Physics Department
The University of Jordan

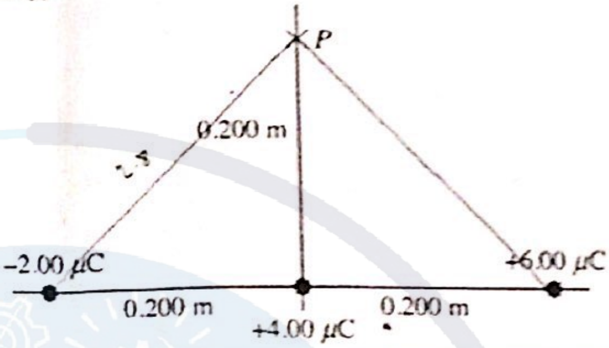
Physics 102
First Exam

2^{nd} Semester 2017/2018
12/03/2018

Student Name:.	**Section Number:......**
Student ID No.: :..	**Instructor: Dr. ....**
Information: $g = 9.8\ m/s^2$, $k = 1/4\pi\varepsilon_0 = 9\times10^9\ N\cdot m^2/C^2$, $\varepsilon_0 = 8.85\times10^{-12}\ C^2/N\cdot m^2$	

1) Three point charges of -2.00 µC, +4.00 µC, and +6.00 µC are placed along the *x*-axis as shown in the figure. What is the electric potential at point *P* (relative to infinity) due to these charges?

A) +307 kV
B) -307 kV
C) -154 kV
D) +154 kV
E) 0 kV



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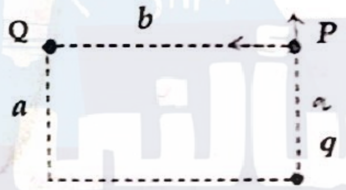
2) If a = 60 cm, b = 80 cm, Q = -4 *nC*, and q = 1.5 *nC*, what is the magnitude of the electric field at point *P* ?

A) 72 N/C
B) 68 N/C
C) 77 N/C
D) 82 N/C
E) 0 N/C



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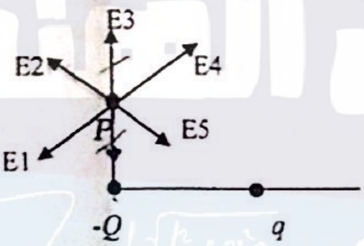
3) Which of the electric field vectors could represent the electric field at point P due to the charges (-*Q*) and (*q*)?

A) E2
B) E3
C) E1
D) E4
E) E5



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4) If the potential in a certain region is given by $V = x^2y + xy^2$, where *x and y*, are measured in meters and *V* is in volts. Find the magnitude of the electric force on a 2.0*C* charge located at the position (*x,y*) = (2 , -3).

A) 34.2 N
B) 25.6 N
C) 17.1 N
D) 8.5 N
E) 0

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5) A uniform linear charge density of $4nC/m$ is distributed along the entire x-axis. Determine the electric flux through a spherical surface (r = 5 cm) centered at the origin.

A) 36
B) 45
C) 54
D) 63
E) 13

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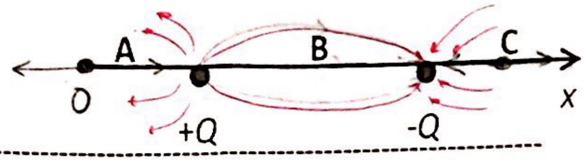
6) A conducting sphere of radius 20.0 cm carries a net charge of +15.0 µC. The electric potential (relative to infinity) at a point 12.0 cm from its center is:

A) 0
B) 675 kV
C) 1125 kV
D) 3380 kV
E) 9380 kV

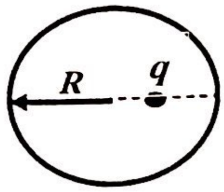
7) Two charges, of equal magnitude and opposite sign ($+Q$ and $-Q$), are placed on the x-axis as shown. In which of the three regions, **A**, **B**, and **C**, on the x-axis can the electric field be zero?

A) Region **A** B) Region **B** C) Region **C**
D) Regions **A** and **C** E) No regions



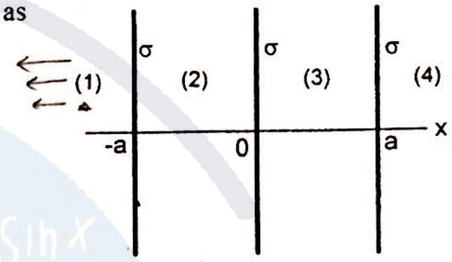
8) A charge q of 1.0×10^{-12} C is located inside a sphere, $R/2$ from its center. What is the electric flux (Φ_E) in ($N \cdot m^2/C$) through the sphere due to this charge?

A) 0.23 B) 8.9 C) 0.023π
D) 0.11 E) The electric flux cannot be determined



9) Three infinite parallel plates carry equal uniform charge densities σ as shown in the figure. The electric field $\vec{E}$ in region (1) is:

A) $-\frac{3\sigma}{2\varepsilon_0}\hat{i}$ B) $-\frac{\sigma}{2\varepsilon_0}\hat{i}$ C) zero D) $\frac{\sigma}{2\varepsilon_0}\hat{i}$ E) $\frac{3\sigma}{2\varepsilon_0}\hat{i}$

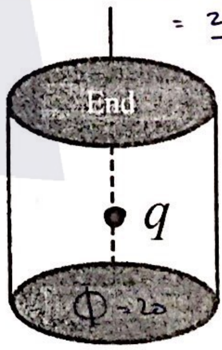


10) Two equal charges Q are separated by a distance d. One of the charges is released and moves away from the other due to the force between them. When the moving charge is a distance $3d$ from the other charge, its kinetic energy is:

A) $\frac{k_eQ^2}{3d}$ B) $\frac{k_eQ^2}{2d}$ C) $\frac{k_eQ^2}{4d}$ D) $\frac{3k_eQ^2}{4d}$ E) $\frac{2k_eQ^2}{3d}$

11) The figure shows a point charge (q) located at the center of a cylinder. If the electric flux leaving one end of the cylinder is 20% of the total flux leaving the cylinder, the portion (جزء) of the flux that leaves the curved surface of the cylinder is:

A) 90% B) 70% C) 85% D) 60% E) 80%



12) A uniform linear charge of 2.0 nC/m is distributed along the x axis from x = 0 to x= 3 m. Which of the following integrals is correct for the magnitude of the y- **component** of the electric field at y = 2 m on the y axis?

A) $\int_0^3 \frac{18x\,dx}{(x^2+4)^{3/2}}$ B) $\int_0^3 \frac{36\,dx}{(x^2+4)^{1/2}}$ C) $\int_0^3 \frac{18x\,dx}{(x^2+4)^{1/2}}$ D) 0 E) $\int_0^3 \frac{36\,dx}{(x^2+4)^{3/2}}$

List your final answers in this table. Only the answer in this table will be graded.

Question	Q1:	Q2:	Q3:	Q4:	Q5:	Q6:	Q7:	Q8:	Q9:	Q10:	Q11:	Q12:
Final Answer	A	C	A	C	B	B	D	D	A	B	E	E
		B	C				E			E	D	

The University of Jordan
School of Science
Department of Physics

2nd Summer Semester 2017
General Physics-2
First Exam, August 9, 2017

Name (In Arabic) :
Student Number :

Instructor : د. علاء حسونة
Section : 3

$k = 1/4\pi\varepsilon_0 = 9 \times 10^9$ N.m²/C²; $\varepsilon_0 = 8.85 \times 10^{-12}$ C²/N.m²; $e = 1.6 \times 10^{-19}$ C; $g = 9.8$ m/s²

Write the letter corresponding to the correct answer in the table

1) The magnitude of the electric field (in N/C) at a point that is 3.0 m away from a 1.0 μC point charge is

a) 230 b) 2300 c) 2000 d) 1000 e) 4600

2) Two point charges, 1.5 μC and 1.0 μC, are separated by 1 cm. The magnitude of the force (in N) exerted by one charge on the other is

a) 135 b) 315 c) 225 d) 405 e) 495

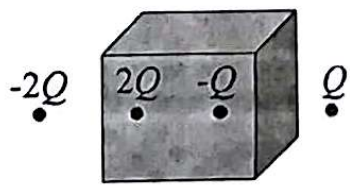
3) The magnitude of the acceleration (in m/s²) of a proton ($m = 1.67 \times 10^{-27}$ kg) in a uniform electric field of magnitude 4×10^4 N/C is

a) 1.9×10^{12} b) 3.8×10^{12} c) 2.9×10^{12} d) 6.7×10^{12} e) 5.7×10^{12}

4) The local surface charge density at a point on the surface of an arbitrarily shaped conductor is 3 nC/m². The magnitude of the electric field at that point (in N/C) is

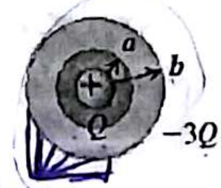
a) 113 b) 452 c) 678 d) 340 e) 1130

5) The figure shows a closed cubical surface with the charges $2Q$ and $-Q$ inside the cube and the charges $-2Q$ and Q outside the cube. If $Q = 3$ nC the net electric flux (in N.m²/C) through the surface of the cube is



a) 282 b) 0 c) 678 d) 339 e) 565

6) A conducting spherical shell with inner radius a and outer radius b has a positive point charge Q located at its center. The total charge on the shell is $-3Q$, and it is insulated from its surroundings. The surface charge density on the inner surface of the conducting shell is

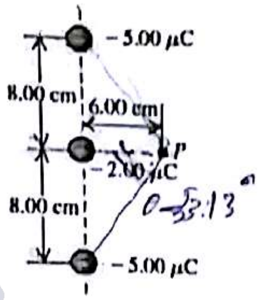


a) $\dfrac{-3Q}{4\pi a^2}$ b) $\dfrac{-3Q}{4\pi b^2}$ c) $\dfrac{-Q}{2\pi b^2}$ d) $\dfrac{3Q}{4\pi a^2}$ e) $\dfrac{-Q}{4\pi a^2}$

