Question.

A small object has charge Q. Charge q is removed from it and placed on a second small object. The two objects are placed 1 m apart. For the force that each object exerts on the other to be a maximum, q should be:

a. 2Q

b. Q

c. Q/2

d. Q/4

Solution.

After removing the charge q we have two charged objects with charges $(Q - q)$ and q.

Let consider the Coulomb's law. By definition of this law:

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

where q_1, q_2 are the charges;

k is the Coulomb's constant;

r is the distance between the charges.

In our case, $q_1 = Q - q$; $q_2 = q$. Therefore, the Coulomb's law will be the following:

$$F = k\frac{(Q - q)q}{r^2}$$

Let define the extremum of function $F(q)$ to determine the maximum of the Coulomb's force:

$$F^{'}(q) = \frac{dF}{dq} = \frac{k}{r^2}(Q - 2q) = 0 \rightarrow Q = 2q \rightarrow q = \frac{Q}{2}$$

So, for the force that each object exerts on the other to be a maximum, q should be equal to $Q/2$.

Answer.

$c. Q/2$