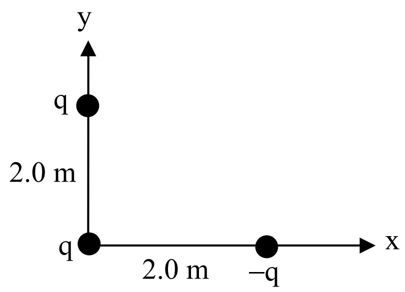
Q1.

Three particles are fixed as shown in Figure 1. If $|q| = 2.0\ \mu C$, what is the net electrostatic force on the particle at the origin? [$\hat{i}$ and $\hat{j}$ are unit vectors along the +x and +y axes, respectively]

Fig#



A) $(9.0\times10^{-3}\ \hat{i} - 9.0\times10^{-3}\ \hat{j})$ N
B) $(1.8\times10^{-2}\ \hat{i} + 1.8\times10^{-2}\ \hat{j})$ N
C) $(-3.0\times10^{-2}\ \hat{i} + 3.0\times10^{-2}\ \hat{j})$ N
D) $(6.4\times10^{-3}\ \hat{i} - 6.4\times10^{-3}\ \hat{j})$ N
E) $(4.6\times10^{-2}\ \hat{i} - 4.6\times10^{-2}\ \hat{j})$ N

Q2.

Two particles are held fixed on an x-axis. Particle 1 of charge $q_1 = -2.1 \times 10^{-8}$ C is at x = 20 cm and particle 2 of charge $q_2 = -4.00q_1$ is at x = 70 cm. At what coordinate on the x-axis is the net electric field produced by the particles equal to zero?

A) −30 cm
B) +30 cm
C) −25 cm
D) +25 cm
E) −20 cm

Q3.

An electric dipole consists of charges -6.0×10^{-6} C and $+6.0 \times 10^{-6}$C separated by a distance of 3.0 mm. Its dipole moment is directed along the +x-axis. This dipole is placed in an electric field of magnitude 46 N/C that makes an angle of 60^o with the +x-axis. What is the magnitude of the torque exerted by the electric field on the dipole?

A) 7.2×10^{-7} N.m.
B) 8.3×10^{-7} N.m.
C) 0 because the net charge is 0.
D) 9.8×10^{-7} N.m.
E) 3.9×10^{-7} N.m.

Q4.
A charged oil drop with a mass of 2×10^{-4} kg is held suspended in equilibrium in the air by a downward electric field of 300 N/C. The charge on the drop is:

A) -6.5×10^{-6} C
B) $+1.5 \times 10^{-6}$ C
C) $+6.5 \times 10^{-6}$ C
D) -1.5×10^{-6} C
E) -4.5×10^{-6} C

Q5.
A charge of 0.80×10^{-9} C is placed at the center of a cube that measures 4.0 m along each edge. What is the electric flux through any two faces of the cube?

A) 30 N · m²/C
B) 45 N · m²/C
C) 90 N · m²/C
D) 23 N · m²/C
E) 64 N · m²/C

Q6.
A positive charge Q = $+5.0 \times 10^{-9}$ C is placed on a conducting spherical shell with inner radius R_1 = 5.0 mm and outer radius R_2 = 6.0 mm. A point charge q = $+1.0 \times 10^{-9}$ C is placed at the center of the shell. The surface charge density on the outer surface of the conducting shell is:

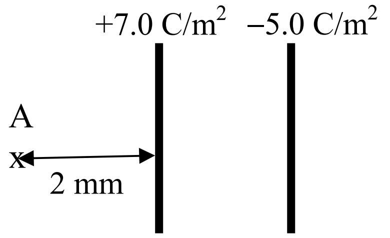
A) $+1.3 \times 10^{-5}$ C/m²
B) -1.3×10^{-5} C/m²
C) $+2.1 \times 10^{-5}$ C/m²
D) -2.1×10^{-5} C/m²
E) $+5.1 \times 10^{-5}$ C/m²

Q7.
A long conducting solid cylinder, with radius R = 10 cm, has a uniform charge density λ = 7.0×10^{-9} C/m. Determine the magnitude of the electric field at a distance r = 12 cm from the axis of the cylinder.

A) 1.1×10^3 N/C
B) 0.55×10^3 N/C
C) 14×10^3 N/C
D) 7.3×10^3 N/C
E) 34×10^3 N/C

Q8.
Consider two non-conducting large parallel plates as shown in Figure 2. What is the magnitude of net electric field at point A?

