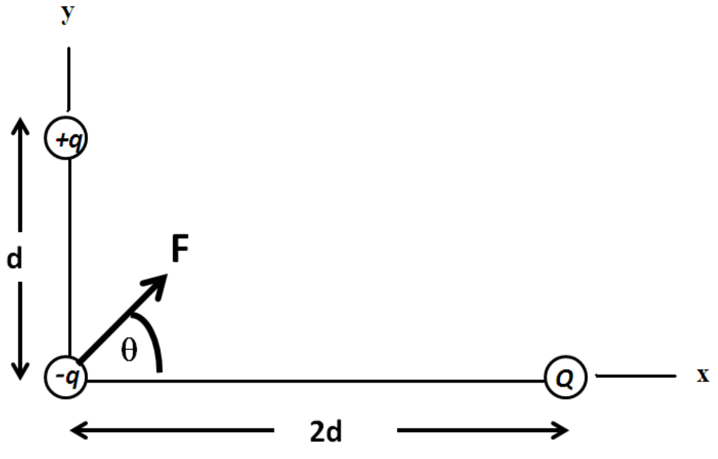
Q1.
Figure 1 shows three charges $+q$,$-q$ and Q along with net force F on charge $-q$. If $\theta = 45°$, the value of charge Q is:

Fig#



A) + 4q
B) – 4q
C) – 3q
D) + 3q
E) + 2q

Sec# Electric Charge - Coulomb's Law
Grade# 50

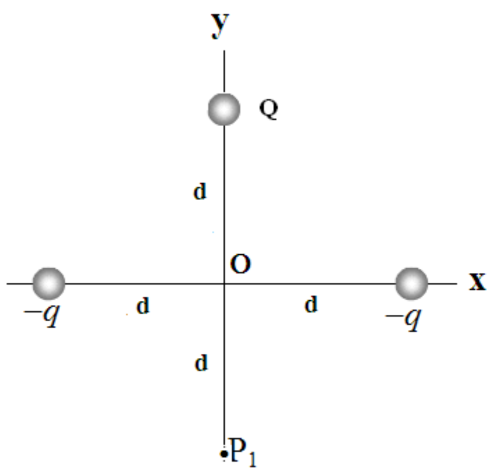
Q2.
Four identical metal spheres (A, B, C, D) have charges of $q_A = -8.0$ μC, $q_B = -2.0$ μC, $q_C = +5.0$ μC, and $q_D = +12.0$ μC. Then, three of the metal spheres are brought together so that they touch each other simultaneously, and then they are separated. Which of the three spheres were touched together, if the final charge on each of the three spheres is + 3.0 μC?

A) A, C, D
B) A, B, C
C) B, C, D
D) A, B, D
E) none of the other answers

Sec# Electric Charge - Charge is Quantized
Grade# 43

Q3.
Three charges ($-q$, $-q$ and Q), with $q = 2.5$ μC, are located at equal distance d from the origin, as shown in **Figure** 2. If the resultant electric field at P_1 due to the three charges is zero, what are the magnitude and sign of charge Q?

Fig#



A) + 7.1 μC
B) + 1.7 μC
C) – 7.1 μC
D) – 1.7 μC
E) + 2.5 μC

Sec# Electric fields - The Electric Field Due to a Point Charge
Grade# 43

Q4.
An electron enters a region of uniform electric field with an initial velocity of 4.2 km/s in the same direction as the electric field, which has a magnitude of 12 N/C. What is the speed of the electron 2.0 ns after entering this region?

A) 0.0 km/s
B) 2.2 km/s
C) 1.3 km/s
D) 3.3 km/s
E) 1.7 km/s

Sec# Electric fields - A point Charge in an Electric Field
Grade# 48

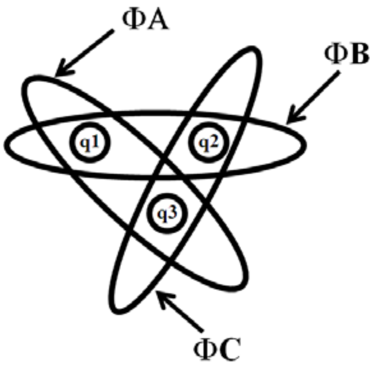
Q5.
A torque of magnitude 0.1 N.m. has been applied to orient an electric dipole at a particular angle with respect to a uniform electric field. When the dipole moment is oriented along the field, the electric potential energy of the dipole is – 0.2 J. What was the initial angle between the dipole moment and the electric field?

