Physics 227 FIRST COMMON HOUR EXAM
Thursday, October 3, 2002
Profs. Shapiro and Devlin

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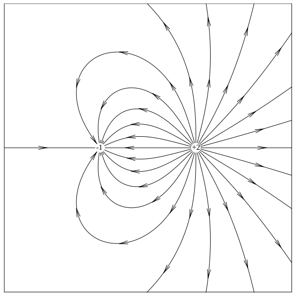
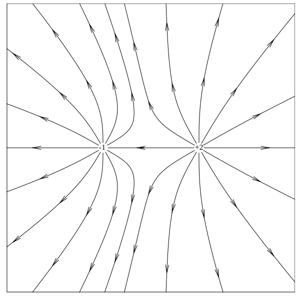
Your name sticker with **exam code**

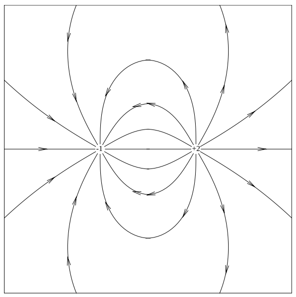
18pt **Turn off and put away cell phones now!**

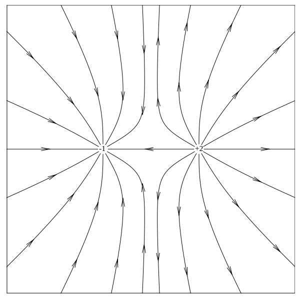
1. The exam will last from 8:00 - 9:20 p.m. Regular final 4-7 Use a #2 pencil to make entries on the answer sheet. Enter the following ID information now, before the exam starts.
2. In the section labelled NAME (Last, First, M.I.) enter your last name, then fill in the empty circle for a blank, then enter your first name, another blank, and finally your middle initial.
3. Under STUDENT # enter your 9-digit Social Security Number.
4. Enter 227 under COURSE, and your section number (see label above) under SEC.
5. **Under CODE enter the exam code given above.**
6. During the exam, you may use pencils, a calculator, and one 8.5 x 11 inch sheet with formulas and notes.
7. There are 18 multiple-choice questions on the exam. For each question, mark only one answer on the answer sheet. There is no deduction of points for an incorrect answer, so even if you cannot work out the answer to a question, you should make an educated guess. **At the end of the exam, hand in the answer sheet and this cover page. Retain the rest of this exam for future reference and study.**
8. When you are asked to open the exam, make sure that your copy contains all 18 questions. Raise your hand if this is not the case, and a proctor will help you. Also raise your hand during the exam if you have a question.
9. Please SIGN the cover sheet under your name sticker and have your student ID ready to show to the proctor during the exam.

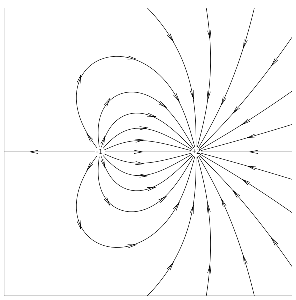
1. Which diagram best represents the field lines around a negative charge, -q, and a positive charge, +2q, as shown in the diagrams?

a) 

b) 

c) 

d) 

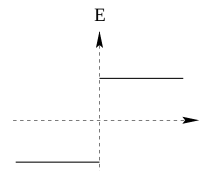
e) 

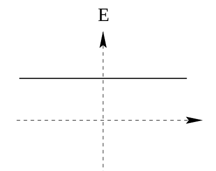
Note: in all figures, the $-q$ charge is on the left and the $+2q$ is on the right.

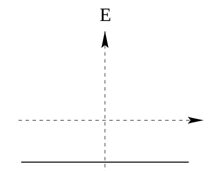
2. Consider a closed Gaussian surface. Which of the following is **false**?

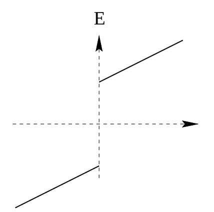
a) If the total electric flux through the surface is zero, then the electric field must be zero everywhere on the surface.
b) If the electric field is zero everywhere on the surface, then there can be no net charge enclosed by the surface.
c) If there is no net charge enclosed by the surface, then the total electric flux through the surface is zero.
d) If the total electric flux through the surface is zero, then the total charge enclosed by the surface is zero.
e) If the electric field is zero everywhere on the surface, then the total electric flux through the surface is zero.

