GIRLS' HIGH SCHOOL AND COLLEGE

2020 – 2021

CLASS -12 A&B

PHYSICS

WORKSHEET- 03

Chapter- ELECTRIC CHARGES & FEIELDS

Topic – ELECTRIC FEIELD

INSTRUCTIONS: Parents kindly instruct you ward to visit the websites https://www.physicsclassroom.com

www.khanacademy.org

https://www.electrical4u.com

https://www.wikipedia.org

or any other relevant site

or refer Nootan ISC 12 Physics-12 by Kumar & Mittal (Nageen Prakashan) or Physics -12 by DK Tyagi(Balaji Publications) to answer the following questions on the given topic.

Note: Electric field(as the name suggests) is the space or area around a charge where its influence can be felt (by other similar entities i.e. charges)

Strength of electric field due to a charge can be gauged by the amount of force it exerts on other charges.

Thus quantitatively Electric field due to a charge at any point is the force

per unit charge exerted by it at that point.

Thus if F is force experienced by charge q at a point, due to any charge Q then field due to Q at that point will be $E = \frac{F}{q}$. (force per unit charge)

Question 1) Obtain SI unit and dimensional formula for electric field.

NOTE: Electric field is a vector quantity and is directed radially outwards from positive point charge and inwards for negative point charge.

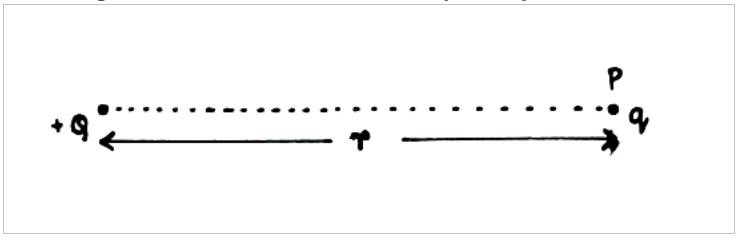
Question 2) Draw electric lines of force for a positive charge and a negative charge.

Question 3) How will you show a uniform electric field?

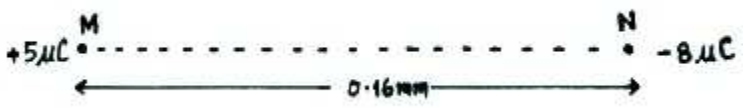
Question 4) An alpha particle is placed in an electric field of $15\times 10^{4} NC^{-1}$. Calculate the force on the particle.

Question 5) Look at the figure, analyze it and hence obtain electric field at P using its quantitative definition. Show its direction as well .How is it depending upon Q, q & r?

Q = Point charge q = a point test charge placed at point P



Question 6) For the given system obtain the force on each charge and compare electric field at both points M & N . Show their respective directions also.



*Now if two charges are placed in close vicinity then field at point close to them will be the result of field due to charge 1 and field due to charge

2 taken together. This result will be the vector sum of both the fields. This is Principle of Superposition which can be extended for n charges as well.

Question 7) If there are 5 charges in the vicinity of point P as shown,

then what is the field at P? Write the expression.

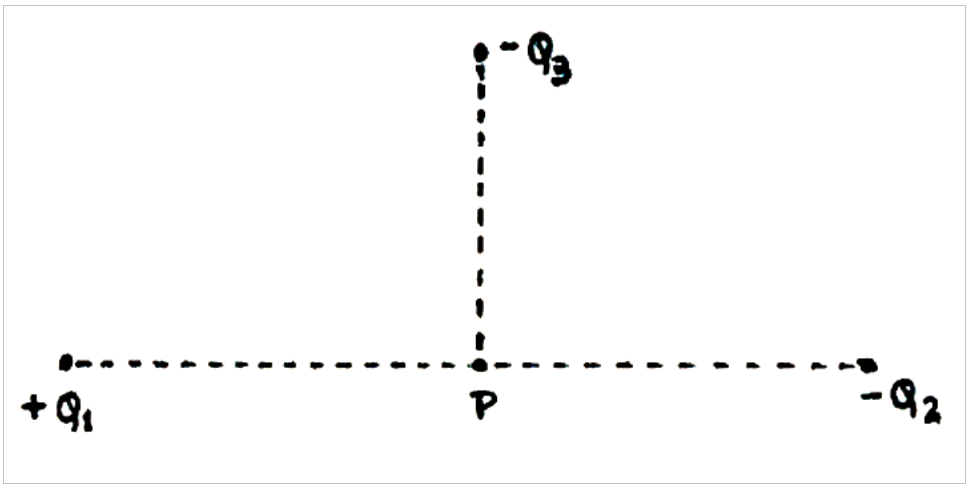
Note: To get the resultant electric field in the above case a vector sum is required. For that revise vectors from previous year's text book thoroughly and hence answer.