A) 30°
B) 90°
C) 45°
D) 10°
E) 0

Sec# Electric fields - A Dipole in an Electric Field
Grade# 48

Q6.
Figure 3 shows three Gaussian surfaces A, B and C, with corresponding electric flux $\Phi_A = -q/\varepsilon_0$, $\Phi_B = +3q/\varepsilon_0$ and $\Phi_C = -2q/\varepsilon_0$ through them, respectively. What is the value of the charge q_1?

Fig#



A) +2q
B) +q
C) −3q
D) +3q
E) −2q

Sec# Gauss's law - Gauss's Law
Grade# 48

Q7.
A charged conducting spherical shell has an inner radius of 6.0 cm and an outer radius of 10 cm. A point charge is placed at the center of the shell such that the resulting surface charge densities on the inner and outer surfaces of the shell are –100 nC/m^2 and +100 nC/m^2, respectively. What is the electric field at a distance of 12 cm from the center of the shell?

A) 7.9×10^3 N/C , outward
B) 7.9×10^3 N/C , inward
C) 9.7×10^3 N/C , outward
D) 9.7×10^3 N/C , inward
E) 5.3×10^3 N/C , outward

Sec# Gauss's law - A Charged Isolated Conductor
Grade# 50

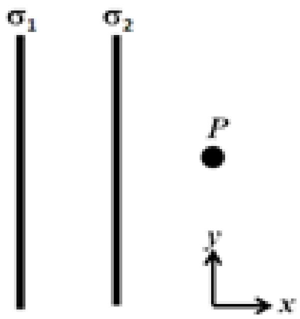
Q8.
An electron experiences a force of magnitude F when it is 2 cm away from a very long, charged wire that has a uniform linear charge density $+\lambda$. If the linear charge density is increased to $+2\lambda$, at what distance from the wire will the electron experience a force of the same magnitude F?

A) 4 cm
B) 1 cm
C) 3 cm
D) 2 cm
E) 6 cm

Sec# Gauss's law - Applying Gauss's Law: Cylindrical Symmetry
Grade# 55

Q9.
Figure 4 shows cross sections through two large parallel non-conducting sheets with surface charge densities $\sigma_1 = -1.8\ \mu C/m^2$ and $\sigma_2 = +1.2\ \mu C/m^2$. What is the electric field at point P (in units of 10^4 N/C)?

Fig#



A) $-3.4\,\hat{\mathbf{i}}$
B) $-6.8\,\hat{\mathbf{i}}$
C) $+3.4\,\hat{\mathbf{i}}$
D) $+6.8\,\hat{\mathbf{i}}$
E) $+1.7\,\hat{\mathbf{i}}$

Sec# Gauss's law - Applying Gauss's Law: Planar Symmetry
Grade# 55

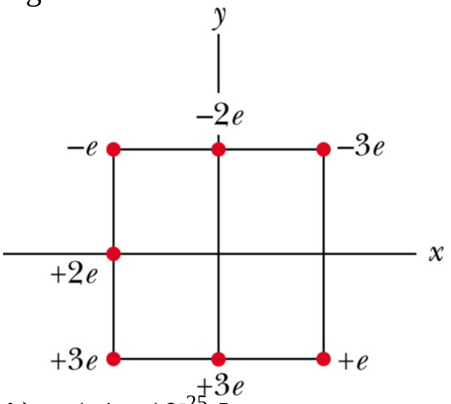
Q10.
A uniformly charged solid insulating sphere has a radius of 5.0 cm. If the magnitude of the electric field due to this sphere at r = 8.0 cm is 2.0×10^5 N/C, what is the magnitude of the field at r = 3.0 cm? [r is the distance from the center of the sphere]

A) 3.1×10^5 N/C
B) 1.8×10^5 N/C
C) 9.0×10^4 N/C
D) 2.7×10^5 N/C
E) 7.2×10^5 N/C

Sec# Gauss's law - Applying Gauss's Law: Spherical Symmetry
Grade# 50

Q11.
In **Figure** 5, seven charged particles are fixed in place to form a square with an edge length of 5.0 cm. How much work must we do to bring a particle of charge + 5*e* initially at rest from an infinite distance to the center of the square?