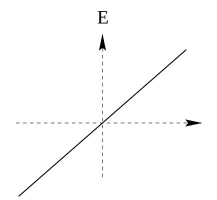
3. In an xyz-coordinate system, a plane of infinite extent with uniform surface charge density $+\sigma$ lies in the xy-plane (z=0). Which graph best represents the z-component of the electric field E *vs.* z along the z-axis?

a) 

b) 

c) 

d) 

e) 

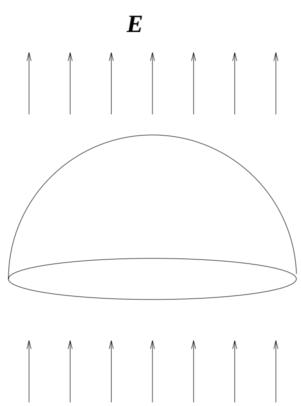
4. Consider a conductor in electrostatic equilibrium. Which of the following statements is **false**?

   a) Any net charge on the conductor must reside on the surface.
   b) The electric field at the surface cannot have a component parallel to the surface
   c) No work is done by the electric field in moving a charge on the surface.
   d) The conductor cannot be given a net charge.
   e) The electric potential must be constant inside the conductor.

5. A charge of $+1.0\ \mu$C is placed at $x = 0$. Where along the x-axis must a second charge of $+4.0\ \mu$C be placed so that the electric field at $x = 10$ cm is zero?

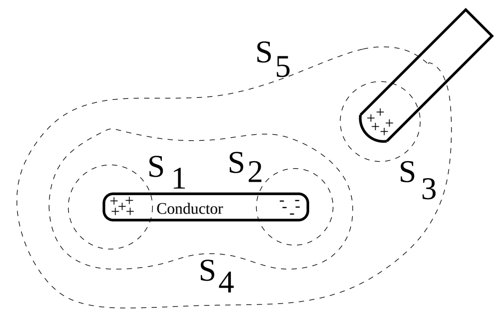
   a) 30 cm
   b) 20 cm
   c) 50 cm
   d) 60 cm
   e) 40 cm

6. An empty hemispherical surface of radius 0.3 m is placed in a uniform electric field of 10 N/C. The field is oriented perpendicular to the flat circular bottom of the hemisphere as shown. The flux of electric field passing through the top curved surface is:



   a) 5.7 Nm^2/C
   b) 2.8 Nm^2/C
   c) 11 Nm^2/C
   d) 19 Nm^2/C
   e) 0

7. A rod containing charge +Q is brought near an initially uncharged isolated conducting rod as shown. Regions with total surface charge +Q and –Q are induced in the conductor as shown in the Figure. The only regions where the net charge in this configuration is non-zero are indicated by the "+" and "–" signs. Let us denote the total flux of electric field outward through closed surface S_1 as Φ_1, through S_2 as Φ_2, etc. Which of the following is necessarily **false**.

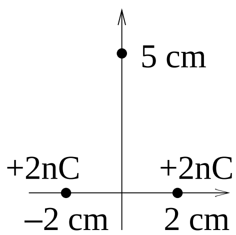


   a) $\Phi_1 > 0$
   b) $\Phi_2 = \Phi_1$
   c) $\Phi_3 = \Phi_1$
   d) $\Phi_4 = 0$
   e) $\Phi_5 = \Phi_1$

8. Two large parallel conducting plates are 10 cm apart and carry equal but opposite charges on their facing surfaces. An electron placed midway between the plates experiences a force of 3.2×10^{-17} N. The potential difference between the plates is

   a) 2000 V
   b) 200 V
   c) 40 V
   d) 20 V
   e) 10 V

9. Two charges, each of +2.00 nC, are at x=2.00 cm and x= − 2.00 cm, on the x-axis, respectively. Relative to $V = 0$ at infinity, the electric potential at y=5.00 cm on the y-axis is:



a) zero
b) 668 V
c) 719 V
d) 12,400 V
e) 334 V

10. A proton with a velocity of $\vec{\mathbf{v}} = (1 \times 10^6 \text{ m/s})\hat{\imath}$ enters a region with a uniform electric field $\vec{\mathbf{E}} = E_0\hat{\imath}$ and is observed to come to rest in 1 second. It is concluded that $E_0 =$

a) -100 N/C
b) (1×10^{-2}) N/C
c) $-(1 \times 10^{-2})$ N/C
d) $-(4 \times 10^{+3})$ N/C
e) 500 N/C

