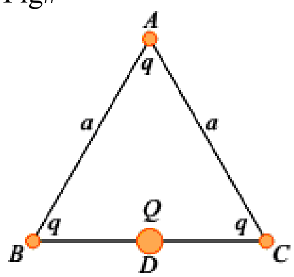
Q1.
An equilateral triangle has a point charge $+q$ at each of the three vertices (A, B, C) as shown in **FIGURE 1**. Another point charge Q is placed at D, the midpoint of the side BC. What is Q if the net electrostatic force on the charge at A due to the charges at B, C, and D is zero?

Fig#



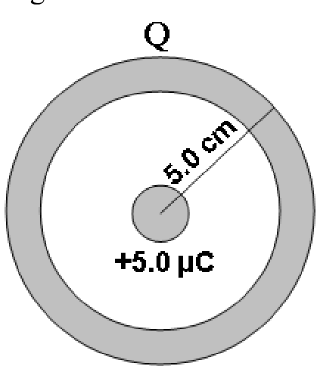
A) $-1.3q$
B) $+2.1q$
C) $-4.1q$
D) $+3.4q$
E) $+1.3q$

Q2.
Two identical conducting spheres A and B carry equal charges and exert electrostatic forces of magnitude F on each other. They are separated by a distance much larger than their diameters. A third identical conducting sphere C is uncharged. Sphere C is first touched to A, then to B, and finally removed. As a result, the electrostatic force between A and B becomes:

A) 3F/8
B) F/4
C) F/2
D) F/16
E) F/8

Q3.
A conducting shell of outer radius 5.0 cm carries a net charge Q = +10 μC. Then a point charge of +5.0 μC is placed at its center as shown in **FIGURE 2**. Find the surface charge density on the ***outer surface*** of the spherical shell.

Fig#



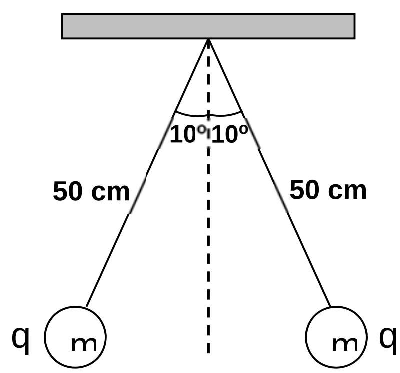
A) $\frac{3\times10^{-2}}{20\pi}$ C/m^2
B) $\frac{1\times10^{-2}}{10\pi}$ C/m^2
C) $\frac{1\times10^{-6}}{20\pi}$ C/m^2
D) $\frac{3\times10^{-2}}{4\pi}$ C/m^2
E) $\frac{1\times10^{-4}}{2\pi}$ C/m^2

Q4.
A point charge of +5 μC is located on the x axis at $x = -3.00$ cm and a second charge of – 8.00 μC is located on the x axis at $x = + 4.00$ cm. Where a third charge of + 6.0 μC should be placed so the net electric field at the origin is zero?

A) $x = +2.38$ cm
B) $x = -2.38$ cm
C) $x = +10.4$ cm
D) $x = -10.4$ cm
E) $x = +4.00$ cm

Q5.
Two small identical metallic spheres, each of mass m = 0.20 g, are suspended as pendulum by light strings as shown in **FIGURE 3**. The spheres are given the same electric charge q, and it is found that they come to equilibrium when each string is at angle of θ = 10º with the vertical. If the string has length L = 50.0 cm, what is the **magnitude** of the charge on each sphere?

Fig#

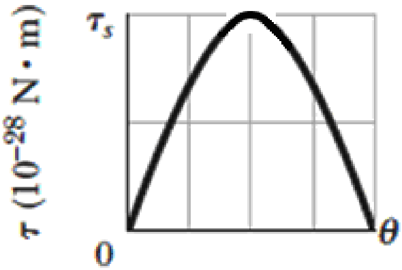


A) 3.4×10^{-8} C
B) 2.0×10^{-7} C
C) 20×10^{-6} C
D) 5.3×10^{-8} C
E) 4.5×10^{-8} C

Q6.

A certain electric dipole is placed in a uniform electric field $\vec{E}$ of magnitude 50 N/C. **FIGURE 4** gives the magnitude τ of the torque on the dipole versus the angle θ between the electric field and the dipole moment $\vec{p}$. The vertical scale is set by $\tau_s = 200\times10^{-28}$ N.m. What is the **magnitude** of $\vec{p}$?

Fig#

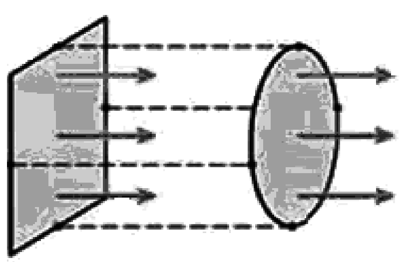


A) 4.0×10^{-28} C.m
B) 2.0×10^{-28} C.m
C) 1.0×10^{-24} C.m
D) 2.5×10^{-28} C.m
E) 3.2×10^{-24} C.m

Q7.

