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

Date Thr, Apr 16, 2009 at 21:00 *Exam 3*

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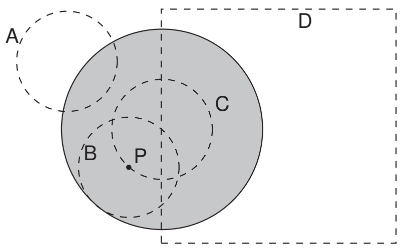
1. [7pt] The figure shows a solid sphere of insulating material. A charge $+Q$ is uniformly distributed through its volume. The dashed lines are cross-sections of spherical or cubical Gaussian surfaces that intersect the sphere. The radii of surfaces A, B, and C are half that of the charged sphere.



For each statement about the total electric flux through the Gaussian surfaces, write in T for True and F for False.

A) The total flux through C is zero.

B) The flux through D is one half of the flux through C.

C) To use Gauss' Law to find the electric field at point P, one should use Gaussian surface B.

D) The flux through A is less than the flux through C.

E) Considering the 6 sides of cubical surface D separately, all 6 sides have an electric flux.

F) The flux through C is larger than the flux through B.

G) The flux through D is four times more than the flux through B.

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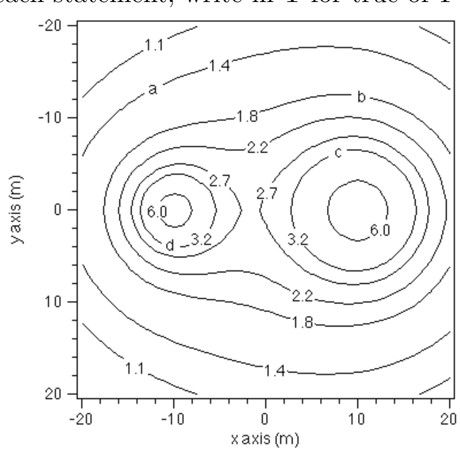
2. [6pt] The figure shows the equipotential contours in the plane of two point charges. The labels on the contours are in Volts. For each statement, write in T for true or F for false.



A) The two charges are roughly in the ratio 2:3

B) There is no point along the line $y = 0$ and between $x = -10$ and $+10$ where the field is zero.

C) There is a point along the line $y = 0$ and between $x = -10$ and $+10$ where the potential is zero.

D) The electrostatic potential energy of a positive charge increases as it is brought from a to b.

E) The above charge configuration can be described as an electric dipole.

F) Net work is done in moving a charge from c to d.

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3. [4pt] A parallel plate capacitor with plates of area A and plate separation d is charged with a battery so that the potential difference between its plates is V. If the capacitor is disconnected from the battery and then its plate separation is decreased to $d/2$, what happens to its capacitance?

A) The capacitance is twice its original value.

B) The capacitance is unchanged.

C) The capacitance is one half of its original value.

D) The capacitance is eight times its original value.

E) The capacitance is four times its original value.

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4. [4pt] Two wires made of different materials have the same uniform current density. They carry the same current only if:

A) their lengths are the same.

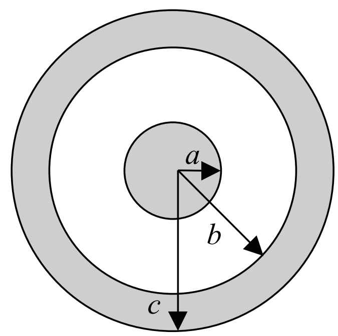
B) the potential differences across them are the same.

C) the electric fields in them are the same.

D) both their lengths and cross-sectional areas are the same.

E) their cross-sectional areas are the same.

A uniformly charged solid conducting sphere of radius $a = 0.43$ m is surrounded by a non-conducting spherical shell of inner radius $b = 0.55$ m and outer radius $c = 0.77$ m. The charge density throughout the material of the shell is $\rho = 10.20\,\mu\text{C/m}^3$ and the net charge on the central sphere is $3.60\,\mu$C.



5. [5pt] What is the magnitude of the electric field (in N/C) at a distance 0.63 m from the center?

A) 7.73×10^4 B) 1.12×10^5 C) 1.62×10^5 D) 2.36×10^5
E) 3.42×10^5 F) 4.95×10^5 G) 7.18×10^5 H) 1.04×10^6

6. [4pt] What is the magnitude of the electric field (in N/C) at a distance 1.00 m from the center?