Fig#



A) $+ 1.4 \times 10^{-25}$ J
B) $- 1.4 \times 10^{-25}$ J
C) $- 2.8 \times 10^{-25}$ J
D) 0
E) $+ 2.8 \times 10^{-25}$ J

Sec# Electric Potential - Electric Potential Energy of a System of Point Charges
Grade# 55

Q12.
In a certain region of space, the electric field is given by $\vec{\mathbf{E}} = 0.40\, x\ \hat{\mathbf{i}}$ (N/C). If the electric potential at the origin is + 5.0 V, what is the electric potential at the point (3.0, 0, 0) m?

A) + 3.2 V
B) + 1.8 V
C) – 1.8 V
D) + 6.8 V
E) – 6.2 V

Sec# Electric Potential - Calculating the Potential from the Field
Grade# 45

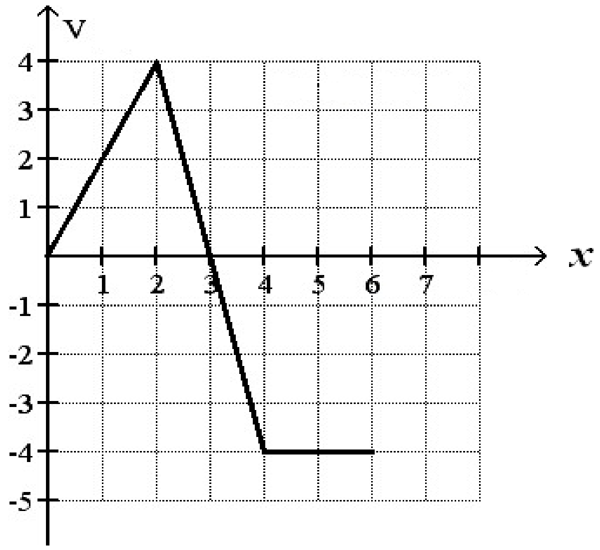
Q13.
Two point charges lie along the *x* axis. One charge (q_1), located at the origin, has a magnitude of + 2*q*. The other charge (q_2) is located at *x* = + 5 cm. If the electric potential, due to the two charges, at *x* = + 4 cm is equal to zero, what are the magnitude and sign q_2?

A) – *q*/2
B) – *q*/4
C) – 2*q*
D) + *q*/2
E) + 2*q*

Sec# Electric Potential - Potential Due to a Point Charge
Grade# 50

Q14.
In a certain situation, the electric potential varies along an *x* axis as shown in **Figure** 7. For which range of *x* is the magnitude of the electric field the largest?

Fig#



A) from x = 2 to x = 4
B) from x = 4 to x = 6
C) from x = 0 to x = 2
D) from x = 5 to x = 6
E) from x = 0 to x = 1

Sec# Electric Potential - calculating the Field from the Potential
Grade# 58

Q15.
Two particles have the same charge of +1 μC. Initially, they are held at rest, separated by a distance d = 1 cm. One of the particles is released and moves away from the other fixed particle. When the moving particle is a distance of $3d$ from the other particle, what is its kinetic energy?

A) 0.6 J
B) 0.2 J
C) 0.3 J
D) 0.1 J
E) 0.0 J

Sec# Electric Potential - Electric Potential Energy of a System of Point Charges
Grade# 53

Q16.

A conducting sphere of radius 16 cm has a net charge of 2.0×10^{-8} C. If the electric potential is zero at infinity, at what distance from the sphere's surface has the electric potential decreased by 500 V from its value on the surface?