7) The electric field at a distance of 0.145 m from the surface of a solid insulating sphere with radius 0.355 m is 1750 N/C. Assuming the sphere's charge is uniformly distributed, the electric field (in N/C) inside the sphere at a distance of 0.100 m from the center is

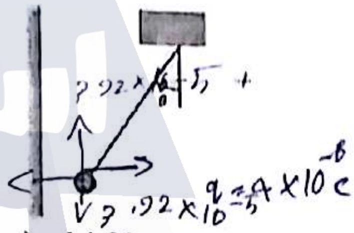
a) 0 b) 1750 c) 2940 d) 1960 e) 980

8) Three negative point charges lie along a line as shown in the figure. The magnitude of the electric field (in N/C) this combination of charges produces at point P, which lies 6.00 cm from the -2.00μC charge measured perpendicular to the line connecting the three charges is



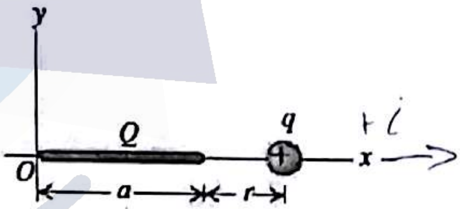
a) 1.0×10^{5} b) 2.0×10^{7} c) 0.5×10^{7}
d) 2.4×10^{5} e) 1.0×10^{7} [redacted]

9) A small sphere with mass 4.00×10^{-6} kg and charge 4.00×10^{-8} C hangs from a thread near a very large, charged insulating sheet. The charge density on the surface of the sheet is uniform and equal to -2.50×10^{-9} C/m2. The angle of the thread is



a) 8.2° b) 12.2° c) 10.2° d) 9.2° e) 14.2°

10) Positive charge Q is distributed uniformly along the x-axis from $x = 0$ to $x = a$. A positive point charge q is located on the positive x-axis at $x = a + r$, a distance $r=a/2$ to the right of the end of Q. The force (magnitude and direction) that the charge distribution Q exerts on q is



a) $\frac{qQ}{3\pi\varepsilon_0 a^2}(-\hat{i})$ b) $\frac{qQ}{3\pi\varepsilon_0 a^2}\hat{i}$ c) $\frac{4qQ}{5\pi\varepsilon_0 a^2}(-\hat{i})$ d) $\frac{4qQ}{5\pi\varepsilon_0 a^2}\hat{i}$ e) $\frac{qQ}{4\pi\varepsilon_0 a^2}\hat{i}$

Q	1	2	3	4	5	6	7	8	9	10
Answer	d	a	b	d	d	d	e	e	e	e

20/20 Excellent

The University of Jordan / Department of Physics
Second Semester 2016/2017
Physics 102/ First Exam

Section number : 7
Lecturer name : د. حنان سعادة

Student name (بالعربية) :
Student number :

Notes: **Turn off your cell phone** and put it out of sight. Keep your calculator on your own desk. Calculators cannot be shared. You have sixty **(60) minutes** to complete your exam.
Be sure to **fill the box** below with your final answers before the end of the exam.

> ❖ Some helpful information:
> p (pico) = 10^{-12}; n (nano) = 10^{-9}; μ (micro) = 10^{-6}; $k_e = 9 \times 10^9$ N.m²/C²; $\varepsilon_0 = 8.85 \times 10^{-12}$ C²/N.m²;
> g = 9.8 m/s²

1	2	3	4	5	6	7	8	9	10
A	E	C	C	B	B	E	D	D	A

10

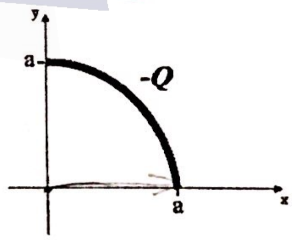
1. A solid conducting sphere has net positive charge and radius R = 0.3 m. At a point 1.2 m from the center of the sphere, the electric potential due to the charge on the sphere is 24 V. Assuming that V = 0 at an infinite distance from the sphere, what is the electric potential (in V) at the center of the sphere?

A) 96 B) 47 C) 39 D) 36 E) 72

2. A small object with electric dipole moment $\mathbf{p} = (2 \times 10^{-3}\ \mathbf{i} + 4 \times 10^{-3}\ \mathbf{j})$ C.m is placed in a uniform electric field $\mathbf{E} = (-7.8 \times 10^{+3}\ \mathbf{i} + 4.9 \times 10^{+3}\ \mathbf{j})$ N/C. The torque acting on this object (in N.m) is:

A) -19.7 **k** B) +30.3 **k** C) -30.3 **k** D) -41 **k** E) +41 **k**

3. Negative charge $-Q$ is distributed uniformly around a quarter-circle of radius a that lies in the first quadrant (الربع الأول) with the center of curvature at the origin, the x-component of the electric field at the origin is:



A) $Q/(4\pi\varepsilon_0 a^2)$ B) $Q/(8\pi^2\varepsilon_0 a^2)$ C) $Q/(2\pi^2\varepsilon_0 a^2)$
D) $Q/(8\varepsilon_0 a^2)$ E) $Q/(4\pi^2\varepsilon_0 a^2)$

4. A point charge q_1 = 4.15 nC is located on the x-axis at x = 1.15 m, and a second point charge q_2 = -6.15 nC is on the y-axis at y = 1.8 m. What is the total electric flux (in N.m²/C) due to these two point charges through a spherical surface centered at the origin with radius 1.4 m?

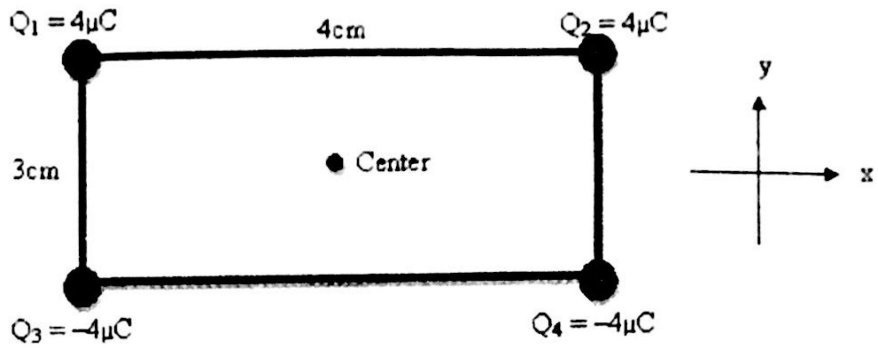
A) -8.12×10^{-2} B) -6.95×10^{2} C) 4.69×10^{2} D) -2.25×10^{2} E) 7.91×10^{-2}

5. Over a certain region of space, the electric potential is V = $-5x-3xy-2yz$ (in V). The x-component of the electric field (in V/m) at the point P that has the coordinates (1, -1, 30) m is:

A) -2 B) 2 C) -5 D) 5 E) 0

6. Consider the following assembly of charges.
· How much work (in J) do you need to bring a charge of 9.3 nC from far away to the center?

A) 10 B) 0
C) 30 D) 45.5
E) 125

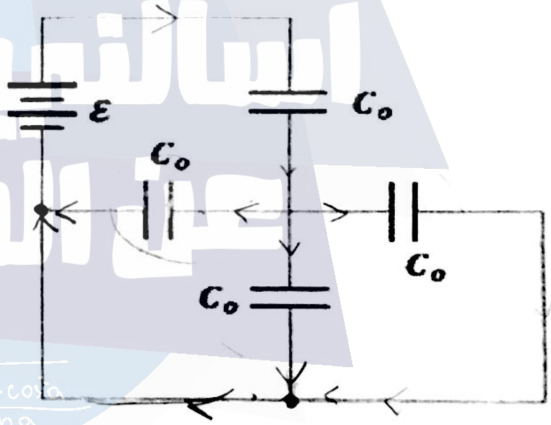


7. A small metal ball of mass 4 grams is charged with -10 μC. A constant uniform electric field is generated in order to suspend (يعلق) the ball in air. What is the minimum field required to achieve this suspension (in N/C)?

A) 3050 (+j) B) 2940 (+j) C) 3920 (+j) D) 2940 (-j) E) 3920 (-j)

8. What is the equivalent capacitance C_{eq} of this circuit (in terms of C_0)?

A) $C_{eq} = 4\ C_0$
B) $C_{eq} = 4\ C_0 / 3$
C) $C_{eq} = C_0 / 4$
D) $C_{eq} = 3C_0 / 4$
E) $C_{eq} = C_0$



9. Consider a parallel plate capacitor in a free space. The electric field between the plates is 3.6×10^5 V/m. When the space between the plates is completely filled with dielectric material, the electric field becomes 2.5×10^5 V/m. What is the value of the dielectric constant?

