1. Which of the following fundamental forces of nature is responsible for the existence of bulk matter?
   a. force of gravity;
   b. electromagnetic force;
   c. nuclear strong force;
   d. nuclear weak force.

Solution:

   Gravity governs the aggregation of matter into stars and galaxies and influences the way that the universe has evolved since its origin in the big bang.

   The electromagnetic force binds negatively charged electrons to positively charged atomic nuclei and gives rise to the bonding between atoms to form bulk matter.

   The other two forces act only on subatomic scales. The strong force binds quarks together within protons, neutrons, and other subatomic particles. Unlike the strong force, which acts only between quarks, the weak force acts on both quarks and leptons.

   The electromagnetic force is ultimately responsible for existence bulk matter.

Answer: _b) electromagnetic force_

2. Two charges Q_1= 500 μC and Q_2= 100 μC are located on the XY plane at the positions $\vec{r}_1 = 3j$ m and $\vec{r}_2 = 4i$ m. Find the force exerted on the Q_2.
   a. 14.4i + 10.8j N;
   b. 14.4i - 10.8j N;
   c. 10.8i − 14.4j N;
   d. 10.8i + 14.4j N.

Solution:

The total force is equal by the Coulomb's law:

$$\overrightarrow{F_{12}} = k \frac{q_1 q_2}{|r_{12}|^2} \frac{\overrightarrow{r_{12}}}{r_{12}}$$

Vectorial distance between the charges:

$$\overrightarrow{r_{12}} = \overrightarrow{r_2} - \overrightarrow{r_1} = 4\vec{\imath} - 3\vec{\jmath}$$

$$|r_{12}| = \sqrt{r_1^2 + r_2^2} = \sqrt{(3\vec{j}\,m)^2 + (4\vec{i}\,m)^2} = 5m$$

$$\vec{F_{12}} = 9 \cdot 10^9 \frac{N \cdot m^2}{C^2} \frac{500 \cdot 10^{-6} C \times 100 \cdot 10^{-6} C}{(5m)^2} \frac{(4\vec{i} - 3\vec{j})m}{5m} = 14.4\vec{i} - 10.8\vec{j} \ N$$

The force exerted on the Q_2 is equal 14.4i - 10.8j N

Answer: <u>b) 14.4i - 10.8j N</u>