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SUBJECT : **TOPIC: CAPACITOR** **TIME:** **DATE:**

1. The energy of a charged capacitor is given by the expression (q = charge on the conductor and C = its capacity)

(a) $\frac{q^2}{2C}$ (b) $\frac{q^2}{C}$

(c) $2qC$ (d) $\frac{q}{2C^2}$

2. The capacity of a condenser is 4×10^{-6} *farad* and its potential is 100 *volts*. The energy released on discharging it fully will be

(a) 0.02 *Joule* (b) 0.04 *Joule*

(c) 0.025 *Joule* (d) 0.05 *Joule*

3. Which one statement is correct ? A parallel plate air condenser is connected with a battery. Its charge, potential, electric field and energy are Q_o, V_o, E_o and U_o respectively. In order to fill the complete space between the plates a dielectric slab is inserted, the battery is still connected. Now the corresponding values Q, V, E and U are in relation with the initially stated as

(a) $Q > Q_o$ (b) $V > V_o$

(c) $E > E_o$ (d) $U > U_o$

4. In a charged capacitor, the energy resides

(a) The positive charges

(b) Both the positive and negative charges

(c) The field between the plates

(d) Around the edge of the capacitor plates

5. The energy stored in a condenser of capacity C which has been raised to a potential V is given by

(a) $\frac{1}{2}CV$ (b) $\frac{1}{2}CV^2$

(c) CV (d) $\frac{1}{2VC}$

6. If two conducting spheres are separately charged and then brought in contact

(a) The total energy of the two spheres is conserved

(b) The total charge on the two spheres is conserved

(c) Both the total energy and charge are conserved

(d) The final potential is always the mean of the original potentials of the two spheres

7. Two insulated charged spheres of radii $20\,cm$ and $25\,cm$ respectively and having an equal charge Q are connected by a copper wire, then they are separated

(a) Both the spheres will have the same charge Q

(b) Charge on the $20\,cm$ sphere will be greater than that on the $25\,cm$ sphere

(c) Charge on the $25\,cm$ sphere will be greater than that on the $20\,cm$ sphere

(d) Charge on each of the sphere will be $2Q$

8. Eight drops of mercury of equal radii possessing equal charges combine to form a big drop. Then the capacitance of bigger drop compared to each individual small drop is

(a) 8 times (b) 4 times

(c) 2 times (d) 32 times

9. Separation between the plates of a parallel plate capacitor is d and the area of each plate is A. When a slab of material of dielectric constant k and thickness $t(t<d)$ is introduced between the plates, its capacitance becomes

(a) $\frac{\varepsilon_0 A}{d+t\left(1-\frac{1}{k}\right)}$ (b) $\frac{\varepsilon_0 A}{d+t\left(1+\frac{1}{k}\right)}$

(c) $\frac{\varepsilon_0 A}{d-t\left(1-\frac{1}{k}\right)}$ (d) $\frac{\varepsilon_0 A}{d-t\left(1+\frac{1}{k}\right)}$

10. The energy of a charged capacitor resides in

(a) The electric field only

(b) The magnetic field only

(c) Both the electric and magnetic field

(d) Neither in electric nor magnetic field

11. No current flows between two charged bodies connected together when they have the same

(a) Capacitance or $\frac{Q}{V}$ ratio (b) Charge

(c) Resistance (d) Potential or $\frac{Q}{C}$ ratio

12. The capacity of a parallel plate condenser is C. Its capacity when the separation between the plates is halved will be

(a) $4C$ (b) $2C$

(c) $\frac{C}{2}$ (d) $\frac{C}{4}$

13. Eight small drops, each of radius r and having same charge q are combined to form a big drop. The ratio between the potentials of the bigger drop and the smaller drop is

(a) 8 : 1 (b) 4 : 1

(c) 2 : 1 (d) 1 : 8

14. 1000 small water drops each of radius r and charge q coalesce together to form one spherical drop. The potential of the big drop is larger than that of the smaller drop by a factor of

(a) 1000 (b) 100

(c) 10 (d) 1

15. A parallel plate condenser is immersed in an oil of dielectric constant 2. The field between the plates is

(a) Increased proportional to 2

(b) Decreased proportional to $\frac{1}{2}$

(c) Increased proportional to $\sqrt{2}$

(d) Decreased proportional to $\frac{1}{\sqrt{2}}$

16. A parallel plate condenser is connected with the terminals of a battery. The distance between the plates is $6mm$. If a glass plate (dielectric constant $K = 9$) of $4.5mm$ is introduced between them, then the capacity will become

