HINTS & SOLUTIONS

SECTION - I (CHEMISTRY)

PART - A

1. A

Sol. Due to metallic oxide.
Hence, (A) is correct.

2. C

Sol. Oleum is mixture of $H_2SO_4 + SO_3 = H_2S_2O_7$
If initial weight of labelled $H_2S_2O_7$ (oleum) = 100 gm
Then weight of H_2SO_4, after dilution = 118 gm
Weight of H_2O = 18 gm

or Moles of H_2O = Moles of SO_3 $= \frac{18}{18} = 1$

$\therefore$ Weight of SO_3 = (1 × 80) gm

% of SO_3 $= \frac{\text{Weight of } SO_3 \times 100}{100} = 80\%$

3. C

Sol. $0.5 \times 2 \times V = \frac{0.5 \times 2 \times 1000}{123.5}$ (Eq. weight of $CuCO_3 = \frac{M}{2}$)

V = 8.097 ≈ 8.1 ml

4. D

Sol. $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = 1.09678 \times 10^7 \left(\frac{1}{1^2} - \frac{1}{2^2}\right)$

$\lambda = 1.2156 \times 10^{-7} m = 1216$ Å

5. D

Sol. Using, pV = nRT
200 × 10 = (0.5 + x) × R × 1000

6. B

Sol. $m_y = 0.25 m_x$, $v_y = 0.75 v_x$

$\lambda = \frac{h}{mv}$ $\lambda_x = \frac{h}{m_x v_x}, \lambda_y = \frac{h}{m_y v_y}$

$\lambda_y = \frac{h}{0.25 M_x \times 0.75 v_x}$ $\lambda_y = 5.33 A$

7. D

Sol. The following reaction occurs:

$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \longrightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

From the above equation, we find that Mohr's salt $\left(FeSO_4.(NH_4)_2 SO_4.6H_2O\right)$ and dichromate reacts in 6 : 1 molar ration.

8. A

Sol. According to the stoichiometry of balanced equation 28 g N_2 react with 6 g H_2

$\underset{1\,mole=28g}{N_2} + \underset{3\,mole=6g}{3H_2} \longrightarrow 2NH_3$

$\therefore$ For 56 g of N_2, 12 g of H_2 is required.

9. A

Sol. Conceptual

10. C

Sol. Conceptual

11. B

Sol. No. of spectral lines $= \frac{n(n-1)}{2}$ = 6

12. B
Sol. Use Rydberg Formula.

13. C

14. B
Sol. 13 & 14
The spherically symmetric state S_1 of Li^{2+} with one radial node is 2s. Upon absorbing light, the ion gets excited to state S_2, which also has one radial node. The energy of electron in S_2 is same as that of H-atom in its ground state.

$\therefore E_n = \frac{Z^2}{n^2}E_1$ where E_1 is the energy of H-atom in the ground state $= \frac{(3)^2 E_1}{n^2}$ for Li^{2+}

$E_n = E_1 \Rightarrow n = 3$
$\therefore$ State S_2 of Li^{2+} having one radial node is 3p.
Orbital angular momentum quantum number of 3p is 1.

Energy of state $S_1 = \frac{(3)^2}{(2)^2}E_1 = 2.25E_1$

15. B
Sol. Formula of alkane is C_3H_8

16. B

Sol. Mole fraction of CO_2 in final gaseous sample is $\frac{6}{44}$

PART - B

1. A → R; B → T; C → P, S; D → Q, R
Sol. Theory Based

2. A → R; B → P; C → Q; D → R
Sol. Equivalent Mass = Molar Mass / n-factor.

3. A → R; B → S; C → Q; D → P
Sol. $T_C = \frac{8a}{27Rb}$

$P_C = \frac{a}{27b^2}$

$V_C = 3b$

$T_B = \frac{a}{Rb}$

$T_i = \frac{2a}{Rb}$

4. A → R, P; B → R, T; C → S; D → Q
Sol. Conceptual

SECTION - II (MATHEMATICS)
PART– A

1. C

Sol. $\theta = \tan^{-1}\left(\frac{2\sqrt{h^2-ab}}{a+b}\right) = \tan^{-1}\left(\frac{2\sqrt{25-4m}}{4+m}\right)$

and $abc + 2fgh - af^2 - bg^2 - ch^2 = 0$

$\Rightarrow m = 4$

2. C

Sol. Refracted ray passes through the point (1, 0) and slope of refracted ray is $m = \tan(-30°) = -\frac{1}{\sqrt{3}}$

3. A

Sol. $r = 20 cm$ and $l = r\theta \Rightarrow l = 20\frac{\pi}{3} cm$

4. D

Sol. $\frac{5\pi}{12} - \frac{\pi}{12} = \frac{\pi}{3} \Rightarrow \tan\left(\frac{5\pi}{12} - \frac{\pi}{12}\right) = \tan\frac{\pi}{3} = \sqrt{3}$

5. A

Sol. Vertices of triangle are (0, 3), (0, 1) and (2, 1).

