposite face, as shown in the figure. Assuming that there are no other electric-field lines crossing the surfaces of the parallelopiped, determine the net charge contained within, and the average volume charge density. [**Ans:** $Q_{\mathbf{inside}} = -0.2655\,nC$**,** $\rho = -1.77\,\mu C/\,m^3$]



Question 3.3. The electric field vector at the surface of the earth is $200\,N/C$ toward the center. The field vector is reduced to $20\,N/C$ at a height of $1400\,m$. What is the average volumetric charge density in the air enclosed between the earth surface and the height given ? [**Ans:** $1.13 \times 10^{-12} C/m^3$]

Question 3.4. An infinite charged plane in the $z-x$ plane with a surface charge density of $70\,nC/m^2$, a second infinite plane carrying a surface charge density of $50\,nC/m^2$, intersects the $z-x$ plane at the z-axis and makes an angle of $40°$ with the $z-x$ plane as shown in the figure. Find the electric field at the point A $(x = 6\,m, y = 2\,m)$, and the point B $(x = 6\,m, y = 8\,m)$.



[**Ans:** $\vec{\boldsymbol{E}}_{\boldsymbol{A}} = 1815.7\hat{\boldsymbol{i}} + 1790.8\hat{\boldsymbol{j}}\,(N/C)$, $\vec{\boldsymbol{E}}_{\boldsymbol{B}} = -1815.7\hat{\boldsymbol{i}} + 6118.7\hat{\boldsymbol{j}}\,(N/C)$]

Question 3.5. An infinite plane of charge with surface charge density $\sigma_1 = 3\mu C/m^2$ is parallel to the xz plane at $y = -0.6\,m$. A second infinite plane of charge with surface charge density $\sigma_2 = -2\mu C/\,m^2$ is parallel to the yz plane at $x = 1\,m$. A sphere of radius $1\,m$ with its center in the xy plane at the intersection of the two charged planes $(x = 1\,m, y = -0.6\,m)$ has a surface charge density $\sigma_3 = -3\mu C/\,m^2$. Find the magnitude and direction of the electric field on the x axis at (a) $x = 0.4\,m$ and (b) $x = 2.5\,m$. [**Ans:** $\vec{\boldsymbol{E}}_{\boldsymbol{x=0.4\,m}} = 1.129 \times 10^5 (N/C)\hat{\boldsymbol{i}} + 1.695 \times 10^5 (N/C)\hat{\boldsymbol{j}}$, $\vec{\boldsymbol{E}}_{\boldsymbol{x=2.5\,m}} = -2.337 \times 10^5 (N/C)\hat{\boldsymbol{i}} + 1.212 \times 10^5 (N/C)\hat{\boldsymbol{j}}$]

Question 3.6. An infinitely long, thick, non-conducting cylindrical shell of inner radius a and outer radius b has a uniform charge density ρ. Find the electric field everywhere. [**Ans:** $\vec{\boldsymbol{E}}_{\boldsymbol{r \geq b}} = \dfrac{\rho(b^2 - a^2)}{2\epsilon_0 r}$, $\vec{\boldsymbol{E}}_{\boldsymbol{a \leq r \leq b}} = \dfrac{\rho(r^2 - a^2)}{2\epsilon_0 r}$, $\vec{\boldsymbol{E}}_{\boldsymbol{r \leq a}} = 0$]

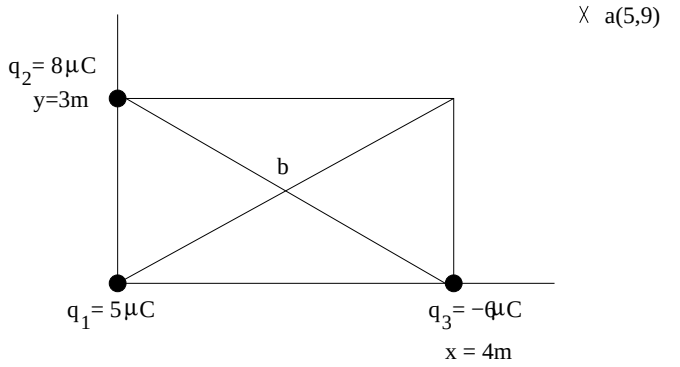
4 Electric Potential Energy and Electric Potential

