King Fahd University of Petroleum and Minerals

Department of Physics

PHYS102-052

MAJOR 2 EXAM

<u>Test Code</u>: 015

Monday 1st May 2006

Exam Duration: 2hrs (from 6:30pm to 8:30pm)

Name:	
Student Number:	
Section Number:	

1. Each of the four capacitors shown in figure 5 is 500 μF. The voltmeter reads 1000V. The magnitude of the charge, on each capacitor plate is:
   A) 3.5 C
   B) 0.2 C
   C) 0.5 C
   D) 5.5 C
   E) 2.2 C

2. A particle with a charge of 5.5×10^{-8} C is fixed at the origin. How much work is done by external agent to move a charge of -2.3×10^{-8} C from point A to point B shown in figure 6.
   A) 3.1×10^{-3} J
   B) -6.0×10^{-5} J
   C) zero
   D) 6.0×10^{-5} J
   E) -3.1×10^{-3} J

3. A parallel-plate capacitor has a plate area of 0.2 m^2 and a plate separation of 0.1mm. The electric field between the plates is 2.0×10^6 V/m. The energy stored in the capacitor is:
   A) 4.36 mJ
   B) 2.76 mJ
   C) 1.54 mJ
   D) 0.15 mJ
   E) 0.35 mJ

4. A charged particle with a mass of 2×10^{-4} kg is held suspended (stationary) by a downward electric field of 300 N/C. The charge on the particle is:
   A) -1.5×10^{-6} C
   B) $+1.5 \times 10^{-6}$ C
   C) -6.5×10^{-6} C
   D) $+4.0 \times 10^{-6}$ C
   E) $+6.5 \times 10^{-6}$ C

5. Consider the charges shown in figure 1. Find the magnitude and sign of charge Q_4 so that the net electrostatic force on charge Q_5 is zero.
   A) – 0.9 nC
   B) + 2.5 nC
   C) – 2.5 nC
   D) – 1.8 nC
   E) + 1.8 nC

6. An air-filled parallel-plate capacitor has a capacitance of 1 pF. The plate separation is then doubled and a wax dielectric is inserted, completely filling the space between the plates. As a result, the capacitance becomes 2 pF. The dielectric constant of the wax is:
   A) 0.4
   B) 4.0
   C) 8.0
   D) 2.0
   E) 0.5

7. A long solid non-conducting cylinder (radius = 12 cm) has a uniform charge density ($5.0\ nC/m^3$) distributed throughout its volume. Determine the magnitude of the electric field 5.0 cm from the axis of the cylinder.
   A) 5 N/C
   B) 14 N/C
   C) 31 N/C
   D) 25 N/C
   E) 20 N/C

8. A large insulating solid sphere has a charge density of $5\ nC/m^3$. Calculate the electric field inside the sphere at a distance of 10 cm from its center.
   A) 12.6 N/C
   B) 0
   C) 26.4 N/C
   D) 18.8 N/C
   E) 5.50 N/C

9. In figure 2, two charges $q_1 = -5.0\ \mu C$, $q_2 = 10\ \mu C$, are fixed on the x-axis. At what distance, measured from q_1, the electric field will be zero?
   A) 2.4 m to the left of q_1
   B) 1.5 m to the left of q_1
   C) 0.25 m to the left of q_1
   D) 3.5 m to the left of q_1
   E) 0.25 m to the right of q_1

10. Which of the following charge **CANNOT** be found in nature?
A) 4.8×10^{-19} C
B) 64×10^{-19} C
C) 16×10^{-19} C
D) 0.8×10^{-19} C
E) 3.2×10^{-19} C

11. Two conducting spheres, one having twice the diameter of the other, are separated by a distance large compared to their diameters. The smaller sphere has charge q and the larger sphere is uncharged. If the spheres are connected by a long thin conducting wire:
A) 1 and 2 have the same charge
B) The value of the electric field at both surfaces is same
C) 1 and 2 have the same potential
D) 2 has half the potential as 1
E) 2 has twice the potential as 1

12. Two small identical conducting spheres, initially uncharged are separated by a distance of 1.0 m. Find the number of electrons that must be transferred from one sphere to the other in order to produce an attractive force of 2×10^{4} N between the spheres.
A) 1.6×10^{15}
B) 2.4×10^{13}
C) 9.3×10^{15}
D) 2.1×10^{16}
E) 3.5×10^{12}

13. Two electrons are initially far away. Each electron is moving toward the other one with a speed of 500 m/s. Find the closest distance they can get to each other.
A) 4.14 mm
B) 0.67 mm
C) 1.53 mm
D) 1.01 mm
E) 9.11 mm