A) 3.45×10^4 B) 4.59×10^4 C) 6.11×10^4 D) 8.13×10^4
E) 1.08×10^5 F) 1.44×10^5 G) 1.91×10^5 H) 2.54×10^5

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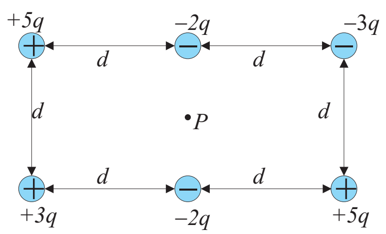
7. [4pt] Two infinite positively charged plates with a uniform charge density of $7.60\,\mu\text{C/m}^2$ are placed parallel to the yz-plane with one plane passing through $x = 0.70\,\text{cm}$ and the other through $x = -0.70\,\text{cm}$. Determine the magnitude of the electric field at the point $(x, y, z) = (5.90,\ 0,\ 0)\,\text{cm}$ in units of N/C.

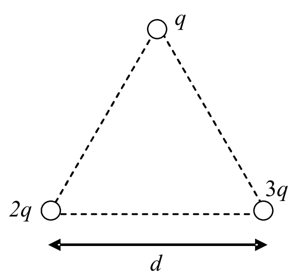
A) 0.00 B) 5.95×10^5 C) 6.72×10^5 D) 7.60×10^5
E) 8.58×10^5 F) 9.70×10^5 G) 1.10×10^6 H) 1.24×10^6

8. [6pt] In the figure below, point P is at the center of the rectangle. Suppose $d = 0.40\,\text{m}$ and $q = 1.15 \times 10^{-9}\,\text{C}$. With $V = 0$ at infinity, what is the net electric potential (in V) at P due to the six charged particles?



A) 1.83×10^1 B) 2.44×10^1 C) 3.26×10^1 D) 4.35×10^1
E) 5.82×10^1 F) 7.77×10^1 G) 1.04×10^2 H) 1.39×10^2

9. [5pt] Three point charges are arranged in an equilateral triangle of side $d = 26.9\,\text{cm}$ as shown in the figure. The charges are q, $2q$, and $3q$, where $q = 12.7\,\mu\text{C}$. What is the electric potential energy of the system, in J? (As usual, let $U = 0$ correspond to the case where all the particles are infinitely far away from each other.)

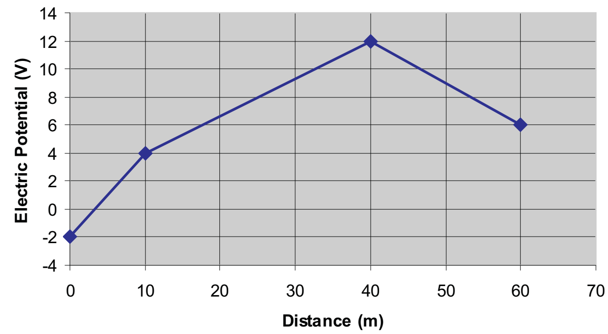


A) 4.74×10^1 B) 5.93×10^1 C) 7.41×10^1 D) 9.26×10^1
E) 1.16×10^2 F) 1.45×10^2 G) 1.81×10^2 H) 2.26×10^2

10. [5pt] Two concentric thin spherical shells have radii of 4.7 cm and 6.6 cm. The surface charge density on both spheres is $75\,\text{nC/m}^2$. What is the electric potential of the surface of the inner sphere, in Volts?

A) 5.07×10^2 B) 6.26×10^2 C) 7.74×10^2 D) 9.57×10^2
E) 1.18×10^3 F) 1.46×10^3 G) 1.81×10^3 H) 2.23×10^3

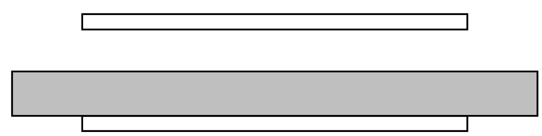
A plot of electric potential vs. distance along the x-axis is shown in the figure below. Consider a mobile point charge of 6.7 C placed somewhere along the x axis.



11. [5pt] Suppose the point charge has a mass 3.6 kg and is constrained to move along the x-axis. If the initial speed of the particle is 8.51 m/s along the $+x$-axis when the particle is located at $x = 0$, what is the speed of the particle (in m/s) when it is located at $x = 60\,\text{m}$?

