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Prodi : Magister Pendidikan Fisika

Tugas 1 : Elektrodinamika

1. The object can be called the positive charged, if it is...
B. The object has the lack of electrons
Reason :
An object is charged when electrons are added or removed from it. When the electrons are removed the object becomes positively charged.

2. Two charges are separated 2 meter of distance on the air. If the distance of them becomes two times before, how many is the force ?
E. 0,25
Solution :
Known : $r_1 = 2m$
$r_2 = 2r_1 = 4m$
Unknown : F_2 :

$$\boxed{F = K \frac{q_1 \cdot q_2}{r^2}}$$

$$\frac{F_1}{F_2} = \frac{\dfrac{\cancel{k q_1 \cdot q_2}}{(r_1)^2}}{\dfrac{\cancel{k q_1 \cdot q_2}}{(r_2)^2}}$$

$$\frac{F_1}{F_2} = \frac{r_2^2}{r_1^2}$$

$$\frac{F_1}{F_2} = \frac{(4r_1)^2}{r_1^2}$$

$$F_1 \cdot r_1^2 = F_2 \cdot 4 \cdot r_1^2$$

$$F_2 = \frac{F_1 \cdot r_1^2}{4}$$

$$F_2 = \frac{1}{4} = 0,25$$

3. Known :
$q_1 = -9 \mu C = -9 \cdot 10^{-6} C$
$q_2 = +6 \mu C = +6 \cdot 10^{-6} C$
$r = 3$ meter
$K = 9 \cdot 10^9 Nm^2C^{-2}$
Unknown : $F = ?$
Solution :

$$F = K \frac{q_1 \cdot q_2}{r^2} = 9 \cdot 10^9 Nm^2C^{-2} \frac{(-9 \cdot 10^{-6} C \times +6 \cdot 10^{-6} C)}{(3m)^2}$$

$$= \cancel{9} \cdot 10^9 N\cancel{m^2}\cancel{C^{-2}} \frac{(-54 \cdot 10^{-12} \cancel{C^2})}{\cancel{9m^2}}$$

$$= -54 \cdot 10^{-3} N = 0,054 N$$

A

4. Known:

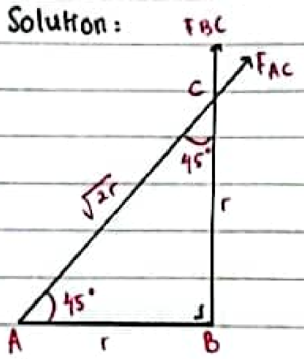
$F_{BC} : F$

$q_A : q_B : q_C : q$

Unknown : F_C ... ?

D $F\sqrt{2}$

Solution:



$F : k \frac{q_A q_B q_C}{r^2}$

$F_{AC} : k \frac{q_A q_B q_C}{r^2}$

$F_{AC} : k \frac{q_A q_B q_C}{(\sqrt{2}r)^2}$

$F_{AC} : k \frac{q_A q_B q_C}{2r}$

$F_{AC} : \frac{1}{2} F$

$F_{BC} : k \frac{q_A q_B q_C}{r^2} : F$

$F_C : \sqrt{F_{BC}^2 + F_{AC}^2 + 2 F_{BC} . F_{AC} . \cos 45°}$

$F_C : \sqrt{F^2 + (\frac{1}{2}F)^2 + 2(F)(F\frac{1}{2})\frac{1}{2}\sqrt{2}}$

$F_C : \sqrt{F^2 + \frac{1}{4}F^2 + F^2 + \frac{1}{2}\sqrt{2})}$

$F_C : \sqrt{\frac{5}{4}F^2 + \frac{\sqrt{2}}{2}F^2}$

$F_C : \sqrt{\frac{5}{4}F^2 + \frac{\sqrt{2}}{2}F^2}$

$F_C : \sqrt{1,25 F^2 + 0,7F}$

$F_C : \sqrt{1,95 F^2}$

$F_C : 1,4 F^2$ atau $F_C : \sqrt{2}\, F$

5. Known:

$q_1 : 24.10^{-6}$ C

$q_2 : 20.10^{-6}$ C

$r : 12$ m

$\varepsilon_r : 3$

Unknown:

$F : ?$

B 0,01 N

Solution: $F : \frac{k}{\varepsilon_r} \times \frac{Q_1 . Q_2}{r^2}$

$: \frac{9.10^9}{3} \times \frac{(24.10^{-6})(20.10^{-6})}{(12)^2}$

$: 3.10^9 \times \frac{480.10^{-12}}{144}$

$: \frac{1.440.10^{-3}}{144} : 10.10^{-3} : 0,01$ N

8. Known:

$q_A : -2\,\mu C : -2.10^{-6}$ C

$q_B : +8\,\mu C : +8.10^{-6}$ C

$q_C : +3\,\mu C : +3.10^{-6}$ C

$r_{AB} : 10$ cm $: 10^{-1}$ m

Unknown : r_{AC} : ?

