VISUAL PHYSICS ONLINE

MODULE 4.1
ELECTRICITY

QUESTIONS AND PROBLEMS

EX100

Two brushes are charged by vigorously brushing a moulting dog. (a) Will the hairs that fall out attract or repel each other? (b) Will the hairs be attracted to the brush or repelled from it? (c) Will the two brushes attract or repel each other? Explain.

EX200

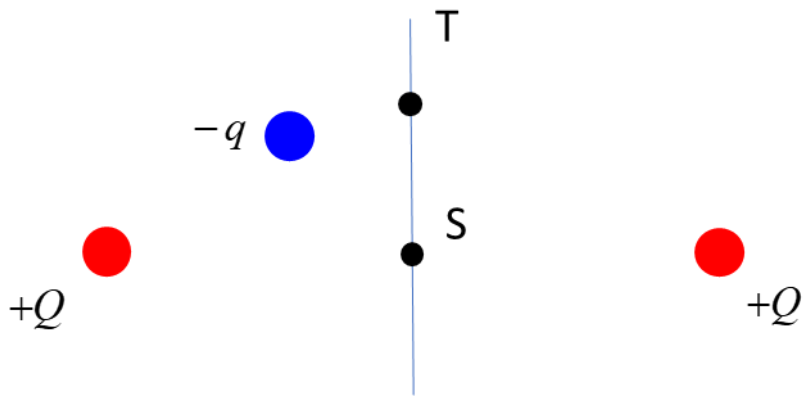
A glass rod is rubbed with silk. After the glass rod has become charged, has the mass of the glass rod changed? Explain.

EX300

A proton and electron are initially a fixed distance apart. When released simultaneously, they are free to move. When they collide, are they (a) at the mid-point of their initial separation, (b) closer to the electron's initial position, or (c) closer to the proton's initial position? Explain.

EX400

A charged objected -q can be placed at either point S or point T as shown in the figure. Assume that points S and T lie on the line midway between two positive charges +Q. Is the resultant force experienced by the by the charged object -q at point S (a) greater than or (b) equal to or (c) less than the resultant force experience at point T?



EX450

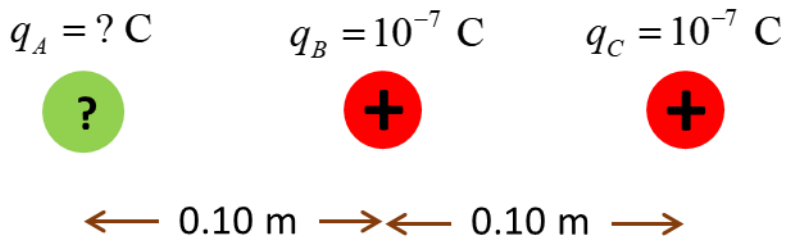
As two small spheres are brought close together, they are found to attract each other by an electrostatic force. What can you say about the charges on the two spheres?

EX500

Image three point-like objects A, B and C each with a charge +q located at the corners of an equilateral triangle. Draw a diagram to show the physical situation. Show the forces acting on charge A due to the presence of charges B and C and the resultant (net) electrostatic force acting on A.

EX600

Three charges A, B and C are arranged in a straight line. Assume that q_A and q_B are held in fixed positions. Calculate the value of the charge q_A that would be required to hold q_C in equilibrium.



Answer 100

In the brushing process, charge (electrons) will be transferred between the brush and the hairs. This will leave the brush and the hairs oppositely charged, one negative and the other positive.

(a) The hairs carry the same charge, so they will repel each other.

(b) The hairs and brush have opposite signs for their charges, so they will attract each other.

(c) The brushes carry like charges and so repel each other.

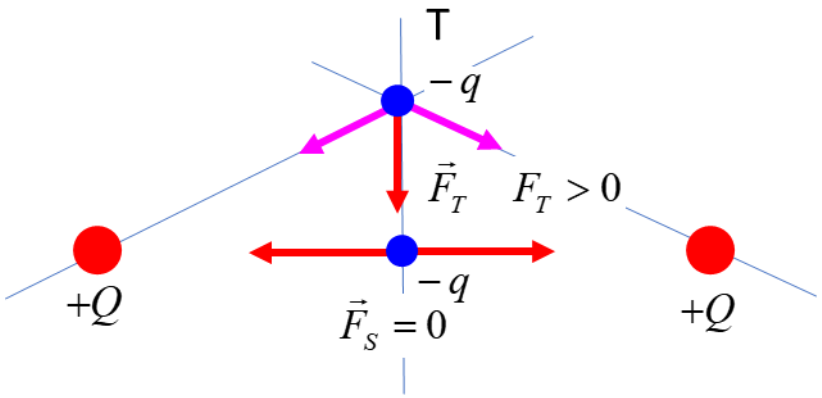
Answer 200

When glass is rubbed with silk, it becomes positively charged as electrons are transferred from the glass to the silk. Each electron has a small mass but non-zero mass. Therefore, the glass rod mass decreases ever so slightly as it is charged.

Answer 300

Newton's 3rd law – the force exerted on the electron and the force exerted on the proton are equal in magnitude and opposite in direction. Since they are oppositely charged, they attract each other. Newton's 2nd law, the acceleration of a particle is inversely proportional to the mass of the particle. The electron has a much greater acceleration then the proton as the mass of the electron is significantly less than that of a proton $\left(m_e \sim m_p / 2000\right)$ and will travel a much greater distance than the proton. So, the collision will occur at a positon much closer to the initial location of the proton.

