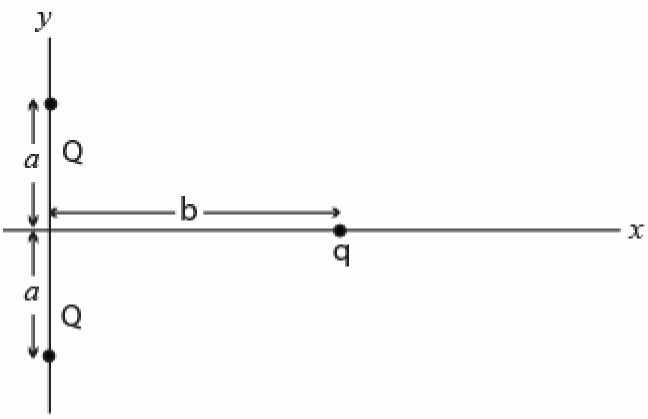
Q1.
In figure 1, Q = 60 μC, q = 20 μC, a = 3.0 m, and b = 4.0 m. Calculate the total electric force on q due to the other 2 charges.

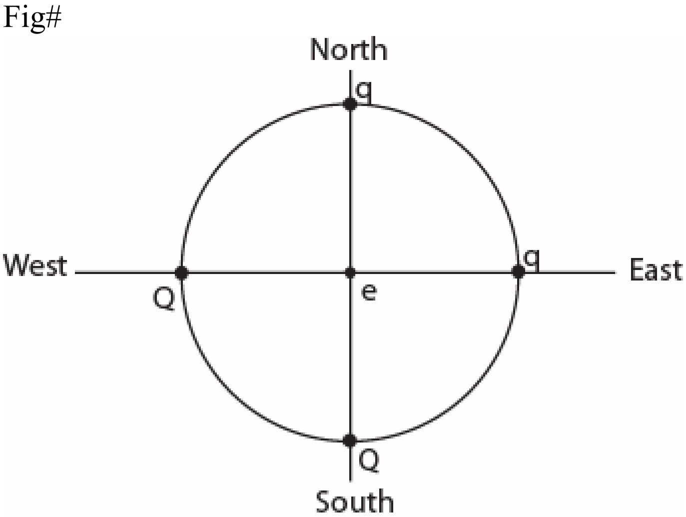
Fig#



A) 0.69 $\hat{i}$ (N)
B) 1.12 $\hat{j}$ (N)
C) –0.34 $\hat{i}$ (N)
D) –0.69 $\hat{i}$ (N)
E) 0.34 $\hat{i}$ (N)

Q2.
In figure 2, four positive charges are placed on the circumference of a circle of diameter 2.0 m and fixed at their positions. If an electron is placed at the center of the circle, then the electron will [Take Q = 60 μC, q = 20 μC].

Fig#



A) move South West.
B) move North East.
C) move toward the West.
D) move toward the South.

E) stay at the center.

Q3.

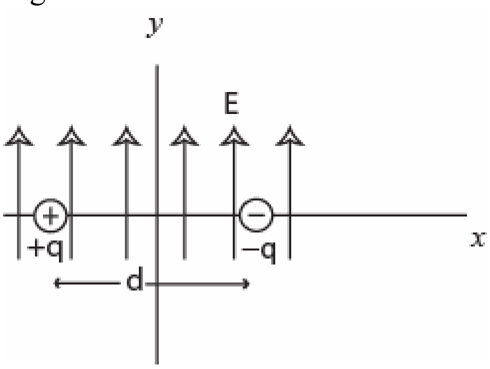
A proton enters a region of uniform electric field $\vec{E} = 80\ \hat{j}$ (N/C) with an initial velocity $\vec{v} = 20\ \hat{i}$ (km/s). What is the speed of the proton 2.0 μs after entering this region?

A) 25 km/s
B) 15 km/s
C) 42 km/s
D) 35 km/s
E) 4.7 km/s

Q4.

An electric dipole consists of two opposite charges, each of magnitude 5.00×10^{-19} C, separated by a distance d = 1.00×10^{-9} m. The dipole is placed in a uniform electric field of strength 2.45×10^{5} N/C. Calculate the torque exerted on the dipole when the dipole moment is perpendicular to the electric field as shown in figure 3.

Fig#



A) 1.23×10^{-22} N.m. into the page.
B) 5.20×10^{-19} N.m. out of the page.
C) 2.00×10^{-22} N.m. into the page.
D) 2.00×10^{-22} N.m. out of the page.
E) 5.20×10^{-19} N.m. into the page.

Q5.

