AVIRAL JEE | NEET | FOUNDATIONS

WEEKLY TEST TARGET - JEE - TEST - 22
SOLUTION Date 13-10-2019

[PHYSICS]

1. **(a)** Potential difference across the condenser

$$V = V_1 + V_2 = E_1 t_1 + E_2 t_2 = \frac{\sigma}{K_1 \varepsilon_0} t_1 + \frac{\sigma}{K_2 \varepsilon_0} t_2$$

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

2. **(c)** $C = \dfrac{\varepsilon_0 A}{d - t + \dfrac{t}{K}} = \dfrac{1}{4\pi \times 9 \times 10^9} \cdot \dfrac{\pi (0.12)^2}{\left(2 + \dfrac{1}{2}\right) 10^{-3}}$

$$= \frac{2 \times 144 \times 10^{-10}}{36 \times 5} = 160 \text{ pF}$$

3. **(a)** In air the potential difference between the plates

$$V_{air} = \frac{\sigma}{\varepsilon_0} . d \qquad \text{... (i)}$$

In the presence of partially filled medium potential difference between the plates

$$V_m = \frac{\sigma}{\varepsilon_0}\left(d - t + \frac{t}{K}\right) \qquad \text{... (ii)}$$

Potential difference between the plates with dielectric medium and increased distance is

$$V'_m = \frac{\sigma}{\varepsilon_0}\left\{(d + d') - t + \frac{t}{K}\right\} \qquad \text{... (iii)}$$

According to question $V_{air} = V'_m$ which gives

$$K = \frac{t}{t - d'}$$

Hence $K = \dfrac{2}{2 - 1.6} = 5$

4. **(d)** $C = \dfrac{\varepsilon_0 A}{d}$ and $C' = \dfrac{\varepsilon_0 A}{\left\{d - \dfrac{d}{2} + \dfrac{(d/2)}{\infty}\right\}} = \dfrac{2\varepsilon_0 A}{d}$

$\Rightarrow C' = 2C$

5. **(d)** $C_{air} = \frac{\varepsilon_0 A}{d}$, with dielectric slab $C' = \frac{\varepsilon_0 A}{\left(d - t + \frac{t}{K}\right)}$

Given $C' = \frac{4}{3}C \Rightarrow \frac{\varepsilon_0 A}{\left(d - t + \frac{t}{K}\right)} = \frac{4}{3} \times \frac{\varepsilon_0 A}{d}$

$\Rightarrow K = \frac{4t}{4t - d} = \frac{4(d/2)}{4[(d/2) - d]} = 2$

6. **(c)** $C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = 2.4\ \mu F.$

Charge flown $= 2.4 \times 500 \times 10^{-6}\ C = 1200\ \mu C.$

7. **(a)** $\frac{1}{C_s} = \frac{1}{3} + \frac{1}{9} + \frac{1}{18} = \frac{1}{2} \Rightarrow C_s = 2\ \mu F$

$C_p = 3 + 9 + 18 = 30\ \mu F \Rightarrow \frac{C_s}{C_p} = \frac{2}{30} = \frac{1}{15}$

8. **(c)** Charge flowing $= \frac{C_1 C_2}{C_1 + C_2} V$

Potential diff. across $C_1 = \frac{C_1 C_2 V}{C_1 + C_2} \times \frac{1}{C_1} = \frac{C_2 V}{C_1 + C_2}$

9. **(a)** In parallel combination $V_1 = V_2$

or $\frac{q_1}{C_1} = \frac{q_2}{C_2} \Rightarrow \frac{q_1}{q_2} = \frac{C_1}{C_2}$

10. $C_R = C_1 + C_2 = \frac{k_1 \varepsilon_0 A_1}{d} + \frac{k_2 \varepsilon_0 A_2}{d}$

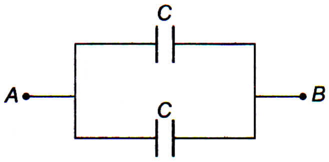
$= \frac{2 \times \varepsilon_0 \frac{A}{2}}{d} + \frac{4 \times \varepsilon_0 \frac{A}{2}}{d} = 2 \times \frac{10}{2} + 4 \times \frac{10}{2} = 30\ \mu F$

11. **(d)** The given circuit is equivalent to parallel combination of two identical capacitors, each having capacitance $C = \frac{\varepsilon_0 A}{d}$. Hence $C_{eq} = 2C = \frac{2\varepsilon_0 A}{d}$

12. **(b)** The given arrangement is equivalent to the parallel combination of three identical capacitors. Hence equivalent capacitance $= 3C = 3\frac{\varepsilon_0 A}{d}$

13. **(a)** The given circuit is equivalent to a parallel combination two identical capacitors

