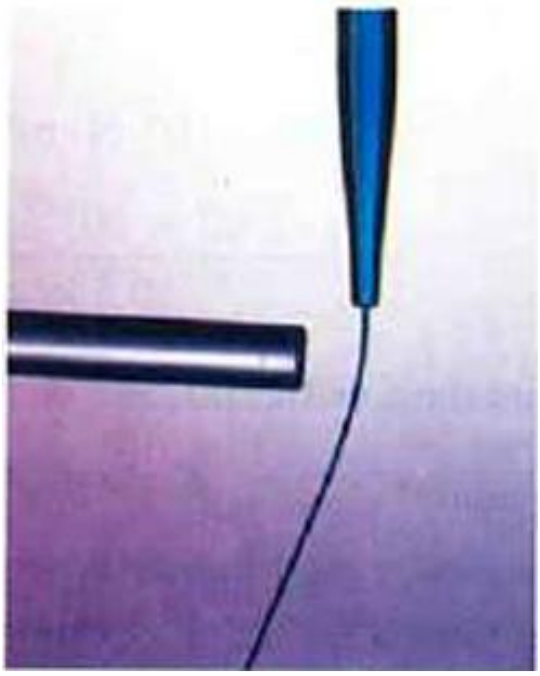
Problem Set 9
Physics, summer 2020/21

1) **(1p.)** Can you explain the attraction of water to the charged rod in the figure below?

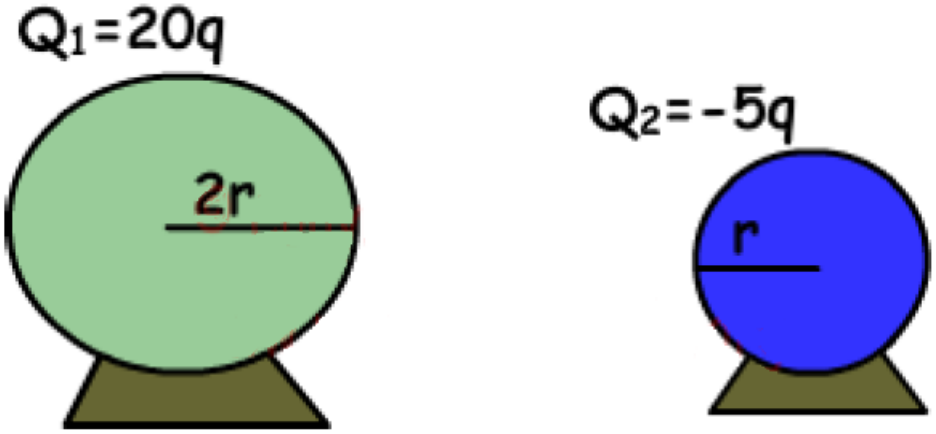


Answer:
Water molecules are polarized, giving them slightly positive and slightly negative sides. This makes water even more susceptible to a charged rod's attraction. In addition, tap water contains dissolved ions (positive and negative charges). As the water flows downward, due to the force of gravity, the charged conductor exerts a net attraction to the opposite charges in the stream of water, pulling it closer.

2) **(2p.)** What force does the electric field found in the previous example exert on a point charge of -0.250μC?

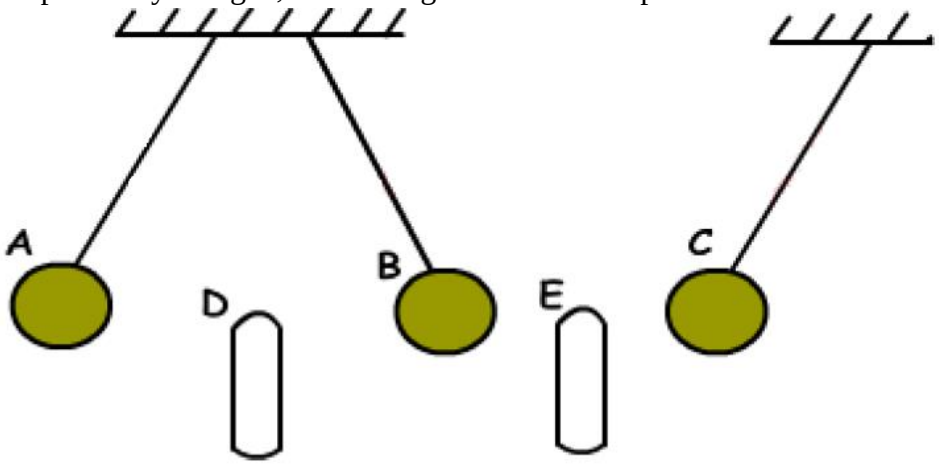
Answer:
Since we know the electric field strength and the charge in the field, the force on that charge can be calculated using the definition of electric field $E=F/q$ rearranged to $F=qE$.
Solution:
The magnitude of the force on a charge $q=-0.250\mu C$ exerted by a field of strength $E=7.20\times10^5$ N/C is thus,
$F=-qE=(8.59\times10^{-6}C)(7.2\times10^{-6}N/C)=0.18\ N$
Because q is negative, the force is directed opposite to the direction of the field.
The force is attractive, as expected for unlike charges. (The field was created by a positive charge and here acts on a negative charge.) The charges in this example are typical of common static electricity, and the modest attractive force obtained is similar to forces experienced in static cling and similar situations.