Question 4.1. Three point charges $5\,\mu C$, $8\,\mu C$, and $-6\,\mu C$ are placed at the vertices of a rectangle as shown in the figure.

a) Calculate the electric potential at points a with $x = 5\,m$, $y = 9\,m$ and b located at the center of the intersection of the diagonals of the rectangle. [**Ans:** $V_A = 7.6\,kV$, $V_B = 25.2\,kV$]

b) What is the work done needed to move a charge of $4\,\mu C$ from a to b ? [**Ans:** $W^{\mathbf{ex}}_{A \to B} = 0.0704\,J$]

c) What is the work needed to assemble the three charges q_1, q_2 and q_3 ? [**Ans:** $U = -0.0339\,J$]



Question 4.2. Two spherical shells of charge are as shown in the figure. Shell 1 has its center in the origin, with $R_1 = 5\,m$, $Q_1 = 100/k$, and shell 2 has its center C at $x = 2\,m$, with $R_2 = 2\,m$, $Q_2 = 128\sqrt{2}/k$. Find:

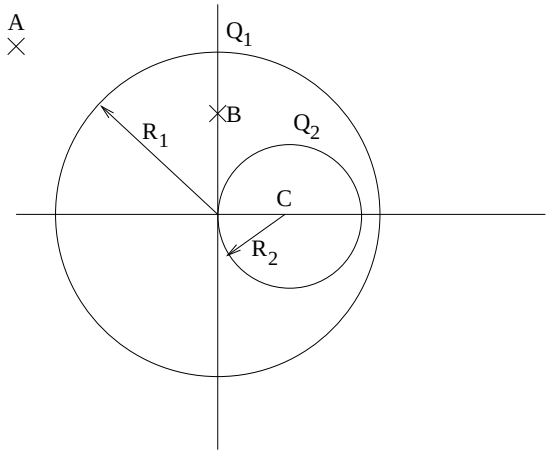
a) The electric field at point A with $x = -6\,m$, $y = 8\,m$. [**Ans:** $\vec{\boldsymbol{E}}_{\boldsymbol{A}} = -1.6\hat{\boldsymbol{i}} + 1.8\hat{\boldsymbol{j}}\,(N/C)$]

b) The electric field at point B with $x = 0\,m$, $y = 2\,m$. [**Ans:** $\vec{\boldsymbol{E}}_{\boldsymbol{B}} = 16(-\hat{\boldsymbol{i}} + \hat{\boldsymbol{j}})\,(N/C)$]

c) The electric potential at point A. [**Ans:** $V_A = 26\,V$]

d) The electric potential at point B. [**Ans:** $V_B = 84\,V$]

e) The work needed to move a charge of $5\,nC$ from A to B. [**Ans:** $290\,nJ$]



Question 4.3. A spherical conductor of radius R_1 is charged to $20\,kV$. When it is connected by a long, fine wire to a second conducting sphere far away, its potential drops to $12\,kV$. What is the radius of the second sphere ? [**Ans:** $R_2 = \frac{2}{3}R_1$]

5 Capacitors

Question 5.1. A parallel-plate capacitor has square plates of size $10\,cm$ and a separation of $d = 4\,mm$. A dielectric slab of constant $\kappa = 2$ has the same area as the plates.

a) What is the capacitance without the dielectric ? [**Ans:** $22.1\,pF$]

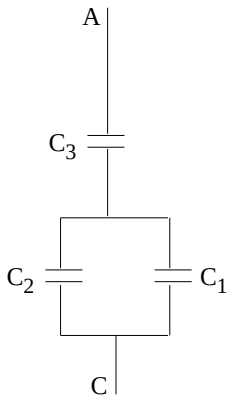
b) What is the capacitance if the dielectric slab fills the space between the plates ? [**Ans:** $44.2\,pF$]

c) What is the capacitance if a dielectric slab of thickness $3\,mm$ is inserted into the $4\,mm$ gap ? [**Ans:** $35.36\,pF$]