A) 2.5 B) 3.0 C) 1.32 D) 1.44 E) 4.1

10. A solid nonconducting sphere of radius 12 cm has a charge of uniform density (19 nC/m³) distributed throughout its volume. The magnitude of the electric field (in N/C) 15 cm from the center of the sphere is:

A) 55 B) 20 C) 66 D) 78 E) 49

The end of the exam

50+ Years of Excellence

الجامعة الأردنية
THE UNIVERSITY OF JORDAN

THE UNIVERSITY OF JORDAN
PYSICS DEPARTMENT
GENERAL PHYSICS II (0302102) / FIRST EXAM / MARCH 16th 2016
SECOND SEMESTER 2015/2016

اسم الطالب : الرقم الجامعي:
اسم المدرس: KEY رقم الشعبة :

Q1	D	Q2	B	Q3	E	Q4	A	Q5	C
Q6	A	Q7	D	Q8	A	Q9	B	Q10	B

ANSWER ALL THE FOLLOWING QUESTIONS

ε_o= 8.85x10^{-12} C^2/Nm^2, k_e = 9x10^9 Nm^2/C^2, g = 10 m/s^2, μC = 10^{-6}C, nC = 10^{-9}C, pC = 10^{-12}C

Q1. Three charged particles lie on a straight line as shown below. Charges q_1 and q_2 are held fixed and charge q_3 is free to move. If q_3 is in equilibrium (no net electrostatic force acts on it), then q_1 in terms of q_2 (in magnitude) is:

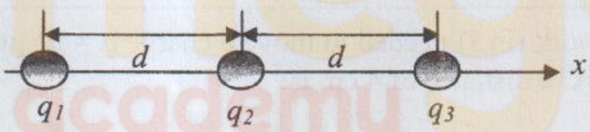
(a) $q_1 = 2\, q_2$

(b) $q_1 = 1/2\, q_2$

(c) $q_1 = 1/4\, q_2$

(d) $q_1 = 4\, q_2$

(e) $q_1 = q_2$



Q2. A charge of + 6 nC is placed on the x-axis at x = 3 m. A second charge of − 8 nC is placed on the y-axis at y = 2 m. The resulting electric field (in N/C) at the origin is:

(a) $\vec{E} = 6\hat{i} + 18\hat{j}$ (b) $\vec{E} = -6\hat{i} + 18\hat{j}$ (c) $\vec{E} = -6\hat{i} - 18\hat{j}$

(d) $\vec{E} = 6\hat{i} - 18\hat{j}$ (e) $\vec{E} = 18\hat{i} + 6\hat{j}$

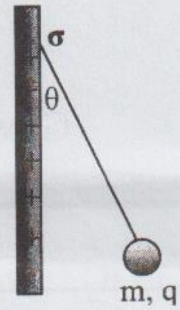
Q3. A particle with a mass of 1×10^{-8} kg and a charge of 3 μC is released from rest in a uniform electric field E = 200 N/C. The speed (in m/s) of this particle 6 s after being released is:

(a) 1.2×10^5 (b) 1.8×10^5 (c) 2.4×10^5 (d) 3×10^5 (e) 3.6×10^5

Q4. A uniform electric field $\vec{E} = 3\hat{i} + 5\hat{j} + 6\hat{k}$ N/C intersects a surface of area 2 m^2. The flux (in N . m^2/C) through this area if the surface lies in the yz-plane is:

(a) 6 (b) 10 (c) 12 (d) 18 (e) 30

Q5. A small non-conducting ball of mass m = 1.0 mg and charge q = 10 nC hangs from an insulating thread (حبل خفيف) that makes an angle θ = 30° with a vertical uniformly charged non-conducting sheet. Considering the gravitational force on the ball and assuming that the sheet extends far vertically, the surface charge density σ (in nC/ m²) of the sheet is:



(*a*) 4.1 (b) 5.1 (c) 10.2
(d) 6.8 (e) 3.4

Q6. An insulating solid sphere of radius 20 cm carries a uniform volume charge density ρ = 35 nC/m³. The electric field (in N/C) at 10 cm away from its center is:

(*a*) 131.8 (b) 169.6 (c) 113 (d) 188.3 (e) 150.7

Q7. A charge q_1 = 70 nC lies on the x-axis at x = − 3 m. At what distance (in m) on the x-axis one must put a second charge q_2 = − 20 nC to make the electric potential (relative to infinity) at the origin equals 100 V?

(*a*) x = 1.06 (b) x = 1.20 (c) x = 2 (d) x = 1.64 (e) x =1.38

Q8. The work (in J) needed to move a charge q = 10 μC in a uniform electric field of strength 4 × 10⁶ N/C a distance of 4 cm is:

(*a*) 1.6 (b) 2 (c) 2.4 (d) 2.8 (e) 3.2

Q9. Three equal positive charges (each of charge Q) are at the corners of an equilateral triangle (مثلث متساوي الأضلاع) of side a, the potential energy stored in this system is:

(*a*) $3k_eQ^2/a^2$
(b) $3k_eQ^2/a$
(c) k_eQ^2/a
(d) $2k_eQ^2/a$
(e) $3k_eQ^2/2a$

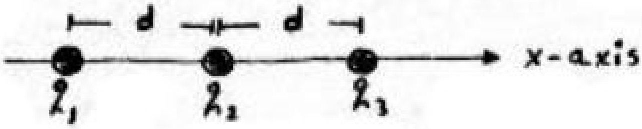
Q10. A charge Q is distributed uniformly on a ring of radius 10 cm. If the electric potential (relative to infinity) at the center of this ring is 180 V, then the magnitude of Q (in nC) is:

(*a*) 1.5 (b) 2 (c) 2.5 (d) 3 (e) 3.5

Solution

كل الشكر للطالب
صفوان العقيلي
على حل الاسئله

Q.1 :-



at q_3 → "equilibrium point" نقطة التعادل

↳ $\sum F = 0$

$\Rightarrow F_1 = F_2$ (acts on q_3)

$\cancel{q_3} E_1 = \cancel{q_3} E_2 \rightarrow \cancel{K_e} \frac{q_1}{(2d)^2} = K_e \frac{q_2}{d^2}$

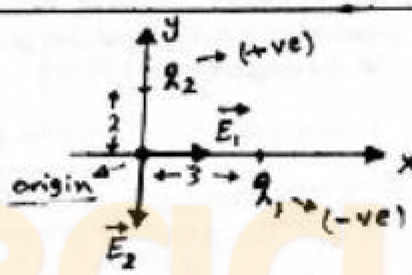
$\frac{q_1}{4\cancel{d^2}} = \frac{q_2}{\cancel{d^2}} \rightarrow \boxed{q_1 = 4 q_2}$

(a) ✓

Q.2 :- $q_1 = -6 * 10^{-9}$ C , $x = 3$m

$q_2 = +8 * 10^{-9}$ C , $y = 2$m ⇒

$\vec{E}_{net}$ at the origin ??



الإتجاه من الشكل

$\Rightarrow \vec{E}_{net} = \vec{E}_1 + \vec{E}_2$

$* \; E_1 = K_e \frac{q_1}{(3)^2} = \frac{9*10^{9} (6*10^{-9})}{9} = 6 \rightarrow \vec{E}_1 = 6(+\hat{i})$

$* \; E_2 = K_e \frac{q_1}{(2)^2} = \frac{9*10^{9} (8*10^{-9})}{4} = 18 \rightarrow \vec{E}_2 = 18(-\hat{j})$

$\therefore \boxed{\vec{E}_{net} = 6\hat{i} - 18\hat{j}}$ (d)

Q.3 :- $m = 1*10^{-8}$ kg ; $q = 3*10^{-6}$C ; from rest → $V_0 = 0$

$E = 200$ N/C → find v_f after $t = 3$s

$\Rightarrow v_f = \cancel{v_0}^{0} + at = at \rightarrow a = \frac{qE}{m} = \dots = 6*10^4 \; m/s^2$

$\therefore V_f = (6*10^4)*3 = 18*10^4$

$= 1.8*10^5$ m/s ✓

(b)

Q.4 :- $\vec{E} = 3\hat{i} + 5\hat{j} + 6\hat{k}$, $A = 3 \; m^2$ (the surface lies in the xy-plane)

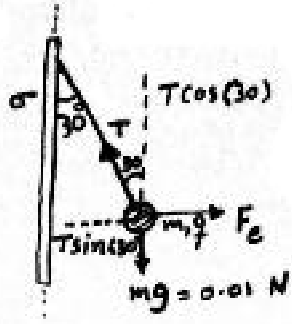
$\therefore \vec{A} = 3\hat{k}$ // ⊥ on the surface

$\Rightarrow \phi_E = \vec{E} \cdot \vec{A} = (3\hat{i} + 5\hat{j} + 6\hat{k}) \cdot (3\hat{k}) = 18$ ✓

(d)

Q.5 :- $T\frac{\sqrt{3}}{2} = mg \rightarrow T = \frac{2}{\sqrt{3}}mg$

$\rightarrow T = 0.011$ ✓



$\Rightarrow F_e = qE = \frac{T}{2} = 5.5 \times 10^{-3}$

$\therefore E = \frac{5.5\times10^{-3}}{25\times10^{-9}} = 0.22\times10^{6} = 22\times10^{4}$ N/C

$E = \frac{\sigma}{2\epsilon_0} = 22\times10^{4} \rightarrow \sigma = 44\epsilon_0\times10^{4}$

$= 3$

Q.6: $E = K_e \frac{Qr}{R^3}$

$= 9\times10^{9} \frac{(60\pi R^3\times10^{-9})(10\times10^{-2})}{R^3}$

$\Rightarrow E = 169.6$ N/C

; $R = 20$ cm (radius)

$r = 10$ cm, $\rho = 45$ nC/m³

$Q = \rho V = \frac{4}{3}\pi R^3(45\times10^{-9})$

$\therefore Q = 60\pi R^3\times10^{-9}$ C

(b)

Q.7 :- $q_1 = 70$ nC ; $x_1 = -3$ m // $q_2 = -20$ nC ; $x_2 = ??$

$V = 120$ (net potential)

$\Rightarrow V_1 + V_2 = 120 \rightarrow K_e\left(\frac{q_1}{x_1} + \frac{q_2}{x_2}\right) = 120 \Rightarrow 9\times10^{9}\left(\frac{70\times10^{-9}}{3} + \frac{-20\times10^{-9}}{x_2}\right) = 120$

.... $\Rightarrow x_2 = 2$ m

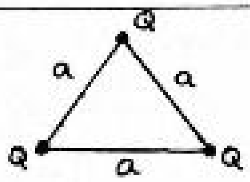
(c)

Q.8 :- $W = q\Delta V$ $\Rightarrow \Delta V = Ed = 4\times10^{6}(8\times10^{-2}) = 32\times10^{4}$ V

$\therefore W = 10\times10^{-6}(32\times10^{4}) = 3.2$ J

(e)

Q.9 :-



$\Rightarrow U = K_e\left(\frac{Q^2}{a} + \frac{Q^2}{a} + \frac{Q^2}{a}\right) = 3K_e\frac{Q^2}{a}$

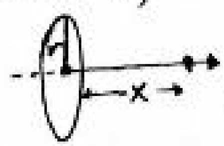
(d)

Q.10 :- ring ⇒ $r = 10$ cm , $V = 270$ V (at the center)

$\Rightarrow Q = \frac{Vr}{K_e} = \frac{270(10\times10^{-2})}{9\times10^{9}}$

$\therefore Q = 3$ nC

(d)



$V = \frac{K_e Q}{\sqrt{r^2 + x^2}}$

* at the center → $x = 0$

$\therefore V = \frac{K_e Q}{r}$

University of Jordan
Faculty of Science
Department of Physics

Second Semester 2014/2015
Date: 18/3/2015
Time: 3:30-4:30

General Physics II (0302102)
First Exam

Name:------Key----------------
Number:-------------------------------
Instructor:----------------------------

Constants: $\varepsilon_o = 8.85\times10^{-12}\ C^2/N.m^2$, $e = 1.602\times10^{-19} C$, $m_e = 9.11\times10^{-31}$ kg, $k_e = 9\times10^9\ N.m^2/C^2$

Answer Sheet

List your final answer in this table. Only the answer in this table will be graded.

