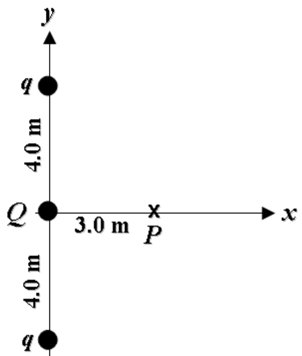
Q1.
Three point charges are fixed on the *x* axis. Charge q_1 is at $x = +1$ m, charge q_2 is at $x = 0$, and charge q_3 is at $x = -1$ m. For the net electrostatic force on q_3 to be zero:

A) q_1 and q_2 must have opposite signs and $|q_1| > |q_2|$.
B) q_1 and q_2 must have the same sign and $|q_1| > |q_2|$.
C) q_1 and q_2 must have opposite signs and $|q_1| < |q_2|$.
D) q_1 and q_2 must have the same magnitude and have the same sign.
E) q_1 and q_2 must have opposite signs and their magnitudes depend on q_3.

Q2.
Three point charges are fixed on the y axis, as shown in Figure 1, with $q = +1.0$ μC. The net electric field at point *P* is zero. What is the charge Q?

Fig#



A) − 0.43 μC
B) + 0.43 μC
C) + 0.22 μC
D) − 0.22 μC
E) − 2.0 μC

Q3.
An electron is initially moving with velocity $\vec{v} = +5.0\times10^6\,\hat{i}\ (m/s)$. What electric field is needed to momentarily stop the electron in a distance of 3.0 cm?

A) $+ 2.4\,\hat{i}$ kN/C
B) $- 2.4\,\hat{i}$ kN/C
C) $+ 7.6\,\hat{i}$ kN/C
D) $- 7.6\,\hat{i}$ kN/C
E) $+ 1.3\,\hat{i}$ kN/C

Q4.
An electric dipole consists of two opposite charges, each of magnitude 2.0 nC. A uniform electric field of magnitude 300 N/C makes an angle of 25° with the dipole moment of the dipole. If the torque exerted by the field has a magnitude of 2.5×10^{-11} N.m, the distance between the two charges of the dipole is:

A) 99 μm
B) 46 μm
C) 18 μm
D) 38 μm
E) 53 μm

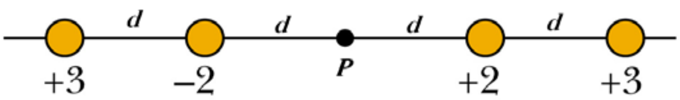
Q5.
Positive charge q is distributed uniformly throughout an insulating sphere of radius R, centered at the origin. A particle with a positive charge q is placed at $x = 2R$ on the x axis. The magnitude of the electric field at $x = R/2$ on the x axis is:

A) $q/72\pi\varepsilon_o R^2$
B) $q/9\pi\varepsilon_o R^2$
C) $q/8\pi\varepsilon_o R^2$
D) $17q/72\pi\varepsilon_o R^2$
E) zero

Q6.
Figure 2 shows the cross sections of four very long rods that extend into and out of the page. The value below each rod is the uniform linear charge density λ in units of μC/m, and the distance d = 1.0 cm. What is the net electric field at point P?

Fig#

#:



A) -7.2×10^6 i (N/C)
B) $+7.2 \times 10^6$ i (N/C)
C) -1.1×10^7 i (N/C)
D) $+1.1 \times 10^7$ i (N/C)
E) Zero

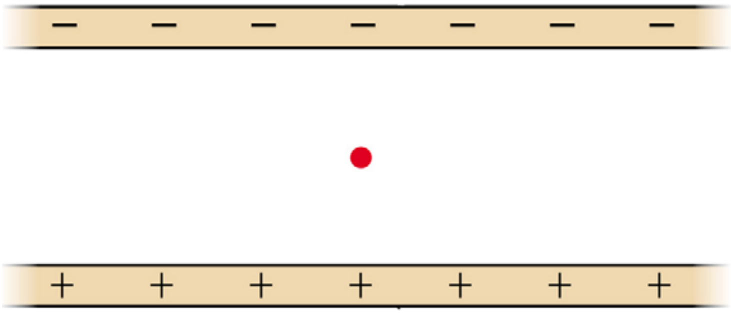
Q7.
A point charge $q = +4.00$ μC is placed at the center of a conducting spherical shell. The net electric flux outside the shell is -1.00×10^6 N.m^2/C. What is the net charge of the shell?

