Additional Problem Vb for Physics 102

This problem is part of your written homework for chapter 21.

Just as the electric field is electric force per unit charge, we can define a gravitational field as the gravitational force on an object, divided by the object’s mass:

\[ g \equiv \frac{F_g}{m}. \]

a) What are the dimensions of the gravitational field \( g \)? How does the gravitational field \( g \) relate to the meaning of the symbol \( g \) we learned in Physics 101?

The following statement appears in a science book for general audiences (The Aurora Watcher’s Handbook, by Neil Davis):

Electrons have a very small mass, so a gravity field such as the Earth’s has little effect... only electric fields have a profound effect on the speed, and hence the kinetic energy, of electrically charged particles.

In the rest of this problem, we will evaluate the above statement.

b) Suppose an electron is initially at rest near the Earth’s surface. Considering only the effects of the Earth’s gravitational field and neglecting any other forces, what would be the electron’s acceleration? Based on this, calculate the electron’s speed and kinetic energy after it has fallen a distance of 1.0 m.

c) Suppose an electron is initially at rest in an electric field of magnitude 1.0 N/C. Considering only the effects of this electric field and neglecting any other forces, what would be the electron’s acceleration? Based on this, calculate the electron’s speed and kinetic energy after it has moved a distance of 1.0 m.

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Now imagine a particle with the same charge as the electron, but with 200 times the mass. Such particles actually exist in nature; they are known as muons.

d) Repeat parts b) and c) considering a muon rather than an electron. (This should require very little additional calculation; use proportional reasoning.)

e) Discuss the statement quoted below part (a) in light of your calculations. In what ways is it accurate? In what ways, if any, is it wrong or misleading?