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Physics 125, Analytical Physics II **Section 99**

Date Thr, Mar 12, 2009 at 21:00 *Exam 2*

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1. [6pt] For each statement, write in T for True, F for False. If the first is for True and the rest for False, enter TFFFFF).

A) A point charge placed inside a uniformly charged shell experiences no electrostatic force.

B) Electric field lines may cross each other

C) The direction of electric field lines is the direction of the force on an electron placed in the field.

D) An electron shot into a uniform electric field at an arbitrary angle with respect to the electric field will follow a parabolic path.

E) If a point charge moves at right angles to an electric field, then no force acts on the charge.

F) In a solid metallic sphere, the charge resides on the surface alone.

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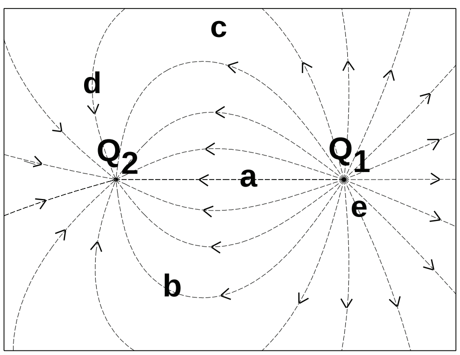
2. [6pt] The figure shows the E-field in the plane of two point charges.



Which of the following statements is true? (Write T for True and F for False.

A) Charges Q_1 and Q_2 have the same sign.

B) The E-field at 'b' points directly toward Q_2.

C) The magnitude of the E-field at 'a' is larger than at 'c'.

D) An electron placed at 'a' would start to accelerate towards the right.

E) The E-field at 'c' is zero.

F) The net charge $Q_1 + Q_2$ is positive.

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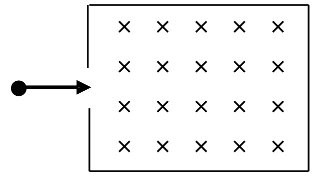
3. [4pt] An electron traveling horizontally enters a region where a uniform electric field is directed into the page. What is the direction of the force exerted on the electron once it has entered the field?



A) to the left

B) out of the page, toward the reader

C) into the page, away from the reader

D) upward

E) downward

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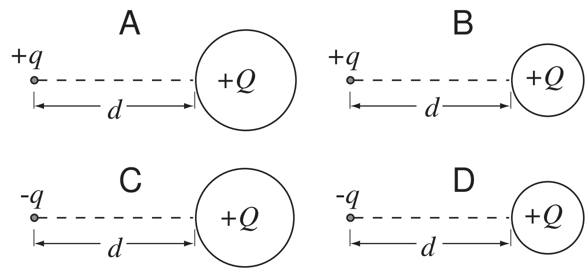
4. [5pt] The figures show 4 examples of a point charge placed a distance d away from the surface of a uniformly charged spherical shell of insulating material. The diameters of the spheres in B and D are the same and smaller than the equal diameters in A and C. The charge on the spheres is the same in all cases. The point charge has the same magnitude in all cases, but is positive for cases A and B, and negative for C and D.



Choose the listing which correctly ranks the examples according to the force on the point charge, in order from most attractive to most replusive. If there is a tie, those cases can be listed in any order.

A) (most attractive) BACD (most repulsive)

B) (most attractive) DCBA (most repulsive)

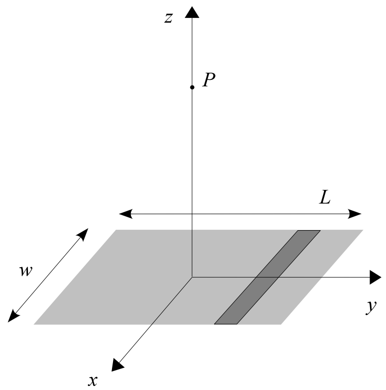
C) (most attractive) DCAB (most repulsive)

D) (most attractive) DACB (most repulsive)

E) (most attractive) CDAB (most repulsive)

(Please turn to the next page...)