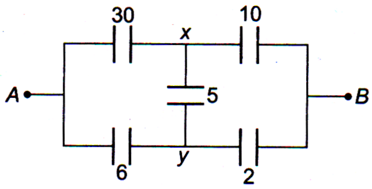
Hence equivalent capacitance between A and B is



$$C = \frac{\varepsilon_0 A}{d} + \frac{\varepsilon_0 A}{d}$$

$$= \frac{2\varepsilon_0 A}{d}$$

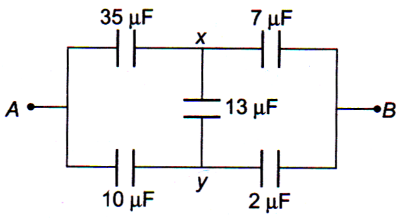
14. **(b)** Circuit can be redrawn as



Now $V_x = V_y$, Since $\frac{30}{6} = \frac{10}{2}$

$$C_{eq} = \left(\frac{30 \times 10}{30 + 10}\right) + \left(\frac{6 \times 2}{6 + 2}\right) = 9\ \mu\text{F}$$

15. **(b)** Circuit can be redrawn as



Now, $V_x = V_y$

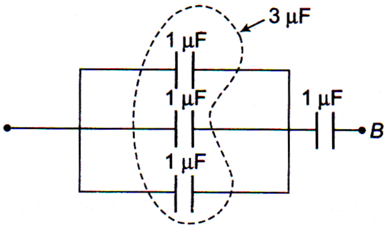
Hence $\frac{35\ \mu\text{F}}{10\ \mu\text{F}} = \frac{7\ \mu\text{F}}{2\ \mu\text{F}}$

$$C_{eq} = \left(\frac{7 \times 35}{7 + 35}\right) + \left(\frac{10 \times 2}{10 + 2}\right) = \frac{35}{6} + \frac{10}{6} = \frac{45}{6}$$

$$C_{eq} = \frac{15}{2}$$

16. **(d)** In series combination, charge is same on each capacitor.

17. **(d)** The circuit can be drawn as follows



$$\Rightarrow C_{AB} = \frac{3\times 1}{3+1} = \frac{3}{4}\,\mu F$$

18. **(b)** Total capacitance of given system $C_{eq} = \frac{8}{5}\,\mu F$

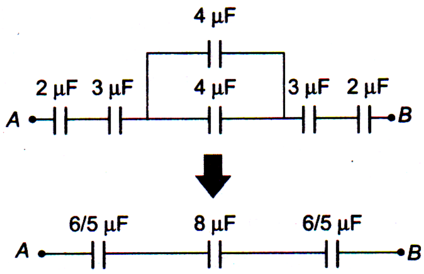
$$U = \frac{1}{2}C_{eq}V^2 = \frac{1}{2}\times\frac{8}{5}\times 10^{-6}\times 225 = 180\times 10^{-6}\,J$$

$$= 180\times 10^{-6}\times 10^{7}\,erg = 1800\,erg$$

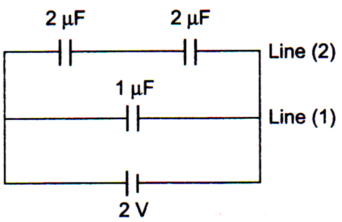
19. **(c)** $Q_1 = Q_2 + Q_3$ because in series combination charge is same on both the condenser and $V = V_1 + V_2$ because in parallel combination $V_2 = V_3$.

Hence $V = V_1 + V_2$

20. **(b)** $\frac{1}{C_{eq}} = \frac{5}{6} + \frac{1}{8} + \frac{5}{6} = \frac{20+3+20}{24} \Rightarrow C_{eq} = \frac{24}{43}\,\mu F$

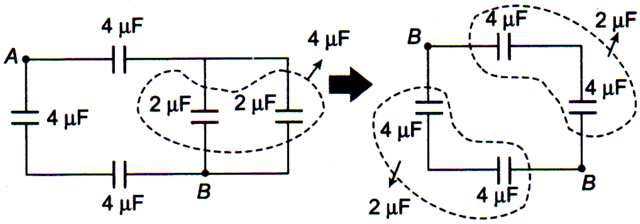


21. **(d)** Potential difference across both the lines is same i.e., 2 V. Hence charge flowing in line 2



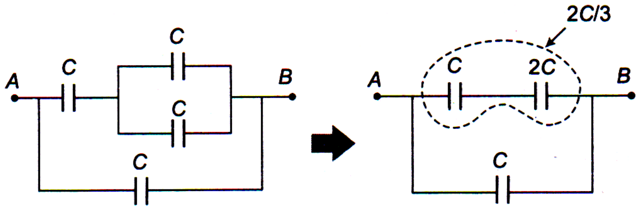
$Q = \left(\frac{2}{2}\right)\times 2 = 2\,\mu C$. So charge on each capacitor in line (2) is 2 μC.

