Physics 2B, Electricity and Magnetim -- Spring 2009 Instructor: B. Grinstein

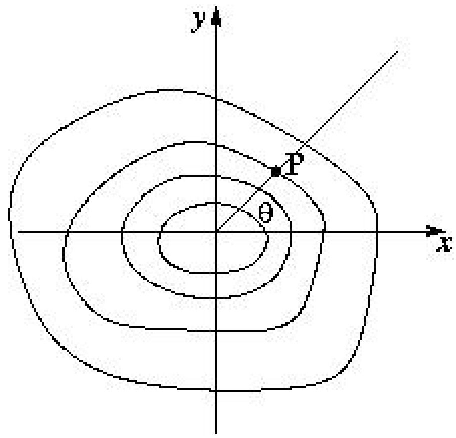
Quiz # 4

INSTRUCTIONS: Fill, tear and return the bottom strip of the front page with your scantron. Keep the top portion of the front page and the rest of the quiz. Use a pencil #2 to fill your scantron. Write your code number and bubble it in under "EXAM NUMBER". Bubble in the quiz form (see letter A--D at bottom of page) in your scantron under "TEST FORM"

Useful numbers: $K = 9.0 \times 10^9\ Nm^2/C^2$, $\varepsilon_o = 8.85 \times 10^{-12}\ C^2/Nm^2$, $e = 1.60 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg

$\mu_o = 4\pi \times 10^{-7}$ T m/A

1) Equipotential lines are as drawn in the figure. Which of the following vectors best approximate the direction of the electric field at point P, assuming the equipotential lines shown differ by the same amount, and increase from the origin. Disregard the $\hat{\mathbf{k}}$ field component. A straight line through P is drawn to inidcate it is at an angle θ above the x–axis.



