Exercise ?

Multiple choice questions:

Each of the following questions is followed by four answers. Select the correct answer in each case.

1. A charge Q is divided into two parts q and Q-q and separated by a distance R. The force of repulsion between them will be maximum when:
   a. $q = Q/4$
   b. $q = Q/2$
   c. $q = Q$
   d. None of these

2. Some charge is being given to a conductor. Then its potential
   a. Is maximum at surface
   b. Is maximum at centre
   c. Is remain same throughout the conductor
   d. Is maximum somewhere between surface and centre

3. Electric potential of earth is taken to be zero because the earth is good:
   a. Semiconductor
   b. Conductor
   c. Insulator
   d. Dielectric

4. A proton is about 1840 time heavier than an electron. When it is accelerated by a potential difference if 1 kV, its kinetic energy will be:
   a. 1840 keV
   b. 1/1840 keV
   c. 1 keV
   d. 920 keV

5. A capacitor is charged with a battery and then it is disconnected. A slab of dielectric is now inserted between the plates, then
   a. The charge in the plates reduces and potential difference increase
   b. Potential difference between the plates increase, stored energy decreases and charge remains the same

c. Potential difference between the plates decreases, stored energy decreases and charge remains unchanged

d. None of the above

6. A one microfarad capacitor of a TV is subjected to 4000 V potential difference. The energy stored in capacitor is

a. 8 j

b. 16 j

c. 4×10^{-3} j

d. 2×10^{-3} j

$Q = CV$
$= (1 \times 10^{-6})(4000)$
$= 4 \times 10^{-3}$ J

$U = \frac{CV^2}{2}$

$U = 8$ J

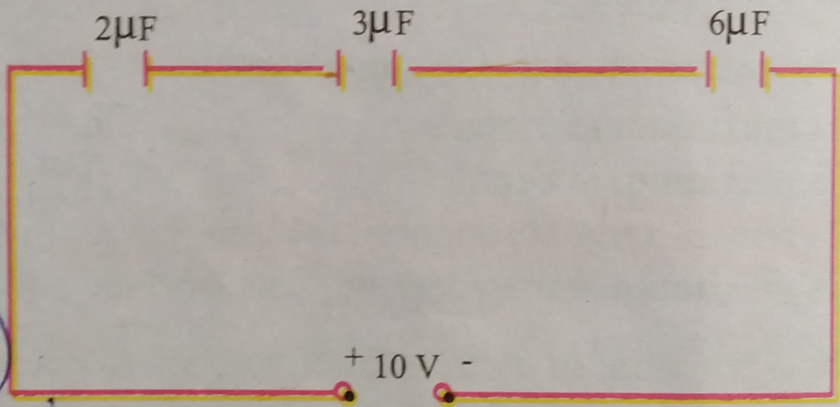
7. In the figure below, the charge on 3 μF capacitor is

a. 5 μC

b. 10 μC

c. 3 μC

d. 6 μC



$= Q\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$

$= Q\left(\frac{1}{2} + \frac{1}{3} + \frac{1}{6}\right)$

$= Q\left(\frac{3+2}{6} + \frac{1}{6}\right)$

$V = Q\left(\frac{5+1}{6}\right)$

$V = Q$

$Q = V$

$Q = 10\,\mu C$

8. The electric potential between two points A and B is ΔV. The work done W by the field in moving a charge q from A to B is

a. $W = -q\ \Delta V$

✓b. $W = q\ \Delta V$

c. $W = -\Delta V/q$

d. $W = \Delta V/q$

$\Delta V = W/q$

$W = \Delta V q$

9. The electric flux through the surface of a sphere due to a charge q placed at its centre depends upon

a. the radius of the sphere

b. the quantity of charge outside the sphere

c. the surface area of the sphere

✓d. the quantity of charge inside the sphere

$\phi = \frac{Q}{\epsilon_0}$

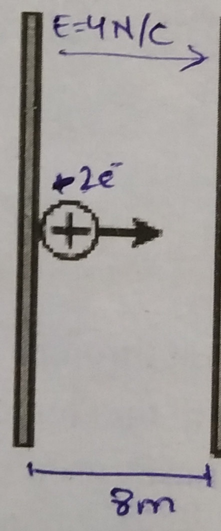
10. Two parallel, metal plates are a distance 8.00 m apart. The electric field between the plates is uniform, directed toward the right, and has a magnitude of 4.00 N/C. If an ion of charge+2e is released at rest at the left-hand plate, what is its kinetic energy when it reaches the right-hand plate?

a. 4 eV.

✓b. 64 eV.

c. 32 eV.

d. 16 eV



$K.E = qV$

$= 2e \times Ed$

$= 2e \times 4 \times 8$

$K.E = 64\ eV$

Comprehensive questions

1. State and explain coulombs law. Do include the case when the charges are placed in dielectrics. Discuss how the unit of charge coulomb is defined?
2. Explain the concept of electric field and hence define electric field intensity. Discuss the direction as well as the unit of $\vec{E}$
3. Explain the concept of electric flux. Using mathematical expressions of electric flux to show that how electric flux is maximum and minimum.

