Gravitational Force and Electric Force

Last year you found that you could calculate the amount of gravitational force exerted on any object that has mass (like you yourself, for instance) and happens to be in the gravitational field created by another object with mass (like Earth, for instance). We use the symbol m for the mass of the object that feels the force. The symbol g stands for the strength of the gravitational field produced by the other object. Here's how we calculated the force experienced by the object:

$$F_{grav} = mg \tag{1}$$

At the surface of Earth we found the strength of Earth's gravitational field to be $g = 9.8$ N/kg.

In the same way, we can calculate the electric force exerted on an object that has electric charge and happens to be in the electric field created by another electrically charged object.

$$F_{elec} = q\mathbb{E} \tag{2}$$

Compare the previous two equations. They follow the same pattern. Just as q stands for the amount of electric charge an object has, m stands for how much "gravitational charge" an object has. We use the word "mass" instead of calling it "gravitational charge," but you should get the idea. We measure the amount of electric charge an object possesses in Coulombs (C). We measure the amount of gravitational charge (mass) an object has in kilograms (kg).

Also, we know that g is the strength of a gravitational field in N/kg. In just the same way $\mathbb{E}$ is the strength of an electric field in N/C.

Example 1

You find that the strength of an electric field is 2000 N/C. How much force will it exert on a particle that possesses 0.004 C?

Solution

$$F_{elec} = q\mathbb{E}$$

$$F_{elec} = 0.004 \text{ C} \cdot 2000 \frac{\text{N}}{\text{C}}$$

$$F_{elec} = 8 \text{ N}$$

Example 2

A dust particle carries an electric charge of 2×10^{-4} C. It is in an electric field that exerts a force of 4 N on it. What is the strength of this electric field?

Solution

$$F_{elec} = q\mathbb{E}$$

$$\mathbb{E} = \frac{F_{elec}}{q}$$

$$\mathbb{E} = \frac{4 \text{ N}}{2 \times 10^{-4} \text{ C}}$$

$$\mathbb{E} = \frac{2}{10^{-4}}$$

$$\mathbb{E} = 2 \times 10^{4} \text{ N/C}$$

Problems

1. How much force does an electric field with a strength of 3 N/C exert on an object that has a charge of 2 C?

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2. An electric field has a strength of 200 N/C. How much force would it exert on an object having a charge of 0.5 C?

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3. A particle carries an electric charge of 0.004 C. It is in an electric field with a strength of 1000 N/C. How big is the electric force on this particle?

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4. The strength of the gravitational field on Mars is 3.7 N/kg. How much gravitational force will a 100 kg rover experience on Mars' surface?

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5. You land on Ganymede. The strength of its gravitational field is 1.4 N/kg. How much gravitational force will you feel if your mass is 90 kg?

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6. The strength of an electric field at a certain location in space is 500 N/C. How much force will a particle that possesses a 1×10^{-5} C electric charge experience?

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7. The strength of an electric field at a certain location in space is 10,000 N/C. How much force will a particle that possesses a 2×10^{-6} C electric charge experience?

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8. The strength of an electric field at a certain location in space is 300,000 N/C. How much force will a particle that possesses a 2×10^{-9} C electric charge experience?

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