Answer 400



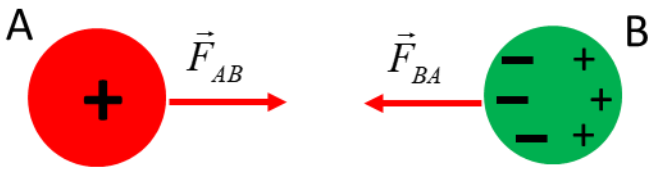
The net force at point S is less than the net force at point B.

Answer 450

If the two spheres attract each other, there are two possibilities.

(1) The spheres carry opposite charges.

(2) One sphere is charged and the other is uncharged (neutral). As the spheres get closer, the neutral sphere has its charge redistributed by induction. The initially uncharged sphere may be either a conductor or insulator.

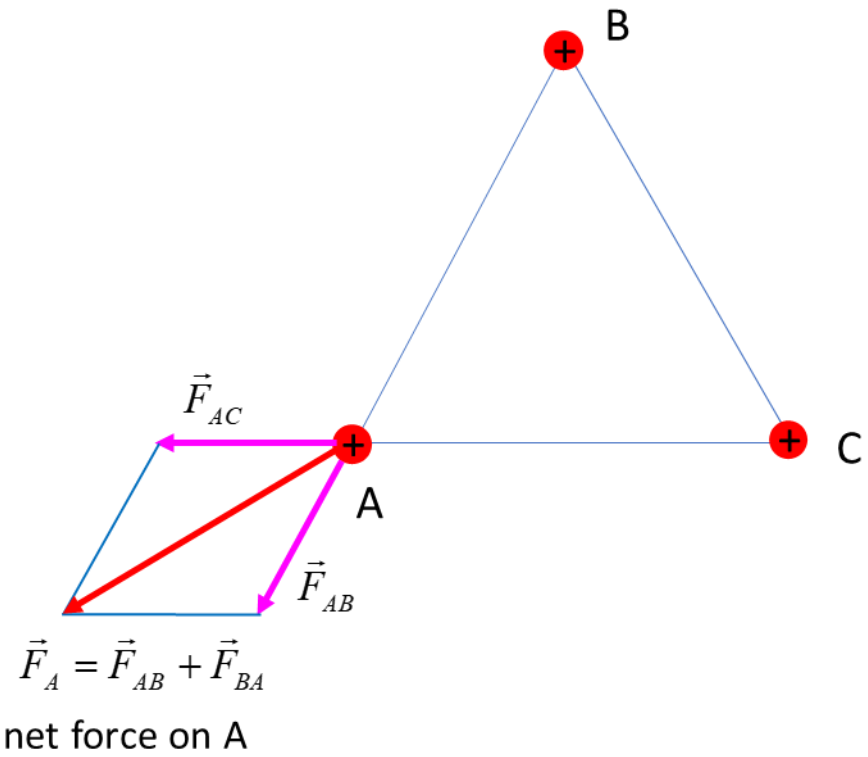


net attractive force between the two spheres A and B

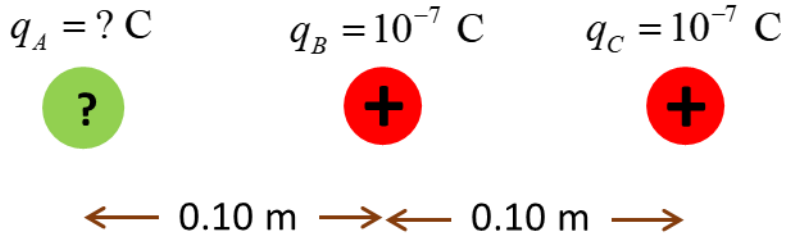
$$\vec{F}_{AB} = -\vec{F}_{BA}$$

Answer 500

The force on A due to the charge B will act along the line joining A and B. Because A and B are like charges, the electrostatic force is repulsive. Similarly, the repulsive force on A due to charge C is along the line joining A and C. Because charges B and C are identical and equidistance from A, the two forces are equal in magnitude.



Answer 600

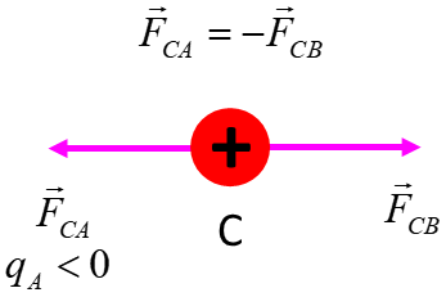


The charge q_C will be in equilibrium only if the net force acting on it is zero. Since charge B repels charge C, then charge A must attract charge C. Thus, q_A must be a negative charge.

$$q_A = ?\ \text{C} \quad q_B = 10^{-7}\ \text{C} \quad q_C = 10^{-7}\ \text{C} \quad r = 0.1\ \text{m}$$

Electric force between two charges

$$F = k\frac{|Q_A||Q_B|}{r^2}$$



$$F_{CA} = k\frac{|q_C||q_A|}{(2r)^2} \quad F_{CB} = k\frac{|q_C||q_B|}{r^2}$$

$$k\frac{|q_C||q_A|}{(2r)^2} = k\frac{|q_C||q_B|}{r^2}$$

$$|q_A| = 4|q_B| = (4)(10^{-7})\ \text{C}$$

$$q_A = -4\times10^{-7}\ \text{C}$$

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If you have any feedback, comments, suggestions or corrections please email Ian Cooper

ian.cooper@sydney.edu.au

Ian Cooper School of Physics University of Sydney