5. [4pt] Charge is distributed uniformly on a rectangular surface of length L and width w as shown in the figure. The surface charge density is given by σ.



The charge on the shaded strip is given by ________. To obtain the net electric field at the point P, you would integrate the ________ of the electric field contribution from the shaded region with integration limits ________.

A) $dq = \sigma L\, dy$, $y-$component, $-L/2$ to $L/2$
B) $dq = \sigma w\, dy$, $z-$component, $-L/2$ to $L/2$
C) $dq = \sigma L\, dx$, $z-$component, $-w/2$ to $w/2$
D) $dq = \sigma w\, dy$, $y-$component, $-L/2$ to $L/2$
E) $dq = \sigma L\, dx$, $y-$component, $-w/2$ to $w/2$
F) $dq = \sigma w\, dx$, $z-$component, $-w/2$ to $w/2$

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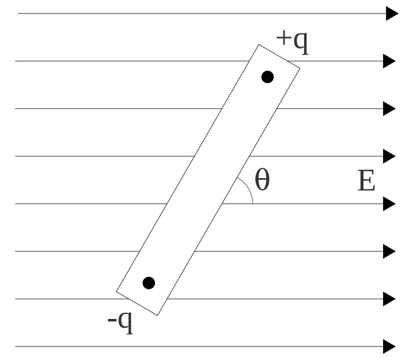
6. [4pt] Choose the **INCORRECT** statment:

A) Gauss' law applies to a closed surface of any shape.
B) Gauss' law can be derived from Coulomb's law.
C) If a Gaussian surface encloses an electric dipole, then the net flux is zero.
D) Gauss' law states that the net flux out of a closed surface is proportional to the net charge enclosed within the surface.
E) According to Gauss' law, if a closed surface encloses no charge, then the electric field vanishes everywhere on the surface.

A pair of equal and opposite charges of 0.01 C separated by 1.5 cm are placed in an Electric Field of strength 7 N/C as shown in the diagram.



7. [5pt] If the dipole moment $\vec{p}$ makes an angle of 24° with the electric field, then what is the magnitude of the torque that acts on the dipole, in $\mathrm{N \cdot m}$?

A) 0.00 B) 2.67×10^{-4} C) 3.12×10^{-4} D) 3.65×10^{-4}
E) 4.27×10^{-4} F) 5.00×10^{-4} G) 5.85×10^{-4} H) 6.84×10^{-4}

8. [4pt] Calculate the force that acts on the dipole, in N.

A) 0.00 B) 4.83×10^{-2} C) 7.00×10^{-2} D) 1.02×10^{-1}
E) 1.47×10^{-1} F) 2.13×10^{-1} G) 3.09×10^{-1} H) 4.49×10^{-1}

9. [5pt] Considering the situation above, answer the following true or false questions.

A) The torque vector on the dipole points into the plane of the paper.
B) If allowed to rotate about its center, the dipole would swing counter-clockwise.
C) Work is done by the field on the dipole, in rotating it from an angle θ of 90 degrees to an angle of 30 degrees.
D) The dipole moment points from the negative to the positive charge.
E) The potential energy of the dipole is maximum and equal to the absolute value of pE when the field is orthogonal to the dipole moment.

10. [5pt] Determine the potential energy of the dipole when it is oriented at an angle 34° to the field, in units of J.

A) -8.70×10^{-4} B) -7.44×10^{-4} C) -6.36×10^{-4}
D) -5.44×10^{-4} E) 5.44×10^{-4} F) 6.36×10^{-4}
G) 7.44×10^{-4} H) 8.70×10^{-4}

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11. [6pt] At some instant, the velocity of an electron moving between two charged parallel plates is $\vec{v} = (46.0\hat{i}+2.8\hat{j})\times 10^4$ m/s. Suppose that the electric field between the plates is given by $\vec{E}$ =$22\hat{j}$ N/C. After the x-coordinate has changed by 2.7 cm, how much has the y-coordinate changed?

