

TIME LIMIT: 1.5 HRS.

MAX MARKS: 35

General Instructions:

- 1) All questions \rightarrow compulsory with no choices.
- 2) 1 to 5 : +1 marks each (PART-A)
- 3) 5 to 10 : 2 marks each. (PART-B)
- 4) 11 to 15 : 3 marks each. (PART-C)
- 5) 16 : 5 marks question (PART-D)
- 6) TOPICS: ELECTRIC FORCE, ELECTRIC FIELD, GAUSS LAW.

PART-A

- ① Two charges of magnitude $-2q$ & $+q$ are located at $(a, 0)$ & $(4a, 0)$ resp. what is electric flux due to these charges through sphere of radius $3a$ with its centre at origin?
- ② Define dielectric constant in terms of permittivity of medium & vacuum.
- ③ An electric dipole having charges with mag. $20 \times 10^{-6} \text{ C}$ is enclosed in closed surface?. what is net flux coming out of this surface?
- ④ what is angle b/w direction of electric field at any axial point & equatorial point?
- ⑤ Force acting b/w two point charges q_1 & q_2 kept at some distance apart in air is ATTRACTIVE or REPULSIVE when
 - ① $q_1 q_2 > 0$
 - ② $q_1 q_2 < 0$

PART-B

- ⑥ a) sketch electric lines of forces for:
 - (i) two point charges q_1 & q_2 ($q_1 > q_2$) separated by distance d (HAVING SAME MAG LIKE CHARGES)
 - (ii) ($q_1 = q_2$) {unlike charges}
- b) define electric dipole moment. Is it scalar or vector? what is its SI unit?

1. Quantum

⑦ (i) Distance b/w of field point on axis of small dipole is doubled -

By what factor will \vec{E} due to dipole charges?

(ii) A charge q is placed at centre of cube of length l . what is electric flux passing through two opposite faces of cube?

⑧ plot graph showing variation of coulomb force F v/s $(1/r^2)$ where r is distance b/w two charges of each pair of charge :-

- (i) $(1\mu C, 2\mu C)$
- (ii) $(2\mu C, -3\mu C)$

Interpret graph obtained.

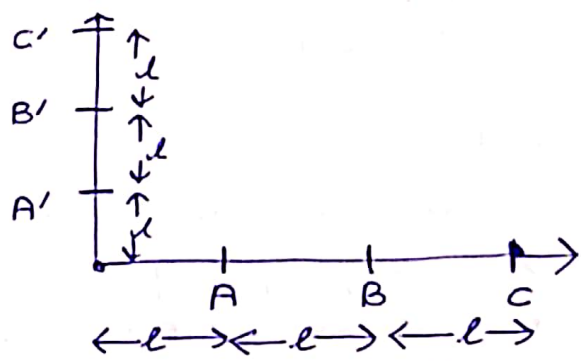
⑨ Derive an expression of electric field line on equatorial line of short dipole.

⑩ An electric dipole is held in uniform electric field.
 (i) show that net force acting on it is zero.
 (ii) Dipole is aligned \parallel to field. Find work done in rotating it by 180°

PART-C

⑪

FIELD POINT	A	B	C	A'	B'	C'
MAGNITUDE OF ELECTRIC FIELD	$E/8$	$E/8$	$E/27$	$E/2$	$E/16$	$E/54$

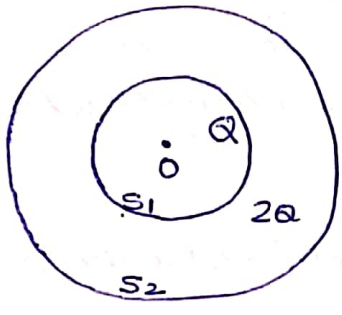


Above data has been obtained by someone for dependence of magnitude of electric field with distance from some reference point O'.

Ⓐ What do you observe FROM DATA?

Ⓑ Identify charge distribution for which above data has been taken?

12) S_1 & $S_2 \rightarrow$ two hollow concentric circles/spheres enclosing Q & $2Q$ resp.



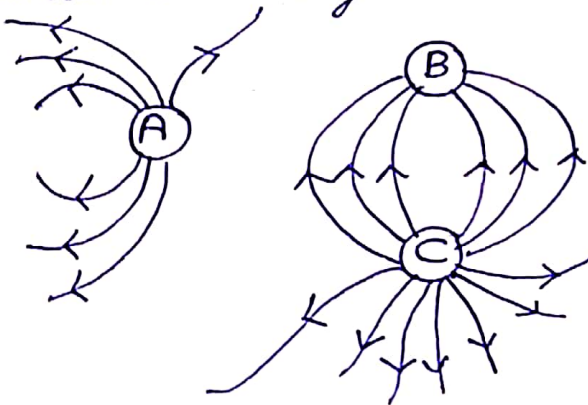
- (i) what is ratio of electric flux through S_1 & S_2 ?
- (ii) how would electric flux through S_1 change if medium of dielectric constant ϵ is introduced in space inside S_1 in place of air.

13) electric dipole of dipole moment \vec{p} is placed in uniform \vec{E} .

- a) (i) write expression of Torque experienced by dipole.
- (ii) Identify two pairs of \perp or vectors in above expression.
- b) show diagrammatically orientation of dipole in field for which
 - (i) Torque MAX.
 - (ii) half of max.
 - (iii) Zero.
 - (iv) Torque minimum.

14) Two charges q & $-3q$ are placed fixed on x -axis separated by distance ' d '. where should 3rd charge $2q$ be placed such that it will experience no force?

15) Following figure shows electric line of force for around 3 charges A, B & C



- (i) Which charges are \oplus ve?
- (ii) which charge has highest magnitude & why?
- (iii) In which region or regions could \vec{E} be zero - OPTIONS
 - (a) near A (c) near C [JUSTIFY YOUR
 - (b) near B (d) nowhere ANS]

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PART-D

- (16) (i) using Gauss law, show mathematically that for any point outside shell, the field due to uniformly charged shell is same as entire charged shell is concentrated at centre.
- (ii) what is the value of electric field inside shell?
- (iii) show graphical representation of E vs. r , where r varies from centre of shell to point P lying outside the shell.