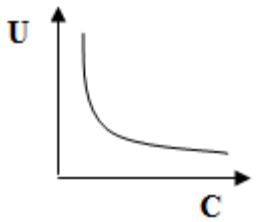
ELECTRIC POTENTIAL & CAPACITANCE

TARGET PHYSICS - 2022

Very Short Answer Type Questions (1 Mark)

1. Define dielectric constant of a medium in terms of capacitance of a parallel plate capacitor.
2. Two charged metal spheres of radii R and 2R temporarily placed in contact and then separated. At the surface of each, which sphere has the greater value of the following : (a) charge, (b) charge density, (c) potential, (d) electric field.
3. An uncharged insulated conductor A is brought near a charged insulated conductor B. What happens to charge and potential of B ?
4. Define capacitance of a conductor.
5. Two copper spheres of same radii, one hollow and other solid are charged to same potential. Which, if any, of the two have more charge ?
6. The graph shows the variation of the total energy(U) stored in a capacitor against the value of the capacitance(C). Which of the two – the charge on the capacitor or the potential used to charge it, is kept constant for this graph ?



7. Define polarisation density.
8. An air capacitor is given a charge of 2 μC raising its potential to 200 V. If on introducing dielectric medium, its potential falls to 50 V, what is the dielectric constant of the medium?
9. A capacitor of capacitance C is charged to a potential V. The charging battery is removed. The charged capacitor is then connected to another capacitor of same capacitance. How will the potential in the first capacitor be effected if the second capacitor is connected (i) in series (ii) in parallel ?
10. N identical capacitors are joined in series and the combination is given a potential difference V. If these capacitors be disconnected and joined in parallel, what potential difference will be obtained across the combination?

Short Answer Type Questions (2 Marks)

1. Two spherical conductors A and B of radii r_A and r_B ($r_A > r_B$) are given equal amounts of charge. In which direction will the charge flow when these spheres are brought in contact ? Give reason for your answer.
2. A parallel plate capacitor is charged by a battery, which is then disconnected. A dielectric slab is now introduced so as it fill the space between the plates. What happens to (a) charges on the plates, (b) capacitance, (c) potential difference between the plates, (d) electric field between the plates and, (e) energy stored in the capacitor ? Explain.
3. Explain the action of a parallel plate capacitor. A parallel plate capacitor is charged to a potential difference V and disconnected from the supply. If the distance between the plates is doubled, explain how do (i) electric field, (ii) capacitance and (iii) energy stored change?
4. **A small sphere of radius r_1 and charge q_1 is enclosed by a spherical shell of radius r_2 and charge q_2. Show that if q_1 is positive, charge will necessarily flow from the sphere to the shell (when the two are connected by a wire) no matter what the charge on the shell is.**

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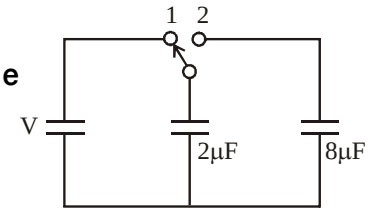
5. A large hollow metallic sphere A is charged positively to a potential of 100 V and a small sphere to a potential of 50 V. Now B is placed inside A and they are connected by a wire. In which direction will the charge flow ?
6. Keeping the voltage of the charging source constant, what would be the percentage change in the energy stored in a parallel plate capacitor if the separation between its plates were to be decreased by 10 % ?
7. The separation between the plates of a charged capacitor has to be increased. Explain when work done will be more : in case battery is removed after charging the capacitor or battery remains connected ?
8. Three capacitors each of capacitance C and of breakdown voltage V are joined in series. What will be the capacitance and breakdown voltage of the combination ?
9. A battery remains connected to a parallel plate capacitor and a dielectric slab is inserted between the plates. Explain what will be the effect on its : (i) Capacitance, (ii) Charge, (iii) Potential difference, (iv) electric field (v) energy stored.
10. Explain the action of a parallel plate capacitor. A parallel plate capacitor is charged to a potential difference V and disconnected from the supply. If the distance between the plates is doubled, explain how do (i) electric field, (ii) capacitance and (iii) energy stored change?
11. A parallel plate capacitor is maintained at a certain p.d. When a dielectric slab of thickness 3 mm is introduced between the plates, in order to maintain the same p.d., the distance between the plates is increased by 2.4 mm. Find the dielectric constant of the slab.
12. A slab of material of dielectric constant K has the same area as the plates of a parallel plate capacitor but has a thickness 3d/4, where d is the separation of plates. How is the capacitance changed when the slab is inserted between the plates ?