The square and circle in **FIGURE 5** are in the same uniform electric field which is perpendicular to both the square and circle. The diameter of the circle equals the edge length of the square. Find the ratio of the electric flux through the square Φ_s to the circle Φ_c (i.e. $\Phi s/\Phi c$).

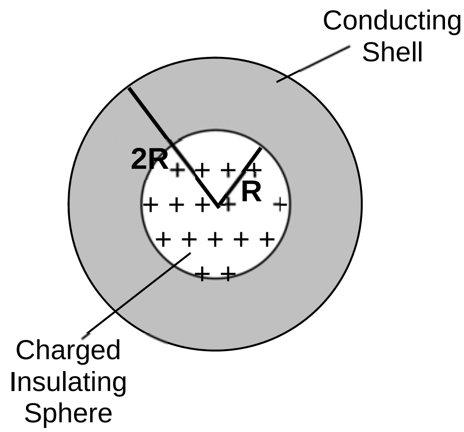
Fig#

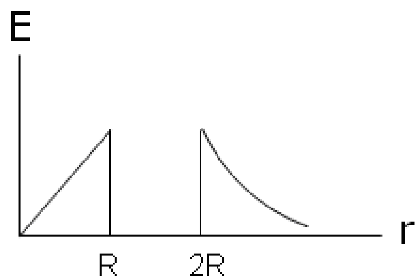


A) 1.27
B) 0.795
C) 1.00
D) 0.637
E) 0.318

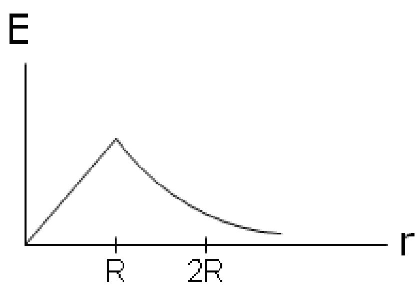
Q8.
A positive charge is uniformly distributed throughout a solid insulating sphere of radius R placed inside a solid metallic conducting shell of radius 2R, as shown in **FIGURE 6**. Which of the following graphs represents the variation of the magnitude of the electric field along the radial direction from the center of the spheres?

Fig#

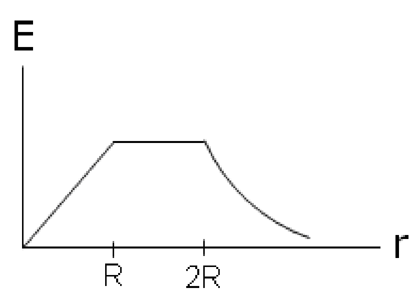




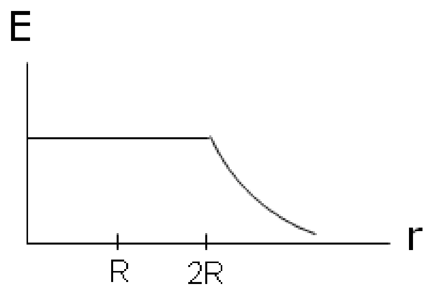
A)



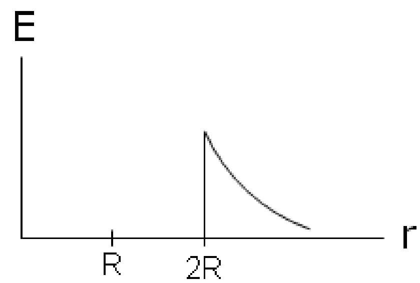
B)



C)



D)

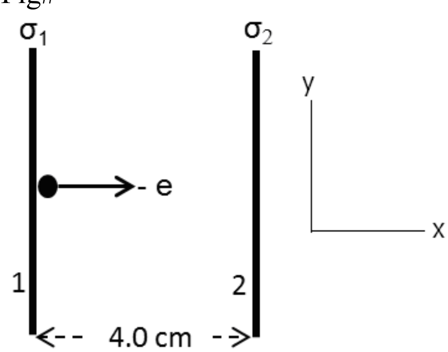


E)

Q9.

