A protein molecule in an electrophoresis gel has a negative charge. The exact charge depends on the pH of the solution, but 30 excess electrons is typical. We will walk through calculating the magnitude of the electric force on a protein in a 1500 Newtons/Coulomb electric field.

First, we are told to assume that each protein molecule has 30 excess electrons. We can find the net charge on a protein molecule by multiplying the number of excess electrons per molecule by the charge of each electron.
We are told in part one of the electricity and magnetism reading that each electron has a charge of -1.6×10^{-19} Coulombs. Thus, the net charge on a protein molecule is equal to

(30 electrons/protein molecule) x (-1.6×10^{-19} Coulombs/electron)
= -**4.8** x 10^{-18} Coulombs/protein molecule (Note: I just plugged this into my calculator to find the answer.)

We are only concerned about the magnitude of the electric force, and so we can drop the minus sign in front of the charge per protein molecule.

The force by an electric field on a charged particle within the field can be found with the following formula:

(force on a charged particle) = (the charge of the particle) x (the electric field strength).

Again, we are only concerned about the magnitude of the force on the protein, and so we can say:

(the magnitude of the force on the charged particle) = (the magnitude of the charge of the particle) x (the electric field strength).

Thus, the magnitude of the electric force on a protein particle in the electric field of strength given above is equal to

(**4.8** x 10^{-18} Coulombs/protein molecule) x (1500 Newtons/Coulomb)
= **[y]** x 10^{-15} Newtons. Notes: The magnitude of the charge of the particle comes from the first part of the calculation, and the electric field strength comes from the problem statement.