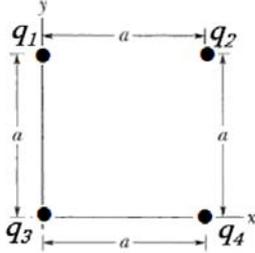


Q1. As shown In **Figure 1** four particles form a square of side length  $a$ . The charges  $q_1 = + Q$ ,  $q_2 = q_3 = q$ ,  $q_4 = - 4.00 Q$ . What is the ratio  $q/ Q$  if the net electrostatic force on  $q_1$  is zero?

Fig#



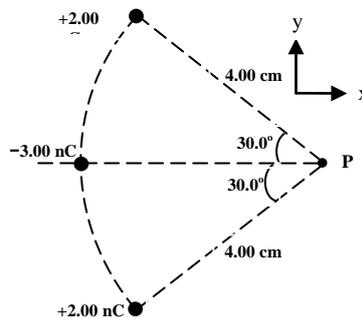
- A) 1.41
- B) 0.707
- C) 2.82
- D) 1.00
- E) Zero

Q2. Consider two neutral point particles of mass 5.0 g each. A total of  $4.0 \times 10^{12}$  electrons are transferred from one neutral particle to the other particle. How far apart must the two particles be if the magnitude of the electrostatic force between them is equal to the magnitude of the weight of one of the particles on earth surface?

- A) 27 cm
- B) 31 cm
- C) 33 cm
- D) 25 cm
- E) 39 cm

Q3. Three point charges are located on a circular arc as shown in **Figure 2**. What is the magnitude of net electric field at point P, the center of the arc?

Fig#



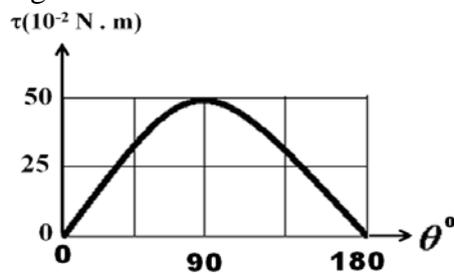
- A)  $2.61 \times 10^3$  N/C
- B)  $2.08 \times 10^4$  N/C
- C)  $1.64 \times 10^3$  N/C
- D)  $3.64 \times 10^3$  N/C
- E)  $2.25 \times 10^5$  N/C

Q4. An electron enters a region of uniform electric field  $\vec{E} = (60\hat{i})$  N/C with a velocity  $\vec{v}_i = (50\hat{i})$  km/s. How far does the electron travel in the first  $2.0 \times 10^{-9}$  s time interval after entering the field?

- A)  $7.9 \times 10^{-5}$  m
- B)  $1.1 \times 10^{-5}$  m
- C)  $2.7 \times 10^{-4}$  m
- D)  $1.3 \times 10^{-6}$  m
- E)  $4.2 \times 10^{-5}$  m

Q5. A certain electric dipole is placed in a uniform electric field  $\vec{E}$  of magnitude 10 N/C. The magnitude of torque on the dipole plotted as a function of the angle between  $\vec{E}$  and the dipole moment  $\vec{p}$  is shown in **Figure 3**. How much work is needed by an external agent to turn the electric dipole from  $30^\circ$  to  $60^\circ$  with respect to  $\vec{E}$  field?

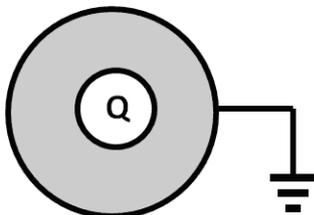
Fig#



- A)  $+1.83 \times 10^{-1}$  J
- B)  $-1.83 \times 10^{-1}$  J
- C)  $+2.66 \times 10^{-1}$  J
- D)  $-2.66 \times 10^{-1}$  J
- E)  $+9.20 \times 10^{-2}$  J

Q6. A metallic sphere contains a cavity at the center as shown in **Figure 4**. The outer surface of the sphere is grounded by connecting a conducting wire between it and the earth. A negative point charge  $Q = -5.4 \times 10^{-9}$  C is placed inside the cavity of the sphere. What is the net electric flux through the outer surface of the metallic sphere?

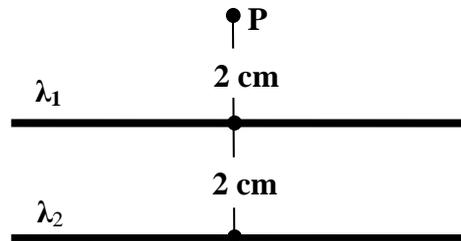
Fig#



- A) 0
- B)  $+6.1 \times 10^2$  N.m<sup>2</sup>/C
- C)  $-6.1 \times 10^2$  N.m<sup>2</sup>/C
- D)  $+3.1 \times 10^2$  N.m<sup>2</sup>/C
- E)  $-3.1 \times 10^2$  N.m<sup>2</sup>/C

Q7. Consider two infinitely long thin wires carrying uniform linear charge densities  $\lambda_1$  and  $\lambda_2$ . The wires are arranged as shown in **Figure 5** and  $\lambda_2 = +5.50$  nC/m. If the net electric field at P is zero, determine the magnitude of  $\lambda_1$ .

