FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Advanced)-2019

PAPER –1

ANSWERS, HINTS & SOLUTIONS

Physics **PART – I**

SECTION – A

1. BD

Sol. $T\cos\theta = mg_{eff}$ .....(i)

$T\sin\theta = \dfrac{m\nu^2}{\ell\sin\theta}$ ....(ii)

By (i)

$$T = \frac{mg_{eff}\cos\theta}{\cos^2\theta} = \frac{mg}{\dfrac{g^2}{\left[g^2 + \left(\dfrac{qE}{m}\right)^2\right]}} = mg\left[1 + \left(\frac{qE}{mg}\right)^2\right]$$

By (i) & (ii)

$$\frac{mg_{eff}}{\cos\theta}\sin\theta = \frac{m\nu^2}{\ell\sin\theta} \Rightarrow \nu = \sqrt{(g_{eff}\sin\theta)\ell\tan\theta} = \frac{qE}{m}\sqrt{\frac{\ell}{g}}$$

$$\therefore K.E = \frac{1}{2}m\left(\frac{qE}{m}\right)^2\frac{\ell}{g} = \frac{q^2E^2\ell}{2mg}$$

2. ABD

Sol. By first low of thermodynamics

$Q = W + \Delta U$

$\Rightarrow 2Q = \Delta U$ ……………. (i)

$\Rightarrow 2\cancel{n}C\left(\cancel{T_B - T_A}\right) = \cancel{n}\dfrac{5R}{2}\left(\cancel{T_B - T_A}\right)$

$\therefore C = \dfrac{5R}{4}$

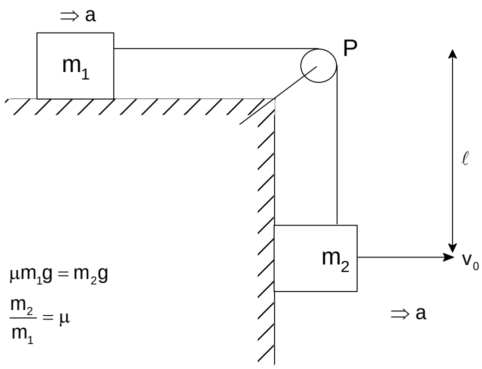
By (i)

$$Q = \frac{1}{2}\Delta U = \frac{1}{2}\left[\frac{5}{2}\left(6P_oV_o - 4P_oV_o\right)\right] = \frac{5}{2}P_oV_o$$

sinceΔU = -2W, therefore temperature goes on increasing from A to B

3. AC

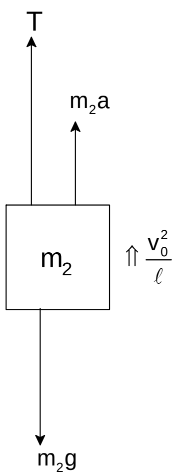
Sol.



$\mu m_1 g = m_2 g$

$\frac{m_2}{m_1} = \mu$

Lets observe the motion of m_2 from an observer fixed at P (point on string)



$$T + m_2 a - m_2 g = \frac{m_2 v_0^2}{\ell} \quad ....(1)$$

for m_1

$$T - \mu m_1 g = m_1 a \quad ....(2)$$

$$\text{from}(1) \text{ and } m_1 a + \mu m_1 g - m_2 a - m_2 g = \frac{m_2 v_0^2}{\ell}$$

$$a = \frac{m_2 \frac{v_0^2}{\ell}}{(m_1 + m_2)} = \left(\frac{\mu}{1+\mu}\right)\frac{v_0^2}{\ell}$$

ROC of m_2

$$T - m_2 g = \mu m_{1g} + \left(\frac{\mu m_1}{1+\mu}\right)\frac{v_0^2}{\ell} - m_2 g$$

$$= \left(\frac{\mu m_1}{1+\mu}\right)\frac{v_0^2}{\ell} = m_2\frac{v_0^2}{R}$$

$$R = \left(\frac{m_2}{\mu m_1}\right)(1+\mu)\ell = \ell(1+\mu)$$

4. BD

Sol. $i = \frac{24}{3+9+6} = \frac{4}{3}A$

$V_1 = \frac{4}{3}\times 9 = 12V$

$V_2 = \frac{4}{3}\times 6 = 8V$

at $t = \infty$

$V_2 = V_1 = 24$

5. BC

Sol. $E_0 z^2\left(1-\frac{1}{9}\right) - E_0 z^2\left(\frac{1}{4}-\frac{1}{9}\right) = 3E_0$