14. Three large insulating sheets of charge with the given charge densities are shown in figure 4. The magnitudes of electric field at points A and B are respectively
A) $3\sigma_o / \varepsilon_o$, $3\sigma_o / \varepsilon_o$
B) $2\sigma_o / \varepsilon_o$, 0
C) $\sigma_o / 2\varepsilon_o$, $\sigma_o / 2\varepsilon_o$
D) $3\sigma_o / \varepsilon_o$, 0
E) σ_o / ε_o , 0

15. A conducting spherical shell with a net charge q_o has an outer radius R. A point charge q_o is placed at a distance R/3 from the center of the shell. What is the surface charge density on the outer surface of the shell?
A) $-2q_o / 4\pi R^2$
B) $q_o / 4\pi R^2$
C) 0
D) $2q_o / 4\pi R^2$
E) $-q_o / 4\pi R^2$

16. In a certain region of the xy plane, the electric potential is given by $V(x,y) = 2xy - 3x^2 + 5y$, where At which point is the electric field equal to zero?
A) (7.5 , 3.5)
B) (–2.5, –7.5)
C) (3.5 , 8.5)
D) (–3.5, 2.5)
E) (7.5 , –2.5)

17. Capacitors A and B have the same capacitance. Capacitor A is charged so that it stores 4 J of energy and capacitor B is uncharged. The capacitors are then connected in parallel. The total stored energy in the capacitors is now:
A) 1 J
B) 4 J
C) 14 J
D) 8 J
E) 2 J

18. A charged solid conducting sphere has a radius = 20 cm and a potential of 400V. Calculate the electric field 40 cm from the center of the sphere,
A) 250 V/m
B) 750 V/m
C) 500 V/m
D) 100 V/m
E) 400 V/m

19. Two large metal plates are 10.0 cm apart and have a uniform electric field between them as shown in figure 3. An electron is released from rest from the negative plate at the same time a proton is released from rest from the positive plate. Find the ratio of the distance covered by proton to that of electron when they pass each other.
A) 5.46×10^{-4}
B) 7.87×10^{-4}
C) 9.43×10^{-4}
D) 1.09×10^{-4}
E) 3.32×10^{-4}

20. Consider a long wire of linear charge density λ. Now imagine a closed cylindrical Gaussian surface of radius r and length L with the wire as the axis. What is the electric flux through the cylinder surface?
A) $(2\pi r^2/L + L)\,\lambda/\varepsilon_o$
B) $\lambda L/\varepsilon_o$
C) 0
D) $(\lambda\, L^2 / \pi\, r^2)\,\lambda$
E) $(2\pi r^2 + L)\,\lambda/\varepsilon_o$