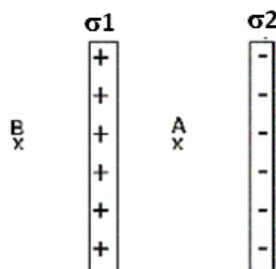
Fig#



- A) 2.75 nC/m
- B) 1.50 nC/m
- C) 1.75 nC/m
- D) 2.00 nC/m
- E) 0.50 nC/m

Q8. **Figure 6** shows two large, parallel, non-conducting sheets, each with fixed uniform charge density:  $\sigma_1 = +2.0 \times 10^{-6}$  C/m<sup>2</sup>,  $\sigma_2 = -4.0 \times 10^{-6}$  C/m<sup>2</sup>. The ratio of the magnitude of the electric field at point A to that at point B, ( $E_A/E_B$ ), is:

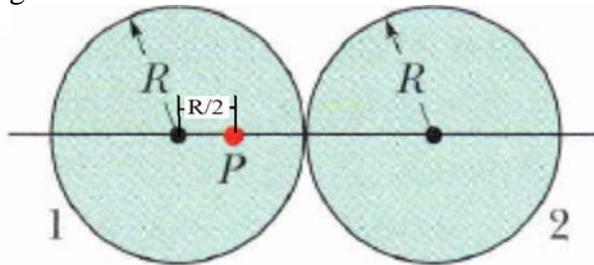
Fig#



- A) 3.0
- B) 0.5
- C) 1.0
- D) 3.5
- E) 1.5

Q9. **Figure 7** shows the cross sectional area of two identical charged solid spheres, 1 and 2, of radius  $R$ . The charge is uniformly distributed throughout the volumes of both the spheres. The net electric field is zero at point P, which is located on a line connecting the centers of the spheres, at radial distance  $R/2$  from the center of sphere 1. If the charge on sphere 1 is  $q_1 = 7.8 \mu\text{C}$ , determine the magnitude of the charge  $q_2$  on sphere 2.

Fig#



- A)  $8.8 \mu\text{C}$
- B)  $3.2 \mu\text{C}$
- C)  $9.3 \mu\text{C}$
- D)  $3.5 \mu\text{C}$
- E)  $6.8 \mu\text{C}$

Q10. Two charges,  $Q_A = +2 \mu\text{C}$  and  $Q_B = -6 \mu\text{C}$ , are located on the x-axis at  $x_A = -1 \text{ cm}$  and  $x_B = +2 \text{ cm}$ , respectively. Where should a third charge,  $Q_C = +6 \mu\text{C}$ , be placed on the positive x-axis so that the potential at the origin is equal to zero?

- A)  $x = 6 \text{ cm}$
- B)  $x = 4 \text{ cm}$
- C)  $x = 7 \text{ cm}$
- D)  $x = 3 \text{ cm}$
- E)  $x = 1 \text{ cm}$

Q11. The electric potential over a particular region is given by  $V(x,y) = 9 - 7x - 5y^2$ . Determine the angle between the electric field  $\vec{E}$  at point P and the positive x axis. The coordinates of the point P are  $x=1.00 \text{ m}$  and  $y=2.00 \text{ m}$ .

- A)  $70.7^\circ$
- B)  $43.6^\circ$
- C)  $46.6^\circ$
- D)  $83.6^\circ$
- E)  $53.6^\circ$

Q12. A metallic isolated sphere of diameter 3.5 cm, fixed in space, carries +9.0 nC charge. A proton was released from rest at the sphere's surface. Determine the maximum speed of the proton. (Assume  $V=0$  at infinity)

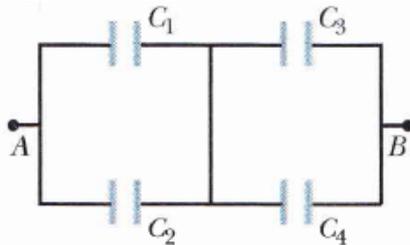
- A)  $9.4 \times 10^5$  m/s
- B)  $1.2 \times 10^5$  m/s
- C)  $3.1 \times 10^3$  m/s
- D)  $4.2 \times 10^7$  m/s
- E)  $3.2 \times 10^7$  m/s

Q13. Two metal spheres 1 and 2 with radii  $r_1 = 1.0$  cm and  $r_2 = 2.0$  cm carry charges  $q_1 = +22$  nC, and  $q_2 = -10$  nC, respectively. Initially both spheres are far apart. Then the spheres are connected by a thin wire, how much charge is lost by sphere 1 when the electrostatic equilibrium is reached?

