Physics 272– Practice Exam II
Spring 2012
Prof. Mohan Kalekar

Your name sticker with exam code

1. The exam will last from 3:25pm to 4:25pm. 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, 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 Student ID Number. Under COURSE enter 272. Under CODE enter the exam code given above.

4. During the exam, you may use pencils, a calculator, and ONE 8 $\frac{1}{2}$" × 11" sheet of paper with formulas and notes.

5. There are 16 multiple-choice questions on the exam. For each question, mark only one answer on the answer sheet. There is no subtraction 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 only the answer sheet. Retain this question paper for future reference and study.

6. Useful numerical constants are given on the next page. Before starting the exam, make sure that your copy contains the page of constants and all 16 questions. Bring your exam to the proctor if this is not the case.
Acceleration due to gravity $g = 9.8 \text{ m/s}^2$
Elementary charge $e = 1.6 \times 10^{-19} \text{ C}$
Proton charge $= 1.6 \times 10^{-19} \text{ C}$
Electron charge $= -1.6 \times 10^{-19} \text{ C}$
1 electron volt (eV) $= 1.6 \times 10^{-19} \text{ J}$
Proton mass $= 1.673 \times 10^{-27} \text{ kg} = 938.3 \text{ MeV/c}^2$
Electron mass $= 9.11 \times 10^{-31} \text{ kg} = 0.511 \text{ MeV/c}^2$
$1/4\pi\varepsilon_0 = 9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$
$\mu_0 = 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A}$

Powers of ten:

<table>
<thead>
<tr>
<th>femto (f) $10^{-15}$</th>
<th>pico (p) $10^{-12}$</th>
<th>nano (n) $10^{-9}$</th>
<th>micro (µ) $10^{-6}$</th>
<th>milli (m) $10^{-3}$</th>
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<td>centi (c) $10^{-2}$</td>
<td>kilo (k) $10^3$</td>
<td>Mega (M) $10^6$</td>
<td>Giga (G) $10^9$</td>
<td>Tera (T) $10^{12}$</td>
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1. Consider a closed Gaussian surface. Which of the following are true?

- I: If the electric field points inward everywhere on the surface, the net enclosed charge must be negative.
- II: If the surface encloses a positive $+Q$ and a negative charge $-3Q$, the total electric flux through the surface must be negative.
- III: If the total electric flux through the surface is zero, then the electric field must be zero everywhere on the surface.

a) All three statements are true
b) I and II are true; III is false
c) I is true; II and III are false
d) II is true; I and III are false
e) II and III are true; I is false

2. See the figure for this question. A long, insulating solid cylinder of radius $R$ carries a uniform volume charge density $\rho$. What is the magnitude of the electric field for $r > R$, where $r$ is the perpendicular distance from the axis of the cylinder?

a) $\rho r / 2\varepsilon_0$
b) $\rho R^2 / 2\varepsilon_0 r$
c) $\rho r / 3\varepsilon_0$
d) $\rho R^3 / 3\varepsilon_0 r^2$
e) None of the other answers

3. See the figure for this question. Consider two concentric, conducting spherical shells. The outer shell has a charge of $+3\mu C$ on its inner surface, and a charge of $-7\mu C$ on its outer surface. What are the charges on the surfaces of the inner shell with radii $R_1$ and $R_2$ respectively?

a) Zero and $-3\mu C$
b) Zero and $+4\mu C$
c) $-3\mu C$ and $+3\mu C$
d) $+3\mu C$ and $-3\mu C$
e) None of the other answers
4. A charge of $+5nC$ is on the y-axis at $y = +6cm$, and a charge of $-5nC$ is on the y-axis at $y = -6cm$. What is the electric potential at the point (8,0), i.e. $x = +8cm$, $y = 0$?
   a) 450 V
   b) 540 V
   c) Zero
   d) 9000 V
   e) 900 V

5. An electron initially at rest is accelerated through a potential difference of 3 V. What speed does it acquire?
   a) About $1 \times 10^2$ m/s
   b) About $1 \times 10^3$ m/s
   c) About $1 \times 10^4$ m/s
   d) About $1 \times 10^5$ m/s
   e) About $1 \times 10^6$ m/s

6. A charge $Q$ is at the origin. Concentric with it is a conducting spherical shell of inner radius $a$ and outer radius $b$. The shell has no NET charge. The radial distance $r$ is measured from the center. In the region $r < a$, what is the electric potential $V(r)$, if we make the usual choice that $V = 0$ at infinity?
   a) $Q/(4\pi\varepsilon_0 r)$
   b) $(Q/(4\pi\varepsilon_0 a)) + (Q/(4\pi\varepsilon_0 r))$
   c) $(Q/(4\pi\varepsilon_0 a)) + (Q/(4\pi\varepsilon_0 r))$
   d) $(Q/(4\pi\varepsilon_0 r)) - (Q/(4\pi\varepsilon_0 a))$
   e) $(Q/(4\pi\varepsilon_0 a)) + (Q/(4\pi\varepsilon_0 a)) - (Q/(4\pi\varepsilon_0 a))$