6. C

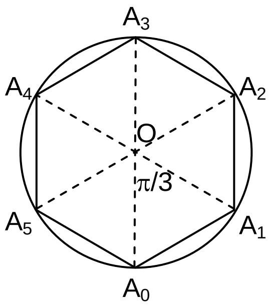
Sol. $A_0A_2 = A_0A_4$

OA_0A_1 is an equilateral triangle.

$\Rightarrow A_0A_1 = 1$

$(A_0A_2)^2 = (OA_0)^2 + (OA_2)^2 - 2(OA_0)(OA_2)\cos\frac{2\pi}{3}$

$\Rightarrow A_0A_2 = \sqrt{3}$



7. B

Sol. Maximum value of $|PA - PB|$ is $|AB|$, which is possible only when P, A, B are collinear.

8. A

Sol. $\frac{\sin 2A}{\sin 2B} = \frac{2}{3} \Rightarrow 9\sin^2 A\cos^2 A = 4\sin^2 B\cos^2 B$

Let $\sin^2 A = x$ and $\sin^2 B = y$

$\Rightarrow 3x + 2y = 1$ and $9x(1-x) = 4y(1-y)$

$\Rightarrow x = \frac{1}{9}$ and $y = \frac{1}{3}$

9. B

Sol. $8 = \frac{1}{2}(AC)(BD)\sin\theta$, where θ is the angle between the diagonals.

10. A

Sol. $\cos(\pi - \theta) = \frac{OA^2 + OB^2 - AB^2}{2(OA)(OB)}$, where O is the intersection point of diagonals.

11. C

Sol. $\sin\left(\alpha + \frac{2\pi}{3}\right)\sin\left(\alpha + \frac{4\pi}{3}\right) + \sin\left(\alpha + \frac{4\pi}{3}\right)\sin\alpha + \sin\alpha\sin\left(\alpha + \frac{2\pi}{3}\right)$

$= \frac{1}{2}\left[\cos\frac{2\pi}{3} - \cos(2\pi + 2\alpha) + \cos\frac{4\pi}{3} - \cos\left(2\alpha + \frac{4\pi}{3}\right) + \cos\frac{2\pi}{3} - \cos\left(2\alpha + \frac{2\pi}{3}\right)\right]$

12. D

Sol. $x^2(qy - rz) = \sin^2\alpha\left(\cos\left(\alpha + \frac{2\pi}{3}\right)\sin\left(\alpha + \frac{2\pi}{3}\right) - \cos\left(\alpha + \frac{4\pi}{3}\right)\sin\left(\alpha + \frac{4\pi}{3}\right)\right)$

$= \frac{\sin^2\alpha}{2}\left[\sin\left(2\alpha + \frac{4\pi}{3}\right) - \sin\left(2\alpha + \frac{8\pi}{3}\right)\right] = -\frac{\sqrt{3}}{4}(1 - \cos 2\alpha)\cos 2\alpha$

13. D

Sol. Point of concurrency is (2, 1).

14. A

Sol. If L_3 is parallel to L_2, then $k=-\frac{6}{5}$.

15. C

Sol. $\sin\frac{9\pi}{14}\sin\frac{11\pi}{14}\sin\frac{13\pi}{14}=\cos\frac{2\pi}{14}\cos\frac{4\pi}{14}\cos\frac{6\pi}{14}$ and $\cos\frac{6\pi}{14}=-\cos\frac{8\pi}{14}$

16. B

Sol. $m=3,\ n=10$

PART – B

1. A →S B →P C →Q D →R

Sol. (A) $a+b\left(\frac{1}{2}\right)+c=0$

(B) Point of concurrency is $(1,-1)$

(C) Coordinates of the required point are $\left(1\pm\frac{1}{\sqrt{2}}\cos\theta,1\pm\frac{1}{\sqrt{2}}\sin\theta\right)$