Question	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Answer	a	c	d	b	d	b	c	b	e	c

---

1. Three point charges, two positive and one negative, each having a magnitude of 20 μC are placed at the vertices of an equilateral triangle (30 cm on a side). What is the magnitude of the electrostatic force on the negative charge?

   (a) 69 N (b) 39 N (c) 25 N (d) 58 N (e) 85 N

2. Charge of uniform density 4.0 nC/m is distributed along the x axis from $x = -2.0$ m to $x = +3.0$ m. What is the magnitude of the electric field at the point $x = +5.0$ m on the x axis?

   (a) 49 N/C (b) 66 N/C (c) 13 N/C (d) 16 N/C (e) 19 N/C

3. A conducting sphere of radius 10 cm is charged with a total positive charge 100 nC. What is the potential difference between two points, one located 3.0 cm away from the center and the other at the surface?

   (a) 28 V (b) 66 V (c) 57 V (d) 0 V (e) 85 V

4. Over a certain region of space, the electric potential is $V = 2xy - x^2z + z^3y^2$.

What is the magnitude of the electric field at the point P that has coordinates of (1.0, 2.0, -1.0) m?

(a) 49 N/C (b) 13 N/C (c) 19 N/C (d) 66 N/C (e) 22 N/C

5. A charge of uniform volume density (40 nC/m^3) fills a cube with 8.0 cm edges. What is the total electric flux (in units of $N.m^2/C$) through the surface of this cube?

(a) 4.6 (b) 1.1 (c) 5.7 (d) 2.3 (e) 3.5

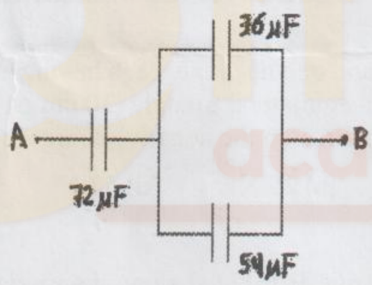
6. A long straight metal rod has a radius of 2.0 mm and a surface charge of density 0.40 nC/m^2. Determine the magnitude of the electric field 3.0 mm from the axis.

(a) 45 N/C (b) 30 N/C (c) 15 N/C (d) 75 N/C (e) 60 N/C

7. The electric field (in N/C) of a point charge q = 8.0 nC at a point located 2.0 m from the charge is:

(a) 27 (b) 72 (c) 18 (d) 36 (e) 68

8. If $V_A - V_B = 50$ V, how much energy is stored in the 54 μF capacitor?



(a) 1.6 mJ (b) 13 mJ (c) 8.9 mJ (d) 19 mJ (e) 23 mJ

9. Which of the following is not a capacitance? (K is the dielectric constant)

(a) $\frac{\varepsilon_0 A}{d}$ (b) $\frac{\kappa\varepsilon_0 A}{d}$ (c) $\frac{ab}{k_e(b-a)}$ (d) $\frac{l}{2k_e \ln(b/a)}$ (e) $\frac{k_e\varepsilon_0 A}{d}$

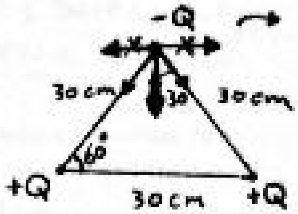
10. How much charge is on each plate of a 4.00 μF capacitor when it is connected to a 12.0 V battery?

(a) 20μC (b) 77μC (c) 48μC (d) 68μC (e) 32μC

Solution

Q.1 :- * equilateral triangle ≡ مثلث متساوي الأضلاع → جميع زواياه $60°$

$Q = 20\ \mu C$



→ متساويان في المقدار ومتعاكسان في الاتجاه

the net force ⇒ $F = F_1 \cos 30 + F_2 \cos 30$

$= 2F \cos 30°$ → $F_1 = F_2$ ⇒ نفس الشحنة نفس المسافة

$= \sqrt{3}\, F$

$$F = K_e \frac{QQ}{r^2} = K_e \frac{Q^2}{r^2} = \frac{9 \times 10^{9} (400 \times 10^{-12})}{900 \times 10^{-4}}$$

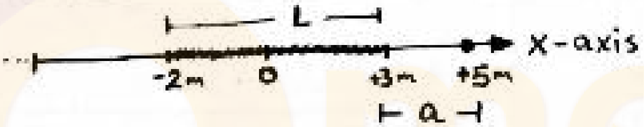
$= 40\ N$

⇒ the net force → $F = \sqrt{3}\,(40)$

$\simeq 69\ N$

كل الشكر للطالب
صفوان العقيلي
على حل الاسئلة

Q.2 :-



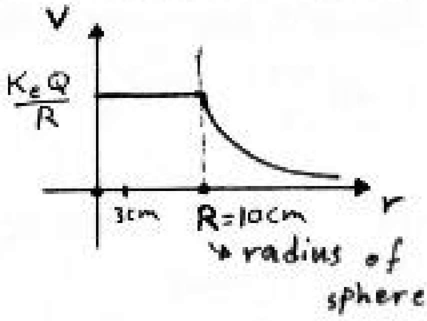
∴ $L = 5\ m$, $a = 2\ m$, $\lambda = 4\ \frac{nC}{m}$

$$E = K_e \frac{Q}{a(L+a)} = K_e \frac{\lambda L}{a(L+a)} = \frac{(9 \times 10^{9})(4 \times 10^{-9})(5)}{2(7)}$$

$= 12.86 \approx 13\ N/C$

Q.3 :- (conducting sphere) →

$R = 10\,cm$



⇒ potential is constant between the center of sphere & its surface

∴ potential difference (ΔV) → Zero

Q.4 :- $V = 2xy - x^2 z + z^3 y^2$, $(1, 2, -1)$ [x, y, z]

* نشتق ثم نعوض النقطة

* $E_x = -\frac{\partial V}{\partial x} = -(2y - 2xz)$ ⇒ $E_x = -6$ ✓
* $E_y = -\frac{\partial V}{\partial y} = -(2x + 2yz^3)$ ⇒ $E_y = 2$ ✓
* $E_z = -\frac{\partial V}{\partial z} = -(-x^2 + 3z^2y^2)$ ⇒ $E_z = -11$ ✓

$$\therefore E = \sqrt{E_x^2 + E_y^2 + E_z^2} = \sqrt{36 + 4 + 121} = \sqrt{161} \approx 13\ N/C$$

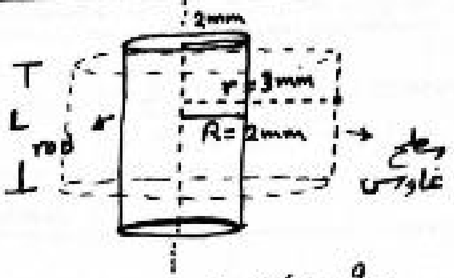
Q.5 :- $\rho = 40\ nC/m^3$

Cube → edge = 8 cm

$\Rightarrow \phi_E = \dfrac{q_{in}}{\epsilon_0}$ / $q_{in} = \rho V = (40\times10^{-9})(8\times10^{-2})^3 = 20.5\times10^{-12}\ C$

$= \dfrac{20.5\times10^{-12}}{8.85\times10^{-12}} = 2.3$

Q.6 :- $R = 2mm$, $\sigma = 0.4\ nC/m^2$
$r = 3mm$



$\therefore E(2\pi r L) = \dfrac{\sigma(2\pi R L)}{\epsilon_0}$

$\Rightarrow \phi_E = \dfrac{q_{in}}{\epsilon_0}$

$E A_G = \dfrac{\sigma A}{\epsilon_0}$ → مساحة سطح rod داخل سطح غاوس

A_G: لمساحة سطح غاوس

$\Rightarrow E = \dfrac{\sigma R}{\epsilon_0 r}$

$\rightarrow E = \dfrac{(0.4\times10^{-9})(2\ mm)}{(8.85\times10^{-12})(3\ mm)}$

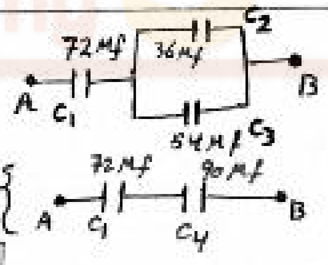
$= 30\ N/C$

Q.7 :- $E = K_e \dfrac{q}{r^2} = 9\times10^9 \dfrac{(8\times10^{-9})}{4} = 18\ N/C$

Q.8 :- $V_1 + V_4 = 50\ V$ —①

$Q_1 = Q_4 \Rightarrow C_1 V_1 = C_4 V_4$ —②

$V_1 = \dfrac{C_4}{C_1} V_4$



$C_4 = C_2 + C_3 = 90\ \mu f$

→ eq'n ①: $\dfrac{C_4}{C_1} V_4 + V_4 = 50$ → $V_4 = 22.22V$

$\Rightarrow V_4 = V_2 = V_3 = 22.22V$ $\Rightarrow U_E = \dfrac{1}{2} C V^2 = \dfrac{1}{2}(54\mu f)(22.22)^2$