(a) 2 times (b) The same

(c) 3 times (d) 4 times

17. Between the plates of a parallel plate condenser, a plate of thickness t_1 and dielectric constant k_1 is placed. In the rest of the space, there is another plate of thickness t_2 and dielectric constant k_2. The potential difference across the condenser will be

(a) $\frac{Q}{A\varepsilon_0}\left(\frac{t_1}{k_1}+\frac{t_2}{k_2}\right)$ (b) $\frac{\varepsilon_0 Q}{A}\left(\frac{t_1}{k_1}+\frac{t_2}{k_2}\right)$

(c) $\frac{Q}{A\varepsilon_0}\left(\frac{k_1}{t_1}+\frac{k_2}{t_2}\right)$ (d) $\frac{\varepsilon_0 Q}{A}(k_1t_1+k_2t_2)$

18. The distance between the plates of a parallel plate condenser is $8mm$ and P.D. $120\,volts$. If a $6mm$ thick slab of dielectric constant 6 is introduced between its plates, then

(a) The charge on the condenser will be doubled

(b) The charge on the condenser will be reduced to half

(c) The P.D. across the condenser will be $320\,volts$

(d) The P.D. across the condenser will be $45\,volts$

19. The capacity and the energy stored in a parallel plate condenser with air between its plates are respectively C_o and W_o. If the air is replaced by glass (dielectric constant = 5) between the plates, the capacity of the plates and the energy stored in it will respectively be

(a) $5C_o, 5W_o$ (b) $5C_o, \frac{W_0}{5}$

(c) $\frac{C_o}{5}, 5W_o$ (d) $\frac{C_o}{5}, \frac{W_o}{5}$

20. N identical spherical drops charged to the same potential V are combined to form a big drop. The potential of the new drop will be

(a) V (b) V/N

(c) $V \times N$ (d) $V \times N^{2/3}$

21. A $6\mu F$ capacitor is charged from $10\,volts$ to $20\,volts$. Increase in energy will be

(a) $18\times10^{-4}J$ (b) $9\times10^{-4}J$

(c) $4.5\times10^{-4}J$ (d) $9\times10^{-6}J$

22. Twenty seven drops of water of the same size are equally and similarly charged. They are then united to form a bigger drop. By what factor will the electrical potential changes

(a) 9 times (b) 27 times

(c) 6 times (d) 3 times

23. The distance between the plates of a parallel plate capacitor is d. A metal plate of thickness $d/2$ is placed between the plates. The capacitance would then be

(a) Unchanged (b) Halved
(c) Zero (d) Doubled

24. An uncharged capacitor is connected to a battery. On charging the capacitor
(a) All the energy supplied is stored in the capacitor
(b) Half the energy supplied is stored in the capacitor
(c) The energy stored depends upon the capacity of the capacitor only
(d) The energy stored depends upon the time for which the capacitor is charged

25. The capacitance of an air capacitor is $15\mu F$ the separation between the parallel plates is $6mm$. A copper plate of $3mm$ thickness is introduced symmetrically between the plates. The capacitance now becomes

(a) $5\mu F$ (b) $7.5\mu F$
(c) $22.5\mu F$ (d) $30\mu F$

26. The plates of a parallel plate capacitor of capacity $50\mu C$ are charged to a potential of $100\,volts$ and then separated from each other so that the distance between them is doubled. How much is the energy spent in doing so
(a) $25\times10^{-2}J$ (b) $-12.5\times10^{-2}J$
(c) $-25\times10^{-2}J$ (d) $12.5\times10^{-2}J$

27. The area of the plates of a parallel plate condenser is A and the distance between the plates is $10mm$. There are two dielectric sheets in it, one of dielectric constant 10 and thickness $6mm$ and the other of dielectric constant 5 and thickness $4mm$. The capacity of the condenser is
(a) $\frac{12}{35}\varepsilon_0 A$ (b) $\frac{2}{3}\varepsilon_0 A$
(c) $\frac{5000}{7}\varepsilon_0 A$ (d) $1500\,\varepsilon_0 A$

28. An air capacitor of capacity $C=10\mu F$ is connected to a constant voltage battery of $12V$. Now the space between the plates is filled with a liquid of dielectric constant 5. The charge that flows now from battery to the capacitor is
(a) $120\mu C$ (b) $699\mu C$
(c) $480\mu C$ (d) $24\mu C$

