PHYS 1320 (Spring 2024) Sonnenfeld Online HW #4: Gauss's Law

Problem 1: A planar surface has area A and unit normal $\hat{n}$. This planar surface resides in a region where the uniform electric field may be expressed as $\vec{E} = +E_0\ \hat{i}$.

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Part (a) Select *all* orientations of the planar surface that maximize the electric flux through the planar surface.
MultipleSelect :

1) $\hat{n} = -\hat{j}$
2) $\hat{n} = -\hat{k}$
3) $\hat{n} = +\hat{j}$
4) $\hat{n} = -\hat{i}$
5) $\hat{n} = +\hat{i}$
6) $\hat{n} = +\hat{k}$

Part (b) Select *all* orientations of the planar surface that minimize the electric flux through the planar surface.
MultipleSelect :

1) $\hat{n} = -\hat{j}$
2) $\hat{n} = -\hat{k}$
3) $\hat{n} = +\hat{j}$
4) $\hat{n} = -\hat{i}$
5) $\hat{n} = +\hat{i}$
6) $\hat{n} = +\hat{k}$

Part (c) Select *all* orientations of the planar surface that maximize the *magnitude* of the electric flux through the planar surface.
MultipleSelect :

1) $\hat{n} = -\hat{j}$
2) $\hat{n} = -\hat{k}$
3) $\hat{n} = +\hat{j}$
4) $\hat{n} = -\hat{i}$
5) $\hat{n} = +\hat{i}$
6) $\hat{n} = +\hat{k}$

Part (d) Select *all* orientations of the planar surface that minimize the *magnitude* of the electric flux through the planar surface.
MultipleSelect :

1) $\hat{n} = -\hat{j}$
2) $\hat{n} = -\hat{k}$
3) $\hat{n} = +\hat{j}$
4) $\hat{n} = -\hat{i}$
5) $\hat{n} = +\hat{i}$
6) $\hat{n} = +\hat{k}$

Problem 2: A box in the shape of a cube has side lengths of 6.04 cm. The total outward flux through the box is 1.57 $\mathrm{N \cdot m^2/C}$.
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What is the total charge, in coulombs, enclosed by the box?
Numeric : A numeric value is expected and not an expression.
q = _____ C

Problem 3: A uniform electric field of magnitude ***1.25*** $\times 10^4$ $\mathrm{N/C}$ is perpendicular to a square surface with ***2.2*** m side lengths.
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What is the magnitude of the electric flux through the surface, in newton squared meters per coulomb?
Numeric : A numeric value is expected and not an expression.
$|\Phi_E|$ = _____ N·m^2/C

Problem 4: A circular loop of radius $R = 6.32$ cm is centered at the origin where there is a constant electric field

$$\vec{E} = \left(61.9 \text{ N/C}\right)\hat{i} + \left(111 \text{ N/C}\right)\hat{j}$$

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Part (a) What is the flux through the loop, in newton squared meters per coulomb, when the loop is oriented such that its normal vector is in the positive x direction?
Numeric : A numeric value is expected and not an expression.
Φ_1 = _____ $\mathrm{N \cdot m^2/C}$

Part (b) What is the flux through the loop, in newton squared meters per coulomb, when the loop is oriented such that its normal vector is in the negative y direction?
Numeric : A numeric value is expected and not an expression.
Φ_2 = _____ $\mathrm{N \cdot m^2/C}$

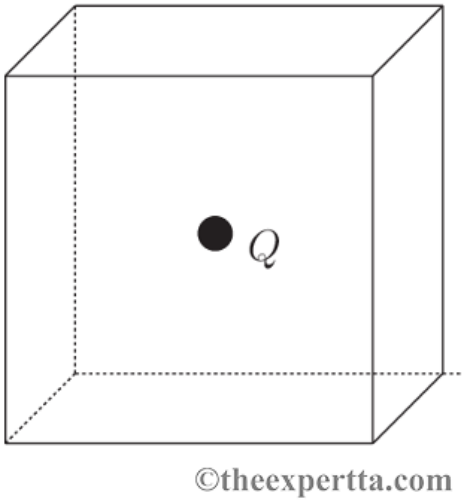
Part (c) What is the flux through the loop, in newton squared meters per coulomb, when the loop is oriented such that its normal vector is in the positive z direction?
Numeric : A numeric value is expected and not an expression.
Φ_3 = _____ $\mathrm{N \cdot m^2/C}$

Problem 5: An infinite charged wire with charge per unit length λ lies along the central axis of a cylindrical surface of radius *r* and length *L*.