To determine the distance of particle C from particle A so that it isn't influenced by the Coulomb's Force from Particles A and B, we must ensure that the total force exerted by the two particles on particles C is 0.

$F_{CA} = k\frac{q_C . q_A}{r^2_{CA}}$ $F_{CB} = k\frac{q_C . q_B}{r^2_{CB}}$

We want the sum of these two forces to be zero.

$$F_{CA} = F_{CB}$$

$$\cancel{k}\frac{q_C . q_A}{r^2_{CA}} = \cancel{k}\frac{q_B . q_A}{r^2_{CB}}$$

$$\frac{q_C . q_A}{r^2_{CA}} = \frac{q_B . q_A}{(r - r_{CA})^2}$$

$$\frac{3.10^{-6} . (-2.10^{-6})}{r^2_{CA}} = \frac{2.10^{-6} . 8.10^{-6}}{(10^{-1} - r_{CA})^2}$$

$$\frac{-6.10^{-12}}{r^2_{CA}} = \frac{16.10^{-12}}{(10^{-1} - r_{CA})^2}$$

$$6(10^{-1} - r_{CA})^2 = 16 r^2_{CA}$$

$$6.10^{-1} - 1{,}2 r_{CA} + r^2_{CA} = 16 r^2_{CA}$$

$$17 r^2_{CA} + 1{,}2 r_{CA} - 0{,}6 = 0$$

$$17 r^2_{CA} + 1{,}2 r_{CA} - 0{,}6 = 0$$

$r_{CA} = 0{,}013$ m atau 1,3 cm.

A On the left a bit close to the charge at point A.

7. known :

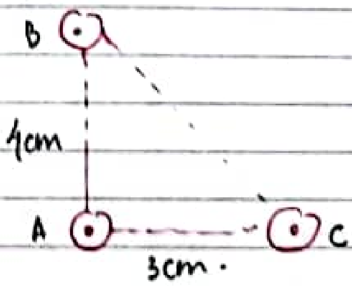
A = 18 μC

B = +25 μC

C = -30 μC

Unknown : E = ?

Solution



$$E_B = k\frac{q_B}{r_{BC}^2} = \frac{9.10^9 . \cancel{25}.10^{-6}}{\cancel{25}.10^{-4}} = 9.10^7 \text{ N/C}$$

$$E_A = k\frac{q_A}{r_{AC}^2} = \frac{\cancel{9}.10^9 . 18.10^{\cancel{-6}\ -2}}{\cancel{9}.10^{\cancel{-4}}} = 18.10^7 \text{ N/C}$$

$$E_C = \sqrt{E_B^2 + E_A^2 + 2 E_A E_B \cos\theta}$$

$$= \sqrt{81.10^{14} + 324.10^{14} + 194{,}4.10^{14}}$$

$$= \sqrt{599{,}4 .10^{14}}$$

$$= \sqrt{6} = (6)^{1/2} \text{ dyne/uc}$$

B

9. Known Unknown : $r = ?$

$q_1 = 5\ \mu C$

$q_2 = 5\ \mu C$

$F = 0,025\ N$

Solution :

$$F = k\ \frac{q_1 . q_2}{r^2}$$

$$0,025\ N = 9 . 10^9\ Nm^2 C^{-2} . \frac{5 . 10^{-6} C . 5 . 10^{-6} C}{r^2}$$

$$25 . 10^{-3}\ N = 9 . 10^9\ Nm^2 \cancel{C^{-2}} . \frac{25 . 10^{-12} \cancel{C^2}}{r^2}$$