Question 5.2. In the following circuit of capacitors, where $C_1 = 3\,\mu F$, $C_2 = 1.5\,\mu F$ and $C_3 = 2\,\mu F$:

a) Find the equivalent capacitance between AC. [**Ans:** $1.3846\,\mu F$]

b) If a battery of $12\,V$ is connected between A and C, find the total charge on the capacitors C_1, C_2 and C_3. [**Ans:** $Q_1 = 11.073\,\mu C$, $Q_2 = 5.5365\,\mu C$, $Q_3 = 16.61\,\mu C$]

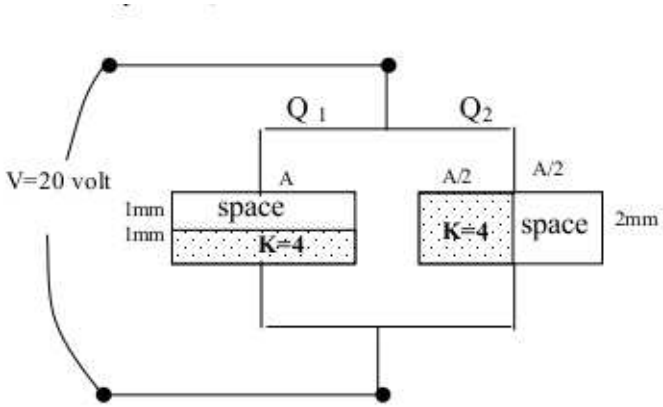


Question 5.3 (**Final 2/1/2006**).

c) For the following capacitor circuit; find
- The equivalent capacitance
- The charges Q_1 and Q_2

Consider the area of both capacitors

A= 1 cm^2



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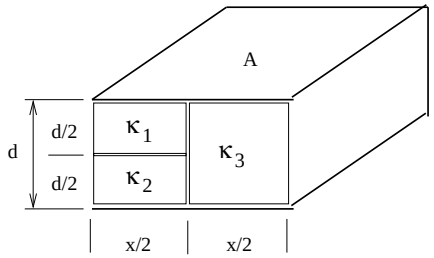
Question 5.4. Find the capacitance of the parallel-plate capacitor shown in the figure.



[**Ans:** $\left(\dfrac{\kappa_1\kappa_2}{\kappa_1+\kappa_2}+\dfrac{\kappa_3}{2}\right)C_0$]

6 EMF and DC Circuits

Question 6.1. In the circuit shown in the figure, find:

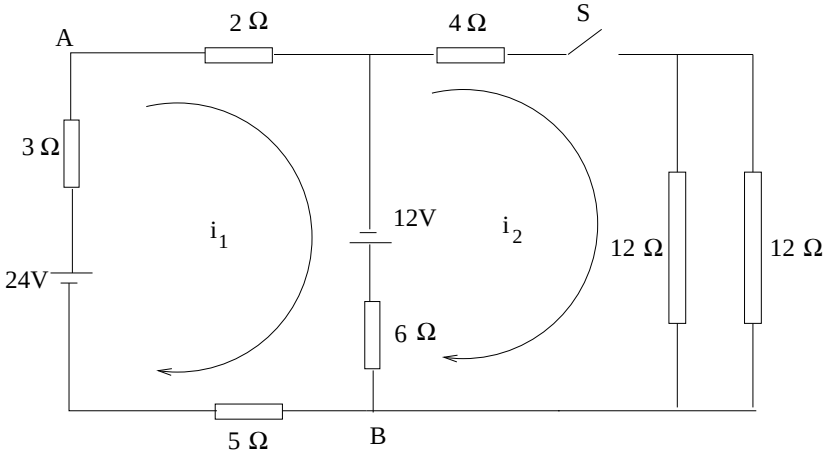
a) The currents in the loops when S is open. [**Ans:** $2.25\,A$**,** $0\,A$]

b) The currents in the loops when S is closed.[**Ans:** $2.29\,A$**,** $0.109\,A$]
(The questions below are to be answered when S is closed).

c) The potential difference $V_{AB} = V_B - V_A$ between A and B.[**Ans:** $-5.7\,V$]

d) The power delivered by the $24\,V$ emf. [**Ans:** $54.96\,W$]

e) The power dissipated in the $5\,\Omega$ resistor. [**Ans:** $26.22\,W$]

