43. The weight must be balanced by the force from the electric field:

$mg = qE;$

$(1.67 \times 10^{-27}\ \text{kg})(9.80\ \text{m/s}^2) = (1.60 \times 10^{-19}\ \text{C})E$, which gives $E = \boxed{1.02 \times 10^{-7}\ \text{N/C (up)}.}$

44. Because we can treat the charge on the Earth as a point charge at the center, we have

$E = kQ/r^2;$

$150\ \text{N/C} = (9.0 \times 10^9\ \text{N}\cdot\text{m}^2/\text{C}^2)Q/(6.38 \times 10^6\ \text{m})^2$, which gives $Q = \boxed{6.8 \times 10^5\ \text{C}.}$

Because the field points toward the center, the charge must be $\boxed{\text{negative.}}$

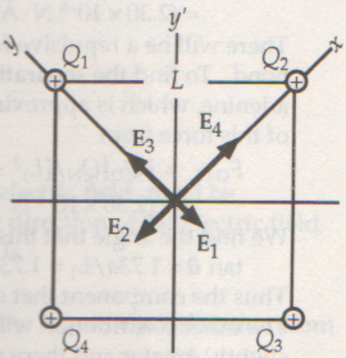
45. The weight must be balanced by the force from the electric field:

$mg = \rho\frac{4}{3}\pi r^3 g = NeE;$

$(1000\ \text{kg/m}^3)\frac{4}{3}\pi(1.8 \times 10^{-5}\ \text{m})^3(9.80\ \text{m/s}^2) = N(1.60 \times 10^{-19}\ \text{C})(150\ \text{N/C}),$

which gives $N = \boxed{1.0 \times 10^7\ \text{electrons.}}$

46. The directions of the individual fields will be along the diagonals of the square, as shown. All distances are the same. We find the magnitudes of the individual fields:



$E_1 = kQ_1/(L/\sqrt{2})^2 = 2kQ_1/L^2$

$= 2(9.0 \times 10^9\ \text{N}\cdot\text{m}^2/\text{C}^2)(1.0 \times 10^{-6}\ \text{C})/(0.25\ \text{m})^2 = 2.88 \times 10^5\ \text{N/C}.$

$E_2 = kQ_2/(L/\sqrt{2})^2 = 2E_1 = 2(2.88 \times 10^5\ \text{N/C}) = 5.76 \times 10^5\ \text{N/C}.$

$E_3 = kQ_3/(L/\sqrt{2})^2 = 3E_1 = 3(2.88 \times 10^5\ \text{N/C}) = 8.64 \times 10^5\ \text{N/C}.$

$E_4 = kQ_4/(L/\sqrt{2})^2 = 4E_1 = 4(2.88 \times 10^5\ \text{N/C}) = 11.52 \times 10^5\ \text{N/C}.$

We simplify the vector addition by using the xy-coordinate system shown. For the components of the resultant field we have

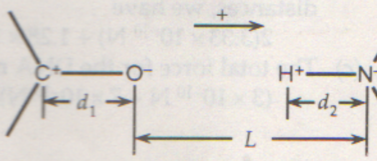
$E_x = E_4 - E_2 = 11.52 \times 10^5\ \text{N/C} - 5.76 \times 10^5\ \text{N/C} = 5.76 \times 10^5\ \text{N/C};$

$E_y = E_3 - E_1 = 8.64 \times 10^5\ \text{N/C} - 2.88 \times 10^5\ \text{N/C} = 5.76 \times 10^5\ \text{N/C}.$

Thus we see that the resultant will be in the y'-direction:

$E = 2E_x \cos 45° = 2(5.76 \times 10^5\ \text{N/C}) \cos 45° = \boxed{8.1 \times 10^5\ \text{N/C up.}}$

47. We find the force between the groups by finding the force on the CO group from the HN group. A convenient numerical factor will be



$ke^2/(10^{-9}\ \text{m/nm})^2$

$= (9.0 \times 10^9\ \text{N}\cdot\text{m}^2/\text{C}^2)(1.60 \times 10^{-19}\ \text{C})^2/(10^{-9}\ \text{m/nm})^2$

$= 2.30 \times 10^{-10}\ \text{N}\cdot\text{nm}^2.$

For the forces on the atoms, we have

$F_O = kQ_O\{[Q_H/(L - d_2)^2] - (Q_N/L^2)\} = ke^2 f_O f_H\{[1/(L - d_2)^2] - (1/L^2)\}$

$= (2.30 \times 10^{-10}\ \text{N}\cdot\text{nm}^2)(0.4)(0.2)\{[1/(0.28\ \text{nm} - 0.10\ \text{nm})^2] - [1/(0.28\ \text{nm})^2]\} = 3.33 \times 10^{-10}\ \text{N}.$

$F_C = kQ_C\{[Q_N/(L + d_1)^2] - Q_H/(L + d_1 - d_2)^2]\} = ke^2 f_C f_N\{[1/(L + d_1)^2] - [1/(L + d_1 - d_2)^2]\}$

$= (2.30 \times 10^{-10}\ \text{N}\cdot\text{nm}^2)(0.4)(0.2)\{[1/(0.28\ \text{nm} + 0.12\ \text{nm})^2] - [1/(0.28\ \text{nm} + 0.12\ \text{nm} - 0.10\ \text{nm})^2]\}$

$= -8.94 \times 10^{-11}\ \text{N}.$

Thus the net force is

$F = F_O + F_C = 3.33 \times 10^{-10}\ \text{N} - 8.94 \times 10^{-11}\ \text{N} = \boxed{2.4 \times 10^{-10}\ \text{N (attraction).}}$