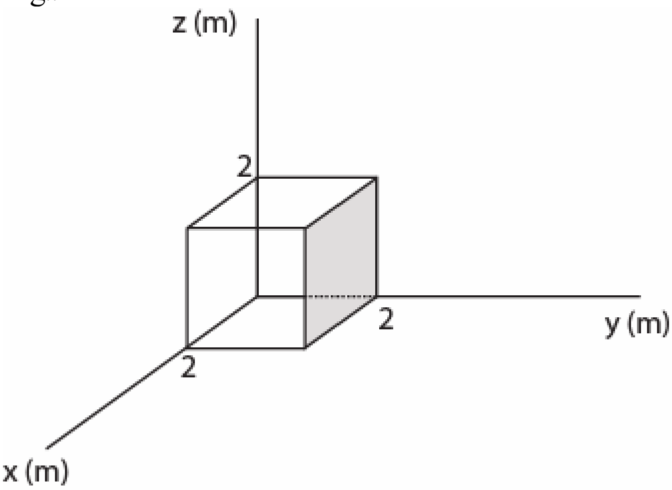
Consider a conducting neutral spherical shell having an inner radius of 3.70 cm and an outer radius of 4.50 cm. A positive point charge q is placed at the center of the shell. The magnitude of the electric field a distance 5.00 cm from the center of the shell is 2500 N/C. Calculate the magnitude of the charge density on the outer surface of the shell.

A) 2.73×10^{-8} C/m^2
B) 1.34×10^{-8} C/m^2
C) 5.16×10^{-8} C/m^2
D) 6.10×10^{-7} C/m^2

E) Zero

Q6.
Figure 7 shows a Gaussian cube of side 2.0 m. The cube is placed in a non-uniform electric field $\vec{E} = 24\,\hat{i} + 30y\,\hat{j} + 16\,\hat{k}$. The electric flux (in N.m^2/C) through the shaded face is:

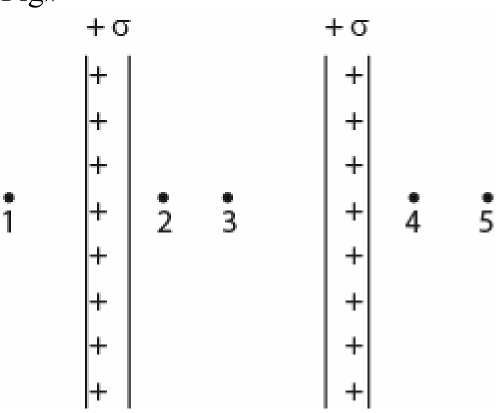
Fig#



A) 240
B) 960
C) 640
D) 140
E) Zero

Q7.
Two large thin non-conducting parallel sheets carry positive charges of equal magnitude that are distributed uniformly over their outer surfaces as shown in figure 8. Rank the points 1 through 5 according to the magnitude of the electric field at the points, greatest to least.

Fig#

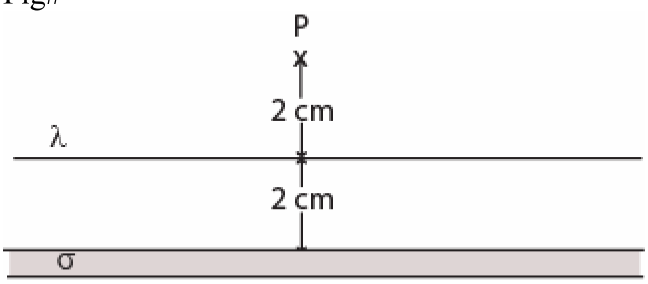


A) 1, 4, and 5 tie, then 2 and 3 tie.
B) 2, 3, 1, 4, 5.
C) 1, 2, 3, 4, 5.

D) 2 and 3 tie, then 1 and 4 tie, then 5.
E) 2 and 3 tie, then 1, 4, and 5 tie.

Q8.
Consider an infinitely large non-conducting flat sheet carrying a uniform charge density σ = +20 nC/m^2 and a long thin wire carrying a uniform charge density λ = –2.0 nC/m arranged as shown in figure 4. The magnitude of the net electric field due to these two charge distributions at point P is

Fig#



A) 670 N/C
B) 450 N/C
C) 240 N/C
D) 120 N/C
E) 930 N/C

Q9.
A non-conducting solid sphere of radius R = 10.0 cm has a uniformly distributed charge Q = $+1.50\times10^{-6}$ C. Find the magnitude of the potential difference between a point at r = 50.0 cm and a point on the surface of the sphere.

A) 108 kV
B) 207 kV
C) 98.0 kV
D) 340 kV
E) 42.0 kV

Q10.
A proton is released from rest in a uniform electric field of magnitude 8.0×10^{4} V/m directed along the positive x-axis. The proton undergoes a displacement of 0.50 m along the direction of the field. Calculate the change in the potential energy of the proton.

A) – 40 keV
B) 40 keV
C) – 20 keV
D) 20 keV
E) Zero

Q11.
Consider two concentric conducting thin spherical shells. The first one has a radius $R_1 = 10.0$ cm and carries a charge $Q_1 = +5.00\ \mu C$ and the second shell has a radius $R_2 = 20.0$ cm and carries a charge $Q_2 = -10.0\ \mu C$. Calculate the potential at a distance of 10.0 cm from the center of the shells. Take the potential to be zero at infinity.