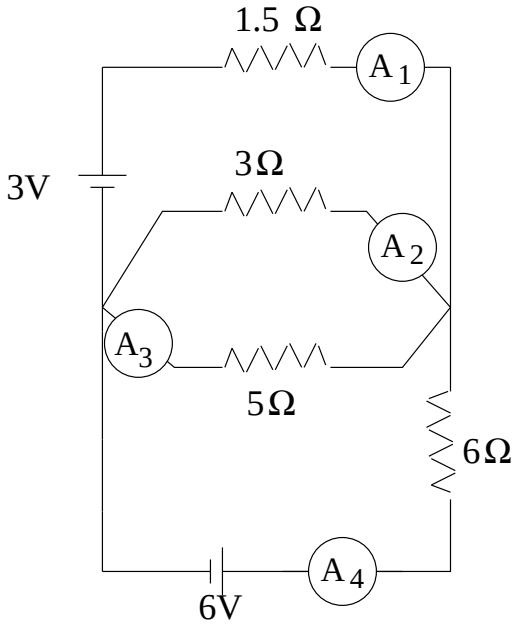


Question 6.2. In the circuit shown, find

a) the readings of the ammeters,

b) the power delivered by the $3\,V$ emf,

c) the power dissipated in the $6\,\Omega$ resistor.



[**Ans:** $A_1 = 0.5365\,A$, $A_2 = 0.7316\,A$, $A_3 = 0.4390\,A$, $A_4 = 0.6341\,A$, $P_{3V} = 1.61\,W$, $P_{6\,\Omega} = 2.413\,W$]

7 Magnetic Force and Magnetic Torque

Question 7.1. Find the magnetic force $\vec{\boldsymbol{F}}$ on a charge $q = 5\,nC$ with velocity $\vec{\boldsymbol{v}} = 3\hat{\boldsymbol{i}} - 4\hat{\boldsymbol{j}} + 7\hat{\boldsymbol{k}}\,(m/s)$, in a magnetic field $\vec{\boldsymbol{B}} = 7\hat{\boldsymbol{i}} - 10\hat{\boldsymbol{j}} + 13\hat{\boldsymbol{k}}\,(T)$. [**Ans:** $\vec{\boldsymbol{F}} = 90\hat{\boldsymbol{i}} + 50\hat{\boldsymbol{j}} - 10\hat{\boldsymbol{k}}\,(nN)$]

Question 7.2. A proton moving in a circular path perpendicular to a constant magnetic field takes $1.0\,\mu s$ to complete one revolution. Determine the magnitude of the field. [**Ans:** $B = 0.06558\,T$]

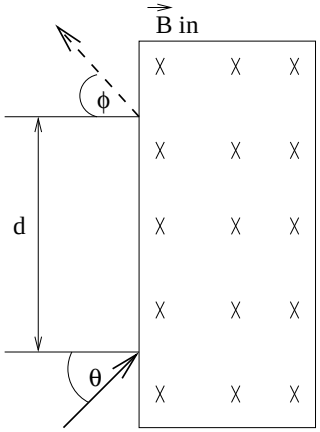
Question 7.3. A proton moves in a circular orbit of radius $65\,cm$ perpendicular to a uniform magnetic field of magnitude $0.75\,T$.

a) What is the period for this motion ?

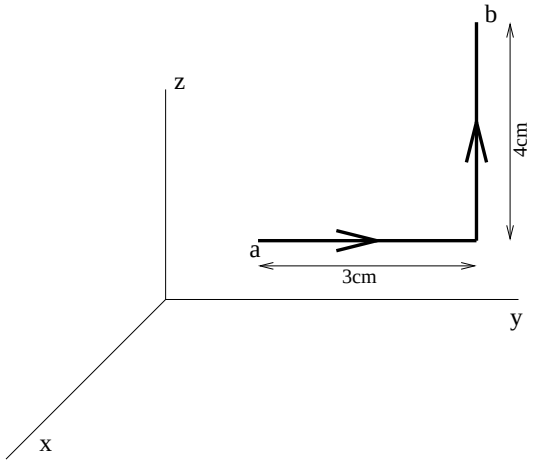
b) Find the speed of the proton.

c) Find the kinetic energy of the proton.

