KING ABDULAZIZ UNIVERSITY- FACULTY OF SCIENCE

PHYSICS DEPARTMENT- ELECTRICITY & MAGNETISM (PHYS 202)

A

EXAM I – SUMMER TERM 2011 **TIME: 90 MINS**

Student Name: ……………………………… **Student Number:** ………………………… **Section:** ……………………

1. Two small charged balls have charges of q and nq where q = 5 μC. If they are 15 cm apart and the force between them is 30 N, the value of n is:

(a) 15 (b) 12 (c) 9 (d) 6 (e) 3

2. If the magnitude of the electrostatic force between two protons is equivalent to the weight of a single electron, the separation (in **SI** units) between theses protons is:

(a) 7.2 (b) 5.1 (c) 1.68 (d) 2.27 (e) 0.12

3. The number of electrons that passes through a wire having current of 1 mA for 32 sec is:

(a) 4×10^{19} (b) 4×10^{14} (c) 2×10^{19} (d) 2×10^{17} (e) 10^{18}

4. A distance of 10 cm separates two charges q_1= 5 μC and q_2. If the attractive force between them is 36 N, the charge q_2 is:

(a) 8 μC (b) -8 μC (c) 8 nC (d) -8 nC (e) 5 μC

5. Eight equal charges (Q= 6 nC) are arranged on the corners of a cube of edge 2 m. The magnitude of the electrostatic force on a 2 μC charge, located at the center of the cube, is:

(a) 2.7×10^{-5} N (b) 5.4×10^{-5} N (c) 1.35×10^{-5} N (d) 6.75×10^{-6} N (e) zero

6. The electric field at a point 2 m away from a point charge Q is 18 N/C (outwards). The charge Q is:

(a) 8 nC (b) -8 nC (c) 16 nC (d) -16 nC (e) 8 μC

7. A particle of mass 2 g is held stationary in air due to a downward electric field of magnitude 19.6 kN/C. The charge of the particle is:

(a) 1 C (b) -1 mC (c) 1 mC (d) -1 μC (e) 1 μC

8. Under the effect of a uniform electric field, an electron is uniformly accelerated from zero to 3×10^5 m/s within a distance of 2 cm. The magnitude of the electric field (in **SI** units) is:

(a) 2.35 (b) 6.5 (c) 12.8 (d) 5.69 (e) 1.28

9. In **Fig. 1**, a neutral particle **A** vertically enters a uniform electric field. The possible path of the particle is:

(a) 1 (b) 2 (c) 3 (d) 4 (e) 5

10. An electric dipole, consisting of +2 μC and -2 μC charges, is placed in a uniform electric field of 300 N/C. If the maximum torque on the dipole is 1.8×10^{-6} N.m, the length of the dipole is:

(a) 1.2 cm (b) 3 cm (c) 3 mm (d) 1.2 mm (e) 1 m

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11. In **Fig. 2**, the net electric flux through the Gaussian surface $\mathbf{S_1}$ (in **SI** units) is:

(a) 11.1 (b) 4.9 (c) -6.2 (d) 6.2 (e) 4

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12. The electric field at a distance 12 cm from the surface of a metal sphere of radius 10 cm is 1800 N/C directed radially outwards. The surface charge density is:

(a) 77 nC/m^2 (b) 64 nC/m^2 (c) -77 nC/m^2 (d) -64 nC/m^2 (e) zero

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13. A wire of length 2 mm carries a linear charge density 8 nC/m and surrounded by a metal sphere of radius 4 mm and charge 4 pC. The strength of the electric field just outside the sphere is:

(a) 7 kN/C (b) 5 kN/C (c) 2.25 kN/C (d) 11.25 kN/C (e) zero

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14. The electric field at 2 cm from a long-straight wire is 20 N/C. The electric field at 5 cm from the wire (in **SI** units) is:

(a) 50 (b) 8 (c) 4 (d) 20 (e) 100

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15. The correct statement for the electric field lines is:

(a) They are directed away from negative charges

(b) They are directed into positive charges

(c) They never cross each other

(d) Both answers (a) and (b)

(e) None of these

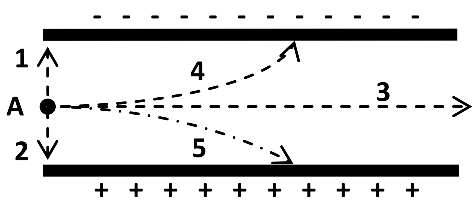


Fig. 1

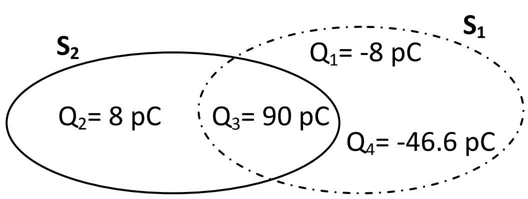


Fig. 2

Physical quantity	Value	Physical quantity	Value
Charge of electron	$\lvert e\rvert = 1.6\times10^{-19}$ C	Charge of proton	$e = 1.6\times10^{-19}$ C
Mass of electron	$m_e=9.11\times10^{-31}$ kg	Mass of proton	$m_p=1.67\times10^{-27}$ kg
Coulomb's constant	$k=9\times10^9$ N.m^2/C^2	Permittivity constant	$\varepsilon_o=8.85\times10^{-12}$ C^2/(N.m^2)

