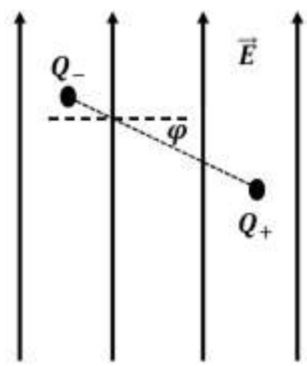
Quiz Average **4.8** **Quiz High Score** **6.0**

PH 221 **Quiz # 02 (10 pts)** **Name** **Solution**

An electric dipole is formed from two charges identical in magnitude but oppositely charged as shown in the diagram on the right. $Q_+ = -Q_- = +45.3\ \text{mC}$. The charges are separated by a distance $d = 6.78 \times 10^{-3}\ \text{m}$. The dipole is placed inside an electric field which is $\vec{E} = 9.12 \times 10^5\ {}^{\text{N}}/_{\text{C}}\ \widehat{(+\jmath)}$. The angle indicated in the diagram is $\varphi = 27.0°$. What is the magnitude and direction of the torque acting on the dipole due to the electric field?



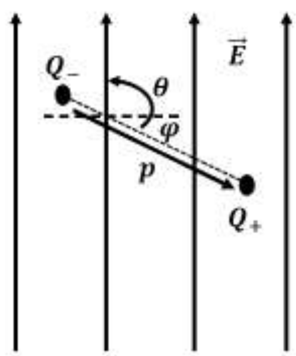
A. $\mathbf{2.49 \times 10^2\ m\ N\ (\widehat{CCW})}$

B. $2.49 \times 10^2\ \text{m N}\ (\widehat{\text{CW}})$

C. $1.27 \times 10^2\ \text{m N}\ (\widehat{\text{CCW}})$

D. $1.27 \times 10^2\ \text{m N}\ (\widehat{\text{CW}})$

Draw in the dipole moment vector $\vec{p}$



Torque is $\vec{\tau} = \vec{p}\ x\ \vec{E}$. The magnitude is $\tau = pE\ sin(\theta) = QdE\ sin(90.0° + \varphi)$ Since the dipole moment goes from negative charge towards positive charge. Electric fields make dipole moments align with electric fields, so the direction of the torque is counter-clockwise.

$$\tau = QdE\ sin(90.0° + \varphi)$$

$$= (45.3\ x\ 10^{-3} C)(6.78\ x\ 10^{-3}\ m)(9.12\ x\ 10^5\ {}^{N}/_{C})\ sin(90.0° + 27.0°)$$

$$\tau = 2.80\ x\ 10^2\ m\ N\ sin(117.°) = 2.49\ x\ 10^2\ m\ N$$

So, the correct answer is A !

An electric dipole has a dipole moment of magnitude $1.98 \text{ x } 10^{-8}$ C m. It is placed inside of a constant electric field of magnitude $3.81 \text{ x } 10^{7}\ ^{\text{N}}/_{\text{C}}$. The dipole moment initially makes an angle of $166.°$ with the direction of the electric field. It is twisted to a final angle of $37.6°$ with the direction of the electric field. How much work did the electric field do rotating the dipole moment?

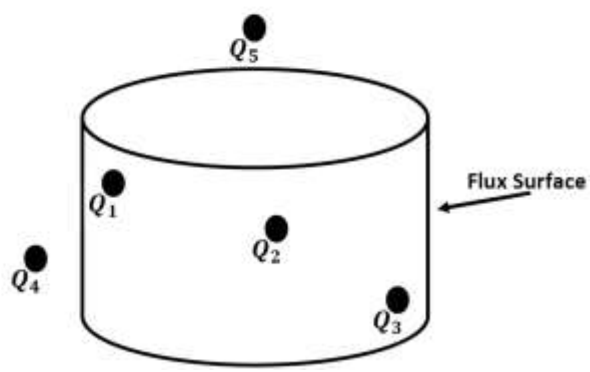
A. -0.278 J **B.** $\mathbf{+1.33}$ **J** **C.** -1.33 J **D.** $+0.278$ J

$$W_{Field} = -\Delta U = U_f - U_0 = -\left(-pE\,cos(\theta_f) - (-pE\,cos(\theta_0))\right) = -pE\left(cos(\theta_0) - cos(\theta_f)\right)$$

$$W_{Field} = -(1.98\ x\ 10^{-8}\ C\ m)(3.81\ x\ 10^{7}\ ^{N}/_{C})(cos(166.°) - cos(37.6°))$$

$$W_{Field} = -7.54\ x\ 10^{-1}\ J(-1.76) = +1.33\ J$$

So, the correct answer is B !



Shown on the left is a collection of charges and a surface that we wish to measure the net electric flux passing through it. The charges have the following values: $Q_1 = -49.0$ mC, $Q_2 = +27.0$ mC, $Q_3 = +51.0$ mC, $Q_4 = -99.0$ mC, and $Q_5 = +84.0$ mC. The charges Q_1, Q_2 and Q_3 are inside the surface. Charges Q_4 and Q_5 are outside. What is the net electric flux passing through this surface area?