Also remember Electric field at a pt. due to a pt. charge is along the line joining the charge and the point (direction being dependent on the nature of the charge)

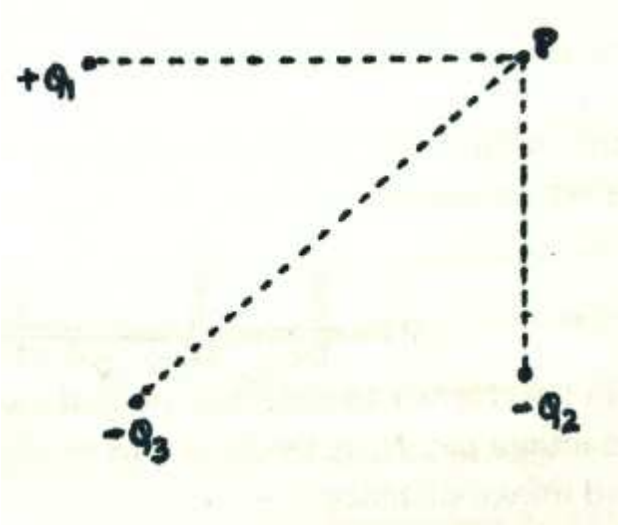
Question 8) Copy the diagram and show the direction of electric fields

E_1, E_2, E_3 due to +Q,-Q_2,-Q_3respectively at point P.

ii)



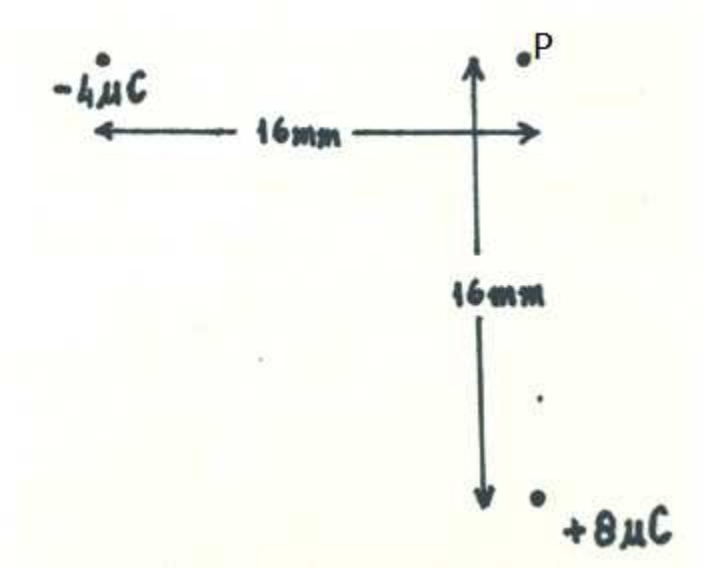
iii)



Question 9) Find the resultant electric field in the following cases

i)

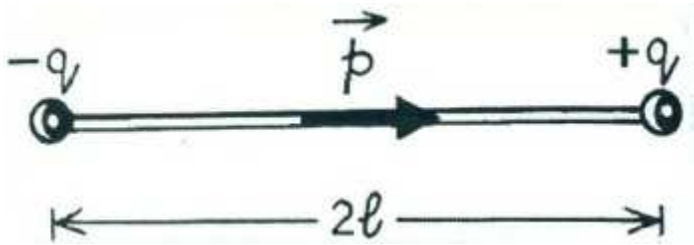
ii)



Copy the figures and complete them by showing the directions of electric fields of each charge and show the direction of the resultant.

