جامعة بيرزيت

BIRZEIT UNIVERSITY

Physics 132 First Exam
Second Semester 2016/2017

17

Date: Tuesday 28/3/2017 **Time: 90 Minutes**

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Please put (*) next to your discussion instructor name and circle your discussion section:

	Section #		Instructor	Section #	
Areej Abdel Rahman	D1		Hazem Abu Sara	D5	
Wael Karsin	D2	✓	Dua' Abu Mura	D6, D11, D13, D15	✓
Hebah Fasafia	D3, D10		Abdallah Sayyed-Ahmad	D7, D9, D14	
Ghassan Abbas	D4, D8		Nadaa Hamamra	D12, D16	

Exam Instructions:

- Write your name and student # where asked in the top of the sheet.
- Mark one box only using (×) in the answer sheet below to indicate the answer you consider best for each question.
- You cannot enter more than one (×) for a particular question. If you do, zero marks will be given for that question.
- Before you start the exam, make sure that you have 8 pages and 18 questions.
- Cell phones are not allowed and should be kept off during the exam.
- Last page has some useful constants and formulas.

Answer Sheet

	(a)	(b)	(c)	(d)	(e)
1	✓				
2				✓	
3	✓				
4		✓			
5					✓
6					✓
7			✓		
8				✓	
9		✓			

	(a)	(b)	(c)	(d)	(e)
10					✓
11			✓		
12					✓
13		✓			
14			✓		
15				✓	
16	✓				
17		✓			
18				✓	

(1) An electron traveling north enters a region where the electric field is uniform and points north. The electron:

(a) slows down
(b) speeds up
(c) turn west
(d) turn east
(e) continues with the same speed in the same direction

(2) The equipotential surfaces associated with a charged point particle are:

(a) radially outward from the particle
(b) vertical planes
(c) horizontal planes
(d) concentric spheres centered at the particle
(e) none of the above

(3) Which of the following physical quantities are vectors: (I) electric field (II) electric charge (III) electric flux (IV) electric potential

(a) (I) only
(b) (III) only
(c) (I) and (II)
(d) (I) and (III)
(e) (I) and (IV)

(4) Two conducting spheres are far apart. The smaller sphere carries a total charge of Q. The larger sphere has a radius that is twice that of the smaller sphere and is neutral. After the two spheres are connected by a conducting wire, the charges on the smaller and larger spheres, respectively, are:

(a) Q/2 and Q/2
(b) Q/3 and 2Q/3
(c) 2Q/3 and Q/3
(d) zero and Q
(e) 2Q and −Q

(5) Total electric charge is conserved

(a) only in insulators
(b) only in conductors
(c) in closed systems
(d) never
(e) always

(6) An electric dipole of dipole moment $\vec{p} = p_0\hat{i} + p_0\hat{j}$ is placed in a uniform electric field $\vec{E} = E_0\hat{i}$. The torque applied on the dipole by the electric field is

(a) $-p_0E_0\hat{i}$
(b) $p_0E_0\hat{k}$
(c) $p_0E_0\hat{j}$
(d) 0
(e) $-p_0E_0\hat{k}$

$\tau = \vec{p} \times \vec{E}$
$= (P_0\hat{i} + P_0\hat{j}) \times (E_0\hat{i})$
$= P_0E(-\hat{k})$ $(\hat{j} \times \hat{i}) = -\hat{k}$

(7) A particle with charge 2.0 μC charge is placed at the origin. An identical particle, with the same charge, is placed 2.0 m from the origin on the x axis, and a third identical particle, with the same charge, is placed 2.0 m from the origin on the y axis. The magnitude of the net force on the particle at the origin is:

(a) 9.0×10^{-3} N
(b) 6.4×10^{-3} N
(c) 1.3×10^{-2} N
(d) 1.8×10^{-2} N
(e) 1.4×10^{-3} N

$F_{12} = \frac{k q_1 q_2}{r^2} = \frac{k(2\times10^{-6})^2}{2^2} = 9\times10^{-3}$
$F_{13} = 9\times10^{-3}$
$F_{net} = 0.0127$
0.013

(8) A thin plastic rod of length L lying on the x axis and has a uniform positive linear charge density λ. With V = 0 at infinity, the electric potential at points A, B and C satisfies

(a) $V_A > V_B > V_C$
(b) $V_C > V_B > V_A$
(c) $V_A > V_C > V_B$
(d) $V_B > V_C > V_A$
(e) $V_C > V_A > V_B$

$V_A < V_C$ $V = \frac{k\,dq}{r}$ $dq = \lambda\,dx$
$= k\lambda \int \frac{dx}{x+d}$
$= k\lambda \ln(x+d)$

$\sqrt{d^2 + x^2}$
$d + x$
$\sqrt{d^2 + (d^2 + x^2)}$ 6.4

(9) Suppose the electric potential due to a given charge distribution can be written in Cartesian Coordinates as $V(x,y,z) = \frac{1}{2x^2+3y^2+5z^2}$ volts. The associated electric field at the point (1, 1, 1) m is