29. The force between the plates of a parallel plate capacitor of capacitance C and distance of separation of the plates d with a potential difference V between the plates, is
(a) $\frac{CV^2}{2d}$ (b) $\frac{C^2V^2}{2d^2}$
(c) $\frac{C^2V^2}{d^2}$ (d) $\frac{V^2d}{C}$

30. Two metal spheres of capacitance C_1 and C_2 carry some charges. They are put in contact and then separated. The final charges Q_1 and Q_2 on them will satisfy
(a) $\frac{Q_1}{Q_2}<\frac{C_1}{C_2}$ (b) $\frac{Q_1}{Q_2}=\frac{C_1}{C_2}$
(c) $\frac{Q_1}{Q_2}>\frac{C_1}{C_2}$ (d) $\frac{Q_1}{Q_2}<\frac{C_2}{C_1}$

31. A parallel plate condenser with oil between the plates (dielectric constant of oil $K=2$) has a capacitance C. If the oil is removed, then capacitance of the capacitor becomes
(a) $\sqrt{2}C$ (b) $2C$
(c) $\frac{C}{\sqrt{2}}$ (d) $\frac{C}{2}$

32. A condenser having a capacity 2.0 micro *farad* is charged to $200\,volts$ and then the plates of the capacitor are connected to a resistance wire. The heat produced in joules will be
(a) $4\times10^{4}J$ (b) $4\times10^{10}J$
(c) $4\times10^{-2}J$ (d) $2\times10^{-2}J$

33. Sixty-four drops are jointed together to form a bigger drop. If each small drop has a capacitance *C*, a potential *V*, and a charge *q*, then the capacitance of the bigger drop will be
(a) C (b) $4C$
(c) $16C$ (d) $64C$

34. A $700\,pF$ capacitor is charged by a $50V$ battery. The electrostatic energy stored by it is

(a) $17.0\times10^{-8}\,J$ (b) $13.6\times10^{-9}\,J$
(c) $9.5\times10^{-9}\,J$ (d) $8.7\times10^{-7}\,J$

35. A variable condenser is permanently connected to a 100 V battery. If the capacity is changed from $2\mu F$ to $10\mu F$, then change in energy is equal to

(a) $2\times10^{-2}\,J$ (b) $2.5\times10^{-2}\,J$

(c) $3.5\times10^{-2}\,J$ (d) $4\times10^{-2}\,J$

36. A $12pF$ capacitor is connected to a $50V$ battery. How much electrostatic energy is stored in the capacitor

(a) $1.5\times10^{-8}\,J$ (b) $2.5\times10^{-7}\,J$

(c) $3.5\times10^{-5}\,J$ (d) $4.5\times10^{-2}\,J$

37. The capacity of a parallel plate condenser is $15\mu F$, when the distance between its plates is 6 *cm*. If the distance between the plates is reduced to 2 *cm*, then the capacity of this parallel plate condenser will be

(a) $15\mu F$ (b) $30\mu F$

(c) $45\mu F$ (d) $60\mu F$

38. In a capacitor of capacitance $20\mu F$, the distance between the plates is $2mm$. If a dielectric slab of width $1mm$ and dielectric constant 2 is inserted between the plates, then the new capacitance is

(a) $2\mu F$ (b) $15.5\mu F$

(c) $26.6\mu F$ (d) $32\mu F$

39. If n drops, each of capacitance C, coalesce to form a single big drop, then the ratio of the energy stored in the big drop to that in each small drop will be

(a) $n : 1$ (b) $n^{1/3} : 1$

(c) $n^{5/3} : 1$ (d) $n^2 : 1$

40. 64 small drops of mercury, each of radius r and charge q coalesce to form a big drop. The ratio of the surface density of charge of each small drop with that of the big drop is

(a) 1 : 64 (b) 64 : 1

(c) 4 : 1 (d) 1 : 4

1. (a) $q = CV$ and $U = \frac{1}{2}CV^2 = \frac{q^2}{2C}$

2. (a) $U = \frac{1}{2}CV^2 = \frac{1}{2} \times 4 \times 10^{-6} \times (100)^2 = 0.02\,J$

3. (a,d)Capacitance will be increased when a dielectric is introduced in the capacitor but potential difference will remain the same because battery is still connected. So according to q = CV, charge will increase *i.e.* $Q > Q_0$ and $U = \frac{1}{2}QV_0, U_0 = \frac{1}{2}Q_0V_0 \Rightarrow Q > Q_0$ so $U > U_0$

4. (c)

5. (b) $U = \int_0^V CV\,dV = \frac{1}{2}CV^2$

6. (b) Law of conservation of charge.