A. $-1.36 \text{ x } 10^{9}\ ^{\text{N}}/_{\text{C}}\,\text{m}^2$

C. $+1.28 \text{ x } 10^{10}\ ^{\text{N}}/_{\text{C}}\,\text{m}^2$

B. $-1.69 \text{ x } 10^{9}\ ^{\text{N}}/_{\text{C}}\,\text{m}^2$

D. $\mathbf{+3.28 \text{ x } 10^{9}\ ^{N}/_{C}\,m^2}$

Gauss's Law tells us:

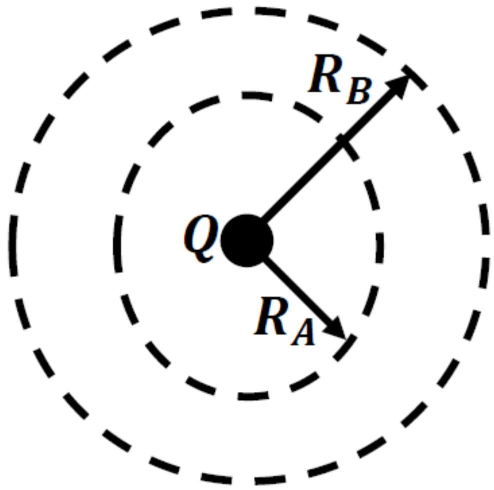
$$\Phi_E = \int \vec{E} \cdot d\vec{A} = \frac{Q_{enclosed}}{\varepsilon_0}$$

$$Q_{enclosed} = Q_1 + Q_2 + Q_3 = -49.0\ mC + 27.0\ mC + 51.0\ mC = +29.0\ mC$$

$$\Phi_E = \frac{Q_{enclosed}}{\varepsilon_0} = \frac{+29.0\ x\ 10^{-3}\ C}{8.85\ x\ 10^{-12}\ ^{C^2}/_{Nm^2}} = +3.28\ x\ 10^{9}\ ^{N}/_{C}\,m^2$$

So, the correct answer is D !

Consider a charge $Q = -37.5\ \mu C$ as shown on the right. There are two potential Gaussian Spheres surrounding it. Sphere A has a radius $R_A = 4.98 \times 10^{-3}$ m. Sphere B has a radius $R_B = 7.32 \times 10^{-3}$ m. Total electric field flux through Sphere A is measured to be $-4.24 \times 10^{6}\ {}^{N}/_{C}\, m^2$. What is the total electric field flux through Sphere B?



A. $-1.96 \times 10^{6}\ {}^{N}/_{C}\, m^2$

B. $\mathbf{-4.24 \times 10^{6}\ {}^{N}/_{C}\, m^2}$

C. $-9.16 \times 10^{6}\ {}^{N}/_{C}\, m^2$

D. $-6.23 \times 10^{6}\ {}^{N}/_{C}\, m^2$

Since Gauss's Law tells us that Electric Field Flux is charge enclosed divided by permittivity of free space.

$$\Phi_E = \int \vec{E} \cdot d\vec{A} = \frac{Q_{Enclosed}}{\varepsilon_0} = \frac{-37.5 \times 10^{-6} C}{8.85 \times 10^{-12}\ {}^{C^2}/_{Nm^2}} = -4.24 \times 10^{6}\ {}^{N}/_{C}\, m^2$$

The size of the sphere does not matter. The flux only depends on the charge enclosed. So, the flux through Sphere B is

$$-4.24 \times 10^{6}\ {}^{N}/_{C}\, m^2$$

So, the correct answer is B !

A nonconducting square plane of charge has side length of $(\mathrm{L} = 3.67\ \mathrm{m})$. The electric field at a distance $(\mathrm{d} = 1.69 \times 10^{-2}\ \mathrm{m})$ above the center of the plane is found to have a strength $2.64 \times 10^{11}\ \mathrm{N}/\mathrm{C}$ and the field points towards the plane of charge. What is the total charge on the plane?

A.	$-17.1\ \mathrm{C}$	**C.**	$\mathbf{-62.9\ C}$
B.	$+17.1\ \mathrm{C}$	**D.**	$+62.9\ \mathrm{C}$

From Gauss's Law we know the electric field for a plane of charge is $\mathbf{E} = \frac{\sigma}{2\varepsilon_0} = \frac{Q/L^2}{2\varepsilon_0} = \frac{Q}{2\varepsilon_0 L^2}$

Solve for Charge

$$Q = 2\varepsilon_0 L^2 E = 2\left(8.85 \times 10^{-12}\ C^2/Nm^2\right)(3.67\ m)^2\left(2.64 \times 10^{11}\ N/C\right) = 62.9\ C$$

Since the field points towards the plane, the charge must be negative!

$$Q = -62.9\ C$$

So, the correct answer is C !

Please send any comments or questions about this page to ddonovan@nmu.edu

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