A) -5.02×10^{-3} B) -5.88×10^{-3} C) -6.87×10^{-3}
D) -8.04×10^{-3} E) -9.41×10^{-3} F) -1.10×10^{-2}
G) -1.29×10^{-2} H) -1.51×10^{-2}

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12. [5pt] Positive point-charges of $+30.5\,\mu$C are fixed at two of the vertices of an equilateral triangle with sides of 1.20 m, located in vacuum. Determine the magnitude of the E-field at the third vertex, in units of N/C.

A) 2.82×10^5 B) 3.30×10^5 C) 3.86×10^5 D) 4.51×10^5
E) 5.28×10^5 F) 6.18×10^5 G) 7.23×10^5 H) 8.46×10^5

13. [5pt] Redo the last problem, this time with charges of $+30.5\,\mu$C and $-30.5\,\mu$C.

A) 1.19×10^5 B) 1.39×10^5 C) 1.63×10^5 D) 1.90×10^5
E) 2.23×10^5 F) 2.61×10^5 G) 3.05×10^5 H) 3.57×10^5

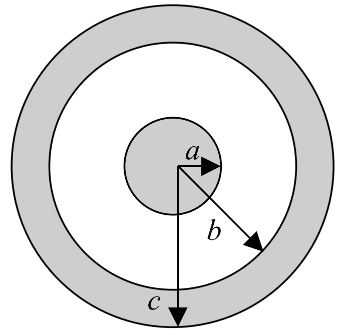
14. [5pt] An electric field in a region is described by $\vec{E} = (1\hat{i} - 6\hat{j} + 5z\hat{k})$ N/C. A cube has its corners at (0,0,0), (a,0,0), (a,a,0), (0,a,0), (0,0,a), (a,0,a), (a,a,a), and (0,a,a), where a=0.6 m. Calculate the electric flux, in $\frac{\text{N}\cdot\text{m}^2}{\text{C}}$, through the face at x=a.

A) -3.60×10^{-1} B) -2.48×10^{-1} C) -1.71×10^{-1}
D) -1.18×10^{-1} E) 1.18×10^{-1} F) 1.71×10^{-1}
G) 2.48×10^{-1} H) 3.60×10^{-1}

15. [6pt] Calculate the total electric flux in $\frac{\text{N}\cdot\text{m}^2}{\text{C}}$ through the whole cube.

A) -1.38 B) -1.22 C) -1.08
D) -9.56×10^{-1} E) 9.56×10^{-1} F) 1.08
G) 1.22 H) 1.38

A uniformly charged solid non-conducting sphere of radius $a = 0.42$ m is surrounded by a conducting spherical shell of inner radius $b = 0.58$ m and outer radius $c = 0.75$ m. The charge density on the central sphere is $\rho = -10.80\,\mu\text{C/m}^3$ and the net charge on the shell is $-3.70\,\mu$C.



16. [5pt] What is the surface charge density on the inner surface of the shell (in $\mu\text{C/m}^2$)?

A) -7.93×10^{-1} B) 1.67 C) 7.93×10^{-1} D) -8.24×10^{-2}
E) 8.75×10^{-1} F) -8.75×10^{-1} G) 8.24×10^{-2} H) 0.00

17. [5pt] What is the surface charge density on the outer surface of the shell (in $\mu\text{C/m}^2$)?

A) -9.98×10^{-1} B) 9.98×10^{-1} C) 4.74×10^{-1} D) -4.93×10^{-2}
E) 5.23×10^{-1} F) -5.23×10^{-1} G) 4.93×10^{-2} H) 0.00

18. [15pt] Thin insulating rods have the rather unusual shape shown: an arc of radius d subtending an angle of π rad, and a straight rod extending radially out from the middle, also of length d. The entire length of the rods are uniformly charged with linear charge density λ. What is the resulting electric field at the point P, at the center of the arc?
You must show all of your work to recieve full credit for this problem. Make sure that your final expression contains only variables given in the problem and fundamental constants.