7. Two conducting hollow spheres have different radii. A thin conducting wire connects the spheres. A charge $Q$ is placed on the smaller sphere. What will then happen?
   a) Charge will flow until the spheres have equal potentials
   b) Charge will flow until the spheres have equal charges
   c) All of the charge will flow to the larger sphere
   d) Charge will flow until the spheres have equal electric fields at their surfaces
   e) There will be no flow of charge, so the charge $Q$ will remain on the smaller sphere
8. A parallel-plate capacitor is connected to an adjustable power supply. Which of the following changes will cause the capacitor’s capacitance to increase?

- I: Increasing the charge put out by the power supply
- II: Decreasing the voltage output of the power supply
- III: Decreasing the separation between the plates

a) All three will increase the capacitance  
b) I and II, but not III  
c) I and III, but not II  
d) III only  
e) None of these will increase the capacitance

9. Capacitors $A$ and $B$ have capacitances of 3 $\mu F$ and 5 $\mu F$ respectively. They are connected in series to a 200 V battery. What will be the final charges on capacitors $A$ and $B$ respectively?

a) 600 $\mu C$ and 1000 $\mu C$  
b) 375 $\mu C$ and 375 $\mu C$  
c) 1600 $\mu C$ and 1600 $\mu C$  
d) 1000 $\mu C$ and 600 $\mu C$  
e) 107 $\mu C$ and 107 $\mu C$

10. Two capacitors have capacitances of 7 $\mu F$ and 5 $\mu F$ respectively. They are connected in parallel to a battery. After the battery has charged them, the 7 $\mu F$ capacitor has a stored energy of $2.24 \times 10^{-4} J$. What is the charge on the OTHER capacitor, i.e. the 5 $\mu F$ one?

a) 40 $\mu C$  
b) None of the other answers  
c) 96 $\mu C$  
d) 56 $\mu C$  
e) 47 $\mu C$

11. Two straight wires $A$ and $B$ of circular cross-section are made of the same metal and have equal lengths, but the resistance of wire $A$ is four times that of wire $B$. How do their radii compare?

a) $r_A = r_B/16$  
b) $r_A = r_B/4$  
c) $r_A = r_B/2$  
d) $r_A = 2r_B$  
e) $r_A = 4r_B$
12. Wires $A$ and $B$ are made of the same metal, but the radius of wire $A$ is twice that of wire $B$. The current in wire $A$ is four times that in wire $B$. How are the drift speeds of charge carriers in the two wires related?
   a) $v_A = 8v_B$
   b) $v_A = v_B$
   c) $v_A = 2v_B$
   d) $v_A = 16v_B$
   e) $v_A = 4v_B$

13. A toaster of resistance $10 \, \Omega$ is connected to a $120 \, V$ dc source. What will be the approximate cost of operating the toaster for 2 minutes, if electricity in New Jersey costs 17 cents per kilowatt-hour?
   a) About 0.8 cent
   b) About 1.2 cents
   c) About 1.6 cents
   d) About 1.8 cents
   e) More than 1.9 cents

14. Two resistors have resistances $R$ and $3R$ respectively. They are connected in series to a $12 \, V$ battery. If the current in the resistors is $2.0 \, A$, what is the value of $R$?
   a) $3.0 \, \Omega$
   b) $0.75 \, \Omega$
   c) $2.0 \, \Omega$
   d) $6.0 \, \Omega$
   e) None of the other answers

15. Resistors $R_1$ and $R_2$ are connected in parallel to an $18 \, V$ battery. The two resistors have an equivalent resistance of $5 \, \Omega$. If the current in resistor $R_2$ is $1.5 \, A$, in which of the following ranges does the value of $R_1$ lie, in units of ohms?
   a) $R_1 < 4$
   b) $4 \leq R_1 < 8$
   c) $8 \leq R_1 < 10$
   d) $10 \leq R_1 < 16$
   e) $R_1 \geq 16$
16. See the figure for this question. Note that two of the resistors have the same resistance $R$, while the one on the far right has resistance $2R$. The current through the middle resistor is 2.0 A down. What is the value of $R$?

a) 6.0 $\Omega$

b) 5.0 $\Omega$

c) 15.0 $\Omega$

d) 4.0 $\Omega$

e) 10.0 $\Omega$