What is the flux through the surface due to the electric field of the charged wire?
Expression :
Φ = _____

Select from the variables below to write your expression. Note that all variables may not be required.
β, **ε_0**, **γ**, **λ**, **θ**, **d**, **g**, **h**, **j**, **k**, **L**, **m**, **P**, **r**, **S**

Problem 6: Consider a cubic surface surrounding a charge *Q* shown in the picture.



If the charge is directly in the center of the cube, what is the flux through each face of the cube?
MultipleChoice :

1) It is impossible to give the answer without exact integration over the surface of a cube.
2) $Q/(3\ \varepsilon_0)$
3) 0
4) Q/ε_0
5) $Q/(6\ \varepsilon_0)$

Problem 7: The figure shows a sphere carrying a uniformly distributed volume charge Q. Three Gaussian surfaces are concentric with the sphere as shown.
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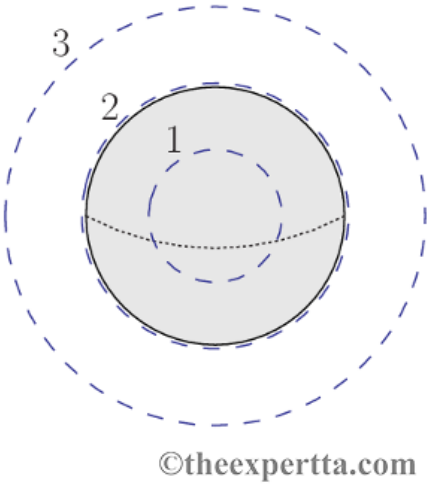

Part (a) Which Gaussian surface(s) has the greatest electric flux though it?
MultipleChoice :

1) They all have the same electric flux.
2) 2
3) 1
4) 3
5) 1 and 2
6) 2 and 3

Part (b) On which of Gaussian surface is the electric field the greatest?
MultipleChoice :

1) They all have the same electric field passing through them.
2) 3
3) 1
4) 1 and 2
5) 2 and 3
6) 2

Problem 8: A point charge is positioned at the very corner of a cube as shown in the figure.
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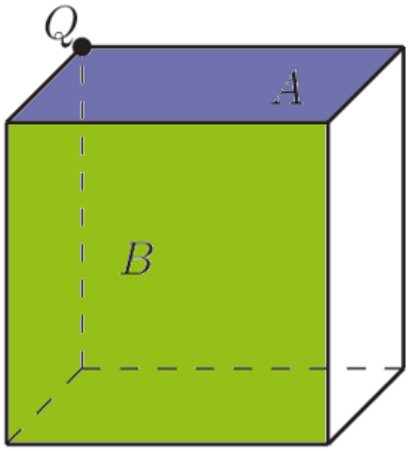

Part (a) What is the electric flux though the side A (the top) of the cube?
MultipleChoice :

1) $Q/(12\varepsilon_0)$
2) $Q/(6\varepsilon_0)$
3) $Q/(3\varepsilon_0)$
4) $Q/(24\varepsilon_0)$
5) $Q/(8\varepsilon_0)$
6) 0

Part (b) What is the electric flux though the side B (the front) of the cube?
MultipleChoice :

1) $Q/(12\varepsilon_0)$
2) $Q/(6\varepsilon_0)$
3) $Q/(3\varepsilon_0)$
4) 0
5) $Q/(8\varepsilon_0)$
6) $Q/(24\varepsilon_0)$