7. (c) After the connection of wire $V_1 = V_2$

$\therefore \frac{Q_1}{25} = \frac{Q_2}{20} \Rightarrow \frac{Q_1}{Q_2} = \frac{25}{20} \Rightarrow Q_1 > Q_2$

8. (c) Volume of 8 small drops = Volume of big drop

$8 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3 \Rightarrow R = 2r$

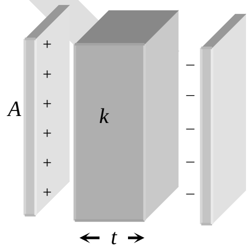
As capacity is r, hence capacity becomes 2 times.

9. (c) Potential difference between the plates V = V_{air} + V_{medium}

$= \frac{\sigma}{\varepsilon_0} \times (d - t) + \frac{\sigma}{K\varepsilon_0} \times t$

$\Rightarrow V = \frac{\sigma}{\varepsilon_0}(d - t + \frac{t}{K})$

$= \frac{Q}{A\varepsilon_0}(d - t + \frac{t}{K})$



Hence capacitance $C = \frac{Q}{V} = \frac{Q}{\frac{Q}{A\varepsilon_0}(d - t + \frac{t}{K})}$

$= \frac{\varepsilon_0 A}{(d - t + \frac{t}{K})} = \frac{\varepsilon_0 A}{d - t\left(1 - \frac{1}{K}\right)}$

10. (a) Stationary charge produces electric field only.

11. (d)

12. (b) $C = \frac{\varepsilon_0 A}{d}. C' = \frac{\varepsilon_0 A}{d/2} \Rightarrow C' = 2C$

13. (b) By using $V_{big} = n^{2/3}v_{small} \Rightarrow \frac{V_{Big}}{v_{small}} = (8)^{2/3} = \frac{4}{1}$

14. (b) $V_{Big} = n^{2/3}v_{small} = (1000)^{2/3}v_{small} = 100\,v_{small}$

15. (b) $E_{medium} = \frac{E_{air}}{K} = \frac{E}{2}$

16. (c) $C \propto \frac{1}{d} \Rightarrow \frac{C_{medium}}{C_{air}} = \frac{d}{d - t + \frac{t}{K}} = \frac{6}{6 - 4.5 + \frac{4.5}{9}} = \frac{6}{2} = 3$

17. (a) Potential difference across the condenser

$V = V_1 + V_2 = E_1t_1 + E_2t_2 = \frac{\sigma}{K_1\varepsilon_0}t_1 + \frac{\sigma}{K_2\varepsilon_0}t_2$

$\Rightarrow V = \frac{\sigma}{\varepsilon_0}\left(\frac{t_1}{K_1} + \frac{t_2}{K_2}\right) = \frac{Q}{A\varepsilon_0}\left(\frac{t_1}{K_1} + \frac{t_2}{K_2}\right)$

18. (d) If nothing is said, it is considered that battery is disconnected. Hence charge remain the same

Also $V_{air} = \frac{\sigma}{\varepsilon_0} \times d$ and $V_{medium} = \frac{\sigma}{\varepsilon_0}(d - t + \frac{t}{k})$

$\Rightarrow \frac{V_m}{V_a} = \frac{(d - t + \frac{t}{k})}{d} \Rightarrow \frac{V_m}{120} = \frac{(8 - 6 + \frac{6}{6})}{8} \Rightarrow V_m = 45V$

19. (b) When a dielectric K is introduced in a parallel plate condenser its capacity becomes K times. Hence $C' = 5C_0$. Energy stored $W_0 = \frac{q^2}{2C_0}$

$\therefore W' = \frac{q^2}{2C'} = \frac{q^2}{2 \times 5C_0} \Rightarrow W' = \frac{W_0}{5}$

20. (d) If the drops are conducting, then

$\frac{4}{3}\pi R^3 = N\left(\frac{4}{3}\pi r^3\right) \Rightarrow R = N^{1/3}r$. Final charge Q = Nq

So final potential $V = \frac{Q}{R} = \frac{Nq}{N^{1/3}r} = V \times N^{2/3}$

21. (b) $\Delta E = E_{Final} - E_{Initial} = \frac{1}{2}C(V_{Final}^2 - V_{Initial}^2)$