A) −12.9 μC
B) − 4.85 μC
C) + 4.85 μC
D) − 8.85 μC
E) + 8.85 μC

Q8.

Two infinite insulating sheets carry equal but opposite surface charge densities. A particle (q = + 1.0 nC, $m = 3.5 \times 10^{-6}$ kg) is at rest in the middle between the two plates (see Figure 3). What is the uniform surface charge density of each plate?

Fig#



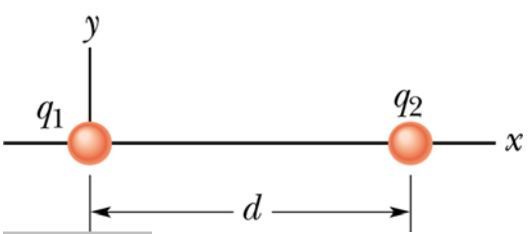
A) 3.0×10^{-7} C/m^2
B) 6.1×10^{-7} C/m^2
C) 1.5×10^{-7} C/m^2
D) 7.5×10^{-8} C/m^2
E) 9.1×10^{-7} C/m^2

Q9.
A uniform electric field is given by $\vec{\mathbf{E}} = 12\,\hat{\mathbf{i}}$ (N/C). The coordinates (in meters) of two points in the xy plane are P_1 = (– 2.0, + 1.0) and P_2 = (+ 1.0, + 5.0). What is the potential difference $V_1 - V_2$?

A) + 36 V
B) – 36 V
C) – 12 V
D) + 12 V
E) + 48 V

Q10.
In Figure 4, particles of charges $q_1 = +5e$ and $q_2 = -15e$ are fixed in place with separation d. With $V = 0$ at infinity, at what point between the two particles and on the x axis is the net electric potential zero? [$e = 1.6 \times 10^{-19}$ C]

Fig#



A) $x = d/4$

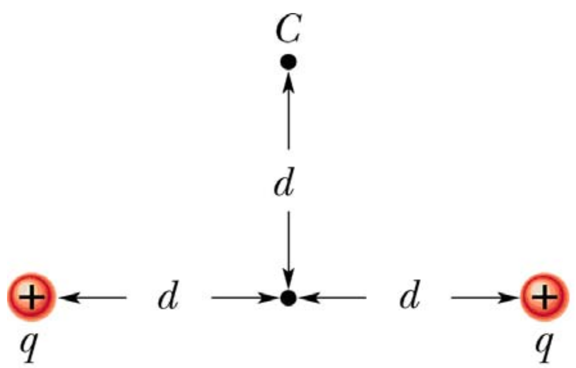
B) $x = 3d/4$
C) $x = d/8$
D) $x = 3d/8$
E) $x = d/2$

Q11.
A conducting spherical shell has a radius of 0.800 m and carries a net charge of + 2.00 μC. Point A is a distance $r_A = 0.500$ m from the center of the shell, and point B is a distance $r_B =$ 1.50 m from the center of the shell. Take $V = 0$ at infinity. What is the electric potential difference $V_B - V_A$?

A) – 10.5 kV
B) + 10.5 kV
C) + 34.5 kV
D) – 34.5 kV
E) zero

Q12.
Two charges $q = + 2.0$ μC are fixed a distance $2d = 2.0$ cm apart (see Figure 5). With V = 0 at infinity, how much work needs to be done by an external agent to move one of the charges to point C?

