Homework 2

1) Two charges of +2q and −5q are placed on a line. The distance between the two charges is d. (a) There is a point on the line where the strength of the electric field due to the two charges is zero. Describe where the point is, relative to the positions of the two charges. (b) Is there any point not on the line, where the strength of the electric field is zero?

Step 1, formulas or related concepts.

$$\vec{\mathbf{E}} = k_e \sum_i \frac{q_i}{r_i^2} \hat{\mathbf{r}}_i$$

Step 2, known quantities.

Charges +2q and −5q, The distance between the two charges is d.

Step 3, direct application of the formulas/concept or the condition to form an equation.

Since these two charges are in different signs, the point where the electric field is zero should be outside the area between these two charges. So I use 'x + d' instead of 'x – d' here.

$$\frac{2q \times k}{x^2} = \frac{5q \times k}{(x+d)^2}$$

$$\Rightarrow x = \frac{2 \pm \sqrt{10}}{3} d = \boxed{1.72d} \left(\frac{2-\sqrt{10}}{3} \text{ is negative so we have to discard it} \right)$$

X is the distance from charge -2 q

b) There is no other points not on the line, and where the strength of the electric is zero.

Step 4, vector involved?

yes.

Step 5, unit in the final answer correct? Answered all were asked?

and all questions answered.

2) An electric field has a value of 350 N/C at a particular point in space, directed along the *x* axis. What is the force this field exerts at this point on a particle of charge (a) 5.00 μC? (b) –8.25 mC (1mC= 10^{-3} C)? (c) –525 C? (d) 5.34×10^{-15} C?

Step 1, formulas or related concepts.

$$\vec{\mathbf{F}} = \vec{\mathbf{E}} \times q_{test}$$

Step 2, known quantities.

An electric field has a value of 350 N/C, And all the test charges

Step 3, direct application of the formulas/concept or the condition to form an equation.

$$(a)\ 5.00\times10^{-6}\times350 = \boxed{1.75\times10^{-3}\ (N)}$$

$$(b)\ -8.25\times10^{-3}\times350 = \boxed{-2.89\ (N)}$$

$$(c)\ -525\times350 = \boxed{1.84\times10^{5}\ (N)}$$

$$(d)\ 5.34\times10^{-15}\times350 = \boxed{1.87\times10^{-12}\ (N)}$$

Step 4, vector involved?

No.

Step 5, unit in the final answer correct? Answered all were asked?

Unit of Force: Newton. All questions answered.

Homework 2

3. In a hydrogen atom in its lowest energy state, the single electron and the single proton are separated by a tiny distance called the Bohr radius, 5.29×10^{-11} m. The proton carries a charge $e = 1.60\times10^{-19}$ C. (a) What is the strength of the electric field generated by the proton at the Bohr-radius distance? (b) In what direction does the field point?

Step 1, formulas or related concepts.

$$\vec{\mathbf{E}} = k_e \frac{q}{r^2}\hat{\mathbf{r}}$$

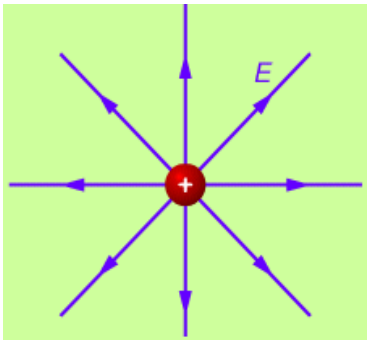
Step 2, known quantities.

the Bohr radius is 5.29×10^{-11} m
The proton charge is $e = 1.60\times10^{-19}$ C

Step 3, direct application of the formulas/concept or the condition to form an equation.

$$a)\ \mathrm{E}=\mathrm{k}_e \frac{q}{r^2} = \frac{1.60\times10^{-19}\times8.99\times10^{9}}{(5.29\times10^{-11})^2} = \boxed{5.14\times10^{11}\left(N/C\right)}$$

b)



Field from a positive charge.

Step 4, vector involved?
No

Step 5, unit in the final answer correct? Answered all were asked?

Unit of Electric Field: N/C, All questions answered.

4. A solid conducting sphere with a radius of 35.4 cm contains a total charge of 5.46 mC, evenly distributed over its surface. (a) What is the direction of the electric field at its surface? (b) What is the strength of the electric field at its surface?

Step 1, formulas or related concepts.

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$

Step 2, known quantities.

Radius of the sphere is 35.4 cm

Total charge is 5.46 mC

Evenly distributed over the surface.

Step 3, direct application of the formulas/concept or the condition to form an equation.

a)Perpendicular to the surface of the sphere.

b) $$E = \frac{q_{total}}{4\pi r^2 \varepsilon_0} = \frac{5.46\times10^{-3}\times8.99\times10^{9}}{(0.354)^2} = \boxed{3.92\times10^{8}\,(N/C)}$$

Step 4, vector involved?

No

Step 5, unit in the final answer correct? Answered all were asked?

.Unit of electric field strength N/C, All questions answered.