FIGURE 7 shows a portion of two large, parallel, non-conducting sheets placed 4.00 cm apart. Uniform charge densities of the sheets are σ_1 and σ_2. In the region between the sheets an electron shot directly away from sheet 1 and has an acceleration of $-2.50 \times 10^{16}\ \hat{i}$ m/s^2. If $\sigma_1 = -5.00\ \mu C/m^2$, find the σ_2? (Ignore the effect of gravity)

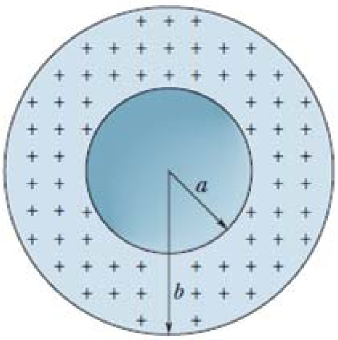
Fig#



A) -7.52×10^{-6} C/m^2
B) $+2.48 \times 10^{-6}$ C/m^2
C) $+6.26 \times 10^{-6}$ C/m^2
D) -4.32×10^{-6} C/m^2
E) -3.79×10^{-6} C/m^2

Q10.
FIGURE 8 shows a spherical insulating shell with uniform volume charge density $\rho = 2.45\ nC/m^3$, inner radius a = 6.00 cm and outer radius b = 12.0 cm. What is the **magnitude** of the electric field at a radial distance of 9.00 cm from the center?

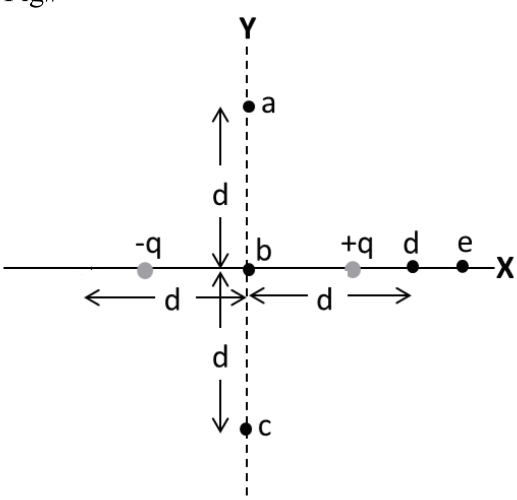
Fig#



A) 5.84 N/C
B) 17.6 N/C
C) 8.54 N/C
D) 21.4 N/C
E) 1.20 N/C

Q11.
Two equal and opposite point charges are placed along the x axis, as shown in **FIGURE 9**. Points a, b, and c are on perpendicular bisector of the line joining the two point charges. Rank the points a, b, c, d, and e according to magnitude of the electric potential, **GREATEST FIRST**.

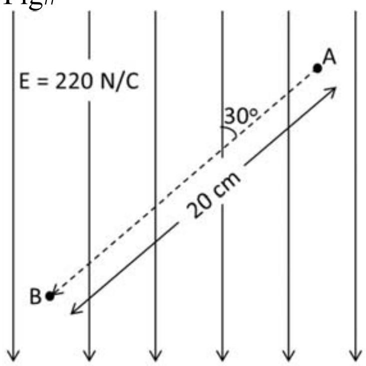
Fig#



A) d, e, then a, b and c all tie
B) d, e, then a and c tie, b
C) a and c tie, d, b, e
D) a and c tie, b, e, d
E) a, b, c, d, e

Q12.
Two points A and B, 20 cm apart, are in uniform electric field E = 220 N/C, as shown in **FIGURE 10**. Calculate the work done by the electric field in moving a point charge -1.50×10^{-6} C from point A to point B.

Fig#



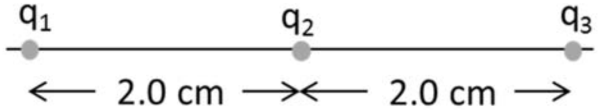
A) -5.72×10^{-5} J
B) $+5.72 \times 10^{-5}$ J
C) $+6.60 \times 10^{-5}$ J
D) -6.60×10^{-5} J
E) $+5.72 \times 10^{-3}$ J

Q13.
Find the electric field $\vec{E}$ at the point (3.0, 2.0, 4.0) m if the electric potential is given by $V = 2.0xyz^2$, where V is in volts and x, y, and z are in meters

A) $\left(-64\hat{i} - 96\hat{j} - 96\hat{k}\right)$ V/m
B) $\left(+64\hat{i} + 96\hat{j} + 24\hat{k}\right)$ V/m
C) $\left(-2.0\hat{i} - 2.0\hat{j} - 4.0\hat{k}\right)$ V/m
D) $\left(+2.0\hat{i} + 2.0\hat{j}\ \_\ 4.0\hat{k}\right)$ V/m
E) $\left(-16\hat{i} - 48\hat{j} - 24\hat{k}\right)$ V/m

Q14.
Three point charges $q_1 = +12$ μC, $q_2 = -24$ μC, and $q_3 = +30$ μC are positioned on a horizontal line as shown in **FIGURE 11**. How much work must an external agent do to exchange the positions of q_1 and q_2?