$= \frac{1}{2}\times 6\times(20^2 - 10^2)\times 10^{-6}$

$= 3\times(400-100)\times 10^{-6} = 3\times 300\times 10^{-6} = 9\times 10^{-4} J$

22. (a) $V_{Big} = n^{2/3}.v_{small} \Rightarrow V_{Big} = (27)^{2/3}.v_{small} = 9\,v_{small}$

23. (d) $C = \frac{\varepsilon_0 A}{d-(d/2)} = 2\frac{\varepsilon_0 A}{d}$

24. (b) In charging of capacitor half of the supplied energy is stored in the capacitor.

25. (d) By using $C_{air} = \frac{\varepsilon_0 A}{d}$, $C_{medium} = \frac{\varepsilon_0 A}{d-t+\frac{t}{K}}$

For $K=\infty$ $C_{medium} = \frac{\varepsilon_0 A}{d-t}$

$\Rightarrow \frac{C_m}{C_a} = \frac{d}{d-t} \Rightarrow \frac{C_m}{15} = \frac{6}{6-3} \Rightarrow C_m = 30\mu C$

26. (a) $W_{ext} = \frac{1}{2}C'V'^2 - \frac{1}{2}CV^2$

$= \left(\frac{1}{2}\right)\left(\frac{C}{2}\right)(2V)^2 - \frac{1}{2}CV^2 = \frac{1}{2}CV^2$

$W_{ext} = \frac{1}{2}\times 50\times 10^{-6}\times(100)^2 = 25\times 10^{-2} J$

27. (c) $C = \frac{\varepsilon_0 A}{\left(\frac{t_1}{k_1}+\frac{t_2}{k_2}\right)} = \frac{\varepsilon_0 A}{\frac{6\times 10^{-3}}{10}+\frac{4\times 10^{-3}}{5}} = \frac{5000}{7}\varepsilon_0 A$

28. (c) Initially charge on the capacitor $Q = 10\times 12 = 120\mu C$

Finally charge on the capacitor $Q' = (5\times 10)\times 12 = 600\mu C$

So charge supplied by the battery later $= Q' - Q = 480\mu C$

29. (a)

30. (b) Potential of both spheres will be same.

31. (d) $C_{air} = \frac{C_{medium}}{K} = \frac{C}{2}$

32. (c) $U = \frac{1}{2}CV^2 = \frac{1}{2}\times 2\times 10^{-6}\times(200)^2 = 4\times 10^{-2} J$

33. (b) $C' = n^{1/3}C = (64)^{1/3}C = 4C$

34. (d) $U = \frac{1}{2}CV^2 = \frac{1}{2}\times 700\times 10^{-12}(50)^2 = 8.7\times 10^{-7} J$

35. (d) $\Delta U = U_2 - U_1 = \frac{V^2}{2}(C_2 - C_1)$

$= \frac{(100)^2}{2}(10-2)\times 10^{-6} = 4\times 10^{-2} J$

36. (a) $U = \frac{1}{2}CV^2 = \frac{1}{2}\times 12\times 10^{-12}\times(50)^2 = 1.5\times 10^{-8} J$

37. (c) $C \propto \frac{1}{d} \Rightarrow \frac{C_1}{C_2} = \frac{d_2}{d_1} \Rightarrow \frac{15}{C_2} = \frac{2}{6} \Rightarrow C_2 = 45\mu F$

38. (c) $C = \frac{\varepsilon_0 A}{d}$ and $C' = \frac{\varepsilon_0 A}{\left(d-t+\frac{t}{K}\right)} \Rightarrow \frac{C}{C'} = \frac{\left(d-t+\frac{t}{K}\right)}{d}$

$\Rightarrow \frac{20}{C'} = \frac{\left(2\times 10^{-3} - 1\times 10^{-3} + \frac{1\times 10^{-3}}{2}\right)}{2\times 10^{-3}} \Rightarrow C' = 26.6\mu F$

39. (c) $U_{Big} = n^{5/3}u_{small}$

40. (d) $\frac{\sigma_{small}}{\sigma_{Big}} = \frac{q}{Q}\times\frac{R^2}{r^2} = \frac{q}{(nq)}\times\frac{(n^{1/3}r)^2}{r^2} = n^{-1/3} = (64)^{-1/3} = \frac{1}{4}$