11. An infinitely long, straight metal rod has a radius of 0.03 m and a charge per unit length, $\lambda = 5 \times 10^{-9}$ C/m. Find the magnitude of electric field at a distance 0.15 m from the axis of the rod.

a) 3000 N/C
b) 300 N/C
c) 6 N/C
d) 30 N/C
e) 600 N/C

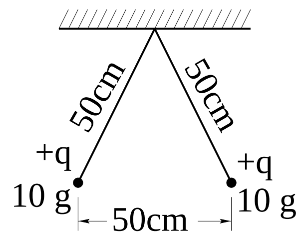
12. In the CRT display of a computer terminal, electrons are emitted from a source and impinge upon a fluorescent screen. If the potential difference between the source and the screen is 10^4V, what is the velocity of an electron just before it hits the screen?

a) (1.8×10^4) m/s
b) (2.4×10^5) m/s
c) (5.9×10^7) m/s
d) (8×10^3) m/s
e) (3.6×10^{15}) m/s

13. Three particles of equal mass and having charges $+Q$, $+2Q$ and $-2Q$ are located at the corners of an equilateral triangle of edge length L. How much total work must be done by an external agent to separate completely the three particles from one another?

a) $4\,k_eQ^2/L$
b) $-4\,k_eQ^2/L$
c) $8\,k_eQ^2/L$
d) $-2\,k_eQ^2/L$
e) none of the others.

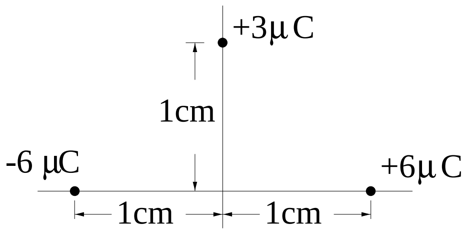
14. Two tiny aluminum-foil balls of mass 10.0g each are suspended from the same point with weightless strings that are 50.0 cm long. When equal charges q are given to each ball, they repel and then come to equilibrium with their centers 50.0 cm apart. The value of q and the tension in the string are respectively.



a) 1.25 μC, 0.113 N
b) 2.17 μC, 0.196 N
c) 0.627 μC, 0.125 N
d) 1.65 μC, 0.113 N
e) 1.65 μC, 0.196 N

Take $g = 9.80\,\text{m/s}^2$

15. A charge of $+6.00\,\mu$C is placed at $(x, y) = (+1.00\,\text{cm}, 0)$, and a charge of $-6.00\,\mu$C is placed at $(x, y) = (-1.00\,\text{cm}, 0)$. What is the magnitude and direction of the force on a charge of $+3.00\mu$C located at (x,y) = (0,+1.00 cm)?



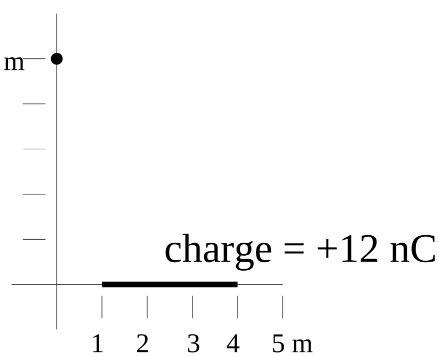
a) $-1620\hat{\imath}$ N
b) $+1146\hat{\imath}$ N
c) $+1620\hat{\imath}$ N
d) $-573\hat{\imath}$ N
e) $-1146\hat{\imath}$ N

16. The electrostatic potential in a region of space is given by $V(x, y) = (324x^2 - 425y)$ V.
The electric field at the point $(2, 2)$ is :