$z = 2$

$\lambda_1 / \lambda_2 = 3$

$KE_1 = E_0\left(1-\frac{1}{9}\right) - \phi$

$KE_2 = E_0 z^2\left(1-\frac{1}{4}\right) - \phi$

$KE \propto \frac{1}{\lambda^2} = 8.5\,eV$

6. ACD

Sol. using Kirchhoff's loop law

$-3i - 1\frac{di}{dt} - 3i + 36 = 0$

$\therefore \frac{di}{dt} = 36 - 6i$ ....(i)

$-3i - 6(i - i_1) + 36 = 0$

$\Rightarrow 3i - 2i_1 = 12$ ....(ii)

by (i) and (ii) $\frac{di_1}{dt} = 12 - 4i_1$

on solving

$i_1 = 3\left(1 - e^{-4t}\right)$

from (ii) $i = 2\left(1 - e^{-4t}\right) + 4$

$\therefore$ power supply by battery = $36(2i - i_1) = 36(9 - e^{-4t})$

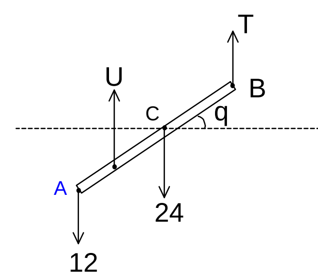
7. C

Sol. U = up thrust = $A\left(\frac{\ell}{2}\right)P_w g$

T + U = 12 g + 24 g

Taking torque about B,

$U\left(\frac{\ell}{2}+\frac{\ell}{4}\right)\cos\theta = 12g(\ell\cos\theta) + 24g\left(\frac{\ell}{2}\cos\theta\right)$



8. BC

Sol. Use $\Delta x = n\lambda$ (for maxima)

& $\Delta x = \left(n + \frac{1}{2}\right)\lambda$ (for minima

9. BCD

Sol. $\overrightarrow{v_B} = 8\hat{j} + 2t\hat{k}$

$\overrightarrow{v_C} = \overrightarrow{v_o} = v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$

$\overrightarrow{r_B} = 8t\hat{j} + t^2\hat{k}$

$\overrightarrow{r_C} = v_x t\hat{i} + v_y t\hat{j} + v_z t\hat{k}$

At 4 sec, $\overrightarrow{r_B} = \overrightarrow{r_C} \Rightarrow v_x = 0, v_y = 8m/s$ & $v_z = 4m/s$

$\therefore \overrightarrow{v_o} = \left(8\hat{j} + 4\hat{k}\right)m/s$

10. AB

Sol. $\Delta\phi = \frac{2\pi}{\lambda}(\Delta x)$ and

$\Delta\phi = \frac{2\pi}{\omega}(\Delta t)$

SECTION – B

11. $(A) \rightarrow q; (B) \rightarrow r; (C) \rightarrow p; (D) \rightarrow s.$

Sol. For (B): $\vec{a}_2 = -r\alpha\hat{j} - \omega^2 r\hat{i} + R\alpha\hat{i} = \left(R\alpha - \omega^2 r\right)\hat{i} - r\alpha\hat{j}$

For (C): $\vec{a}_3 = -r\alpha\hat{i} + \omega^2 r\hat{j} + R\alpha\hat{i} = \left(R\alpha - r\alpha\right)\hat{i} + \omega^2 r\hat{j}$

For (D): $\vec{a}_4 = r\alpha\hat{j} + \omega^2 r\hat{i} + R\alpha\hat{i} = \left(R\alpha + \omega^2 r\right)\hat{i} + r\alpha\hat{j}$

12. $(A) \rightarrow p; (B) \rightarrow q; (C) \rightarrow r; (D) \rightarrow s.$

Sol. C.M. of the cube comes down through a height of $\sqrt{3}$m while C. M. Of displaced water goes up by a height of $\frac{\sqrt{3}}{2}$m.

$\Rightarrow$ Loss in PE of cube = $2000 \times 10 \times \sqrt{3}$ Joule.

$= 2\sqrt{3} \times 10^4$ Joule.