A) $\cos(\theta)\,\hat{\mathbf{i}} - \sin(\theta)\,\hat{\mathbf{j}}$

B) $\sin(\theta)\,\hat{\mathbf{i}} - \cos(\theta)\,\hat{\mathbf{j}}$

C) $-\sin(\theta)\,\hat{\mathbf{i}} + \cos(\theta)\,\hat{\mathbf{j}}$

D) $\cos(\theta)\,\hat{\mathbf{i}} + \sin(\theta)\,\hat{\mathbf{j}}$

E) $-\cos(\theta)\,\hat{\mathbf{i}} - \sin(\theta)\,\hat{\mathbf{j}}$

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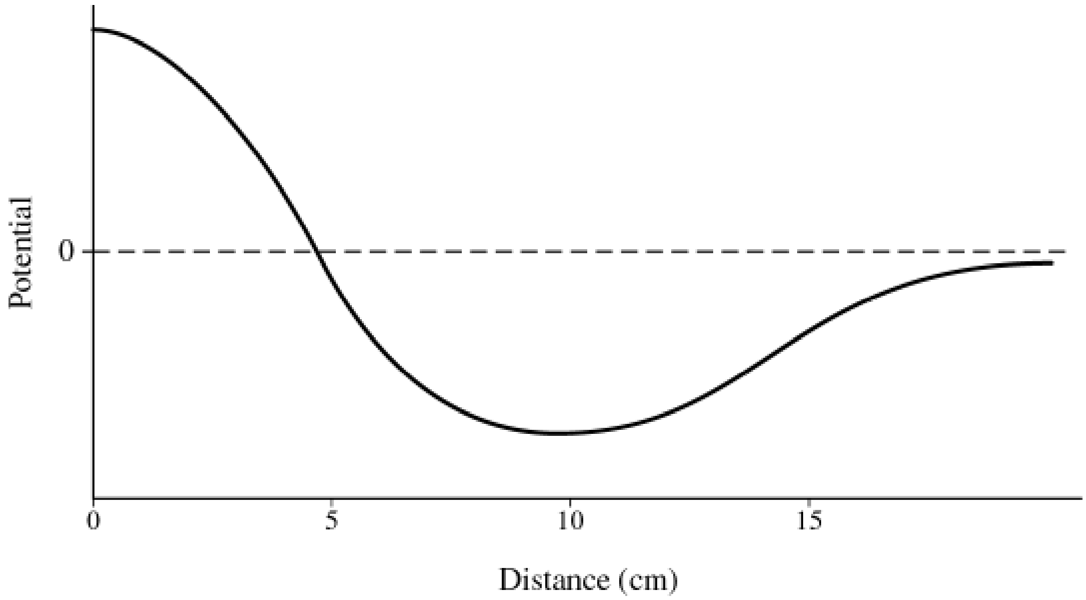
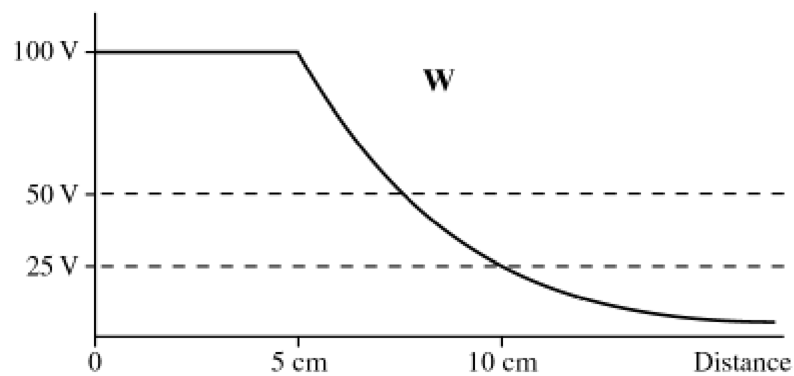
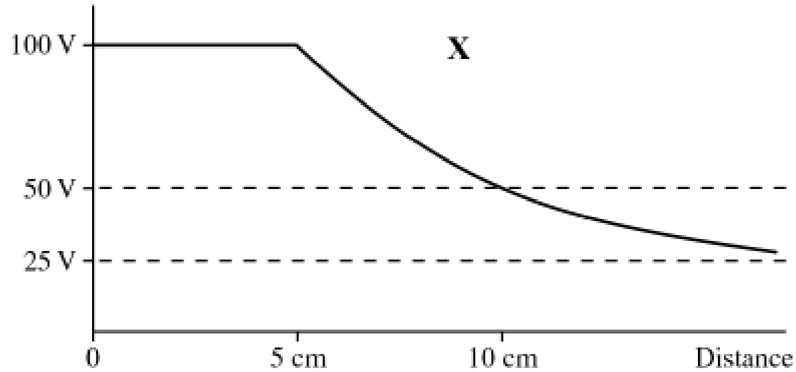
2) The potential as a function of distance is shown in the plot below. Which statement is true?

