52. The angular frequency of the SHM is

$\omega = (k/m)^{1/2} = [(126\ \text{N/m})/(0.800\ \text{kg})]^{1/2} = 12.5\ \text{s}^{-1}$.

If we take down as positive, with respect to the equilibrium position, the ball will start at maximum displacement, so the position as a function of time is

$x = A\cos(\omega t) = (0.0500\ \text{m})\cos[(12.5\ \text{s}^{-1})t]$.

Because the charge is negative, the electric field at the table will be up and the distance from the table is

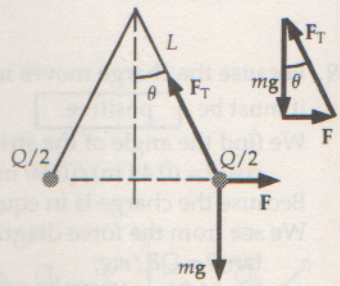
$r = H - x = 0.150\ \text{m} - (0.0500\ \text{m})\cos[(12.5\ \text{s}^{-1})t]$.

The electric field is

$E = kQ/r^2 = (9.0\times10^9\ \text{N}\cdot\text{m}^2/\text{C}^2)(3.00\times10^{-6}\ \text{C})/\{0.150\ \text{m} - (0.0500\ \text{m})\cos[(12.5\ \text{s}^{-1})t]\}^2$

$= \boxed{(1.08\times10^7\ \text{N/C})/\{3 - \cos[(12.5\ \text{s}^{-1})t]\}^2\ \text{up.}}$

53. We consider the forces on one ball. (The other will be the same except for the reversal.) The separation of the charges is



$r = 2L\sin 30° = 2(0.70\ \text{m})\sin 30° = 0.70\ \text{m}$.

From the equilibrium force diagram, we have

$\tan\theta = F/mg = [k(\tfrac{1}{2}Q)(\tfrac{1}{2}Q)/r^2]/mg$;

$\tan 30° = \tfrac{1}{4}(9.0\times10^9\ \text{N}\cdot\text{m}^2/\text{C}^2)Q^2/(0.70\ \text{m})^2(24\times10^{-3}\ \text{kg})(9.80\ \text{m/s}^2)$,

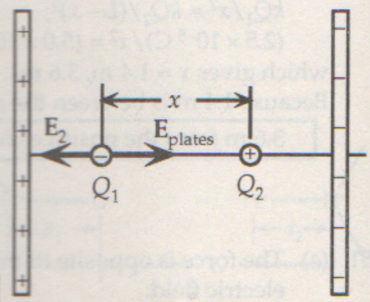
which gives $Q = 5.4\times10^{-6}\ \text{C} = \boxed{5.4\ \mu\text{C}.}$

54. The pea will discharge when the electric field at the surface exceeds the breakdown field. Because we can treat the charge on the pea as a point charge at the center, we have

$E = kQ/r^2$;

$3\times10^6\ \text{N/C} = (9.0\times10^9\ \text{N}\cdot\text{m}^2/\text{C}^2)Q/(0.375\times10^{-2}\ \text{m})^2$, which gives $Q = \boxed{5\times10^{-9}\ \text{C}.}$

55. We find the electric field at the location of Q_1 due to the plates and Q_2.



For the field of Q_2 we have

$E_2 = kQ_2/x^2$

$= (9.0\times10^9\ \text{N}\cdot\text{m}^2/\text{C}^2)(1.3\times10^{-6}\ \text{C})/(0.34\ \text{m})^2$

$= 1.01\times10^5\ \text{N/C}$ (left).

The field from the plates is to the right, so we have

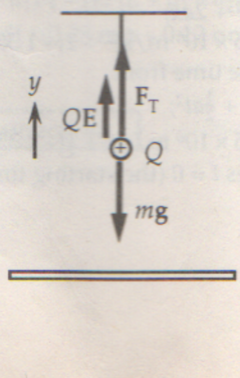
$E_{net} = E_{plates} - E_2$

$= 73{,}000\ \text{N/C} - 1.01\times10^5\ \text{N/C} = -2.8\times10^5\ \text{N/C}$ (left).

For the force on Q_1, we have

$F_1 = Q_1E_{net} = (-6.7\times10^{-6}\ \text{C})(-2.8\times10^5\ \text{N/C}) = \boxed{+0.19\ \text{N (right).}}$

56. We take up as the positive direction and assume that E is up.



From the equilibrium force diagram, we have

$F_T + QE = mg$;

$5.67\ \text{N} + (0.340\times10^{-6}\ \text{C})E = (0.210\ \text{kg})(9.80\ \text{m/s}^2)$,

which gives $E = \boxed{-1.06\times10^7\ \text{N/C (down).}}$