Short Answer Type Questions (3 Marks)

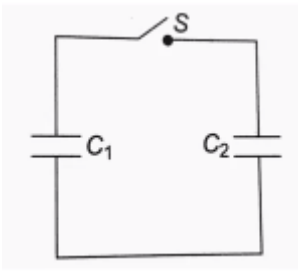
1. Obtain an expression for the energy stored in a parallel plate capacitor. Hence show that electric field *E* is the source of energy with energy density $\frac{1}{2}\varepsilon_0 E^2$.
2. A capacitor of 2μF is charged as shown in the diagram. When the switch S is turned to position 2, find the percentage of its stored energy dissipated.



Long Answer Type Question (5 Marks)

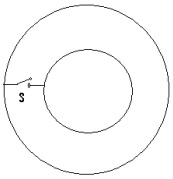
1. Explain the principle of a capacitor. Derive an expression for the capacitance of a parallel plate capacitor.
2. Deduce the expression for the capacitance of a parallel plate capacitor when a dielectric slab of dielectric constant K is inserted between its plates. Assume the slab thickness less than the plate separation.
3. Deduce an expression for the total energy stored in a parallel plate capacitor and relate it to the electric field. Hence obtain the formula for energy density in it.

Numerical Problems

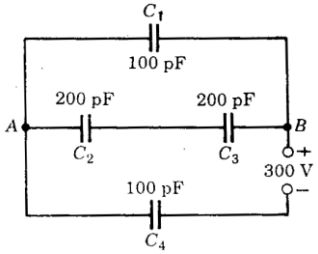


1. A capacitor C_1 is charged to a p.d. V_o. The charging battery is removed and the capacitor is connected to an uncharged capacitor C_2 as shown in figure.
   (a) What will be the final p.d. across the combination ?
   (b) What will be the energy stored before and after the switch is pressed ? What happens to the energy difference ?

2. Two thin conducting shells of radii R and 3R are shown in figure. The outer shell carries a charge +Q and the inner shell is neutral. The inner shell is earthed with the help of switch S. Find the charge attained by the inner shell. (Ans : – Q/3)

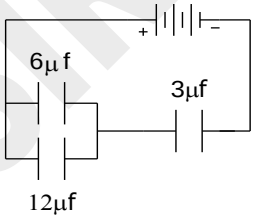


3. Find the equivalent capacitance of the given network of capacitors. For a 300 V supply, determine the charge & the voltage across each capacitor.

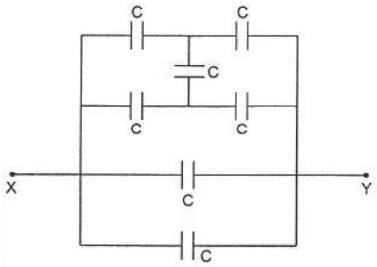


4. Two capacitors, of capacitances 3 μF and 6 μF are charged to potentials of 2 V and 5 V resp. These two charged capacitors are connected in parallel. Find the charge across each of the two.

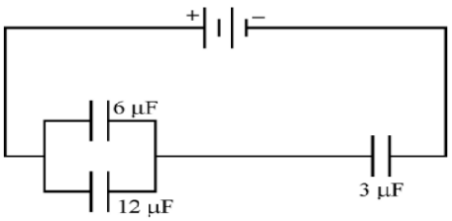
5. A 4 μF capacitor is charged by a 200 V supply. It is then disconnected from the supply, and is connected to another uncharged 2 μF capacitor. How much electrostatic energy of the first capacitor is lost in the form of heat and electromagnetic radiation ?



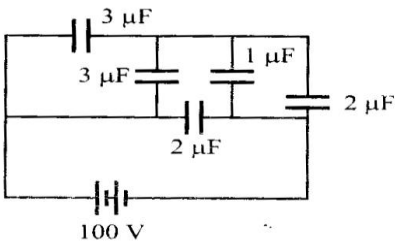
6. What is the equivalent capacitance between points *X* and *Y* of the combination of capacitors shown in figure?



7. In the arrangement of capacitors shown here, the energy stored in the 6μF capacitor is **E**. Find the following (i) Energy in the 12μF capacitor (ii) Energy stored in the 3μF capacitor (iii) Total energy drawn from the battery.



8. The given figure shows a network of five capacitors connected to a 100 V supply. Calculate the total charge and energy stored in the network.



9. A spherical metal shell is to be a 15 x 10^6 V electrode. The dielectric strength of the gas surrounding the electrode is 5 x 10^7 Vm^{-1}. What is the minimum radius of the spherical shell required ?

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