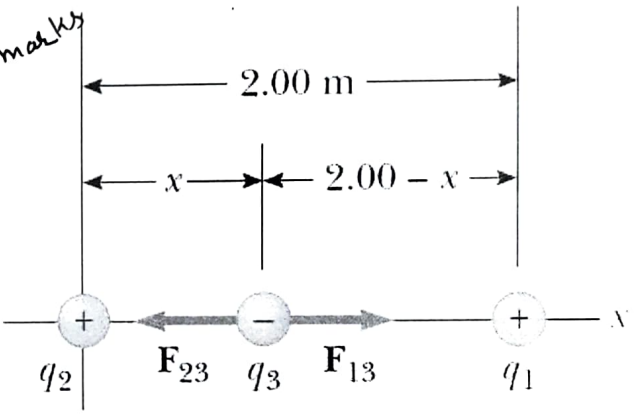
(grading Scheme)

National University of Computer and Emerging Sciences, Lahore Campus				
	Course:	Applied Physics	Course Code:	EE117
	Program:	BS (CS)	Semester:	Fall 2019
	Duration:	60 minutes	Total Marks:	40
	Paper Date:	08-11-2019	Weight	15%
	Section:	All	Page(s):	4
	Exam:	Midterm 2	Roll No:	Nill
	Name	M. Shiraz Ahmad	Section:	B/F
Instruction/Notes:	*Attempt All Questions. Write your answer within the space provided only. Do not attach any rough sheet with the paper.*			

Question 1(a): Three point charges lie along the x axis as shown in the figure below. The positive charge q_1=15μC is at x=2m, the positive charge q_2=6 μC is at the origin, and the resultant force acting on q_3 is zero. **What is the x coordinate of q_3?** (10 marks)

$\varepsilon_0 = 8.85\times 10^{-12}\ C^2\cdot N^{-1}\cdot m^{-2}$

Solution:



2 marks 2 marks

$F_{13} = k\dfrac{|q_1||q_2|}{(2-x)^2}$; $F_{23} = k\dfrac{|q_2||q_3|}{x^2}$

$F_{13} = F_{23}$ → 2 marks

$k\dfrac{|q_1||q_2|}{(2-x)^2} = k\dfrac{|q_2||q_3|}{x^2}$

$(2.00-x)^2|q_2| = x^2|q_1|$

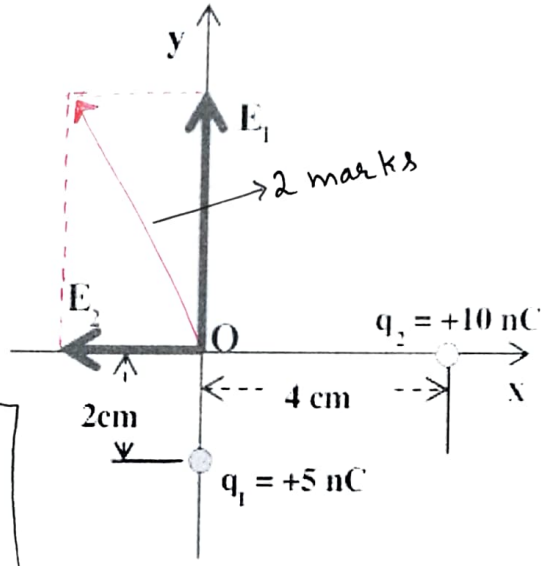
$(4-4x+x^2)(6\times10^{-6}\,C) = x^2(15.0\times10^{-6}\,C)$

$\Rightarrow\ 3x^2+8x-8=0$ → 2 marks

$\Rightarrow$ roots: $\begin{cases} x = 0.775\,m \\ x = -3.44\,m \end{cases}$ → 2 marks

Question 1(b): Find the **(a) magnitude and (b) direction (θ)** of the total electric field at the origin of the coordinate system due to two point charges, q_1 and q_2. The two charges are located at the xy-coordinate position of: (0 cm, -2 cm) and (+4 cm, 0 cm), respectively. **Draw the resultant of Net Electric field on the given figure.** (10 marks)

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2 \cdot N^{-1} \cdot m^{-2}$



$|E_1| = k\dfrac{|q_1|}{r_1^2}$

$= (9\times10^9)\dfrac{5\times10^{-9}\,C}{(2\times10^{-2})^2}$

$|E_1| = 1.12\times10^5\ N/C$ → 2 marks

$|E_2| = k\dfrac{|q_2|}{r_2^2}$

$= (9\times10^9)\dfrac{10\times10^{-9}\,C}{(4\times10^{-2})^2}$

$|E_2| = 0.56\times10^5\ N/C$ → 2 marks

$E = \sqrt{E_1^2 + E_2^2}$

$|E| = 1.25\times10^5\ N/C$ → 4 marks

$\theta = \tan^{-1}\left(\dfrac{E_1}{E_2}\right) = -63.4^\circ$ or $(180^\circ - 63.4^\circ) = 116.6^\circ$ → 4 marks

→ This marking Scheme may vary case to case.