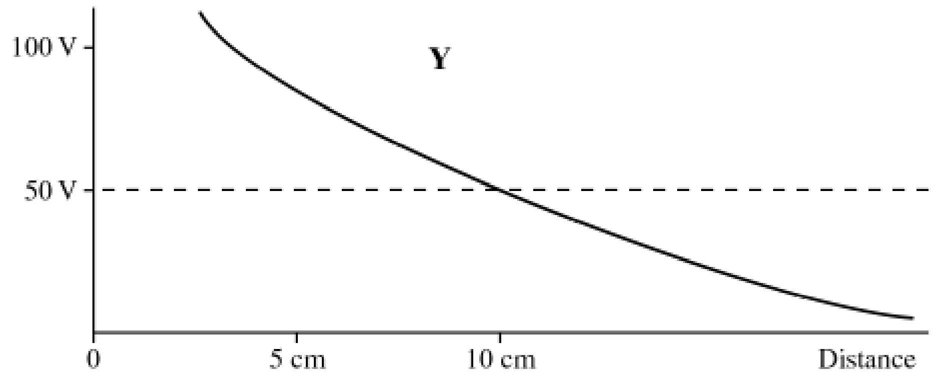


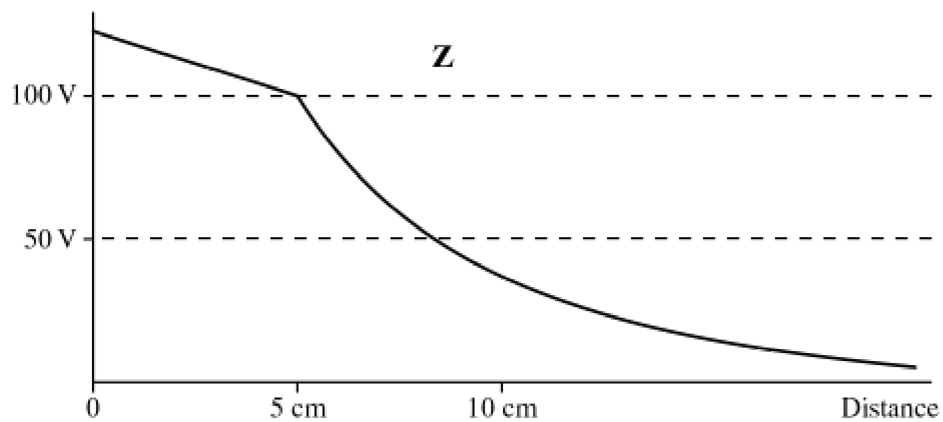
A) The electric field is zero at x=10 cm, its magnitude is at a maximum at x=5 cm, and the field is directed to the left there.
B) The electric field is zero at x=5 cm, its magnitude is at a maximum at x=0, and the field is directed to the right there.
C) The electric field is zero at x=0, its magnitude is at a maximum at x=15 cm, and the field is directed to the left there.
D) The electric field is zero at x=5 cm, its magnitude is at a maximum at x=0 cm, and the field is directed to the left there.
E) The electric field is zero at x=0, its magnitude is at a maximum at x=5 cm, and the field is directed to the right there.

3) A metallic sphere of radius 5 cm is charged such that the potential of its surface is 100 V (with the convention that the potential vanishes at nfinity). Which of the following plots most closely shows the potential as a function of distance from the center of the sphere?









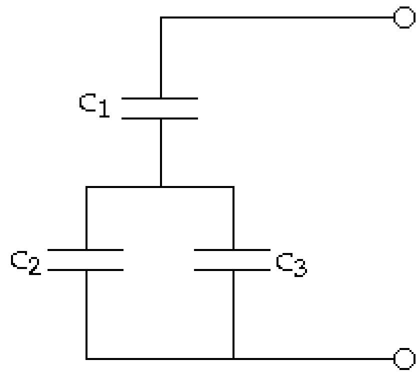
A) Plot X
B) Plot Y
C) Plot Z
D) Plot W
E) More than one of the above.

4) Two capacitors are connected in series. Under what condition are the voltage drops across them equal?
A) The capacitors must be equally charged.
B) The charge on the larger capacitor must be smaller than that on the smaller capacitor.
C) The charge on the larger capacitor must be larger than that on the smaller capacitor.
D) The voltage drop is always equal for capacitors in series.
E) The capacitors must have the same capacitance.

5) A 3.0 pF capacitor consists of two parallel plates that have surface charge densities of $\pm 1.0\ nC/mm^2$. If the potential between the plates is 24.0 kV, find the surface area of one of the plates.

A) $0.0069\ mm^2$ B) $36\ mm^2$ C) $0.014\ mm^2$ D) $72\ mm^2$

6) Three capacitors are arranged as shown. C_1 has a capacitance of 3.0 pF, C_2 has a capacitance of 6.0 pF, and C_3 has a capacitance of 9.0 pF. If the voltage drop across C_2 is 231.0 V, the voltage drop across the entire arrangement is closest to



A) 390 V B) 420 V C) 1400 V D) 920 V

7) An electric field, $\vec{E} = 1/r^2\ \hat{\mathbf{r}}\ N{\cdot}m^2/C$ is located in the xy-plane. Here r is the distance from the origin of the xy-plane, in meters, and $\hat{\mathbf{r}}$ is a unit vector pointing away from the origin. What is the potential difference between r = 5 m and r = 7 m? (that is, what is V(r=8 m) – V(r= 6 m)?)

A) $\frac{7}{218}$ V B) $-\frac{2}{35}$ V C) $\frac{7}{8}$ V D) $\frac{7}{24}$ V

8) An electric qudrupole at the origin of the xy-plane produces an electric potential $V = KA\cos^2\theta/r^3$ at a point P a distance r from the origin and at an angle θ above the x axis. The constant A is called the electric quadrupole moment and has units of m^2C (and the constant K is, as usual, $K=1/4\pi\varepsilon_0$). At the point P the y-component of the electric field is

A) $3KA\cos^2\theta/r^4$

B) $-KA\ (2\cos\theta - 5\cos^3\theta)/r^4$

C) $KA\cos^2\theta/r^4$

D) $5KA\sin\theta\cos^2\theta/r^4$

E) $-KA\ (2\cos\theta - 5\sin\theta\cos^2\theta)/r^4$

Answer Key
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1) E
2) E
3) A
4) E
5) D
6) C
7) B
8) D

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