22. (c) The given circuit can be simplified as follows



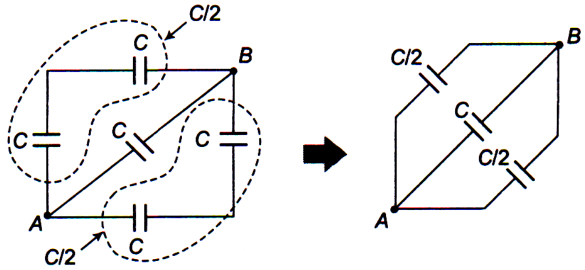
Equivalent capacitance between A and B is $C_{AB} = 4\ \mu F$

23. (c) The given circuit can be simplified as follows:



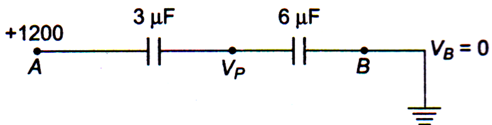
Equivalent capacitance between A and B is $C_{AB} = \frac{5}{3}C$

24. (a) The given circuit can be simplified as follows:



Equivalent capacitance between **A and B** is $C_{AB} = 2\,C$

25. (c) Given circuit can be reduced as follows



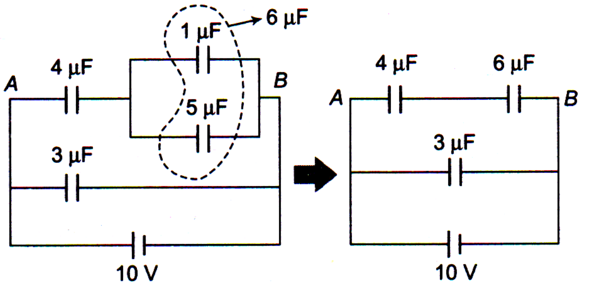
In series combination charge on each capacitor remain same. So using $Q = CV$

$\Rightarrow \quad C_1V_1 = C_2V_2 \Rightarrow 3(1200 - V_p) = 6(V_P - V_B)$

$\Rightarrow \quad 1200 - V_p = 2V_p \qquad (\because\ V_B = 0)$

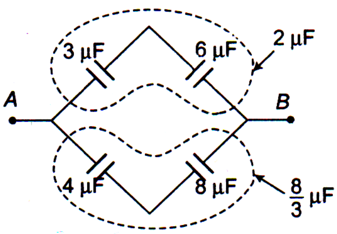
$\Rightarrow \quad 3V_p = 1200 \Rightarrow V_p = 400$ volt

26. **(b)** Equivalent capacity between A and $B = \dfrac{6\times4}{10} = 2.4\,\mu F$



Hence charge across 4 μF (Since in series combination charge remains constant) or 6 μF = 2.4 × 10 = 24 μC.

27. **(d)** Given circuit is balanced Wheatstone bridge. So capacitor of 2 μF can be dropped from the circuit



$\Rightarrow C_{AB} = 2 + \dfrac{8}{3} = \dfrac{14}{3}\,\mu F$

28. **(d)** The capacitance across A and B

$= \dfrac{C_1}{2} + C_1 + C_1 = \dfrac{5}{2}C_1$

As $Q = CV$,

$1.5\,\mu C = \dfrac{5}{2}C_1 \times 6$

$\Rightarrow C_1 = \dfrac{1.5}{15}\times10^{-6} = 0.1\times10^{-6}F = 0.1\,\mu F$

29. **(c)** $V' = \dfrac{V}{8} \Rightarrow \dfrac{V}{K} = \dfrac{V}{8} \Rightarrow K = 8$

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

[CHEMISTRY]

31.

(a) Down the group due to increase in size the strength of metallic bond decreases and so, melting point decreases.
(b) Atomic volume of K is larger as compared to Na. Increase in atomic mass does not overcome the effect of increase atomic volume in case of potassium.
(c) They have low ionisation energies because of their larger atomic size. The heat from the flame excites the outer most orbital electron to a higher energy level. When the excited electrons come back to the ground state, there is emission of radiation in the visible region. Hence, salts of Li to Cs impart characteristic colour to an oxidising flame (of Bunsen burner).

32.

$Na + (x + y) NH_3$ (moderate amount) $\rightarrow [Na(NH_3)x]^+ + [e(NH_3)y]^-$.
The blue colour solution is attributed to the solvated electrons.
The blue colour solution is highly conducting due to the presence of mainly solvated electrons and solvated Na+ ions.
The blue colour solution is not diamagnetic but paramagnetic due to the presence of solvated unpaired electrons.

33.