A) 13 cm
B) 29 cm
C) 36 cm
D) 11 cm
E) 22 cm

Sec# Electric Potential - Potential of a Charged Isolated Conductor
Grade# 50

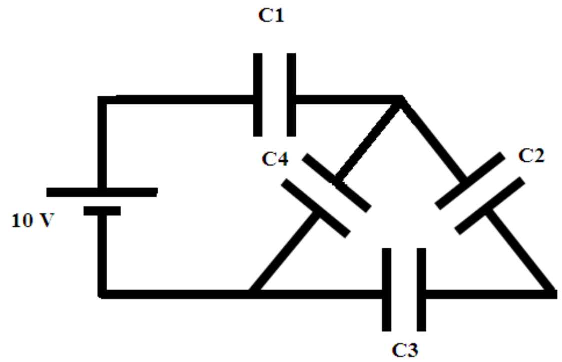
Q17.
The potential difference between the plates of a parallel plate capacitor is 35 V, and the electric field between the plates has a magnitude of 750 V/m. If the plate area is 400 cm^2, what is the capacitance of this capacitor?

A) 7.6×10^{-12} F
B) 7.6×10^{-14} F
C) 7.6×10^{-11} F
D) 7.6×10^{-10} F
E) None of the other choices is correct

Sec# Capacitance - Calculating the Capacitance
Grade# 55

Q18.
Four capacitors, with capacitances $C_1 = 3.0$ μF, $C_2 = 2.0$ μF, $C_3 = 5.0$ μF, and $C_4 = 4.0$ μF, are connected in a circuit to a 10 V battery, as shown in **Figure** 6. How much energy is stored by the combination?

Fig#



A) 97 μJ
B) 64 μJ
C) 53 μJ
D) 59 μJ
E) 25 μJ

Sec# Capacitance - Capacitors in Parallel and in Series
Grade# 50

Q19.
When the potential difference between the plates of a parallel-plate capacitor is *V*, the energy density in the capacitor is *u*. If the potential difference is doubled, which of the following changes would keep the energy density equal to its previous value *u*?

A) doubling the spacing between the plates
B) doubling the area of the plates
C) reducing the area of the plates by half
D) reducing the spacing between the plates
E) The energy density is unaffected by a change in the potential difference.

Sec# Capacitance - Energy stored in an Electric Field
Grade# 50

Q20.
An isolated parallel-plate capacitor stores an energy of 3.4 J. How much work is required by an external agent to insert a dielectric of dielectric constant $\kappa = 2.8$ between the plates of the capacitor?

A) – 2.2 J
B) + 2.2 J
C) – 1.2 J
D) + 1.2 J
E) – 3.5 J

Sec# Capacitance - Capacitor with a Dielectric
Grade# 43

Test Expected Average = 50

$F = k\dfrac{q_1 q_2}{r^2}$ $U = -\vec{P}\cdot\vec{E}$ $\vec{\tau} = \vec{P}\times\vec{E}$ $\Phi = \int_{\text{Surface}} \vec{E}.d\vec{A}$ $\Phi_c = \oint \vec{E}.d\vec{A} = \dfrac{q_{in}}{\varepsilon_0}$ $E = \sigma / 2\varepsilon_o$ $E = \sigma / \varepsilon_o$ $E = k\dfrac{q}{r^2}$ $E = k\dfrac{q}{R^3} r$ $E = \dfrac{2k\lambda}{r}$ $\Delta V = V_B - V_A = -\int_A^B \vec{E}.d\vec{S} = \dfrac{\Delta U}{q_0}$ $V = k\dfrac{q}{r}$ $E_x = -\dfrac{\partial V}{\partial x}, \quad E_y = -\dfrac{\partial V}{\partial y}, \quad E_z = -\dfrac{\partial V}{\partial z}$ $U = k\dfrac{q_1 q_2}{r_{12}}$ $C = \dfrac{q}{V}$ $C = \kappa C_{air}$ $U = \dfrac{1}{2}CV^2$	$v = v_o + at$ $x - x_o = v_o t + \dfrac{1}{2} a t^2$ $v^2 = v_o^2 + 2a(x - x_o)$ **<u>Constants:</u>** $k = 9.00 \times 10^9\ N.m^2/C^2$ $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N.m^2$ $e = 1.60 \times 10^{-19}\ C$ $m_e = 9.11 \times 10^{-31}\ kg$ $m_p = 1.67 \times 10^{-27}\ kg$ $g = 9.8\ m/s^2$ μ = micro = 10^{-6} n = nano = 10^{-9} p = pico = 10^{-12}