WEEKLY TEST OYM TEST - 26 Balliwala
SOLUTION Date 20-10-2019

[PHYSICS]

1. The electric field between two plates charged equally with the same kind of charge is zero. Therefore the electric field at 4 and 5 is zero. For the points outside the plates, the electric field $E = (\sigma/\varepsilon_0)$. Therefore, the electric fields at 1, 2 and 3 tie.

2. Electric field $E = -(V / d)$. For a fixed potential V, E depends on the separation between the potential lines. Separation is minimum at B. Therefore E at B is maximum.

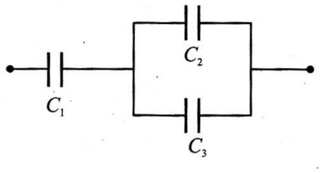
3. The effective capacitance of the parallel combination $C_p = 2C$ where C the capacitance between each pair of plates. The effective capacitance between A and B

$$\frac{1}{C_{AB}} = \frac{1}{C_p} + \frac{1}{C} = \frac{1}{2C} + \frac{1}{C}$$

$$C_{AB} = \frac{2}{3} C = \frac{2}{3} \frac{\varepsilon_0 A}{d}$$

4. The entire system can be split up into three capacitors with capacitances C_1, C_2 and C_3 as shown in figure.

where $C_1 = \frac{3A\varepsilon_0 K_1}{d}$; $C_2 = \frac{2A\varepsilon_0 K_2}{2d}$ and $C_3 = \frac{A\varepsilon_0 K_3}{2d}$.

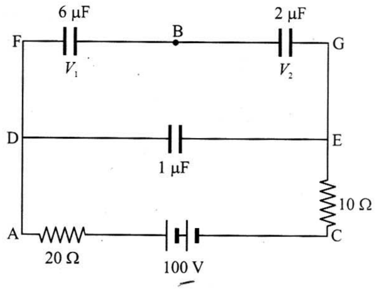


Here C_2 and C_3 are in parallel, with an equivalent capacitance

$$C_2 + C_3 = \frac{A\varepsilon_0}{d}\left(K_2 + \frac{K_3}{2}\right) = C_4 \text{ (say).}$$

Finally, C_1 and C_4 are then in series with effective capacitance $C = \frac{C_1 C_4}{C_1 + C_4} = \frac{42}{13} \frac{A\varepsilon_0}{d}$.

5. At steady state, no current flows through the resistors. Thus, the complete battery voltage drops across the capacitors of 6 μF and 2 μF in series. Since in a series connection.



$Q_1 = Q_2$

$C_1V_1 = C_2V_2$

$6\mu F \times V_1 = 2\mu F \times V_2$

$\therefore \frac{V_1}{V_2} = \frac{1}{3}$

But $V_1 + V_2 = 100\,V$

$\therefore V_1 = 25$ V, $V_2 = 75$ V

6. Since the field is uniform and the loop moves with a uniform speed, the magnetic flux linked with the coil

$\phi = B \times A = BL^2 =$ constant. The induced emf
$e = -d\phi/dt = 0$.

7.

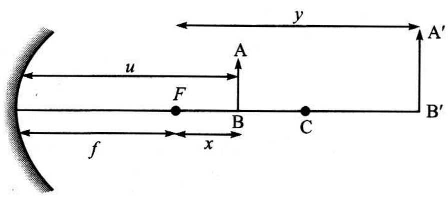
8.

9. $m = \frac{f}{(f-u)}$ $\qquad \frac{1}{2} = \frac{2}{(2-u)}$

$2 - u = 4$

$u = -2$ m

10.



$u = -(f+x)$ v $= -(f+y)$ $f = \frac{-uv}{u+v}$

$= \frac{(f+x)(f+y)}{-(f+x)+(f+y)}$

$\Rightarrow f = \sqrt{xy}$

11. Focal length of a mirror is independent of the refractive index of the medium in which it is placed.

12.

$n_{gw} = \frac{n_g}{n_w} = \frac{1}{\sin C}$

$C = \sin^{-1}\left(\frac{n_w}{n_g}\right) = \sin^{-1}\left[\frac{(4/3)}{(5/3)}\right] = \sin^{-1}\left(\frac{4}{5}\right)$

13.
Deviation, $d = i - r$

$$r = i - d = 45°.$$

From Snell's law,

$$n = \frac{\sin i}{\sin r} = \frac{\sin 60°}{\sin 45°} = \frac{\left(\sqrt{3}/2\right)}{\left(1/\sqrt{2}\right)} = \sqrt{\frac{3}{2}}$$

14.
Refractive index, $n = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}}$

Therefore, n is dimensionless. By the principle of homogeneity, each term in the given equation must be dimensionless. B should have the dimensions of λ^2 i.e., area.