Hydrated radii $\propto \dfrac{\text{Charge}}{\text{Ionic Radii}}$

$Li^+(aq) > Na^+(aq) > K^+(aq) > Rb^+(aq) > Cs^+(aq)$ Hydrated radii

34.

Their oxides and hydroxides form alkaline solutions on treating with water

35.

The alkali metal atoms have the largest size in a partieular period of the periodic table and thus they contain loosely bound electrons which absorb the photons and then re-emit it and producing metallic lustre.

36.

$Na \xrightarrow[\text{Barn}]{\text{Air}} Na_2O + Na_2O_2$

37.

For (a), (c) and (d) refer above question.
(b) Sodium is smaller than potassium in size. The valence shell electron is tightly bound with nucleus and, therefore, more energy is required to eject out the electron. So sodium has higher ionisation energy than that of potassium.

38.

True statement. The CsI, because of bigger cation (Cs^+) and bigger anion (I^-) has smaller hydration enthalpy. As a result, it does not exceed its lattice energy; so CsI is insoluble in water.

39.

They easily lose valence shell electron because of their low ionisation energies, on account of their bigger atomic sizes. So they behave as strong reducing agents.

40.

According to Fajan's rule, NaF has highest ionic character because of smaller size of anion F^-. So NaF has highest melting point. The order of melting point is generally
fluoride > chloride > bromide > iodide.

41.

(a) Bigger anion is stabilised by bigger cation through lattice energy effect.
(b) Because of their high reactivity towards air and water on account of their higher electropositive character
(c) All alkali metals are highly basic in nature and, therefore, their hydrides are ionic solids with high melting points.
(d) In concentrated solution, unpaired electrons with opposite spins paired up, forming the solution diamagnetic.

42.

(a) Lithium shows exceptional behavior in reaction directly with nitrogen of air to form the nitride, Li_3N.
(b) Smaller cation (Li^+) polarises bigger anion (CO_3^{2-}) liberating CO_2 gas. So it has the lowest thermal stability.
(c) The solubility of the alkali metal hydroxides increases down the group from Li to Cs. This is because of the fact that down the group with increasing size of cation, the lattice energy as well as hydration energy also decreases but the change in lattice energy is more as compare to that of hydration energy.

43. Cs because of its low IE emits electron under the influence of even candle light.

44. As the size increases, the metallic bonding decreases.

45. $LiHCO_3$ is unstable and exists only in solution.

46. Non-metal oxides being acidic decompose carbonates to evolve CO_2 gas.

47. $LiNO_3$ like alkaline earth metal and heavy metal nitrates undergo decomposition to evolve NO_2 and O_2

$$4\,LiNO_3 \longrightarrow 2\,Li_2O + 4\,NO_2 + O_2$$

48. Water reacts with Na and K vigorously evolving heat.

49. In solid NaCl, Na^+ and Cl^- ions are strongly attracted by one another and hence there is no net velocity of ions for conduction of electricity.

50. Mixture of K_2CO_3 and Na_2CO_3 is called fusion mixture.

51. $KHCO_3$ is more soluble than $NaHCO_3$ in water.

52. LiCl being covalent has the lowest melting point. The melting points of other halides decrease form NaCl to CsCl as the lattice energies decrease.

53. Since spherical ClO_4^- ion is virtually non-polarizable and the alkali metal perchlorates form ionic crystals, the high solubility of $LiClO_4$ is mainly due to high heat of hydration of Li^+ ion.

54. CaH_2. Because it is cheap and easy to handle.

55. Calcium nitrate

$$2\,Ca(NO_3)_2 \xrightarrow{\Delta} 2\,CaO + 4\,NO_2 + O_2$$

56. $BaCO_3 > SrCO_3 > CaCO_3 > MgCO_3$. Thermal stability decreases as the basic character of the metal hydroxide decreases.

57. Be > Mg > Ca > Sr > Ba. The size of the SO_4^{2-} ion is very large (approx. 3 Å). Therefore, as the size of the cation increases, their hydration energies decrease more rapidly than their lattice energies. Consequently the solubilities of sulphates decrease down the group.

58. No effect. Be being a weaker reducing agent than Mg cannot reduce Mg^{2+} ions to Mg metal.

59. **MgO. Magnesium oxide has high m.p., therefore, it does not decompose in Bunsen burner to give O_2 gas. All other metal oxides decompose to give O_2.**

$$2\,Pb_3O_4 \xrightarrow{\Delta} 6\,PbO + O_2$$

$$2\,NaNO_3 \xrightarrow{\Delta} 2\,NaNO_2 + O_2$$

$$2\,KClO_3 \xrightarrow{\Delta} 2\,KCl + 3\,O_2$$

60. MgO is basic whereas all other three oxides are amphoteric in nature.