Fig#



A) + 243 J

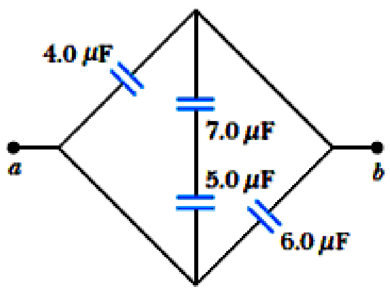
B) − 243 J
C) − 405 J
D) + 405 J
E) + 125 J

Q15.
An air filled parallel plate capacitor is charged to a potential difference of 10 V and then disconnected from the battery. If you double the separation between the plates of the charged capacitor, without touching the plates, which of the following statements is correct

A) Voltage across the plates will double
B) Its capacitance will remain the same
C) Energy stored by the capacitor will remain the same
D) Its capacitance doubles
E) Charge stored reduces to half

Q16.
In **FIGURE 12** the charge stored by the 5.0 μF capacitor is 35 μC find the potential difference between points a and b.

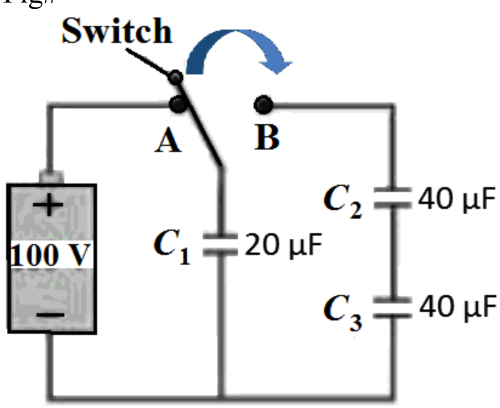
Fig#



A) 12 V
B) 7.0 V
C) 5.0 V
D) 24 V
E) 20 V

Q17.
Initially, the switch in **FIGURE 13** is in position A and capacitors C_2 and C_3 are uncharged (assume for this position of switch C_1 is fully charged). Then the switch is flipped to position B, find the total energy stored by the three capacitors.

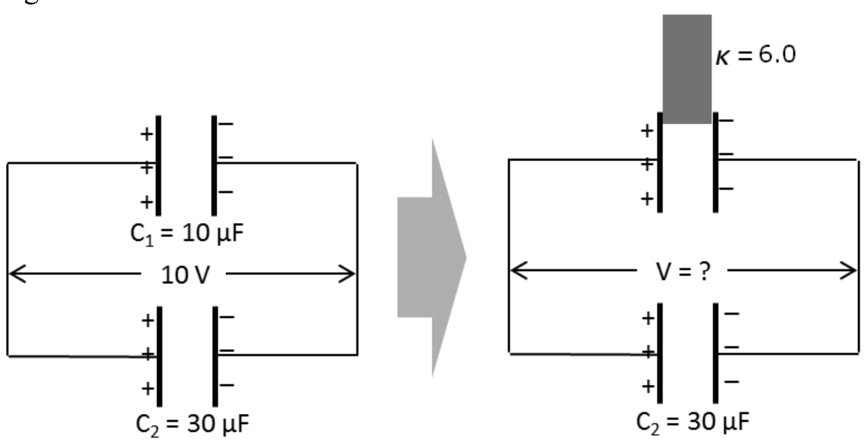
Fig#



A) 0.05 J
B) 0.20 J
C) 0.10 J
D) 0.01 J
E) 0.25 J

Q18.
Two capacitors C_1 and C_2 are charged to a potential difference of 10 V, as shown in **FIGURE 14**. A dielectric material of $\kappa = 6.0$ is inserted between the plates of capacitor C_1. Find the new voltage V across the capacitors.

Fig#

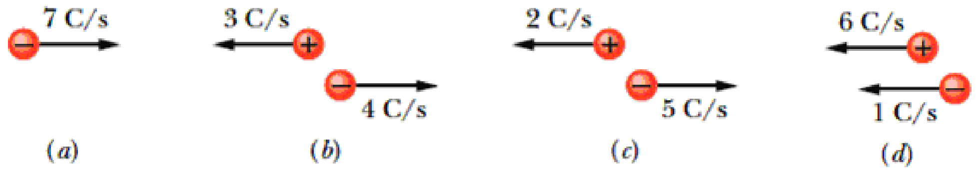


A) 4.4 V
B) 10 V
C) 1.7 V
D) 17 V
E) 6.7 V

Q19.

FIGURE 15 shows four situations in which positive and negative charges move horizontally and give the rate at which each charge moves. Rank the situations according to the effective current through the regions, **GREATEST FIRST**.

Fig#



A) a, b, and c all tie, then d
B) d, b, c, a
C) a, c, b, d
D) all tie
E) a, d, c, b

Q20.

Power dissipated by a resistor decreased by 3.0 W when the voltage applied across the resistor decreased from 12 V to 9.0 V. Find the resistance of the resistor.

A) 21 Ω
B) 13 Ω
C) 36 Ω
D) 26 Ω
E) 50 Ω