(D) $3x+y-7+\lambda(x+5y-7)=0$

2. A →R B →S C →Q D →P

Sol. (A) $2B=A+C\Rightarrow 2B=\pi-B\Rightarrow B=\frac{\pi}{3}$

$C=\frac{\pi}{2}$ and $A=\frac{\pi}{6}$

(B) $\cos\frac{\pi}{6}+\cos\frac{\pi}{3}+\cos\frac{\pi}{2}=\frac{\sqrt{3}+1}{2}$

(C) $\sin\frac{\pi}{3}+\sin\frac{2\pi}{3}+\sin\pi=\sqrt{3}$

(D) $\cot\frac{\pi}{3}\cot\frac{\pi}{2}+\cot\frac{\pi}{2}\cot\frac{\pi}{6}+\cot\frac{\pi}{3}\cot\frac{\pi}{6}=1$

3. A → S B → P C → Q D → T

Sol. (A) $\tan A=3,\ \tan B=2\Rightarrow\tan(A-B)=\frac{1}{7}$

$\sin(2(A-B))=\frac{2\tan(A-B)}{1+\tan^2(A-B)}$

(B) $\tan\alpha\tan(2n-1)\alpha=\tan\frac{\pi}{4n}\tan(2n-1)\frac{\pi}{4n}=\tan\frac{\pi}{4n}\cot\frac{\pi}{4n}$ = 1

(C) $xy+yz+zx=\frac{x^2}{\cos\frac{2\pi}{3}}+\frac{x^2}{\cos\frac{2\pi}{3}\cos\frac{4\pi}{3}}+\frac{x^2}{\cos\frac{4\pi}{3}}$

(D) $y=2-\cos x+1-\cos^2 x=\frac{13}{4}-\left(\cos x+\frac{1}{2}\right)^2$

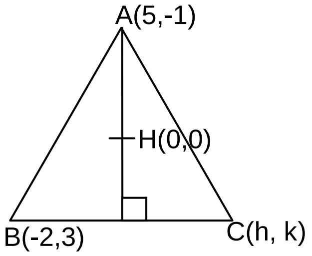
4. A → P B → Q C → S D → S

Sol. (A) $m_{AH}=-\frac{1}{5},\ m_{BC}=5=\frac{k-3}{h+2}$

$\Rightarrow 5h-k+13=0$

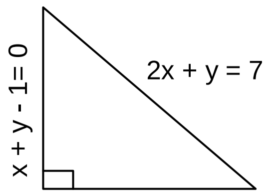
$m_{BH}=\frac{-3}{2}\Rightarrow m_{AC}=\frac{2}{3}=\frac{k+1}{h-5}$

$\Rightarrow k=\frac{2h-13}{3}$



(B) $h+k=4\Rightarrow k=4-h$

(C)



(D) $2b = a + c \Rightarrow a - 2b + c = 0$ and $-ax - by + c = 0$

$\therefore x = -1,\ y = 2$

SECTION - III (PHYSICS)
PART– A

1. B

Sol. 1296 km/day = $\frac{1296}{24} km/hr = 54 km/hr \;\; = 54 \times \frac{1000}{3600}\frac{m}{s} = 15 m/s$

2. C

Sol. $[B] = [x^2] = [L^2]$

$[A] = \frac{[U][x^2]}{[\sqrt{x}]} = \left[ML^{\frac{7}{2}}T^{-2}\right]$

3. A

Sol. For perpendicular vectors $\vec{P} \cdot \vec{Q} = 0$

For collinear vectors $\vec{P} \times \vec{Q} = 0$

4. D

Sol. Polygon law of vector addition gives required results.

5. B

Sol. $\sqrt{x} = (2t - 3)$

$x = 4t^2 - 12t + 9$

$v = 8t - 12$

$a = 8$

6. D

Sol. $a(t = 9) = \frac{5 - 15}{12 - 8} = -2.5 m/s^2$

$a(t = 16) = \frac{10 - 5}{20 - 12} = \frac{5}{8} m/s^2$

$\Delta x =$ area units $v - t$ curve

7. B

Sol. $H = \frac{u^2 \sin^2 \theta}{2g} = 4$ and $R = \frac{u^2 \sin 2\theta}{g} = 12$

$\Rightarrow \; \Rightarrow u = 5\sqrt{5} m/s$ and $\theta = \tan^{-1}\frac{4}{3}$

$T = \frac{2u \sin \theta}{g}$

$u_{min} = u \cos \theta$ at highest point

8. A

Sol. Since $\vec{a}$ is constant and initial velocity is not collinear with $\vec{a}$, its path will be parabola.