Exercise

Multiple Choice Questions

1. (b) $q = Q/2$

   Explanation: According Coulomb's law the force between q and $(Q-q)$ is $F = k\,\frac{q\,(Q-q)}{R^2}$, Now substitute the values given in each option in place of q. Thus for $q = Q/2$ the force F will be maximum.

2. (c) remains same throughout the volume of the conductor.

   Explanation: A charged conducting sphere behaves like a point charge. Therefore, whether we consider a point at its surface or within the conductor the magnitude of electric potential remains same. But if we move away from its surface then $V \propto \frac{1}{r}$, where r is the distance from the centre of the conductor.

3. (b) Conductor

   Explanation: Earth is a large reservoir of electrons. It can absorb or supply as many electrons as required.

4. (c) 1 keV

   Explanation: The K.E. acquired by a charged particle when it moves through a p.d. can be determined as: K.E. = QV → (1)

   If Q = 1e and V = 1 kV then K.E. = 1 keV

5. (c) P.D. between the plates decreases, stored energy decreases and charge remains the same.

   Explanation: In the process of electric polarization of the dielectric material some energy stored in the capacitor is utilized and as a result net electric field intensity between the plates decreases. As V = Ed, therefore, p.d. between the plates also decreases. The remains same due to the fact that capacitor is now not in contact with battery.

6. (a) 8 J

   Explanation: $U = \frac{1}{2} C V^2 = 8$ J

7. (b) 10 μC

   Explanation: In series combination the charge on each capacitor is same. If C_{eq} is the total capacitance of series combination of capacitors and if V is the voltage of the battery then, $Q = C_{eq} V$ → (1)

   $$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \Rightarrow C_{eq} = 1\ \mu F$$

   Thus from eq. 1 ⇒ Q = 10 μC

Exercise

Multiple Choice Questions

1. (b) $q = Q/2$
   Explanation: According Coulomb's law the force between q and $(Q - q)$ is $F = k\frac{q(Q-q)}{R^2}$, Now substitute the values given in each option in place of q. Thus for $q = Q/2$ the force F will be maximum.
2. (c) remains same throughout the volume of the conductor.
   Explanation: A charged conducting sphere behaves like a point charge. Therefore, whether we consider a point at its surface or within the conductor the magnitude of electric potential remains same. But if we move away from its surface then $V \propto \frac{1}{r}$, where r is the distance from the centre of the conductor.
3. (b) Conductor
   Explanation: Earth is a large reservoir of electrons. It can absorb or supply as many electrons as required.
4. (c) 1 keV
   Explanation: The K.E. acquired by a charged particle when it moves through a p.d. can be determined as: K.E. = QV → (1)
   If Q = 1e and V = 1 kV then K.E. = 1 keV
5. (c) P.D. between the plates decreases, stored energy decreases and charge remains the same.
   Explanation: In the process of electric polarization of the dielectric material some energy stored in the capacitor is utilized and as a result net electric field intensity between the plates decreases. As V = Ed, therefore, p.d. between the plates also decreases. The remains same due to the fact that capacitor is now not in contact with battery.
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   Explanation: $U = \frac{1}{2}CV^2 = 8\text{ J}$
7. (b) 10 μC
   Explanation: In series combination the charge on each capacitor is same. If C_{eq} is the total capacitance of series combination of capacitors and if V is the voltage of the battery then, $Q = C_{eq}V$ → (1)
   $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \Rightarrow C_{eq} = 1\ \mu F$
   Thus from eq. 1 ⇒ Q = 10 μC

8. (b) $W = qV$

   Explanation: Work done against electric force is negative but work done due to electric force is positive.

9. (d)

10. (b) 64 eV

    Explanation: K.E. $QV = (2e)(Ed) = 2e(4 \times 8) = 64$ eV

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Explanation: K.E. $QV = (2e)(Ed) = 2e(4 \times 8) = 64$ eV

Conceptual Questions or Short Answer Questions

1. **Answer: The E.F. Intensity may or may not be zero in a region of space where electric** potential remains constant. Following cases or examples may prove helpful to explain.
   Case – 1: The region in which electric field is completely absent then electric potential will also be zero. As a special case we can say that electric potential is constant as zero. Thus in this case electric field intensity will be zero.
   Case – 2: For an equipotential surface electric potential has same value at every point but E.F. intensity is not zero at those points because equipotential surface lie within electric field.
   Case – 3: Within a charged conducting spherical shell electric potential remains constant everywhere but electric field intensity inside a conductor is zero.

2. **Yes, a point charge will follow a straight path if we release it in such a non-uniform electric field whose each electric field line points in a specific direction.**
   Consider figure – 1. In this case the charge will move along a straight line.