(a) $0.04\hat{i} + 0.09\hat{j} + 0.25\hat{k}$ N/C
(b) $0.04\hat{i} + 0.06\hat{j} + 0.10\hat{k}$ N/C
(c) $0.04\hat{i} + 0.12\hat{j} + 0.16\hat{k}$ N/C
(d) $0.02\hat{i} + 0.02\hat{j} + 0.02\hat{k}$ N/C
(e) $0.04\hat{i} + 0.09\hat{j} + 0.16\hat{k}$ N/C

$-\frac{\partial V}{\partial x} = \frac{+(4x)}{(2x^2+3y^2+5z^2)^2}$

$-\frac{\partial V}{\partial y} = \frac{+(6y)}{(2x^2+3y^2+5z^2)^2}$

$-\frac{\partial V}{\partial z} = \frac{+(10z)}{(2x^2+3y^2+5z^2)^2}$

0.04 0.06 0.1

100

(10) The combined charge on two small spheres is +15.0μC. If each sphere is repelled by the other by a force of 5.4 N when the spheres are 30.0 cm apart, the charges on the spheres are:

(a) 7.0μC and 8.0μC = 15
(b) 3.0μC and 12.0μC = 15
(c) 4.0μC and 13.5μC = 17.5
(d) 5.0μC and 10.0μC = 15
(e) 6.0μC and 9.0μC — 15

$F = \frac{K q_1 q_2}{r^2}$

$5.4 = \frac{K q_1 q_2}{(0.3)^2}$

5.4×10^{-11}

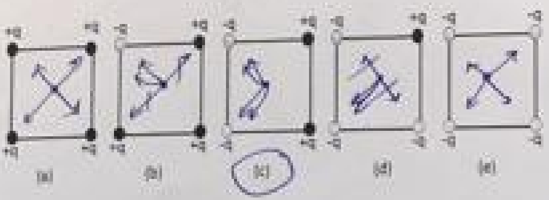
$q_1 = \frac{5.4\times10^{-11}}{q_2}$

$q_2^2 - 15q_2 + 5.4\times10^{-11} = 0$

$\frac{1.8\times10^{-11}}{q_2} + q_2 = 15$

1800

(11) The magnitude of the electric field at the center of the square is greatest for charge configuration



(12) A 5.0 cm radius isolated conducting sphere is charged so its potential is +100 V, relative to the potential far away. The charge density on its surface is:

(a) $2.2 \times 10^{-7}\ C/m^2$
(b) $-2.2 \times 10^{-7}\ C/m^2$
(c) $3.5 \times 10^{-7}\ C/m^2$
(d) $-1.8 \times 10^{-8}\ C/m^2$
(e) $1.8 \times 10^{-8}\ C/m^2$

$V = 100\ V$

$V = \frac{kq}{r}$

$100 = \frac{9 \times 10^{9}\, q}{5 \times 10^{-2}}$

$q = 5.5 \times 10^{-10}$

$\sigma = \frac{5.5 \times 10^{-10}}{4\pi r^2} = 1.77 \times 10^{-8}$

(13) Two electrons are fixed 2.00 cm apart. Another electron is shot from infinity and stops midway between the two. What is its initial speed?

(a) 88.0 m/s
(b) 320 m/s
(c) 160 m/s
(d) 226 m/s
(e) 80.0 m/s

$(K + U)_\infty = (K + U)_{mid}$

$\frac{1}{2}mv^2 + 0 = 0 + 4.608 \times 10^{-26}$

$V = \sqrt{\frac{2 \times 4.608 \times 10^{-26}}{9.11 \times 10^{-31}}}$

318

$U = \frac{qq}{4\pi\epsilon_0 r_1} + \frac{qq}{4\pi\epsilon_0 r_2}$

$\frac{9 \times 10^{9} \times 2 (1.6 \times 10^{-19})^2}{(1 \times 10^{-2})}$

(14) If $\vec{E} = 4.00\, x\, \hat{i}$ N/C, then potential difference $(V_A - V_B)$ between point B on the x-axis at x = 4.00 m and point A on the y-axis at y = 3.00 m is

(a) −16.0 V
(b) 16.0 V
(c) −32.0 V
(d) 32.0 V
(e) −64.0 V

$V = -\int E$
$= -2x^2$

$V_A = 0$
$V_B = -2(4)^2 = -32$

$V_A - V_B = -32 - 0$

(15) A particle that has a mass of 0.10 g and carries a charge of 100.0 μC is placed in a region in which the electric field is given by $\vec{E} = (3.00 - 4.00x^2)\hat{i}\ \frac{N}{C}$. If the particle starts at rest at $x = 0$, then its speed when it reaches position $x = 2.00$ m is