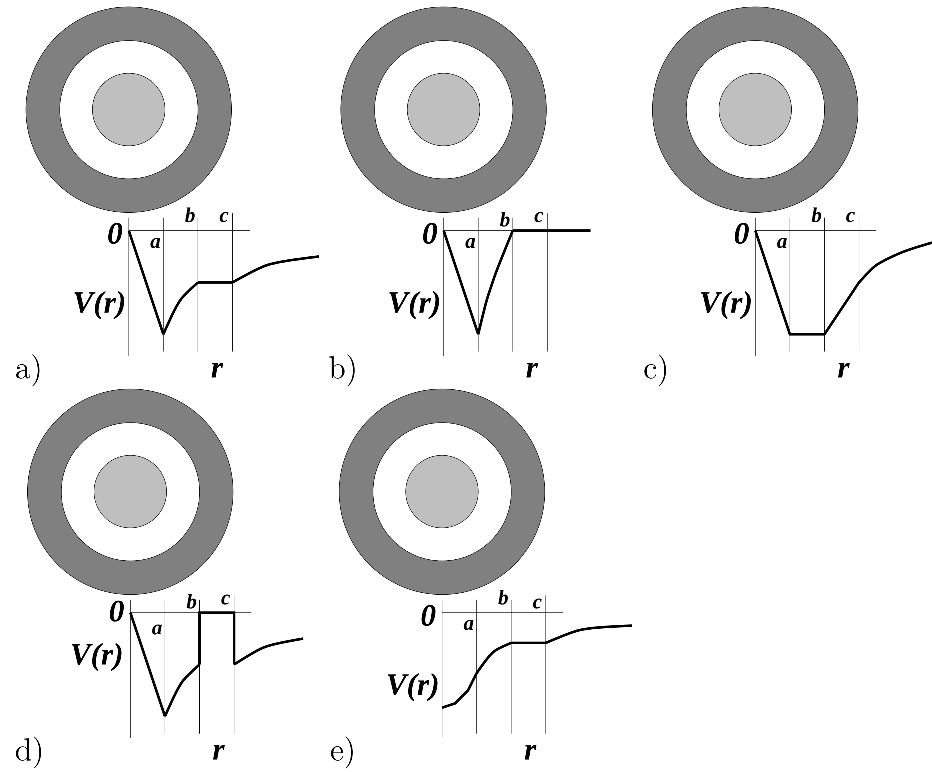
a) $(-1296\hat{\imath} + 425\hat{\jmath})$ N/C
b) $(1296\hat{\imath} - 850\hat{\jmath})$ N/C
c) $(1296\hat{\imath} - 425\hat{\jmath})$ N/C
d) $(850\hat{\imath} + 425\hat{\jmath})$ N/C
e) $(648\hat{\imath} - 850\hat{\jmath})$ N/C

17. A uniformly charged insulated rod extends along the x-axis from $x = 1$m to $x = 4$m, and carries a **total** charge of +12 nC. The electric field at a point $y = 5$m on the y axis has an x-component given by

a) $-36\displaystyle\int_1^4 \frac{dx}{x^2+25}$N/C
b) $-36\displaystyle\int_1^4 \frac{x\,dx}{(x^2+25)^{3/2}}$N/C
c) $-180\displaystyle\int_1^4 \frac{dx}{(x^2+25)^{3/2}}$N/C
d) $-72\displaystyle\int_1^4 \frac{dx}{(x+5)^2}$N/C
e) $-108\displaystyle\int_1^4 \frac{x\,dx}{(x^2+25)^{3/2}}$N/C



18. A nonconducting sphere with radius a is concentric with and surrounded by a conducting spherical shell with inner radius b and outer radius c. The inner sphere has a negative charge uniformly distributed throughout its volume, while the spherical shell has no net charge. The potential $V(r)$ as a function of distance from the center is given by



Some possibly useful information:
c = speed of light = 3.00×10^8 m/s
$q_e = -e$ = charge on an electron = -1.602×10^{-19} Coulombs
$q_p = +e$ = charge on a proton = $+1.602 \times 10^{-19}$ Coulombs
m_e = electron mass = 9.11×10^{-31} kg
m_p = proton mass = 1.67×10^{-27} kg
$k_e = 8.99 \times 10^9\ \text{N}\cdot\text{m}^2/\text{C}^2$
$\epsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N}\cdot\text{m}^2$
$\mu_0 = 4\pi \times 10^{-7}\ \text{T}\cdot\text{m/A}$
$g = 9.80\ \text{m/s}^2$
1 mC = 10^{-3} C   1 μC = 10^{-6} C   1 nC = 10^{-9} C

$\mathrm{pC} = 10^{-12}\ \mathrm{C}$