$\approx 13\ mJ$

Q.9 :- $[K] \equiv$ dimensionless (بدون وحدة) ; $[C] = \dfrac{C^2}{N.m}$

* $\dfrac{\epsilon_0 A}{d} \rightarrow \dfrac{C^2}{N.m^2}\cdot\dfrac{m^2}{m} = \dfrac{C^2}{N.m}$
* $\dfrac{K\epsilon_0 A}{d} \rightarrow \dfrac{C^2}{N.m}$
* $\dfrac{ab}{K_e(b-a)} \rightarrow \dfrac{C^2}{N.m^2}\cdot\dfrac{m^2}{m}$
* $\dfrac{L}{2K_e \ln(b/a)} \Rightarrow \dfrac{C^2}{N.m^2}\cdot m = \dfrac{C^2}{N.m}$
* $\dfrac{K_e\epsilon_0 A}{d} \rightarrow \dfrac{N.m^2}{C^2}\cdot\dfrac{C^2}{N.m^2}\cdot\dfrac{m^2}{m} = m$

(e)

Q.10 :- $Q = CV = (4\mu f)(12V) = 48\ \mu C$

Physics Department

Physics 102 (1st Exam)

First (Fall) 2013/2014 (November 6th, 2013)

Student's Name (In Arabic): Registration #: 0137007

Instructor's Name: Section: 2 12:30

Useful Information: $|q|$ (≡ Absolute Charge on Electron or Proton) = 1.6×10^{-19} C
m_e (≡ Mass of Electron) = 9.11×10^{-31} kg
m_p (≡ Mass of Proton) = 1.67×10^{-27} kg
k_e (≡ Coulomb's Constant) = 9×10^9 N.m²/C²
ε_0 (≡ Permittivity of free space) = 8.85×10^{-12} C² / N.m²
Some of the results are rounded.

Place your answer in the following Table:

Q.#	1	2	3	4	5	6	7	8	9	10	Bonus
Answer	d	d	a	b	d	a	a	b	d	d	c

1. The work that must be done to charge a spherical shell of radius R to a total charge Q is:

a) kQ/R b) kQ^2/R c) kQ/R^2
d) $kQ/2R^2$ e) $kQ^2/2R$

2. A large flat horizontal sheet of charge has a charge per unit area of 9.00 μC/m². The electric field (in kN/C) just above the middle of the sheet is:

a) 805 b) 580 c) 254
d) 508 e) 850

3. A pyramid with horizontal square base, 6.00 m on each side, and a height of 4.00 m is placed in a vertical electric field of 52.0 N/C. The total electric flux (in kN . m²/C) through the pyramid's four slanted surfaces is:

a) 0.83 b) 1.25 c) 1.87
d) 4.99 e) 7.49

4. Three identical charges q are at the vertices of an equilateral triangle of side a. the total electrostatic potential energy stored in the system is

a) $6kq^2/a$ b) $3kq^2/a$ c) $2kq^2/a$
d) kq^2/a e) Zero

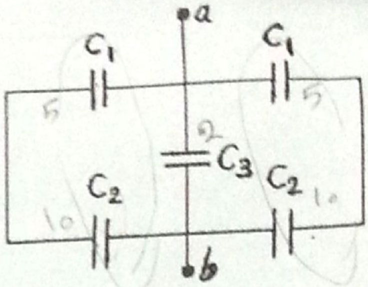
5. The following is not a capacitance: (Note: k_e is Coulomb's constant)

a) $k_e \varepsilon_0 A / d$ b) $\varepsilon_0 A / d$ c) $4\pi\varepsilon_0 a$
d) $\ell / 2 k_e \ln(b/a)$ e) $ab / k_e(b-a)$

6. When a potential difference of 150 V is applied to the plates of a parallel plate capacitor, the plates carry a surface charge density of 30.0 nC/cm². The spacing between the plates (in µm) is:

a) 4.42 b) 2.34 c) 1.11
d) 1.34 e) 3.42

7. The equivalent capacitance (in μF) between points a and b for the group of capacitors connected as shown. Let $C_1 = 5.00\ \mu F$, $C_2 = 10.0\ \mu F$, and $C_3 = 2.00\ \mu F$.



a) 9.50
b) 0.12
c) 8.67
d) 32.0
e) 4.29

---

8. A spherical conductor has a radius of 14.0 cm and charge of 26.0 μC. The electric potential (in MV) at r = 10.0 cm from the center is:

a) 0.84
b) 1.67
c) Zero
d) 2.34
e) 1.95

---

9. Points A [at (2, 3) m] and B [at (5, 7) m] are in a region where the electric field is uniform and given by **E** = (4**i** + 3**j**) N/C. The potential difference $V_A - V_B$ (volts) is:

a) 33
b) 27
c) 30
d) 24
e) 11

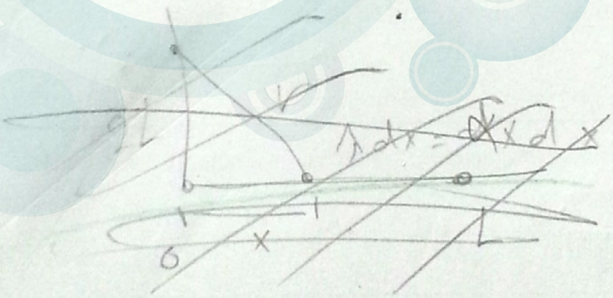
---

10. A non-conducting sphere of radius 10 cm is charged uniformly with a density of 100 nC/m^3. The magnitude of the potential difference (in volts) between the center and a point 4.0 cm away is:

a) 12
b) 6.8
c) 3.0
d) 4.7
e) 2.2

Bonus. A non-uniform linear charge distribution given by $\lambda(x) = a\,x$, where "a" is a constant, is distributed along the x axis from $x = 0$ to $x = +L$. If a = 40 nC / m^2 and L = 0.20 m, the electric potential (in volts) (relative to a potential of zero at infinity) at the point $y = 2L$ on the y axis is:

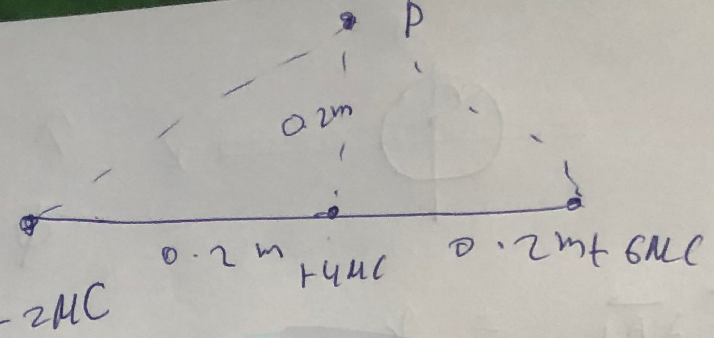
a) 19
b) 17
c) 21
d) 23
e) 14



$$dV = \frac{\alpha x\, dx}{4\pi\epsilon_0 \sqrt{4L^2 + x^2}}$$

$$V = \frac{\alpha}{4\pi\epsilon_0} \int_0^L \frac{x\, dx}{\sqrt{4L^2 + x^2}}$$

1)



$V = ??$

$$V = k\sum \frac{q_i}{r_i} = k\left[\frac{-2\times10^{-6}}{\left(\frac{\sqrt{2}}{5}\right)} + \frac{6\times10^{-6}}{\left(\frac{\sqrt{2}}{5}\right)} + \frac{4\times10^{-6}}{0.2}\right)$$

$\boxed{V = 307.3\ KV}$

---

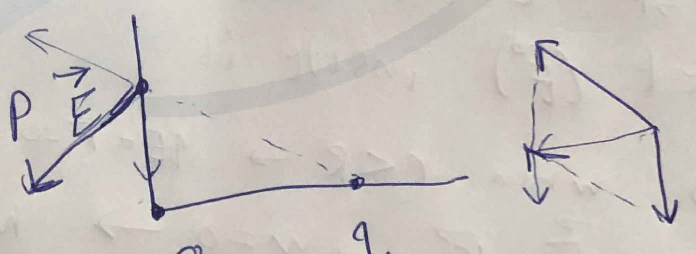
2) $$\vec{E} = \frac{-kq}{b^2}\hat{i} + \frac{kq}{a^2}\hat{j}$$

$$\Rightarrow \vec{E} = \left(-56.25\hat{i} + 37.5\hat{j}\right) N/C$$

$$\rightarrow |\vec{E}| = 67.6 \approx 68\ N/C$$

---

3) E_1 ⓒ



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4) $V = x^2y + xy^2$ $F = ??$ $q = 2$ ~~μ~~C ~~$(x,y) = (2,3)$~~

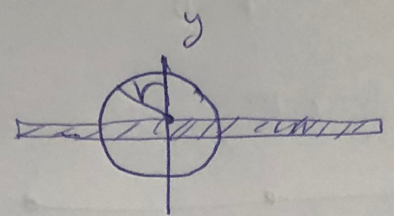
$\boxed{q = 2\ C}$ $(x,y) = (2,-3)$

$$E_x = -\frac{\partial V}{\partial x} = -(2xy + y^2),\quad E_y = -(x^2 + 2xy),\quad E = \sqrt{E_x^2 + E_y^2}$$

E_x: $\downarrow$ 3 ; E_y: ~~16 N/C~~ $\rightarrow 8$; E: $\downarrow 8.54$ ~~26.4~~ $\frac{N}{C}$

$\boxed{F = qE = 17.1 N}$

5)

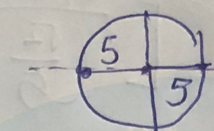


$\lambda = +4\,nC/m$

$\Phi = ??$ $\quad r = 5cm$

$\oint \vec{E} \cdot d\vec{A}\perp = \frac{q}{\varepsilon_0} \rightarrow EA = \frac{q}{\varepsilon_0} \rightarrow \Phi = \frac{q}{\varepsilon_0}$