Gain in PE of water = $1000 \times 10 \times \frac{\sqrt{3}}{2} = \frac{\sqrt{3}}{2} \times 10^4$ Joule

Using work energy theorem:

$W_r + W_{Gravity} = 0$

SECTION – C

13. 5

Sol. $mg\frac{\ell}{4} = \frac{m\ell^2}{3}\alpha$

$\alpha = \frac{3g}{4\ell}$

$F = \frac{m}{2}.\frac{3\ell}{4}.\frac{3g}{4\ell}$

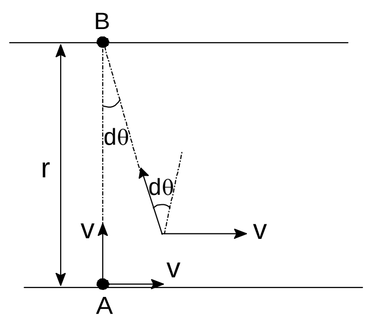
$F = \frac{9mg}{32} = 5N$

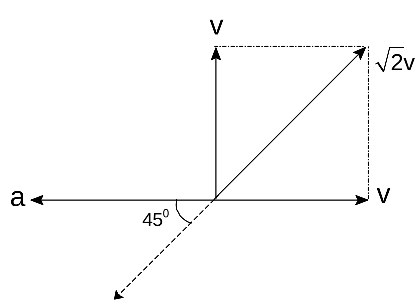
14. 2

Sol. $\frac{dr}{dt} = -v$

$\frac{rd\theta}{dt} = v$

$dv = vd\theta \Rightarrow a = \frac{dv}{dt} = \frac{vd\theta}{dt} = v\omega = v\left(\frac{v}{d}\right) = \frac{v^2}{d}$





$a_r = a\sin 45 = \frac{a}{\sqrt{2}} = \frac{v^2}{\sqrt{2}d} = \frac{\left(\sqrt{2}v\right)^2}{\rho} = \rho = 2\sqrt{2}d$

15. 4

Sol. $V = 220 \pm 1\%$

$I = 5 \pm 1\%$

$W = 555 \pm 2\%$

$W = VI.\cos(\phi)$

$\Rightarrow p.f = \cos(\phi) = \frac{W}{V.I}$

$p.f = \cos(\phi) = \frac{555 \pm 2\%}{(220 \pm 1\%)(5 \pm 1\%)} = \frac{555}{220 \times 5} \pm 4\%$

$p.f = \cos(\phi) = 0.5 \pm 4\%$

16. 5

Sol. $F_{net} = mg - B \Rightarrow m\frac{dv}{dt} = mg - v\rho g$

$\Rightarrow \frac{dv}{dt} = (-)\frac{ga}{4}\left(y - \frac{3}{a}\right) \therefore$ SHM, $T = \frac{2\pi}{\sqrt{\frac{ga}{4}}} = \frac{2\pi}{\sqrt{5}}$ sec

$\therefore K = 5$

17. 5

Sol. Let volume of glass vessel at 20^0C is V_g and volume of mercury at 20^0C is V_m

So volume of remaining space is = V_g - V_m

It is given constant so that

$$V_g - V_m = V_g^{'} - V_m^{'}$$

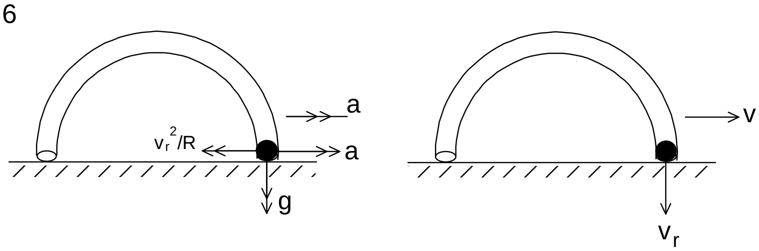
Where $V_0^{'}$ and $V_m^{'}$ are final volumes.

$$V_g - V_m = V_g\{1+\gamma_g\Delta\theta\} - V_m\{1+\gamma_{Hg}\Delta\theta\} \Rightarrow V_g\gamma_g = V_m\gamma_{Hg}$$

$$\Rightarrow V_m = \frac{100\times 9\times 10^{-6}}{1.8\times 10^{-4}} \Rightarrow V_m = 50 \text{ cc.}$$

18. 6

Sol.