(a) 2.00 m/s
(b) 3.00 m/s
(c) 8.00 m/s
(d) 6.00 m/s
(e) 3.50 m/s

$\Delta V = \int_0^2 E\,dx = \frac{3}{?}(x - x^3)\Big|_0^2 = 18\ V$

$(K + U)_i = (K + U)_f$

$(U_i - U_f) = K_f - K_i \quad \Delta U = q\Delta V = 1.8\times10^{-3} = \frac{1}{2}mv^2$

$v^2 = 36$

(16) An infinite straight wire with charge density λ is at the center of an infinite hollow cylinder with charge density σ and a radius R. The electric field magnitude outside the cylinder at a perpendicular distance r from its axis is

(a) $\frac{\lambda + 2\pi R\sigma}{2\pi\epsilon_0 r}$
(b) [illegible]
(c) [illegible]
(d) [illegible]
(e) [illegible]

$E_w + E_c =$

$\frac{\lambda}{2\pi\epsilon_0 r} + \frac{\sigma R}{2\epsilon_0 r}$

$\frac{\lambda + \sigma 2\pi R}{2\pi\epsilon_0 r}$

$\oint E\,dA = \frac{q_{enc}}{\epsilon_0}$

$E = \frac{\sigma R}{\epsilon_0 r}$

(17) The magnitude of the electric field outside a non-conducting sphere of radius R that has a volume charge distribution that varies with radial distance r as given by $\rho(r) = \rho_0\left(\frac{4}{R}r - \frac{5}{R^2}r^2\right)$

(a) [illegible]
(b) 0
(c) [illegible]
(d) [illegible]
(e) [illegible]

$dq = \rho\,dV$

$\int_0^R \rho_0\left(\frac{4r}{R} - \frac{5}{R^2}r^2\right)4\pi r^2\,dr$

$E(4\pi r^2) = \frac{q_{enc}}{\epsilon_0}$

$E = \frac{q_{enc}}{4\pi r^2\epsilon_0}$

$\frac{\rho_0 4\pi}{R^2}\int 4Rr^3 - 5r^4 \quad (Rr^4 - r^5) \quad R^5 - R^5 = 0$

(18) A charge q is uniformly distributed over a thin ring of radius R. A very long uniformly charged rod with linear charge density λ is placed on the axis of the ring with one end coinciding with the center of the ring. The magnitude of the electrostatic force between the ring and the rod is

(a) 0

(b) $\frac{q\lambda}{4\pi\epsilon_0 R^2}$

(c) $\frac{q\lambda}{2\pi\epsilon_0 R}$

(d) $\frac{q\lambda}{4\pi\epsilon_0 R}$

(e) $\frac{q\lambda^2}{4\pi\epsilon_0 R^2}$

$F = \frac{Kqq}{r^2}$

$\frac{q\,\lambda L}{4\pi\epsilon_0 R^2}$

$\frac{q}{L} = \lambda$

$\frac{K\lambda\,2\pi R}{\sqrt{R^2+z^2}}$

Kq

$\frac{qz}{4\pi\epsilon_0 (z^2+R^2)^{3/2}}$

$\frac{q\,z\,(\lambda x)}{4\pi\epsilon_0 z^3}$

Some Useful Formulae and Constants

1. $k = \frac{1}{4\pi\epsilon_0} = 9.0 \times 10^9\ N m^2/C^2$
2. $\epsilon_0 = 8.85 \times 10^{-12} C^2/N.m^2$
3. $e = 1.6 \times 10^{-19} C$
4. $m_e = 9.11 \times 10^{-31} kg$

Electric Charge and Electric Field

5. $\vec{F} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}\hat{r}$
6. $\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$
7. $\vec{F} = q\vec{E}$
8. $\vec{E} = \frac{1}{2\pi\epsilon_0}\frac{\vec{p}}{z^3}$, (for Electric dipole)
9. $\vec{\tau} = \vec{p} \times \vec{E}$
10. $U = -\vec{p}\cdot\vec{E}$

Gauss' Law

11. $\epsilon_0 \oint \vec{E}\cdot d\vec{A} = q$ (Gauss' Law)

Electric Potential

12. $\Delta U = -W$
13. $\Delta V = -W/q$
14. $V_f - V_i = -\int_i^f \vec{E}\cdot d\vec{s}$
15. $E_s = -\frac{\partial V}{\partial s}$
16. $U = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r}$

Sphere

17. $Area = 4\pi R^2$
18. $Volume = \frac{4}{3}\pi R^3$
19. $V = \frac{kQ}{r}$ $(r \geq R)$

(spherically symmetric charge distribution)

Cylinder

20. $Area = 2\pi RL$
21. $Volume = \frac{4}{3}\pi R^3$

Ring

22. $Circumference = 2\pi R$
23. $E_z = \frac{1}{4\pi\epsilon_0}\frac{qz}{(z^2+R^2)^{3/2}}$ (uniformly charged)