A) 0.48 B) 0.70 C) 1.02 D) 1.48
E) 2.14 F) 3.11 G) 4.50 H) 6.53

12. [5pt] A parallel plate capacitor has plate area $A = 65\,\text{cm}^2$ and plate separation $d = 1.16\,\text{cm}$. A potential difference 20 V is applied between the plates. The battery is then disconnected and the capacitor is half filled with a dielectric slab of $\kappa = 3.10$ as shown. What is the magnitude of the charge (in nC) on each of the plates before the battery is removed?



A) 5.39×10^{-2} B) 6.09×10^{-2} C) 6.88×10^{-2} D) 7.77×10^{-2}
E) 8.78×10^{-2} F) 9.92×10^{-2} G) 1.12×10^{-1} H) 1.27×10^{-1}

13. [5pt] What is the Electric field (in N/C) in the dielectric slab?

A) 2.38×10^2 B) 3.16×10^2 C) 4.19×10^2 D) 5.56×10^2
E) 7.38×10^2 F) 9.79×10^2 G) 1.30×10^3 H) 1.72×10^3

14. [5pt] What is the potential difference (in V) between the plates after the slab has been introduced?

A) 6.77 B) 2.00×10^1 C) 1.32×10^1 D) 1.00×10^1
E) 4.10×10^1 F) 2.10×10^1 G) 7.56 H) 1.19×10^1

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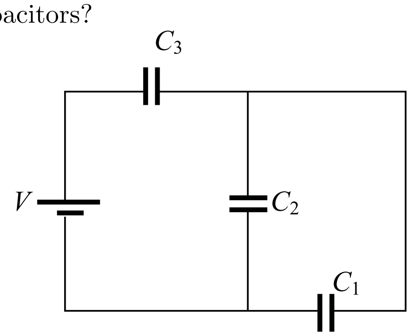
15. [4pt] Three capacitors, $C_1 = 8\,\mu$F, $C_2 = 15\,\mu$F, and $C_3 = 20\,\mu$F are connected to a battery of voltage $V = 42\,$V, as shown in the figure. What is the equivalent capacitance (in μF) of the three capacitors?

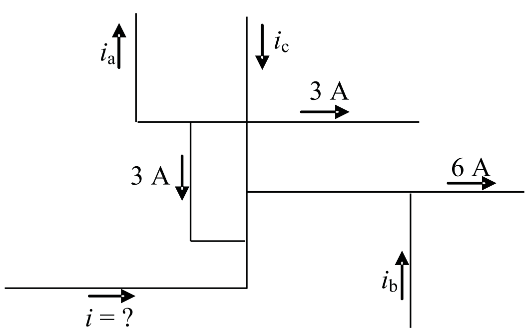


A) 6.13 B) 8.10 C) 1.07×10^1 D) 1.41×10^1
E) 1.87×10^1 F) 2.46×10^1 G) 3.26×10^1 H) 4.30×10^1

16. [5pt] What is the charge on C_2, in μC?

A) 2.27×10^2 B) 2.93×10^2 C) 3.78×10^2 D) 4.88×10^2
E) 6.30×10^2 F) 8.13×10^2 G) 1.05×10^3 H) 1.35×10^3

17. [4pt] In the circuit diagram of wires below, the following currents are known to be flowing (in the directions indicated): $i_a = 3\,$A, $i_b = 4\,$A, $i_c = 6\,$A. Other known currents are indicated directly in the figure. What is the current i (in A) in the wire that enters from the lower left of the figure? Use positive or negative depending on whether that current matched the direction shown. Enter your answer (with appropriate units) on your equation sheet.



18. [4pt] A wire carries a current of 2.7 A. It has a uniform diameter of 0.2 mm and the number of free electrons per unit volume is $4.5 \times 10^{25}\,\mathrm{m}^{-3}$. Find the drift velocity of the electrons in the wire in m/s.

A) 1.02×10^1 B) 1.19×10^1 C) 1.39×10^1 D) 1.63×10^1
E) 1.91×10^1 F) 2.23×10^1 G) 2.61×10^1 H) 3.06×10^1

19. [13pt] A thin wire is bent into the shape of a square. Suppose the length of one side of the square is L and the total charge of the wire is q. Find the electric potential at the center of the square (point P on the figure). You must show all of your work to receive credit for this problem. Make sure you express your final answer only in terms of the variables given in the problem, and fundamental constants. Note that some integrals that may be useful to you are included on your equation sheet.