$$25 . 10^{-3}\ N = \frac{225 . 10^{-3}\ Nm^2}{r^2}$$

$$25 . 10^{-3}\ N . r^2 = 225 . 10^{-3}\ Nm^2$$

$$r^2 = \frac{225 . 10^{-3} \cancel{N} m^2}{25 . 10^{-3} \cancel{N}}$$

$$r^2 = 9\ m^2$$

$$r = \sqrt{9\ m^2}$$

$$r = 3\ m$$

D

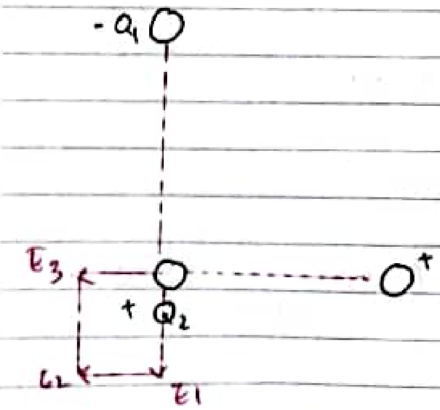
10. Known : Unknown : $F_{q_2} = ?$

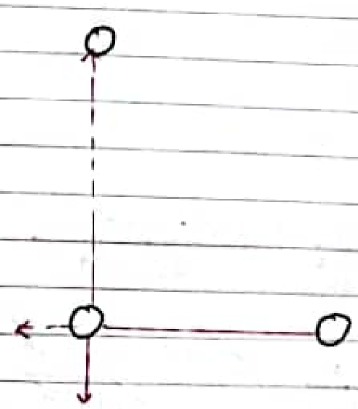
$q_1 = q_3 = 50\ \mu C$

$q_2 = 40\ \mu C$

Solution :

B





because the charger are similar
q_1 and q_2 repel each other
q_2 and q_3 reject each other.

6. C

To determine the location where the $+10\ \mu C$ charge will be placed so that it is not affected by the Coulomb force from Q_1 and Q_2 we need to consider the electric field produced by both of them because the charges of Q_1 and Q_2 are opposite.

Essay :

1. Sketch a graph of the effect of coulomb's force on distance using Coulomb's law. Which states that the force between two charges Q_1 and Q_2 separated by a distance r is inversely proportional to the square of the distance.

the graph will derive that as the distance r increases the force F exponentially decreases in that direction.

2. Known : $q_1 : 8\ \mu C : 8.10^{-6} C$
$q_2 : -4\ \mu C : -4.10^{-6} C$
$r : 2m$

Unknown : $F : ?$

Solution : $F : k\ \frac{q_1.q_2}{r^2}$

$= 9.10^9\ Nm^2C^{-2}\ \frac{(8.10^{-6}C)(-4.10^{-6}C)}{(2m)^2}$

$= 9.10^9\ N\cancel{m^2}\cancel{C^{-2}}\ \frac{\cancel{32}^{\,8}.10^{-12}\cancel{C^2}}{\cancel{4m^2}}$

$= 72.10^{-3} N$

so, the force of the charge is $72.10^{-3} N$ or $0,072 N$.

3. Known : $q_1 : 24\ \mu C : 24.10^{-6} C$ Unknown : $F = ?$
$q_2 : 18\ \mu C : 18.10^{-6} C$
$r : 12 m$

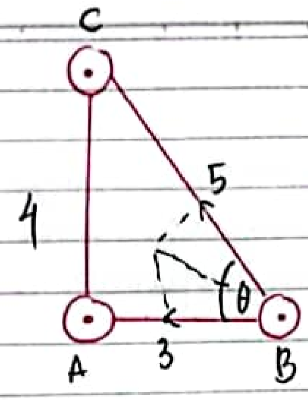
Solution :

$F : k\ \frac{q_1.q_2}{r^2}$

$= 9.10^9\ N m^2 C^{-2}\ \frac{(24.10^{-6}C)(18.10^{-6}C)}{(12m)^2}$

$= 9.10^9\ N\cancel{m^2}\cancel{C^{-2}} \times \frac{\cancel{432}^{\,3}\ 10^{-12}\cancel{C^2}}{\cancel{144}.\cancel{m^2}}$: $27.10^{-3} N$
$= 0,027 N$

4.



6.

Known: q_A : +6 μC = $6 \cdot 10^{-6}$ C

q_B = -6 μC : $6 \cdot 10^{-6}$ C

q_C = +4 μC : $4 \cdot 10^{-6}$ C

Unknown: E_B ... ?

Solution :

$$E_{BC} : k \frac{q_c}{r_{BC}^2} = 9 \frac{\cdot 10^9 \cdot 4 \cdot 10^{-6}}{25} = 1{,}44 \cdot 10^{-3} NC$$

$$E_{AB} = k \frac{q_A}{r_{AB}^2} = \frac{\cancel{9} \cdot 10^9 \cdot 6 \cdot 10^{-6}}{\cancel{9}} = 6 \cdot 10^3 NC$$

$$E_B = \sqrt{EBC^2 + EAB^2 + 2EBC\ EAB \cos\theta}$$

$$= \sqrt{(1{,}44 \cdot 10^3)^2 + (6 \cdot 10^3)^2 + 2 \cdot 1{,}44 \cdot 10^3 \cdot 6 \cdot 10^3}$$

$$= \sqrt{2{,}07 \cdot 36 \cdot 10^6 \cdot 36 \cdot 10^6 \cdot 10{,}368 \cdot 10^6}$$

$$= \sqrt{48.4416 \cdot 10^6}$$

$$= 696 \cdot 10^3$$

$$= 696\,000 \text{ N/C}$$