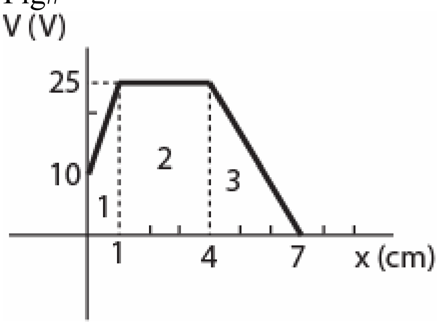
A) Zero
B) – 900 kV
C) + 900 kV
D) 450 kV
E) – 450 kV

Q12.
A particle of charge 3.1 μC is fixed at point P, and a second particle of mass $m = 2.0\times10^{-5}$ kg and same charge is initially held a distance $r_1 = 0.90$ mm from P. The second particle is then released from rest. Determine its speed when it is at a distance $r_2 = 2.5$ mm from P.

A) 2.5 km/s
B) 3.5 km/s
C) 1.5 km/s
D) 4.5 km/s
E) 0.50 km/s

Q13.
In a certain situation, the electric potential varies along an x axis as shown in figure 5 Rank the three regions, shown in the figure, according the magnitude of the x-component of the electric field within them greatest first.

Fig#



A) 1, 3, then 2
B) 1, 2, then 3
C) 3, 1, then 2
D) 2, 3, then 1
E) 3, 2, then 1

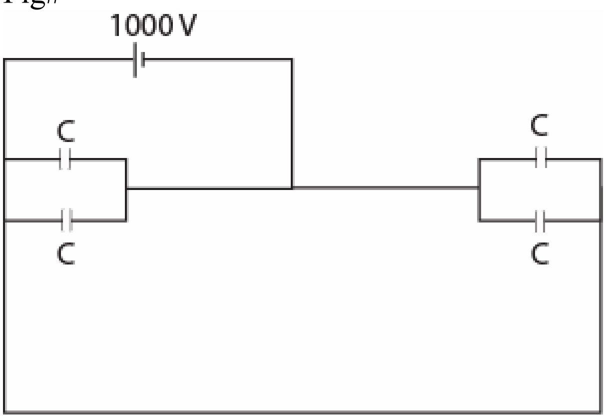
Q14.

A 2.0-μF capacitor and a 1.0-μF capacitor are connected in series and a potential difference of 12 V is applied across the combination. What is the potential difference across the 2.0-μF capacitor?

A) 4.0 V
B) 12 V
C) 3.0 V
D) 6.0 V
E) 8.0 V

Q15.
Each capacitance of the four identical capacitors shown in figure 6 is 500 μF. They are connected to a 1000 V battery as shown in the figure. What is the magnitude of the charge on each capacitor plate?

Fig#



A) 0.50 C
B) 0.20 C
C) 20 C
D) 50 C
E) 1.0 C

Q16.
Capacitors A and B are identical. Capacitors A is charged so that it stores 4.0 J of energy and capacitor B is uncharged. The capacitors are then connected in parallel. The total energy stored in the capacitors is now:

A) 2.0 J
B) 4.0 J
C) 1.0 J
D) 8.0 J
E) 16 J

Q17.

One of the materials listed below is to be placed between two identical metals sheets, of area A, with no air gap, to form a parallel-plate capacitor. Which of the following materials will produce the greatest capacitance?

A) a material of thickness 0.5 mm and dielectric constant 11.
B) a material of thickness 0.2 mm and dielectric constant 3.
C) a material of thickness 0.3 mm and dielectric constant 2.
D) a material of thickness 0.5 mm and dielectric constant 8.
E) a material of thickness 0.2 mm and dielectric constant 2.

Q18.
A certain resistor dissipates 0.500 W when connected to a 3.00 V potential difference. When connected to a 1.00 V potential difference, this resistor will dissipate:

A) 0.0556 W
B) 0.500 W
C) 0.167 W
D) 1.50 W
E) 3.00 W

Q19.
How much would the temperature of a copper wire have to be increased to raise its resistance by 20% over the value it had at 20 ^{o}C? The temperature coefficient of resistivity of copper is 0.0040 $(C^{o})^{-1}$. Neglect any change in length or cross sectional area due to the change in temperature.

A) 50 C^{o}
B) 300 C^{o}
C) 80 C^{o}
D) 260 C^{o}
E) 75 C^{o}

Q20.
Two light bulbs operate from a 120-V voltage source. Bulb A has a power rating of 25.0 W and bulb B has a power rating of 100 W. Which of the following statements is CORRECT?

A) Resistance of A is larger than resistance of B.
B) Resistance of A is smaller than resistance of B.
C) The current through A is higher than the current through B.
D) The resistances of the two bulbs are the same.
E) The currents through the two bulbs are the same.

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.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$v = v_o + at$

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

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

$\varepsilon_0 = 8.85 \times 10^{-12}$ $C^2/N.m^2$
$k = 9.0 \times 10^9$ $N.m^2/C^2$
$e = -1.6 \times 10^{-19}$ 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}