Answer Key

1. C
2. D
3. E
4. C
5. E
6. B
7. B
8. D
9. A
10. D
11. C
12. C
13. D
14. C
15. D
16. B
17. E
18. C
19. A
20. B

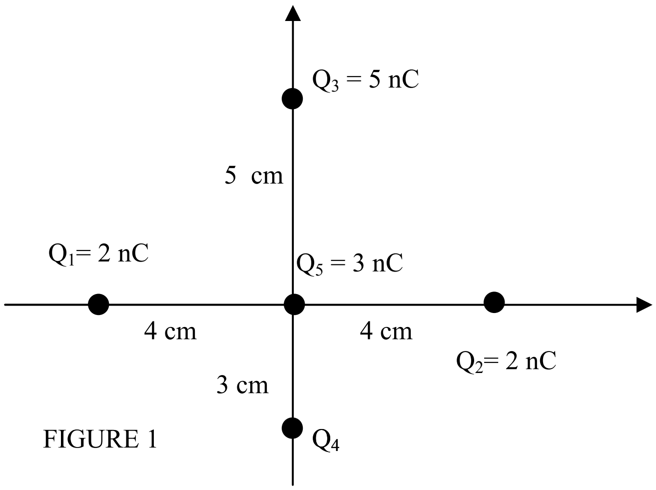

FIGURE 1

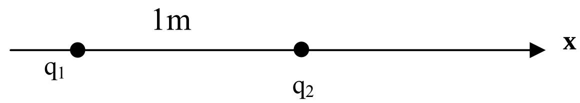

FIGURE 2

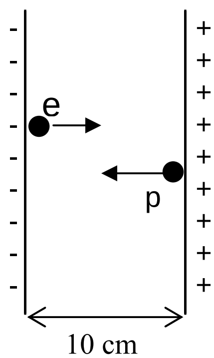

FIGURE 3

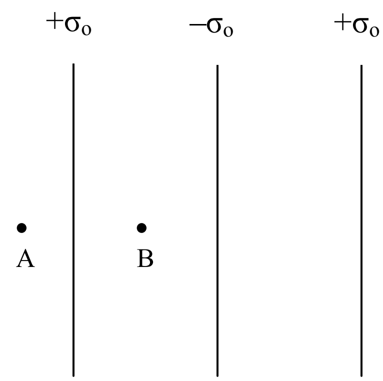

FIGURE 4

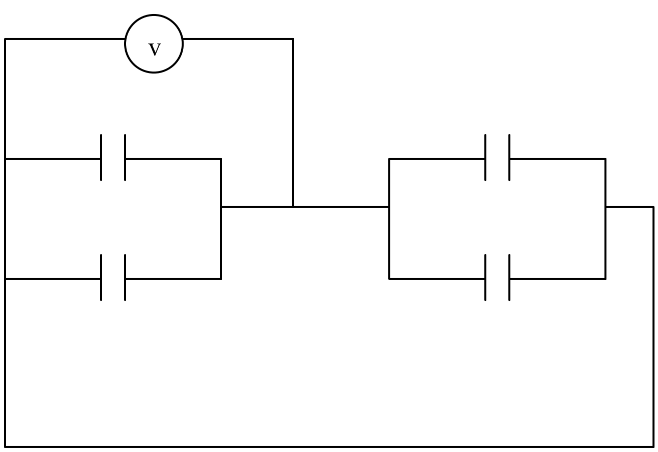

FIGURE 5

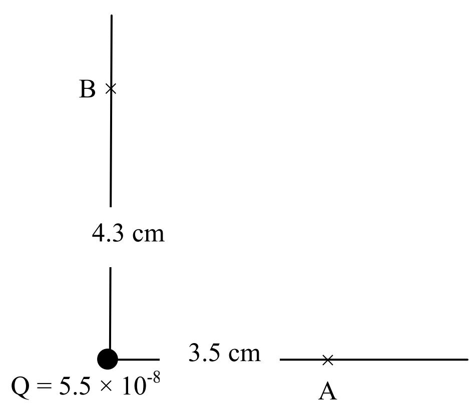

FIGURE 6

Physics 102
Formula Sheet for 2nd Major Exam
Second Semester 2005-2006 (Term 052)

$$F = k\frac{q_1 q_2}{r^2}, \quad \Phi = \int_{\text{Surface}} \vec{E}.d\vec{A}, \quad E = \frac{\sigma}{2\varepsilon_o}$$

$$E = k\frac{q}{r^2}, \quad E = k\frac{q}{R^3}r, \quad E = \frac{2k\lambda}{r}, \quad E = \frac{\sigma}{\varepsilon_o}$$

$$U = -\vec{P}.\vec{E}, \quad \vec{\tau} = \vec{P}\times\vec{E}, \qquad \Delta K = \Delta U$$

$$\Phi_c = \oint \vec{E}.d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$

$$E_x = -\frac{\partial V}{\partial x}, \quad E_y = -\frac{\partial V}{\partial y}, \quad E_z = -\frac{\partial V}{\partial z}$$

$$\Delta V = V_B - V_A = -\int_A^B \vec{E}.d\vec{S} = \frac{\Delta U}{q_0}$$

$$V = k\frac{q}{r}, \quad U = k\frac{q_1 q_2}{r_{12}}, \quad W_{app} = q\Delta V = \Delta U$$

$$C = \frac{q}{V}, \quad C = \kappa C_0, \quad U = \frac{1}{2}CV^2$$

$$i = \frac{dq}{dt}, \quad V = iR, \quad P = iV$$

$$J = \frac{i}{A}, \quad \vec{J} = (ne)\vec{v}_d, \quad \vec{E} = \rho\vec{J}$$

$$R = \rho\frac{L}{A}, \quad \rho - \rho_o = \alpha\rho_o(T - T_o)$$

$$v = v_o + at$$

$$x - x_o = v_o t + \frac{1}{2} a t^2$$

$$v^2 = v_o^2 + 2a(x - x_o)$$

Constants:

$k = 9.0 \times 10^9$ N.m^2/C^2
$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N.m^2
$e = -1.6 \times 10^{-19}$ C
$m_e = 9.11 \times 10^{-31}$ kg
$m_p = 1.67 \times 10^{-27}$ kg
$k_B = 1.38 \times 10^{-23}$ J/K
$N_A = 6.022 \times 10^{23}$ molecules/mole
R = 8.314 J/mol. K
1 atm = 1.013×10^5 N/m^2
g = 9.8 m/s^2

micro = 10^{-6}
nano = 10^{-9}
pico = 10^{-12}