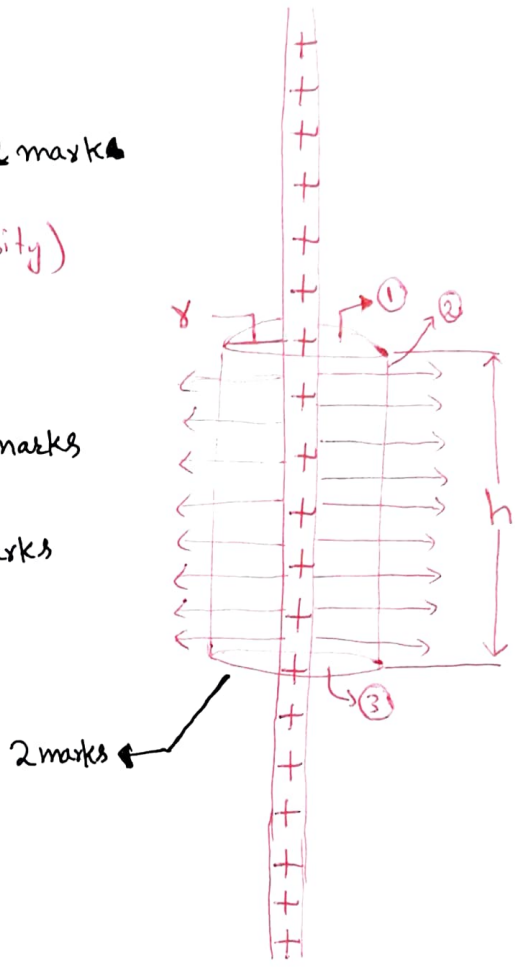
Question 2(a): A Gaussian surface in the form of a closed cylinder surrounds a section of a very long, uniformly charged, cylindrical plastic rod. **Calculate electric field for this rod by applying Gauss law. Make a diagram as well.** (7 marks).

$$\oint \vec{E} \cdot d\vec{A} = \frac{1}{\varepsilon_0} q_{enc} \longrightarrow \text{1 mark}$$

$$E \oint dA = \frac{1}{\varepsilon_0} (\lambda h) \quad (\lambda \rightarrow \text{Linear Charge Density})$$

$$0 + E(2\pi r h) + 0 = \frac{1}{\varepsilon_0} (\lambda h) \rightarrow \text{2 marks}$$

$$\boxed{E = \frac{1}{2\pi\varepsilon_0} \frac{\lambda}{r}} \longrightarrow \text{2 marks}$$



Question 2(b): An unknown charge sits on a conducting solid sphere of radius 10 cm. If the electric field 15 cm from the center of the sphere has the magnitude 3.0×10^3 N/C and is directed radially inward, **what is the net charge on the sphere?** (5 marks).

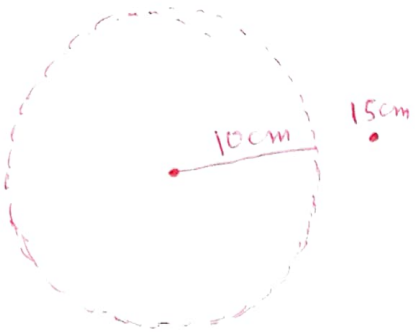
$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2 \cdot N^{-1} \cdot m^{-2}$

$$|q| = 4\pi\varepsilon_0 r^2 E \longrightarrow \text{3 marks}$$

$$= \frac{(0.15\,m)^2 (3.0 \times 10^3\,N/C)}{8.99 \times 10^9\,N \cdot m^2/C^2}$$

$$\boxed{|q| = 7.5 \times 10^{-9}\,C} \longrightarrow \text{2 marks}$$

$$\boxed{q = -7.5 \times 10^{-9}\,C}$$



Question 3: Charge Q1 = 20e Coulombs is at point P_1 (2, 3, 4) m; Charge Q2 = 40e Coulombs is at point P_2 (5, -3, 6) m, where e = elementary electron's charge (1.60×10^{-19} C). $\varepsilon_0 = 8.85\times 10^{-12}\ C^2 \cdot N^{-1} \cdot m^{-2}$

Write a MATLAB program to find:

(a) Coulomb's force acting on charge Q1 (F1),

(b) Coulomb's force acting on charge Q2 (F2)

(8 marks).

→ No predefined grading scheme; if a student is solving by himself & just writing in MATLAB syntax, zero marks will be given.

→ Marks will be given if code relies more on MATLAB in determining the solution.

→ Using built in functions will be appreciated!

Extended Solution:

```
%------------------------%
% Declaring Variables %
%------------------------%
clear all % clear all variables, etc. from memory
P = 1.602e-19; % electrical charge of proton, C
Ep0 = 8.85e-12; % Air permittivity, F/m
Q1 = 20*P; % 1st charge
Q2 = 40*P; % 2nd charge
P1 = [2 3 4]; % location of 1st charge
P2 = [5 -3 6]; % location of 2nd charge
%------------------------%
% Computing the forces %
%------------------------%
R12 = P2-P1; % a vector from point P1 to point P2
R21 = P1-P2; % a vector from point P2 to point P1
R = norm(R12); % norm of vector R12, also norm of vector R21
a12= R12/R; % a unit vector in the direction of vector R12
a21= R21/R; % a unit vector in the direction of vector R12
% Coulomb's law: F = (Q_1 Q_2)/(4 * pi * epislon_0 R^2 ) a_r
F21 = Q1*Q2/(4*pi*Ep0*R^2)*a12; % Force acting on Q2 due to Q1
F12 = Q1*Q2/(4*pi*Ep0*R^2)*a21; % Force acting on Q1 due to Q2
% Display results
F12
F21
```

OP:

F12 = -1.6147e-27 3.2294e-27 -1.0765e-27

F21 = 1.6147e-27 -3.2294e-27 +1.0765e-27