3) **(2p.)** If we touch two spheres to each other, find the final charges of the spheres.



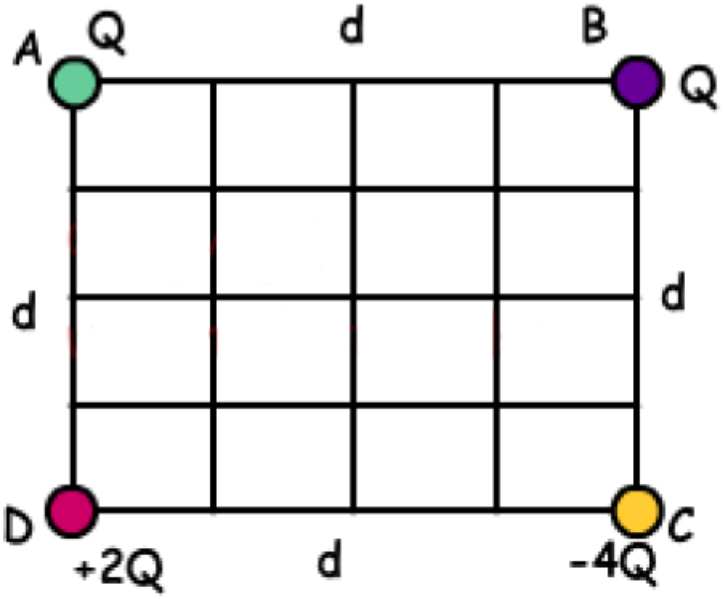
Answer:
Charge per unit radius is found;
$q_r=(Q_1+Q_2)/(r_1+r_2)$
$q_r=(20-5)q/(2r+r)=5q/r$
Solution:
Charge of first sphere becomes;
$Q_1=q_r \times r_1=5q/r \times 2r=10q$
Charge of second sphere becomes;
$Q_2=q_r \times r_2=5q/r \times r=5q$

4) **(2p.)** Charged spheres A, B and C behave like this under the effect of charged rod D and E. If C is positively charged, find the signs of the other spheres and rods.

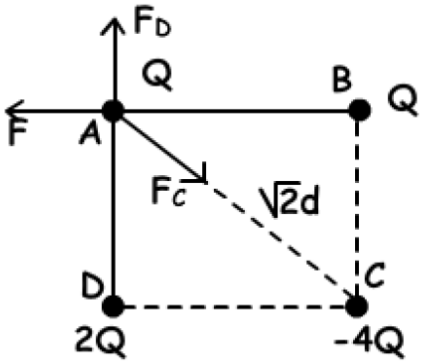


Answer:
We learned that opposite charges attract each other and same charges repel each other. Using this explanation we can say that, if the sign of the C is "+" than rod E must be "-" since it attracts C. B must be "+" since E also attract B. Rod D repels the B so, we say that D must have same sign with B "+" , and finally D also repels A, thus A is also "+".
A(+), D(+), B(+), E(-), C(+)

5) **(3p.)** If force applied by charge placed at point B on A is F, find forces applied by charges C and D on A in terms of F.



Answer:
Free body diagram of forces is given below



Solution

$F = kQ^2/d_2$

$F_C = kQ * (-4Q)/\left(\sqrt{2d}\right)^2 = -4kQ^2/(2d^2) = -2kQ^2/d^2 = -2F$

$F_D = kQ * 2Q/d^2 = 2kQ^2/d^2 = 2F$

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