Question 7.4 (Question 28.27, page 878)**.** A proton with speed v enters a region of uniform magnetic field $B = 0.6\,T$, which is into the page as shown in the figure. Suppose that the distance $d = 0.4\,cm$ and $\theta = 24°$. Find the speed v and the angle ϕ. [**Ans:** $v = 1.26 \times 10^5\,m/s$, $\phi = 24°$]



Question 7.5. The wire segment in the figure carries a current of $1.8\,A$ from a to b in the presence of a magnetic field of $\vec{\boldsymbol{B}} = 1.2\hat{\boldsymbol{k}}\,T$. Find the total force on the wire. [**Ans:** $\vec{\boldsymbol{F}} = 0.0648\hat{\boldsymbol{i}}(N)$]



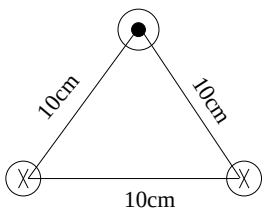
Question 7.6. A $10\,cm$ length of wire carries a current of $2.0\,A$ in the positive x-direction. The force on this wire due to the presence of a magnetic field B is $\vec{\boldsymbol{F}} = 3\hat{\boldsymbol{j}} + 2\hat{\boldsymbol{k}}\,(N)$. If this wire is now rotated so that the current flows in the positive y-direction, the force on the wire is $\vec{\boldsymbol{F}} = -3\hat{\boldsymbol{i}} - 2\hat{\boldsymbol{k}}\,(N)$. Determine the magnetic field vector $\vec{\boldsymbol{B}}$.

8 Magnetic Field from an Electric Current

Question 8.1. Three long, parallel, straight wires pass through the corners of an equilateral triangle of sides $10\,cm$ as shown in the figure. If each current is $15\,A$, find:

a) The force per unit length on the upper wire. [**Ans:** $\vec{\boldsymbol{F}} = 780\hat{\boldsymbol{j}}\,(\mu N)$]

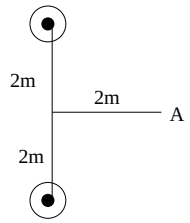
b) The magnetic field B at the upper wire due to the two lower wires. [**Ans:** $\vec{\boldsymbol{B}} = 52\hat{\boldsymbol{i}}\,(\mu T)$]



Question 8.2. Two long parallel conductors each carry a $2\,A$ current. The figure shows an end-view of the conductors, with both currents coming out of the page.

a) What is the force per unit length acting on the two wires ? Is it attractive or repulsive ?

b) Determine the magnitude and direction of the magnetic field at point B.



Question 8.3. A solenoid $2.7\,m$ long has a radius of $0.85\,cm$ and 600 turns. It carries a current I of $2.5\,A$. What is the approximate magnetic field B on the axis of the solenoid ? [**Ans:** $0.7\,mT$]

Question 8.4 (Ampère's Law)**.** A wire of radius $0.5\,cm$ carries a current of $100\,A$ that is uniformly distributed over its cross-sectional area. Find B

a) $0.1\,cm$ from the center of the wire. [**Ans:** $0.8\,mT$]

b) at the surface of the wire. [**Ans:** $4\,mT$]

c) at a point outside the wire $0.2\,cm$ from the surface of the wire. [**Ans:** $2.86\,mT$]

Question 8.5 (Ampère's Law)**.** A tightly wound toroid of inner radius $1\,cm$ and outer radius $2\,cm$ has 1000 turns of wire and carries a current of $1.5\,A$.