9. B

10. C

Sol. [9 - 10]

$\vec{a}_t = (\vec{a} \cdot \hat{v})\hat{v}$

$\vec{a}_n = \vec{a} - \vec{a}_t$

11. D

12. C

Sol. [11 - 12]

$y = ut - \frac{1}{2}gt^2$

$= 4\times 5 - \frac{1}{2}\times 9.8\times 25 = -102.5m$

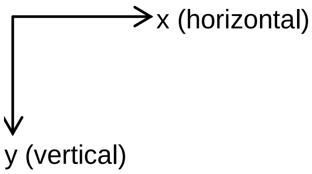
$h = 120.5 - 102.5 = 18m$

After 8 sec body will be at ground at rest
and balloon would have moves 32 m from initial location. So separation would be
$120.5 + 32 = 152.5m$ 13. B

14. A

Sol. [13 - 14]

Let $\vec{v}_R = v_x\hat{i} + v_y\hat{j}$



$\frac{v_x}{v_y} = \tan 30^o$

$\vec{v}_{RM} = (v_x = 0.5)\hat{i} + v_y\hat{j}$

$\frac{v_x - 0.5}{v_y} = \tan 0^o$

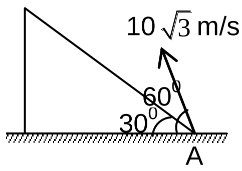
$\Rightarrow v_x = 0.5$ and $v_y = 0.5\sqrt{3}$

15. B

16. D

Sol. [15 - 16]

Consider motion w.r.t. wedge



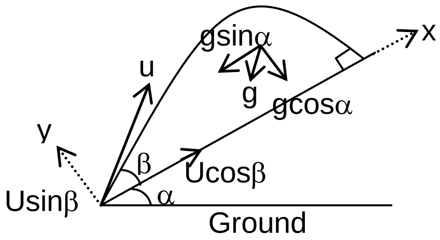
$T = \frac{2u\sin(\alpha-\beta)}{g\cos\beta} = 2\sec$

$\Delta = \frac{u^2\sin^2(\alpha-\beta)}{2g\cos\beta} = \frac{5}{2}\sqrt{3}m$

PART – B

1. A → S B → R C → Q D → P

Sol. Maximum height from ground of projectile is $\frac{u^2\sin^2(\alpha+\beta)}{2g}$



Maximum height from inclined plane is $\frac{U_\perp^2}{2g_\perp}$

$U_\perp = U\sin\beta$ and $g_1 = g\cos\alpha$.

$\therefore$ h from inclined plane = $\frac{U^2\sin^2\beta}{2g\cos\alpha}$

Acceleration of the projectile is always g downward and horizontal component will obviously be zero.

2. A → Q, S B → P C → P D → Q, R

Sol. from graph (A) $\Rightarrow v = kx$ where k is positive constant

acceleration = $v\frac{dv}{dx} = kx + k = k^2x$

$\therefore$ Acceleration is non-uniform and directly proportional to x.

$\therefore (A) \to Q, S$

From graph (B) $\Rightarrow v^2 = kx$ Differentiating both sides with respect to x.

$2v\frac{dv}{dx} = k$ or $v\frac{dv}{dx} = \frac{k}{2}$

Hence, acceleration is uniform

$\therefore (B) \to P$

From graph (C) $\Rightarrow v = kt$

Acceleration = $\dfrac{dv}{dt} = k$

Hence, acceleration is uniform

$\therefore (C) \to P$

From graph (D) $\Rightarrow v = kt^2$

Acceleration is non-uniform and directly proportional to t.

$\therefore (D) \to Q, R$

3. A → Q B → R C → P D → Q

Sol. $|\vec{r}_{AB}| = |\vec{r}_A - \vec{r}_B|$

$|\vec{v}_{AB}| = |\vec{v}_A - \vec{v}_B|$

$|\vec{a}_{AB}| = 0$

4. A → S B → Q C → P D → R

Sol. (A) by $E = \dfrac{3}{2}kT$

(B) by $F = \eta A \dfrac{\Delta v}{\Delta x}$

(C) by $E = hf$

(D) by $Q = \dfrac{KA(\Delta\theta)t}{l}$