15.
Speed of light in glass = $\frac{3\times10^8}{1.5}$ = 2×10^8 m s^{-1}

$\therefore$ time taken by light to travel the thickness of glass slab = $\frac{2\times10^{-2}}{2\times10^8}$ = 10^{-10} s

Alternatively, optical path length = $2 \times 10^{-2} \times 1.5$
= 3×10^{-2} m

16.
$$P = P_1 + P_2 = 2 + 3 = 5D$$

$$F = \frac{1}{P} = \frac{1}{5} = 0.2 \text{ m}$$

$$= 20 \text{ cm}$$

$u = -30$

$$\therefore\ v = \frac{-30\times20}{-30+20} = 60 \text{ cm}$$

17.

18. $I_{res} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$

For maxima, $\phi = 2n\pi$, $n = 0, 1, 2, ...$

$\cos\phi = 1$

For minima, $\phi = (2n-1)\pi$, $n = 1, 2, 3, ...$

$\cos\phi = -1$

$$I_{max} = (a_1 + a_2)^2 = a_1^2 + a_2^2 + 2a_1 2a_2$$
$$= I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}$$
$$\therefore I_{max} = I + 4I + 2\sqrt{I}\sqrt{4I} = 9I$$
$$I_{min} = (a_1 - a_2)^2 = a_1^2 + a_2^2 - 2a_1 2a_2$$
$$= I_1 + I_2 - 2\sqrt{I_1}\sqrt{I_2}$$
$$\therefore I_{min} = I + 4I - 2\sqrt{I}\sqrt{4I} = I$$

19.

20.

Maximum wavelength of visible light $\lambda_m \approx 8000$ Å.

$$E = \frac{hc}{\lambda_{max}} = \frac{(6.6\times10^{-34})\times(3\times10^{8})}{(8000\times10^{-10})\times(1.6\times10^{-19})} = 1.55 \text{ eV}$$

[CHEMISTRY]

21.

$$\text{Molarity} = \frac{25.3\times1000}{106\times250} = 0.955 \text{ M}$$
$$Na_2CO_3 \longrightarrow 2Na^+ + CO_3^{2-}$$
$$= 2\times0.955 + 0.955 \text{ M}$$
$$= 1.910 \text{ M} + 0.955 \text{ M}$$

22. According to Faraday's second law of electrolysis when the same quantity of electricity is passed through the solutions of different electrolytes connected in series, the weights of substances produced at the electrodes are directly proportional to their equivalent weight.

If M stands for atomic weight of substances

Equivalent weight of Cu $= \frac{M}{2}$

Equivalent weight of Ni $= \frac{M}{2}$

Equivalent weight of Ag $= \frac{M}{1}$

So, the proportion of moles of metals

$$\frac{M}{2} : \frac{M}{2} : \frac{M}{1}$$

$\therefore$ 1 : 1 : 2

23. $E^\circ_{cell} = E_C - E_A$

$= -0.45 - (-2.37)$

$= 1.92\text{ V}$

$Mg(s) \mid Mg^{2+}(aq)\, xM \parallel Fe^{2+}(aq)\, 0.01\,M \mid Fe(s)$

The cell reaction is

$$Mg + Fe^{2+} \longrightarrow Mg^{2+} + Fe$$

$$E_{cell} = E^\circ_{cell} - \frac{0.059}{2}\log\frac{[Mg^{2+}]}{[Fe^{2+}]}$$

$$1.92 = 1.92 - \frac{0.059}{2}\log\frac{x}{0.01}$$

$$0 = \frac{-0.059}{2}\log\frac{x}{0.01}$$

$\therefore \quad x = 0.01\,M$

24. $\frac{dx}{dt} = k'[X][B]$

From step I $\quad K_{eq} = \frac{[X]}{[A]^2}$

$$[X] = K_{eq}[A]^2$$

$$\frac{dx}{dt} = k' \cdot K_{eq}[A]^2[B]$$

$$= k[A]^2[B]$$

25. For first order reaction,

$$k = \frac{2.303}{t}\log\frac{a}{a-x}$$

$$6.909 = \frac{2.303}{t}\log\frac{100}{100-75}$$

$$t = \frac{2.303}{6.909}\log 4$$

$$= \frac{1}{3}\log 2^2$$

$$= \frac{2}{3}\log 2$$

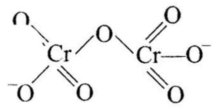
26. $K_4[Fe(CN)_6]$

A negative ion cause the precipitation of positively charged sol and *vice versa*.

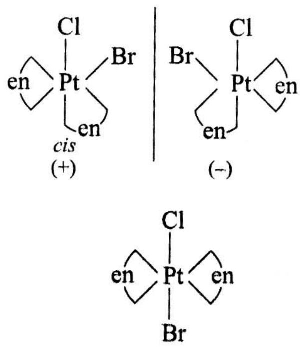
According to Hardy-Schulze rule, in coagulation of a positive sol ferric hydroxide, the flocculating power is maximum for $[Fe(CN)_6]^{4-}$ ion.