$q = \lambda L \rightarrow$



$L = 2r = 10cm$

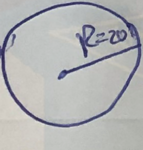
$q = 4\frac{nC}{m} * (5+5)\,cm$

$q = 4 \times 10^{-9} \, (10 \times 10^{-2}) = 4 \times 10^{-10}\,C$

$\rightarrow \boxed{\Phi = \frac{q}{\varepsilon_0} = 45.2 \frac{Nm^2}{C}}$

---

6) in a conducting sphere the net $(\vec{E})$ inside it



conducting sphere $R = 20cm$

$q = +15\,\mu C$

$r = 12cm$

$E = 0$ when $r < R \rightarrow qE = F = 0$

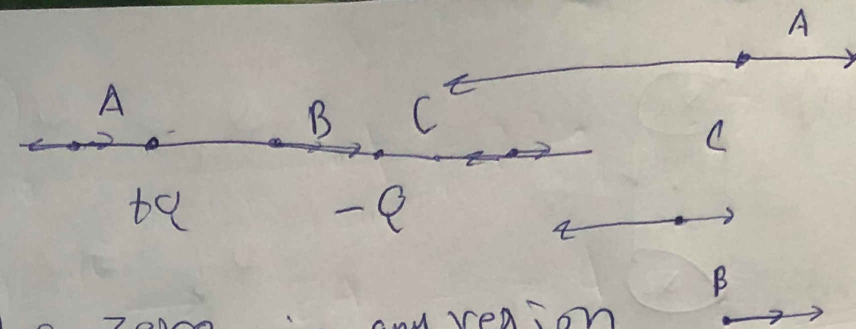
$\rightarrow w = \vec{F} \cdot \vec{r} \rightarrow w = 0 \rightarrow w = U \rightarrow U = q\Delta V$

$\rightarrow \Delta V = 0 \rightarrow \Delta V = (V_A - V_B) = 0$ A, B any aribtrary points inside the sphere

$\Rightarrow V_A = V_B \rightarrow V_A = V_{surface}$

$V = \frac{kQ}{R} = 675\,kV$

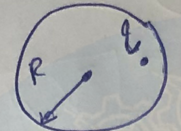
7) No rigons



the Electric Field can't be zero in any region

---

8) $\Phi = \frac{q_{enclosed}}{\varepsilon_0}$



$q = 1\times10^{-12}$ C

$r = R/2$

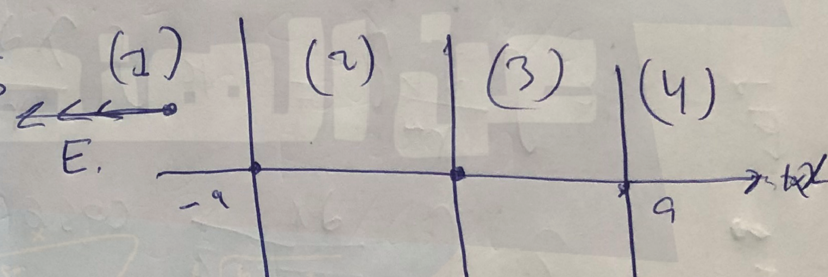
$\Phi = ??$

$$\Phi = \frac{1\times10^{-12}}{8.85\times10^{-12}} = 0.11 \ \frac{N m^2}{C}$$

---

9) $E = -\frac{\sigma_1}{2\varepsilon_0} + \frac{-\sigma_2}{2\varepsilon_0} + \frac{-\sigma_3}{2\varepsilon_0}$

$\sigma_1 = \sigma_2 = \sigma_3 = \sigma$

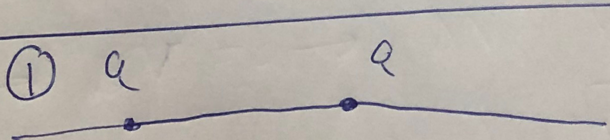


$\rightarrow E = -\left(\frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0}\right)$

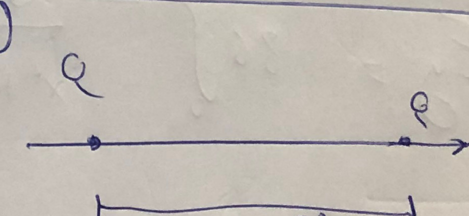
$$E = \frac{-3\sigma}{2\varepsilon_0} \hat{i}$$

---

10)



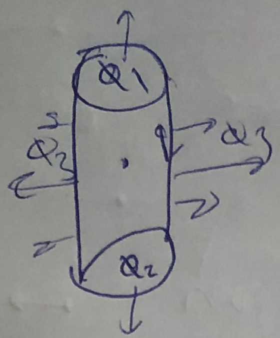
$\rightarrow$



$U_1 + K_1 = U_2 + K_2$ ($K_1 = 0$)

$\frac{KQ^2}{d} = \frac{KQ^2}{3d} + K_2 \rightarrow K_2 = \frac{3KQ^2}{3d} - \frac{KQ^2}{3d} = \frac{2KQ^2}{3d}$

11)



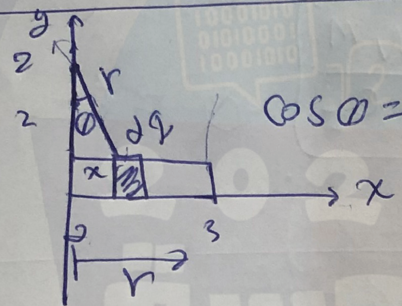
$Q_1 = Q_2 = 20\%$

$Q_3 = 60\%$

$(100\%) - (20\%\ \uparrow) - (20\%\ \downarrow) = 60\%$

---

12)



$\cos\theta = \frac{2}{\sqrt{x^2+4}}$ $\quad r = \sqrt{x^2+4}$

$$\vec{E} = k\int \frac{dq}{r^2}\hat{r} = k\int \frac{\lambda\, dr}{r^2}\hat{r}$$

$$E_y = k\lambda \int \frac{dx}{(\sqrt{x^2+4})^2} \cos\theta$$

$$E_y = k\lambda \int \frac{dx}{(x^2+4)} \frac{2}{\sqrt{x^2+4}} = 9 * 2 * 2 \int_0^3 \frac{dx}{(x^2+4)^{3/2}}$$

$$E_y = 36 \int_0^3 \frac{dx}{(x^2+4)^{3/2}}$$

1) $E = \frac{kq}{r^2} = 1000\ N/C$

---

2) $F = \frac{k q_1 q_2}{r^2} = 1{*}35\ N = 135\ N$

$\boxed{F = 135\ N}$

---

3) $\sum \vec{F} = m\vec{a} \longrightarrow q\vec{E} = m\vec{a} \longrightarrow a = \frac{q\vec{E}}{m}$

$\longrightarrow a = 3.8 \times 10^{12}\ m/s^2$

---

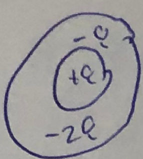
4) $\boxed{E = \frac{\sigma}{\varepsilon_0}}$ any conductor, conducting surface

$\boxed{E = 338.98\ \frac{N}{C} = 340\ \frac{N}{C}}$

5) $\Phi = \frac{q_{net\ enclosed}}{\varepsilon_0} = \frac{(2Q)+(-Q)}{\varepsilon_0}$

$\Phi = \frac{Q}{\varepsilon_0} = 338.98 = 339\ \frac{Nm^2}{C}$

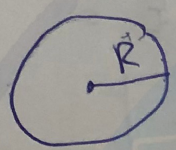
6)



$-3q$

$\sigma = \frac{Q_{inner}}{A_{inner}} = \frac{-q}{4\pi a^2}$

7)



$r = 0.355 + 0.145 = 0.5$

$@\ r = 0.5 \quad E = 1750\ N/C$

$@\ r = 0.1\ m \quad E = ??$

$\oint \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\epsilon_0}$

$\Phi E(4\pi r^2) = \frac{\rho(\frac{4}{3}\pi r^3)}{\epsilon_0} \rightarrow \boxed{E = \frac{\rho r}{3\epsilon_0}}$ @ $r < R$

(2) $E = \frac{kQ}{r^2}$ outside $r > R \rightarrow$ $\boxed{Q = \frac{Er^2}{k} = 4.86 \times 10^{-8}\ C}$ outside

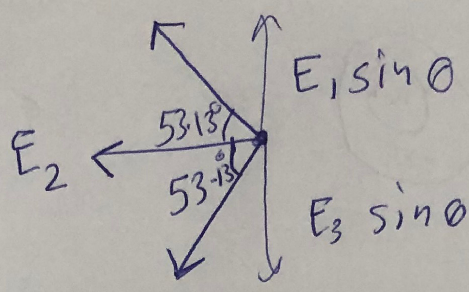
$\rightarrow$ (3) $E = \frac{\rho r}{3\epsilon_0}$ inside

$\rho = \frac{Q}{V} = \frac{Q}{\frac{4}{3}\pi R^3}$

$\rightarrow \boxed{E = 976.78 \approx 980\ \frac{N}{C}}$

$\boxed{\rho = 2.6 \times 10^{-7}\ \frac{C}{m^3}}$

8)



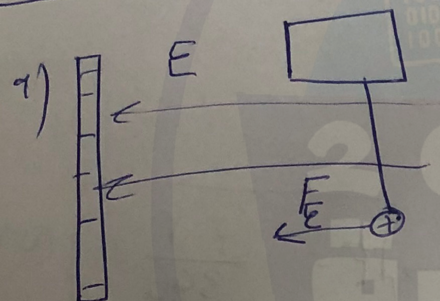
$$E_x = \frac{k q_1}{r_1^2} + \frac{2 k q_2}{r_2^2} \cos\theta$$

$E_2 =$

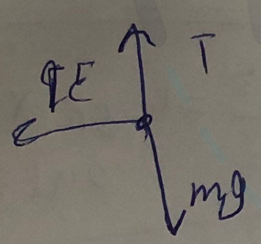
$$E_y = 0 \rightarrow \boxed{E_x = 1.04 \times 10^7 \ N/C}$$