Question 10) A charge 'A' of 400 μC is 12m from the charge B of -10000 μC. Find the strength of the electric field at a point C that is 5m from B and 13m from A.

NOTE: An arrangement of two equal and opposite charges kept close to each other is called an Electric Dipole. Its strength can be known from its dipole moment (p) which depends upon the magnitude of any of the constituting charge and the distance between them. It is also a vector quantity directed from negative charge to positive charge . The following figure shows an electric dipole



Where '*2l*' is the dipole length, then dipole moment p= q × *2l*

(product of magnitude of any one charge and its dipole moment)

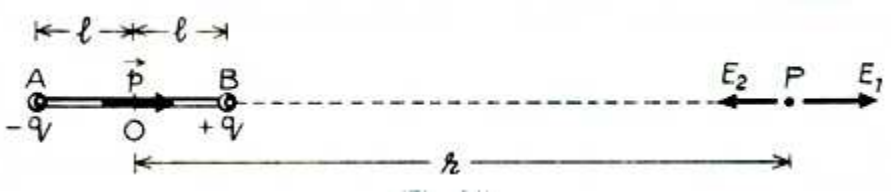
Question 11) Give the unit and dimensional formula for dipole moment.

Question 12) A system has two charges $q_a = 2.5 \times 10^{-7}C$ and $q_b = -2.5 \times 10^{-7}C$

located at points A(0,0,-15cm) and B(0,0,+15cm) respectively. What are the total charge and electric dipole moment of the system?

Question 13) Three charges *+q, -2q, +q* are located at the vertices of an equilateral triangle of side *2l.* What is the equivalent dipole moment of the arrangement?

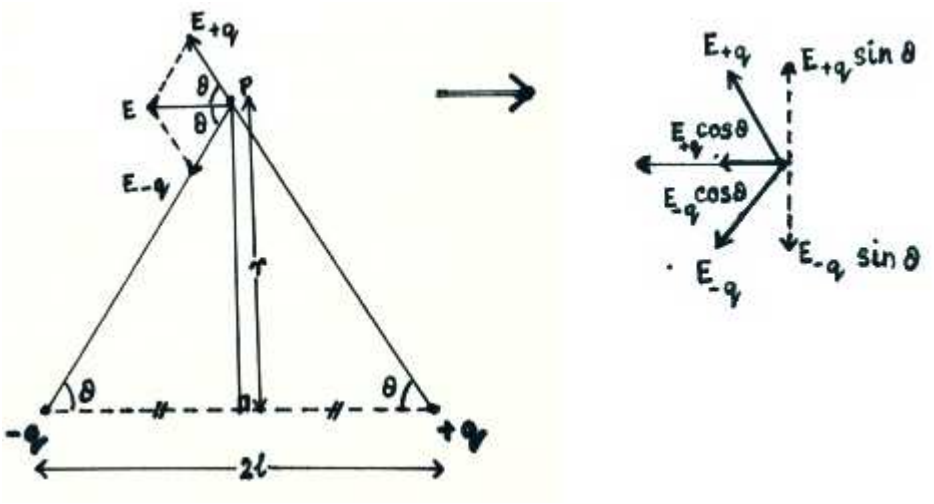
Now observe the given figure carefully and obtain electric field at point P due to the two given charges using principle of superposition



Using the directions of electric fields due to the charges and their magnitudes obtain the resultant field using vector addition.

NOTE: The arrangement of the above two charges is actually that of a dipole. Hence the electric field obtained is the electric field at a point due to an electric dipole. Since P is along the line joining the two charges it is said to be in the <u>axial or end- on position.</u>

Now observe the following figure. Note the arrangement of charges is again that of a dipole with length *2l.* But P is on the perpendicular bisector of the dipole axis. This is called the <u>equatorial or broad-on position.</u> Note the directions of the electric fields and their resultant.