Fig#



A) 1.1×10^{11} N/C
B) 15×10^{11} N/C
C) 2.3×10^{11} N/C
D) 6.5×10^{11} N/C
E) 5.3×10^{11} N/C

Q9.
A non-conducting sphere of radius R = 7.0 cm carries a charge Q = 5.0×10^{-3} C distributed uniformly throughout its volume. At what distance **within the sphere**, measured from the center of the sphere does the electric field reach a value equal to half its maximum value?

A) 3.5 cm
B) 1.5 cm
C) 5.3 cm
D) 2.5 cm
E) 8.1 cm

Q10.
A system consists of a negatively-charged particle moving in an electric field. When the charged particle moves in the direction of the electric field

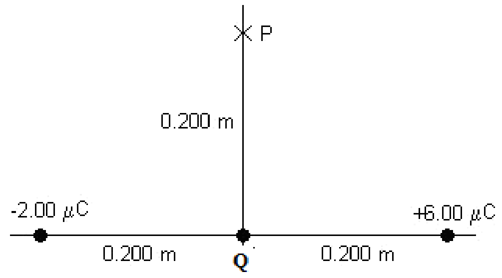
A) The electric potential energy increases.
B) The work done by the electric force on the particle is positive.
C) The electric potential energy decreases.
D) The kinetic energy of the particle increases.
E) The particle acceleration is in the direction of the electric field.

Q11.
If the electric field has magnitude of 200 V/m and makes an angle of 30° with the positive x-axis, what is the potential difference V_B-V_A between point A(0, 0) and point B(3.0 m, 0 m)?

A) − 520 V
B) −350 V
C) + 520 V
D) + 350 V
E) −150 V

Q12.
Three point charges −2.00 μC, Q, and +6.00 μC are fixed along the x-axis as shown in Figure 3. If the net electric potential at point P due to these charges is Zero, the charge Q is:

Fig#



A) –2.83 μC
B) +2.83 μC
C) +5.11 μC
D) −5.11 μC
E) +8.18 μC

Q13.
A +60 × 10^{-6} C charge is held fixed at the origin. If a +10 × 10^{-6} C charge is released from rest at a point x = 40 cm, what is its kinetic energy the instant it passes the point x = 70 cm?

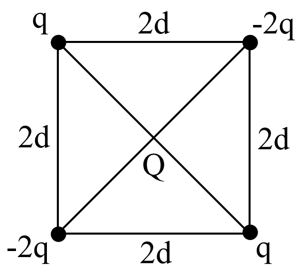
A) 5.8 J
B) 7.4 J
C) 9.3 J
D) 6.9 J
E) 2.5 J

Q14.
A solid conducting sphere of radius 5.0 cm has a charge 0.25 × 10^{-9} C distributed uniformly on its surface. If point A is located at the center of the sphere and point B is 15 cm from the center of the sphere, what is the magnitude of the electric potential difference between these two points?

A) 30 V
B) 23 V
C) 15 V
D) 45 V
E) 60 V

Q15.
In Figure 4, four charges are fixed at the corners of a square whose sides are of length 2d. The work done by an external agent to bring a fifth charge, Q, from infinity to the center of the square as shown in the figure is: (assume the potential at infinity to be zero)

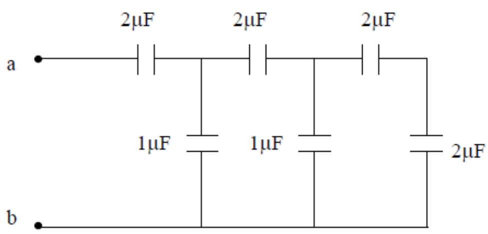
Fig#



A) – 1.4kqQ/d.
B) + 2.8kqQ/d.
C) + 1.4kqQ/d.
D) – 2.8kqQ/d.
E) + 3.4kqQ/d.

Q16.
The equivalent capacitance between points a and b in the combination of capacitors connected as shown in Figure 5 is:

Fig#



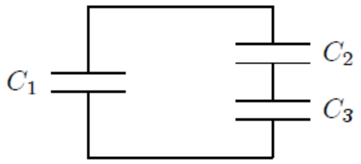
A) 1.0 μF.
B) 2.0 μF.
C) 1.5 μF.
D) 0.5 μF.
E) 3.0 μF.