- A) +18 nC
- B) -18 nC
- C) +12 nC
- D) -12 nC
- E) +14 nC

Q14. **Figure 8** shows a four-capacitor arrangement that is connected to a larger circuit at points A and B. The capacitances are  $C_1 = 10$   $\mu\text{F}$ , and  $C_2 = C_3 = C_4 = 20$   $\mu\text{F}$ . The charge on capacitor  $C_1$  is 30  $\mu\text{C}$ . What is the magnitude of the potential difference  $V_A - V_B$ ?

Fig#



- A) 5.3 V
- B) 3.5 V
- C) 2.2 V
- D) 1.2 V
- E) 7.2 V

Q15. A 200 V battery is connected across 10 identical capacitors which are connected in series. The total energy stored in the combination is 0.0400 J. What is the capacitance of each capacitor?

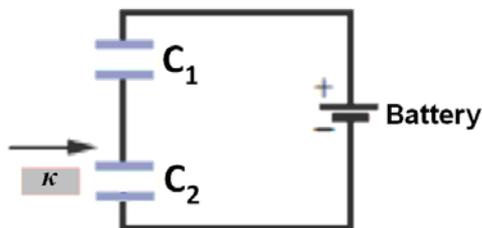
- A) 20.0  $\mu\text{F}$
- B) 1.00  $\mu\text{F}$
- C) 2.00  $\mu\text{F}$
- D) 6.00  $\mu\text{F}$
- E) 30.0  $\mu\text{F}$

Q16. A parallel-plate capacitor filled with a material of dielectric constant 3.60, has a capacitance of 1.25 nF. When 5500 V potential difference is applied across the capacitor, the electric field between the plates is  $1.60 \times 10^7$  V/m. What is the area of the plates?

- A) 0.0135 m<sup>2</sup>
- B) 0.102 m<sup>2</sup>
- C) 0.0194 m<sup>2</sup>
- D) 0.0498 m<sup>2</sup>
- E) 0.387 m<sup>2</sup>

Q17. When a dielectric slab is inserted between the plates of one of the two identical capacitors, as shown in **Figure 9**, which of the following statements describe the situation of  $C_2$  **correctly**?

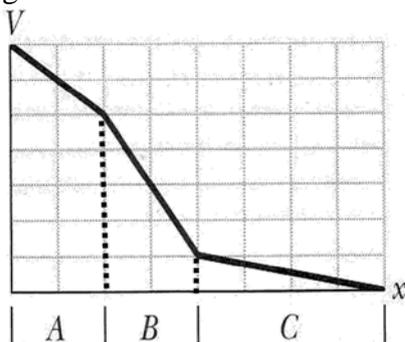
Fig#



- A) Potential energy stored in  $C_2$  decreases
- B) Capacitance of  $C_2$  decreases
- C) Charge on  $C_2$  decreases
- D) Potential difference across  $C_2$  increases
- E) Potential energy stored in  $C_2$  increases

Q18. The electric potential  $V(x)$  versus the position  $x$  along a copper wire carrying current is shown in **Figure 10**. The wire consists of three sections, A, B, and C that differ in radius. Rank the three sections according to the magnitude of the current density, **least first**.

Fig#



- A) C, A, B
- B) A, B, C
- C) C, B, A
- D) B, A, C
- E) A, C, B

Q19. The resistance of a wire at  $0^{\circ}\text{C}$  is  $70.0\ \Omega$ . If temperature of the wire increases to  $100^{\circ}\text{C}$ , its resistance increases by 50 %. What is resistance of the wire at  $120^{\circ}\text{C}$ ? (Ignore changes in the dimensions of the wire)

- A)  $112\ \Omega$
- B)  $211\ \Omega$
- C)  $101\ \Omega$
- D)  $181\ \Omega$
- E)  $150\ \Omega$

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Q20. A copper wire of cross sectional area  $2.00 \times 10^{-6}\ \text{m}^2$  and length  $4.00\ \text{m}$  has a current of  $2.00\ \text{A}$  uniformly distributed across its area. How much electrical energy is transferred into thermal energy in  $1.00\ \text{hour}$  (resistivity of copper =  $1.69 \times 10^{-8}\ \Omega\cdot\text{m}$ )

- A)  $487\ \text{J}$
  - B)  $319\ \text{J}$
  - C)  $727\ \text{J}$
  - D)  $559\ \text{J}$
  - E)  $996\ \text{J}$
-