$E = E_{+q} + E_{-q}$ (vector sum) You can use parallelogram law of vector addition

to find magnitude of E as

$E = \sqrt{E_{+q}^2 + E_{-q}^2 + 2E_{+q}\,E_{-q}\cos 2\theta}$ where 2θ is angle b/w E_{+q} and E_{-q}.

Alternatively the resultant E can also be obtained by resolving E_{+q} and E_{-q} along the horizontal and vertical directions as shown. The vertical components will cancel while the horizontal components will add up.

Question 14) With the help of the above figure obtain the magnitude of the electric field at the broad-on position at a distance 'r' from the dipole.

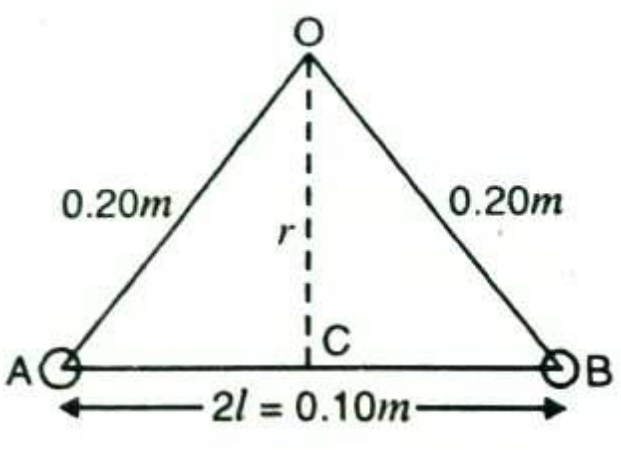
In general dipoles have very small dipole length. This length is very small in comparison to the distance at which electric field is obtained i.e. $l \ll r$ and hence can be neglected while calculating Electric Field due to short dipoles.

Question 15) Give the expression for Electric Fields at the end-on and broad-on positions for a short dipole and compare their values (for the same dipole and for the same end-on and broad-on distances).

Question 16) Two charges of +2.4μC and -2.4μC are at a distance 2.5×10^{-3}m apart from each other. Determine the magnitude of the electric

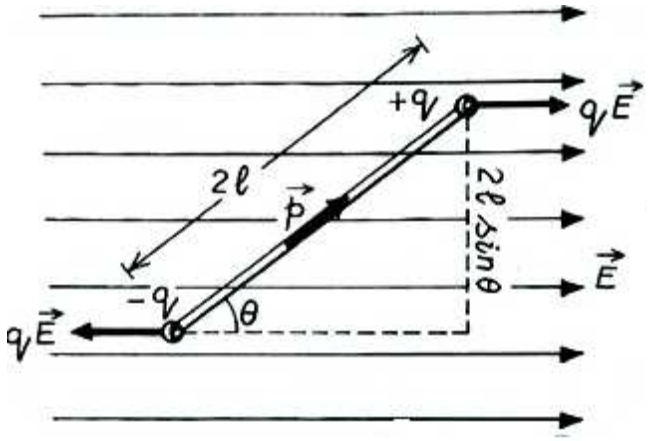
field in the broad-on position at a distance of 0.30m from the dipole. If the dipole be rotated through 90°, then what will be the intensity of the field?

Question 17) Calculate the field due to an electric dipole of length 0.10m and consisting of charges ±100μC at a point 0.20m from each other.



Question 18) In the above question find the electric field along the line joining the two charges, at a distance 0.20m from the mid-point of the dipole.

NOTE: If this dipole is placed in an already existing Electric Field E, its charges will experience forces as shown in figure.



Since these forces are equal and opposite and not acting along the same line they constitute a couple. Revise couple/ torque from last

year’s book.

Question 19) Using the details of the above figure calculate the torque acting on the dipole. Give its unit. Give its expression in the vector form and state when will the torque acting on the dipole be maximum. Also use this information to define its dipole moment.

Question 20) An electric dipole with dipole moment 4×10^{-9} cm is aligned at 30° with the direction of a uniform electric field 5×10^{4} NC^{-1}. Calculate the magnitude of the torque acting on the dipole.

****END***