Summar 2011 – Exam I

① $F = \dfrac{k q_1 q_2}{r^2} \Rightarrow q_2 = F \cdot r^2 / k q_1$ $\quad q_1 = q \;,\; q_2 = nq$

$$nq = \frac{Fr^2}{kq} \Rightarrow n = \frac{Fr^2}{kq^2} = \frac{30 \times (0.15)^2}{9\times10^{9} \times (5\times10^{-6})^2} = 3$$

② $$\frac{ke^2}{r^2} = m_e g \Rightarrow r = \sqrt{\frac{ke^2}{m_e g}} = \sqrt{\frac{9\times10^{9} \times (1.6\times10^{-19})^2}{9.11\times10^{-31} \times 9.8}} = 5.1\ m$$

③ $$q = ne = it \Rightarrow n = \frac{it}{e} = \frac{1\times10^{-3} \times 32}{1.6\times10^{-19}} = 2\times10^{17}$$

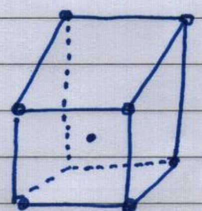
④ $$F = \frac{k q_1 q_2}{r^2} \Rightarrow q_2 = \frac{F r^2}{k q_1} = \frac{36 \times (0.1)^2}{9\times10^{9} \times 5\times10^{-6}} = 8\ \mu C$$

لكن القوة بين الشحنتين تجاذبية Attractive ، يعني أن اشارتهما مختلفة

$$q_2 = -\ 8\ \mu C$$

⑤

$F = 0$



بما أن الشحنات في الاركان متساوية ، يعني أن كل شحنه راح تنفر الشحنه المتوسطة بنفس القوة ، و تصير محصلة القوى صفر

⑥ $$E = \frac{kQ}{r^2} \Rightarrow Q = \frac{Er^2}{K} = \frac{18 \times (2)^2}{9\times10^{9}} = 8\ nC$$

وحيث أن المجال خارج من الشحنه outward فيعني أن الشحنه موجبة

⑦ حتى يتزن الجسم ، لابد من وجود قوتين متساويتين في المقدار ومتعاكستين في الاتجاه ، وحيث أن وزن الجسم يكون للأسفل فلابد أن تكون القوة الكهربية للأعلى . وحيث أن المجال موجب ، فلابد أن تكون **الشحنه سالبة**

$$qE = mg \Rightarrow q = -\frac{mg}{E} = -\frac{2\times10^{-3} \times 9.8}{19.6\times10^{3}} = -1\ \mu C$$

(8) $F = ma$ where $v^2 = v_0^2 + 2ax \Rightarrow a = \dfrac{v^2 - v_0^2}{2x}$

$$a = \frac{(3\times10^{5})^2 - (0)^2}{2(0.02)} = 2.25\times10^{12}\ m/s^2$$

$$F = ma = eE \Rightarrow E = \frac{ma}{e} = \frac{9.11\times10^{-31}\times 2.25\times10^{12}}{1.6\times10^{-19}} = 12.8\ N/C$$

(9) بما أن الجسم متعادل neutral فيعني أن شحنته صفر وبالتالي لا يتأثر بأي مجال ويستمر في خط مستقيم (3)

(10) $\tau_{max} = PE \Rightarrow P = \dfrac{\tau_{max}}{E} = \dfrac{1.8\times10^{-6}}{300} = 6\times10^{-9}\ C.m$

وكذلك

$$P = Qd \Rightarrow d = \frac{P}{Q} = \frac{6\times10^{-9}}{2\times10^{-6}} = 3\ mm$$

(11) $\Phi = \dfrac{q_{enc}}{\epsilon_0} = \dfrac{-8\times10^{-12} - 46.6\times10^{-12} + 90\times10^{-12}}{8.85\times10^{-12}} = 4\ N.m^2/C$

(12) المجال خارج الكرة يساوي

$$E = \frac{kq}{r^2} \Rightarrow q = \frac{Er^2}{k} = \frac{1800\times(0.22)^2}{9\times10^9} = 9.68\times10^{-9}\ C$$

وبما أن المجال خارج من الكرة فالشحنة موجبة، وتصبح قيمة الشحنة السطحية حاصل قسمة الشحنة على مساحة سطح الكرة

$$\sigma = \frac{q}{A} = \frac{q}{4\pi R^2} = \frac{9.68\times10^{-9}}{4\pi\times(0.1)^2} = 77\ nC/m^2$$

(13) $E = \dfrac{kQ}{r^2} = \dfrac{k(\lambda L + q)}{r^2} = \dfrac{9\times10^{9}\times(8\times10^{-9}\times2\times10^{-3} + 4\times10^{-12})}{(4\times10^{-3})^2}$

$E = 11.25\ kN/C$

(14) $E_1 = \dfrac{\lambda}{2\pi\epsilon_0 r_1} \Rightarrow \lambda = (2\pi\epsilon_0)E_1 r_1$, $E_2 = \dfrac{\lambda}{2\pi\epsilon_0 r_2} = \dfrac{(2\pi\epsilon_0)E_1 r_1}{2\pi\epsilon_0 r_2}$

$$E_2 = E_1\left(\frac{r_1}{r_2}\right) = 20\left(\frac{2}{5}\right) = 8\ N/C$$

(15) تتميز خطوط المجال بأنها لا تتقاطع أبداً — الإجابة (c)