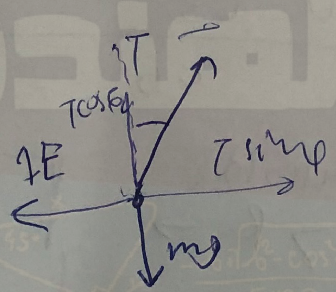
---

9)



$$E = \frac{\sigma}{2\varepsilon_0} = 144.242 \frac{N}{C}$$





$qE = T\sin\theta \qquad mg = T\cos\theta \rightarrow T = \frac{mg}{\cos\theta}$

$qE = mg\tan\theta \rightarrow \frac{q\sigma}{2\varepsilon_0} = mg\tan\theta \rightarrow \frac{q\sigma}{2m\varepsilon_0 g} = \tan\theta$

$\tan\theta = \frac{qE}{mg} \rightarrow \theta = \tan^{-1}\left(\frac{qE}{mg}\right) = 8.2^{\circ}$

10) $E = k \int \frac{dq}{r^2} \hat{r}$

$dq = \lambda dx$

$\int \frac{1}{(x+2)^2}$

$z = x + 2$

$dz = dx$

$\int \frac{1}{z^2} dz$

$$E = k\lambda \hat{i} \int_0^a \frac{dx}{(x + \frac{a}{2})^2}$$

by subsitution $z = x + \frac{a}{2}$

$dz = dx$

$$\Rightarrow E = k\lambda \hat{i} \int_{\frac{a}{2}}^{\frac{3}{2}a} \frac{dz}{z^2} = k\lambda \hat{i} \left[\frac{-1}{z}\right]_{\frac{a}{2}}^{\frac{3}{2}a}$$

$$= k\lambda \hat{i} \left[\frac{1}{z}\right]_{\frac{3}{2}a}^{\frac{a}{2}} = k\lambda \hat{i} \left[\frac{1}{\frac{a}{2}} - \frac{1}{\frac{3}{2}a}\right]$$

$$= k\lambda \hat{i} \left[\frac{2}{a} - \frac{2}{3a}\right] = k\lambda \hat{i} \left[\frac{4}{3a}\right]$$

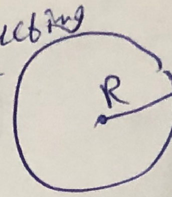
$$\lambda = \frac{Q}{a} \Rightarrow E = \frac{kQ}{a}\left[\frac{4}{3a}\right]\hat{i}$$

$$\vec{E} = \frac{4kQ}{3a^2}\hat{i} \quad \vec{E} = \frac{4}{3}\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{Q}{a^2}\hat{i}$$

$$\vec{E} = \frac{Q}{3\pi\varepsilon_0 a^2} \rightarrow \boxed{F = q\vec{E} = \frac{Qq}{3\pi\varepsilon_0 a^2}}$$

1) $V = \frac{kq}{R}$

conducting sphere



$R = 0.3\,m$

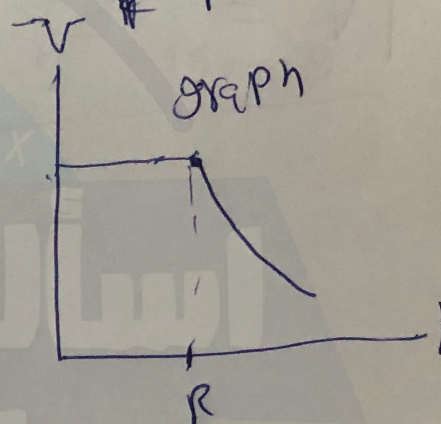
$@\, r = 1.2\,m$

$V = 24\,V$

→ since it's a conducting surface the potential inside the sphere is the same @ every point inside the ~~surface~~ sphere which is equal to the potential at the surface

→ V @ the center @ r=0 ??

graph



$\Rightarrow V = \frac{kq}{r}$, $q = \frac{Vr}{k} = \frac{24 \times 1.2}{9 \times 10^9}$

$q = 3.2 \times 10^{-9}\,C$

$V_{@\,center} = 96\,V$

---

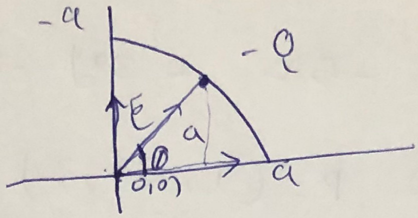
2) $\vec{P} = 2 \times 10^{-3}\,\hat{i} + 4 \times 10^{-3}\,\hat{j}$ Cm $\tau = ??$

$\vec{E} = -7.8 \times 10^{3}\,\hat{i} + 4.9 \times 10^{3}\,\hat{j}$ N/C

$\tau = \vec{p} \times \vec{E} = \begin{vmatrix} i & j & k \\ 2 & 4 & 0 \\ -7.8 & 4.9 & 0 \end{vmatrix} = 0 + 0 + \hat{k} \begin{vmatrix} 2 & 4 \\ -7.8 & 4.9 \end{vmatrix}$

$\tau = \left[(2 * 4.9) - (-7.8 * 4)\right] \hat{k} = 41\,\hat{k}$

3)



$\vec{E} = ??$ $\lambda = \frac{Q}{L}$

$L = r\theta = a\theta = r\theta$ $\boxed{\lambda = \frac{Q}{\frac{\pi}{2} r}}$

$dL = r d\theta = a d\theta$

$\vec{E} = k \int \frac{dq}{r^2} \hat{r} = E_x = \frac{1}{4\pi\varepsilon_0} \int \frac{\lambda \, dL}{r^2} \cos\theta$

$E_x = \frac{1}{4\pi\varepsilon_0} \frac{\lambda}{r^2} \int dL \cos\theta = \frac{1}{4\pi\varepsilon_0} \left(\frac{2Q}{\pi r}\right)\left(\frac{1}{r^2}\right) \int r\cos\theta d\theta$

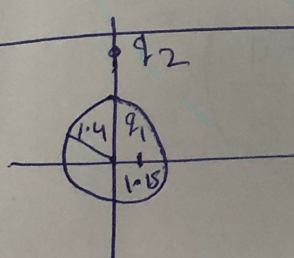
$= \frac{1}{4\pi\varepsilon_0} \left(\frac{2Q}{\pi r^3}\right) r \int_0^{\pi/2} \cos\theta \, d\theta$

$= \frac{1}{4\pi\varepsilon_0} \left(\frac{2Q}{\pi r^2}\right) [\sin\theta]_0^{\pi/2}$ $r = a$

$= \frac{Q}{2\pi^2 \varepsilon_0 r^2} [1 - 0] = \frac{Q}{2\pi^2 r^2 \varepsilon_0} = \boxed{\frac{Q}{2\pi^2 \varepsilon_0 a^2}}$

---

4)



$q_1 = 4.15\,nC$

$q_2 = -6.15\,nC$

$\Phi = \frac{q_{enclosed}}{\varepsilon_0} = \frac{q_1}{\varepsilon_0}$

$q_1 = 4.15 \times 10^{-9}\,C$

$q_2 = -6.15 \times 10^{-9}\,C$

$\Phi = \frac{4.15 \times 10^{-9}}{8.85 \times 10^{-12}} = 468.92 \frac{Nm^2}{C}$

$\boxed{\Phi = 4.69 \times 10^{2} \frac{Nm^2}{C}}$

5) $V = -5x - 3xy - 2yz$

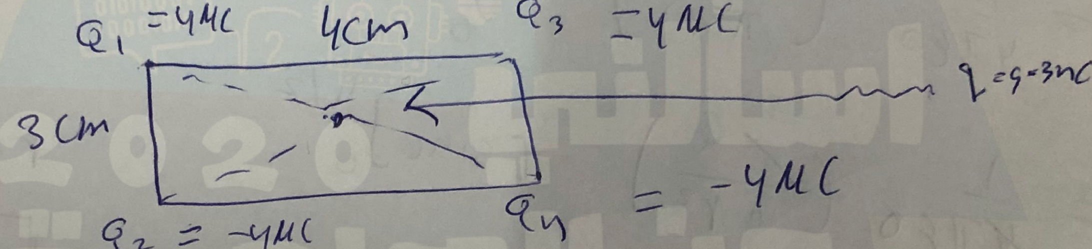
E_x @ $P = (1, -1, 30)$

$E_x = -\frac{\partial V}{\partial x} = -(-5 - 3y - 0) = 5 + 3y$

$E_x = 5 + 3(-1) = 2\ N/C \rightarrow \boxed{E_x = 2\ V/m}$

---

6) B(0)



$W = ??$

$W = U = q\,\Delta V$, ΔV @ the center $= 0$

$q_1 = q_2$ $\quad$ $q_3 = q_4$

$\Delta V = \left(\frac{kQ_1}{r} - \frac{kQ_2}{r}\right) + \left(\frac{kQ_3}{r} - \frac{kQ_4}{r}\right) \rightarrow 0$

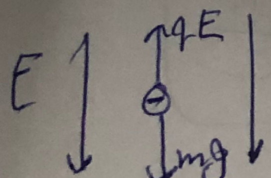
$\Rightarrow U = q\Delta V = 0 \rightarrow W = 0$

---

7) $m = 4 \times 10^{-3}\ kg$

$q = -10\mu C$ $\quad \sum \vec{F} = 0$

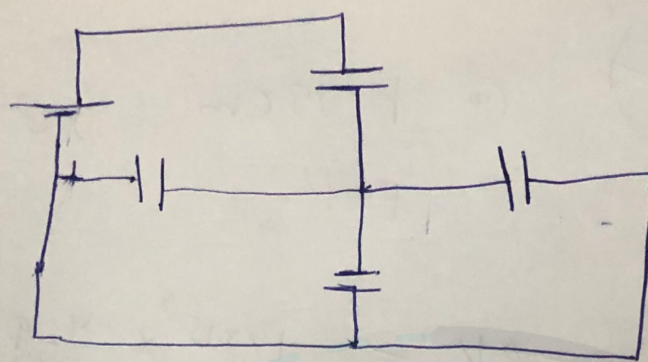
E is downward cause the charge is negative