Fig#



A) + 0.75 J
B) – 0.75 J
C) + 3.6 J
D) – 3.6 J
E) + 37 J

Q13.
In a certain region of space the electric potential increases uniformly from east to west, and does not vary in any other direction. The electric field:

A) points east and does not vary with position.
B) points east and varies with position.
C) points west and varies with position.

D) points west and does not vary with position.
E) points north and does not vary with position.

Q14.
The capacitance of a parallel-plate capacitor is

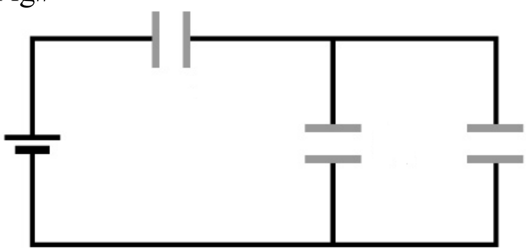
A) proportional to the plate area.
B) proportional to the stored charge.
C) independent of any material inserted between the plates.
D) proportional to the potential difference between the plates.
E) proportional to the plate separation.

Q15.
A capacitor is charged using a battery, and the energy stored in it is U_i. The battery is disconnected and then the charged capacitor is connected to an identical uncharged capacitor. The energy stored by the two capacitors is U_f. Which of the following is CORRECT?

A) $U_f = U_i/2$
B) $U_f = U_i$
C) $U_f = U_i/4$
D) $U_f = 4\ U_i$
E) $U_f = 2\ U_i$

Q16.
Three identical capacitors, each with a capacitance of 6.0 μF, are connected to a 50-V battery as shown in Figure 6. What is the charge stored by the system?

Fig#



A) 200 μC
B) 450 μC
C) 100 μC
D) 900 μC
E) 600 μC

Q17.
A 9.0 pF air-filled capacitor is required to store an energy of 7.4 μJ with a potential difference of 650 V. To do that, a dielectric should be inserted between the plates of the capacitor. What is the dielectric constant?

A) 3.9
B) 2.4
C) 4.7
D) 8.8
E) 5.4

Q18.
An electric current of 0.35 A passes through a cylindrical copper wire of cross sectional area 3.1×10^{-6} m^2. What is the magnitude of the electric filed inside the wire? The resistivity of copper is 1.7×10^{-8} Ω.m.

A) 1.9×10^{-3} V/m
B) 1.5×10^{-13} V/m
C) 6.4×10^{1} V/m
D) 1.8×10^{-14} V/m
E) 0

Q19.
A copper wire has an initial resistance of 100 Ω, and is connected to a 5.0 V battery. The temperature coefficient of resistivity of copper is $\alpha = 4.3 \times 10^{-3}$ (°C)$^{-1}$. If the wire is cooled by 50 C°:

A) The power dissipated in the wire will increase by 68 mW.
B) The power dissipated in the wire will decrease by 68 mW.
C) The power dissipated in the wire will increase by 47 mW.
D) The power dissipated in the wire will decrease by 47 mW.
E) The power dissipated will not change.

Q20.
A 10-Ω resistor has a constant current passing through it. If 1200 C of charge pass through the resistor in 5.0 minutes, what is the magnitude of the potential difference applied to the resistor?

A) 40 V
B) 2.5 V
C) 0.40 V
D) 25 V
E) 4.0 V

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.

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

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

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

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

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

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

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

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

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

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

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

$I = \frac{dQ}{dt}$, $I = J A$,

$R = \frac{V}{I} = \rho \frac{L}{A}$

$\rho = \rho_0 [1 + \alpha(T - T_0)]$, $P = IV$

$v = v_o + at$

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

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

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N.m^2$

$k = 9.0 \times 10^9\ N.m^2/C^2$

$e = -1.6 \times 10^{-19}$ C

$m_e = 9.11 \times 10^{-31}$ kg

$m_p = 1.67 \times 10^{-27}$ kg

1 eV = 1.6×10^{-19} J

g = 9.8 m/s^2

micro (μ) = 10^{-6}

nano (n) = 10^{-9}

pico (p) = 10^{-12}