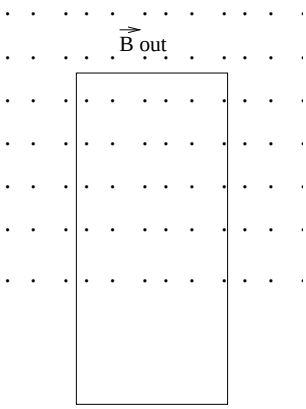
a) What is the magnetic field at a distance of $1.1\,cm$ from the center ? [**Ans:** $0.027\,T$]

b) What is the field $1.5\,cm$ from the center ? [**Ans:** $0.02\,T$]

9 Magnetic Induction (Faraday's Law)

Question 9.1. A magnetic field $\vec{\boldsymbol{B}} = 3t\hat{\boldsymbol{i}} - 5\sin(5\pi t)\hat{\boldsymbol{j}} + 17t^3\hat{\boldsymbol{k}}\,(T)$ is applied at a coil with area $A = 3\,m^2$, and with a normal vector $\vec{\boldsymbol{n}} = 4\hat{\boldsymbol{i}} + 5\hat{\boldsymbol{j}} - 7\hat{\boldsymbol{k}}$. Find the induced emf at $t = 4\,s$. [**Ans:** $\mathcal{E}_{\mathbf{ind}} = -1.925\,kV$]

Question 9.2. The rectangular coil in the figure has 80 turns, is $25\,cm$ wide and $30\,cm$ long, and is located in a magnetic field $B = 1.4\,T$ directed out of the page as shown, with only half of the coil in the region of the magnetic field. The resistance of the coil is $24\,\Omega$. Find the magnitude and direction of the induced current if the coil is moved with a speed of $2\,m/s$ (a) to the right, (b) up, (c) to the left, and (d) down. [**Ans: right** $0\,A$**, up** $2.33\,A$ **(clockwise), left** $0\,A$**, down** $2.33\,A$ **(counter-clockwise)**]

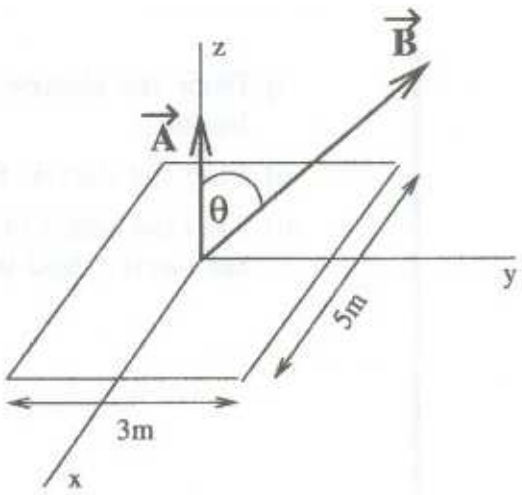


Question 9.3. Suppose the coil in Question 9.2 is rotated about its vertical centerline at constant angular velocity of $2\,rad/s$. Find the induced current as a function of time. [**Ans:** $I(t) = 0.35\sin(2t)$]

Question 9.4. [Final 13/6/2004]

b) A rectangular coil with sides $5\,m$ and $3\,m$, containing 200 turns lies on the xy-plane. A uniform magnetic field makes an angle of $\theta = 60°$ with the positive z-axis, and its magnitude changes with time according to: $B(t) = 0.05t + 0.03t^3$.

i) Find the magnitude of the induced emf in the coil at $t = 2\,s$.
ii) Find the current in the coil if the resistance of the coil is 30Ω.
iii) Find the torque acting on the coil at $\theta = 60°$ and $t = 2\,s$.



A Constants

Coulomb constant	k	$9 \times 10^9\, N.m^2/C^2$
Fundamental charge	e	$1.6 \times 10^{-19}\, C$
Mass of electron	m_e	$9.11 \times 10^{-31}\, Kg$
Mass of proton	m_p	$1.67 \times 10^{-27}\, Kg$
Permittivity of free space	ϵ_0	$8.85 \times 10^{-12}\, C^2/N.m^2$
Permeability of free space	μ_0	$4\pi \times 10^{-7}\, N/A^2$

B Theory

- Electric field due to an infinite plane of charge.
- Electric field due to a spherical shell of charge.

- Electric field due to an infinite line of charge.
- Electrostatic potential energy of a charge configuration.
- Capacitance of a parallel plate capacitor.
- Microscopic model of current: $I = nqvA$ (p.773).
- Circular motion of a charge in a magnetic field.
- Motional emf.
- Comparison between electric force and magnetic force.
- Units of all quantities studied in the course.
- All equations studied in the course.