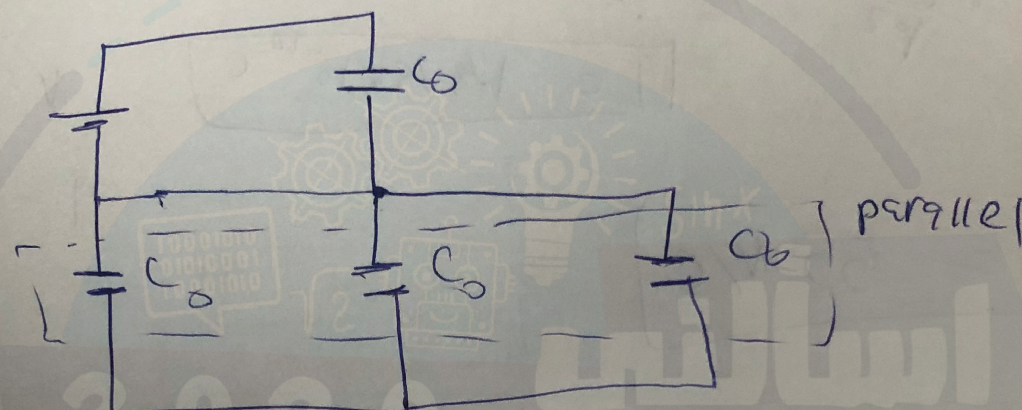
$\rightarrow mg = qE \rightarrow |\vec{E}| = \frac{mg}{q} = 3924\ N/C$

$\boxed{\vec{E} = -3924\,\hat{j} \approx -3920\,\hat{j}}$

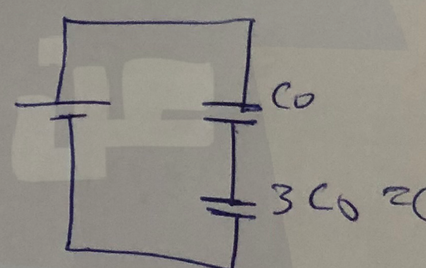
8)



بسط →



$C_{eq} = C_o + C_o + C_o = 3C_o$ →



$\frac{1}{C_{eq}} = \frac{1}{3C_o} + \frac{1}{C_o} = \frac{4}{3C_o}$

→ $C_{eq} = \left(\frac{4}{3C_o}\right)^{-1} = \frac{3C_o}{4} = \frac{3}{4}C_o$

---

9) $C = \frac{A\varepsilon}{d}$, $\varepsilon = \kappa\varepsilon_0$, $C = \frac{q}{\Delta V}$, $\Delta V = Ed$

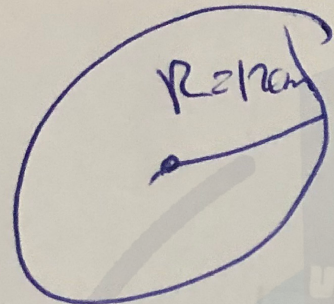
$C = \frac{q}{Ed}$

→ $\frac{q}{Ed} = \frac{A\varepsilon}{d}$ → $q = A\varepsilon E$

→ $q_1 = A\varepsilon_0 E_1$, $q_2 = A\kappa\varepsilon_0 E_2$, $q_1 = q_2 = \text{const}$
same capacitor

$A\varepsilon_0 E_1 = A\kappa\varepsilon_0 E_2$ → $\boxed{\kappa = \frac{E_1}{E_2} = 1.44}$

10)



@ $r = 15\ cm$, $\rho = 19\ nC/m^3$

$E = ??$

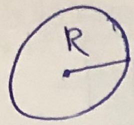
$V = \frac{4}{3}\pi R^3$

$q = \rho V$

$E = k\frac{q}{r^2}$, $q = \rho V = 19\times10^{-9} \times \frac{4}{3}\pi R^3 =$

$q = 1.375\times10^{-10}\ C$

$E = 55\ N/C$

1) 

$U = q\Delta V$, $U = W$

→ $W = q\Delta V$, but charging a sphere it's a process

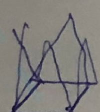
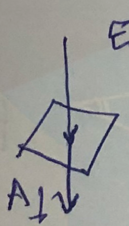
$\partial W = V\,dq \rightarrow W = \int V\,dq \rightarrow W = \frac{K}{R}\int q\,dq$

$$W = \frac{Kq^2}{2R}$$

---

2) $E = \frac{\sigma}{2\varepsilon_0} = 508.47\times10^3$ N/C $= 508$ kN/C

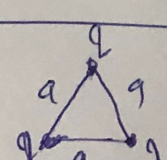
---

3)  

فقط القاعدة لأن العمودي عليها (اتجاه المساحة) في نفس اتجاه المجال

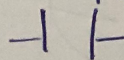
$$\Phi = EA = E(s^2) = E(6^2) = 36\times52 = 1.87 \ \frac{kNm^2}{C}$$

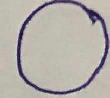
---

4) 

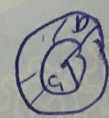
$$V = \frac{kq^2}{a} + \frac{kq^2}{a} + \frac{kq^2}{a} = \frac{3kq^2}{a}$$

5 4) **a)** $\frac{K\varepsilon_0 A}{d}$ is not a capacitor

b) $\frac{\varepsilon_0 A}{d}$ parellel plate 

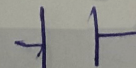
c) $4\pi\varepsilon_0 a$  sphere

d) $1/2\ K\ \ln(b/a)$  cylindrical capacitor

e) $\frac{ab}{K(b-a)}$  Hollow sphere capacitor

answer (a) $\frac{K\varepsilon_0 A}{d}$ is not a capacitance for any capacitor

---

6) **a** $\Delta V = 150\ V$  $\Delta V = Ed$

$\sigma = 30\times10^{-9}\ C/cm^2$

$d = ??$

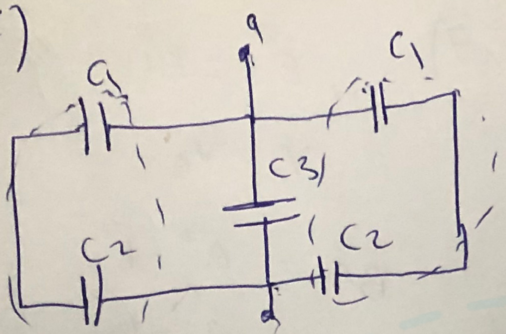
$E = \frac{\sigma}{\varepsilon_0} = 33.9\ \frac{MN}{C}$

$E = \frac{30\times10^{-9}}{(1\times10^{-2})^2} \times \frac{1}{8.85\times10^{-12}}$

$\rightarrow d = \frac{\Delta V}{E} = 4.425\times10^{-6}\ m$

$d = 4.425\ \mu m$

7)

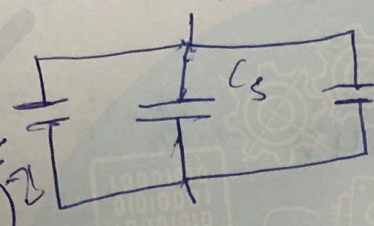


$C_1 = 5\,\mu F$

$C_2 = 10\,\mu F$

$C_3 = 2\,\mu F$

$C_{eq} = ??$



$\left(\frac{1}{C_1}+\frac{1}{C_2}\right)^{-1}$

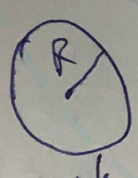
$\left(\frac{1}{C_1}+\frac{1}{C_2}\right)^{-1}$

$$C_{eq} = 2\left(\frac{1}{C_1}+\frac{1}{C_2}\right)^{-1} + C_3 = 2\left(\frac{1}{10}+\frac{1}{5}\right)^{-1} + 2$$

$$\boxed{C_3 = 8.67\,\mu F}$$

---

8)

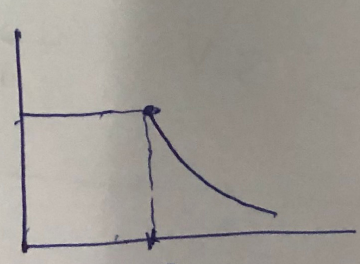


spherical conductor

$R = 14\,cm$, $r = 10\,cm$, $q = 26\,\mu C$

$V = ??$ V @ $r = 10\,cm = ??$

Remember the graph of the "potential" vs distance for a conductor



$$V = \frac{kQ}{R}$$

$$\boxed{V = 1.67\,MV}$$

⟹ The potential inside the sphere is the same as the surface

9) $A(2,3)$ $B(5,7)$, $\vec{E} = (4\hat{i} + 5\hat{j})$ N/C

$V_A - V_B$

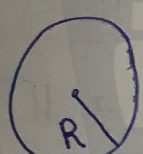
$\vec{BA} = \vec{A} - \vec{B}$

$= -3\hat{i} - 4\hat{j}$

$V_A - V_B = -(\vec{E} \cdot \vec{BA})$

$V_A - V_B \quad -\left[(4\hat{i} + 3\hat{j}) \cdot (-3\hat{i} - 4\hat{j})\right]$

$= (-12 - 12)(-1) = +24V \rightarrow V_A - V_B = 24V$

10)  $\rho = 100\ nC/m^3$, $V_{@r=4cm} - V_{@r=0cm} = ??$

$V_{@r=0} = 0 \rightarrow$ insulating sphere

$\rightarrow @R=0, V=0$

From guass law we know that $E = \frac{\rho r}{3\varepsilon_0}$

$\rightarrow V = \int_a^b \vec{E} \cdot d\vec{r} = \frac{\rho}{3\varepsilon_0} \int_{r=0}^{r=3} r\,dr = \frac{\rho r^2}{6\varepsilon_0} \left[r^2\right]_0^3$

$V = 3.013\ V \approx 3V \rightarrow$ $V_{@r=3} - V_{@r=0} = 3V$