Q17.
A 2-μF and a 1-μF capacitor are connected in series and a potential difference is applied across the combination. The 2-μF capacitor has:

A) half the potential difference of the 1-μF capacitor
B) half the charge of the 1-μF capacitor
C) twice the potential difference of the 1-μF capacitor
D) twice the charge of the 1-μF capacitor
E) none of the other answers

Q18.
Capacitor C_1 is connected to a battery and charged to 4.0×10^{-8} C. It is then disconnected from the battery and connected to two capacitors C_2 and C_3, as shown in Figure 6. The charge on the positive plate of C_1 is 1.0×10^{-8} C. The charges on the positive plates of C_2 and C_3 are, respectively:

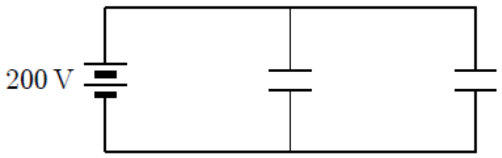
Fig#



A) $q_2 = 3.0 \times 10^{-8}$C and $q_3 = 3.0 \times 10^{-8}$C
B) $q_2 = 4.0 \times 10^{-8}$C and $q_3 = 4.0 \times 10^{-8}$C
C) $q_2 = 3.0 \times 10^{-8}$C and $q_3 = 1.0 \times 10^{-8}$C
D) $q_2 = 2.0 \times 10^{-8}$C and $q_3 = 2.0 \times 10^{-8}$C
E) $q_2 = 1.0 \times 10^{-8}$C and $q_3 = 1.0 \times 10^{-8}$C

Q19.
To store a total of 0.040 J of energy in the two identical capacitors shown in Figure 7, each should have a capacitance of:

Fig#



A) 1.0 μF
B) 0.50 μF
C) 0.10 μF
D) 1.5 μF
E) 2.0 μF

Q20.
A parallel-plate capacitor, of capacitance 1.0×10^{-9} F, with air between the plates, is charged by a battery to a potential difference of 12 V. The battery is then disconnected and a dielectric material with dielectric constant = 4.0 fills the space between the plates. The resulting potential difference, in volts, between the plates is:

A) 3.0
B) 12
C) 4.0
D) 10
E) 5.0

Physics 102
Formula sheet for Second Major

$\hat{i}, \hat{j}$ and $\hat{k}$ are unit vectors along the positive directions of x-axis, y-axis and z-axis respectively.

$F = \frac{kq_1q_2}{r^2}$, $F = q_0 E$

$\Phi = \int_{Surface} \vec{E} \cdot d\vec{A}$, $E = \frac{kq}{r^2}$

$E = \frac{kQ}{R^3} r$, $E = \frac{2k\lambda}{r}$

$\varphi_c = \oint \vec{E}.d\vec{A} = \frac{q_{in}}{\varepsilon_0}$; $E = \frac{\sigma}{2\varepsilon_o}$; $E = \frac{\sigma}{\varepsilon_o}$

$E = \frac{\sigma}{2\varepsilon_o}$, $E = \frac{\sigma}{\varepsilon_o}$

$V = \frac{kQ}{r}$, $W = - \Delta U$

$\Delta V = V_B - V_A = -\int_A^B \vec{E}.d\vec{s} = \frac{\Delta U}{q_0}$

$E_x = -\frac{\partial V}{\partial x}, E_y = -\frac{\partial V}{\partial y}, E_z = -\frac{\partial V}{\partial z}$

$U = \frac{kq_1q_2}{r_{12}}$

$C = \frac{Q}{V}$, $C_o = \frac{\varepsilon_0 A}{d}$, $C = 4\pi\varepsilon_o \frac{ab}{b-a}$,

$U = \frac{1}{2} CV^2$, $u = \frac{1}{2}\varepsilon_o E^2$, $C = \kappa C_0$,

$v = v_o + at$

$x - x_o = v_o t + \frac{1}{2} at^2$

$v^2 = v_o^2 + 2a(x - x_o)$

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N.m^2$
$k = 9.0 \times 10^9\ N.m^2/C^2$
$e = -1.6 \times 10^{-19}\ C$
$m_e = 9.11 \times 10^{-31}\ kg$
$m_p = 1.67 \times 10^{-27}\ kg$
$1\ eV = 1.6 \times 10^{-19}\ J$
$g = 9.8\ m/s^2$

micro (μ) = 10^{-6}
nano (n) = 10^{-9}
pico (p) = 10^{-12}