27. Helium provide inert atmosphere in the welding of metals or alloys that are easily oxidised.
Argon is used in gas filled electric lamps.
Neon is used in electric sign *i.e.*, advertising sign.
P_4O_{10} is used as a valuable drying and dehydrating agent.
PCl_5 is used in organic reaction for the replacement of hydroxyl group by chlorine atom.

28.

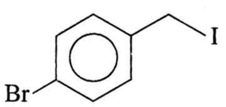


29.



30. The given reaction is an example of elimination reaction, in which one molecule of HBr is eliminated from alkyl halide to give alkene in the presence of alc. KOH.

31.



can give S_N2 reaction under the prevailing condition. By the way, I^- is released into the solution. Dil. HNO_3 neutralises excess NaOH. $AgNO_3$ gives yellow ppt. of AgI.

32. Molecular formula of $A = C_2Cl_3OH$. As (A) reduces Fehling's solution and on oxidation gives a monocarboxylic acid (B). It means (A) must be an aldehyde.

$$\underset{(A)}{CCl_3CHO}$$

This is further confirmed by the reaction

$$C_2H_5OH + Cl_2 \xrightarrow[\text{Oxidation}]{[O]} CH_3CHO \xrightarrow[\text{Chlorination}]{Cl_2} CCl_3CHO$$

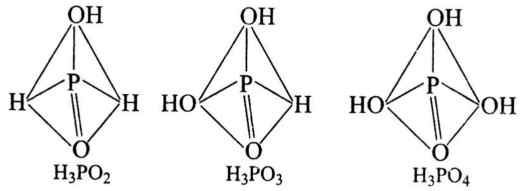
$$A = \text{chloral } [CCl_3CHO]$$

33. The reaction sequence is as follows

$$ArN_2Cl \xrightarrow[\text{Sandmeyer's reaction}]{CuCN/KCN} ArCN \xrightarrow{H\cdot OH} \underset{\text{benzoic acid}}{C_6H_5COOH}$$

$$\xrightarrow[\text{decarboxylation}]{\Delta,\ \text{sodalime}} \underset{\text{benzene}}{C_6H_6}$$

34. H_3PO_2, H_2PO_3 and H_3PO_4 are oxyacids of phosphorus. In all these acids, the central atom (P) is sp^3 hybridised and is surrounded by neighbouring atom tetrahedrally.



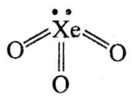
H_3PO_2—Monobasic
H_3PO_3—Dibasic
H_3PO_4—Tribasic
The acidity increases while increasing the oxidation number of central atom

$$H_3\overset{+1}{P}O_2 < H_3\overset{+3}{P}O_3 < H_3\overset{+5}{P}O_4$$

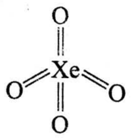
35. Hydration energy varies inversely with size. Among the given oxyacids, ClO_4^- has the smallest size because of the presence of Cl^{7+} followed by ClO_3^- (with Cl^{5+}), ClO_2^- (with Cl^{3+}). ClO^- has the largest size with Cl^+ ion. Hence, the order of increasing hydration energy is

$$ClO^- < ClO_2^- < ClO_3^- < ClO_4^-$$

36. **Structure of XeO_3**



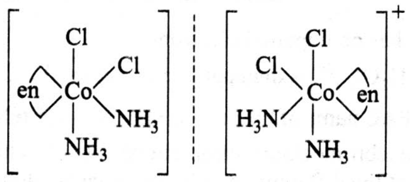
Hence, 3 $p\pi$-$d\pi$ pi-bonds are present.
Structure of XeO_4



Hence, 4 $p\pi$-$d\pi$ bonds are present.

37. Basicity of lanthanide hydroxides decreases along the lanthanide series from left to right. This is because size decreases from left to right due to lanthanide contraction. This result in increased covalent character of M—OH bond.

38. Octahedral complexes of the type $[M(AA)_2b_2]^{n\pm}$ and $[M(AA)a_2b_2]^{n\pm}$ exhibit geometrical isomerism. Options (a), *i.e., trans*-$[Co(en)_2Cl_2]^+$ which belongs to the 1st category is optically inactive owing to the presence of an element of symmetry. However (b), *cis*-$[Co(en)(NH_3)_2Cl_2]^+$ exists in optically active forms.



Complex given in options (c) and (d) are optically inactive as all the ligands are same.

39. $[Co(C_2O_4)_3]^{3-}$ shows optical isomerism.

40. Goldschmidt in 1905 discovered a method for the reduction of haematite (Fe_2O_3) with aluminium metal. The process is known as alumino thermic process, as in this process, large heat is produced. In this, Fe_2O_3 and aluminium are taken in 3 : 1 ratio and this mixture, known as thermite, is ignited to initiate the reaction, when Fe_2O_3 is reduced to molten Fe.

$$2Al + Fe_2O_3 \longrightarrow Al_2O_3 + \underset{\text{molten}}{2Fe} + 3230\ kJ$$