a = acceleration of tube just before the ball hits the floor

v_r = velocity of ball w.r.t. tube

v = velocity of tube w.r.t. ground

as floor is smooth, acceleration of CM of the system in horizontal direction is zero

$$\Rightarrow m\left(a - \frac{v_r^2}{R}\right) + 2m\,a = 0$$

using ME conservation for the system in ground frame, $mgR = \frac{1}{2}m\left(v_r^2 + v^2\right) + \frac{1}{2}(2m)v^2$

on solving, $a = \frac{4g}{6}$

19. 2

Sol. $\because E = (-)13.6\left[\frac{1}{(n+2)^2} - \frac{1}{n^2}\right]z^2 eV$

$$\Rightarrow E = (-)13.6\left[\frac{z^2}{(z+2)^2} - 1\right] = \frac{4(z+1)\times 13.6}{(z+2)^2}eV$$

$\therefore$ energy of electron,

$$K = \frac{h^2}{2\lambda^2 m} = 6eV\left[\because \lambda = \frac{h}{\sqrt{2mK}}\right]$$

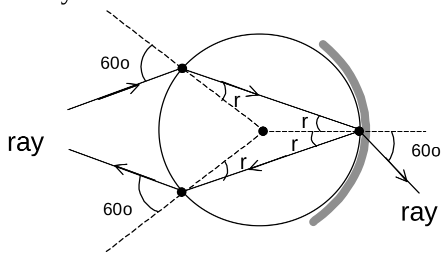
$$\Rightarrow \text{Energy } E = (6+4.2)eV$$

$$\Rightarrow \frac{4\times 13.6(z+1)}{(z+2)^2} = 10.2 \Rightarrow \frac{z+1}{(z+2)^2} = \frac{3}{16} \Rightarrow z = 2, (-)\frac{2}{3}$$

$$\therefore z = 2$$

20. 3

Sol. 1st ray



$\delta_1 = (60^o - r) + (60^o - r) = 2(60^o - r)$

2nd ray

$\delta_2 = (60^o - r) + (\pi - 2r) + (60^o - r) = \pi + 2(60^o - 2r)$

$\because \delta_2 = 3\delta_1 \quad \Rightarrow r = 30^o$

$$\Rightarrow \mu = \frac{\sin i}{\sin r} = \frac{\sin 60^o}{\sin 30^o} = \sqrt{3}$$

$\therefore n = 3$

Chemistry PART – II

SECTION – A

21. AD
Sol. Facts

22. AB
Sol. $ClO_4^- + 2H^+ + 2e^- \longrightarrow ClO_3^- + H_2O$

Eq. mass of $NaClO_4 = \dfrac{23+35.5+64}{2} = 61.25$

No. of equivalents of $NaClO_4 = \dfrac{245}{61.25} = 4 = 4.0F$

The anode efficiency = 60 %

No. of $faradays = \dfrac{4.0}{60} \times 100 = 6.67F$

23. BD
Sol. Both pairs in (b) and (d) produce the same total number of ions after dissociation.

24. ABD
Sol. Such coordination is exhibited by compounds which have BCC Lattice structure.

25. AC
Sol. Fact based.

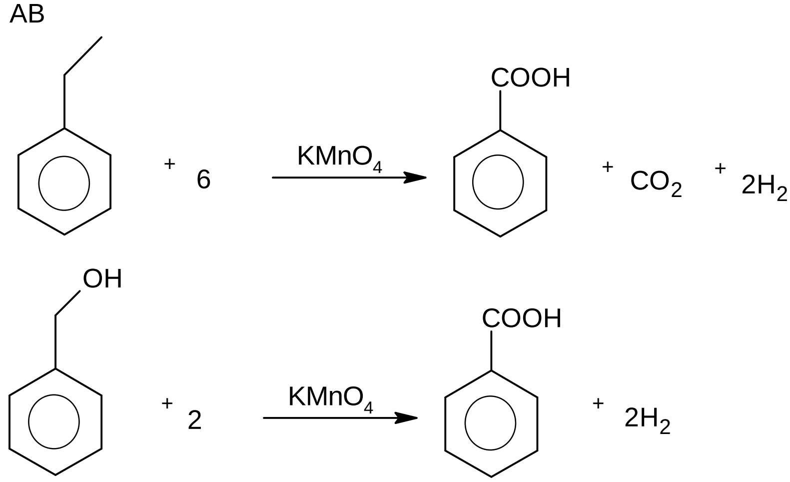
26. ABD
Sol. Facts

27. AD
Sol. Facts

28. BD
Sol.

$$CH\equiv CH \ + \ 2CH_3 \xrightarrow[2.\ 80°C]{1\ \ Hg^{2+}} CH_3CH(OOCH_3)_2 \xrightarrow{300°C} CH_3COOCOCH_3 \ + \ CH_3CHO$$

29. AB
Sol.



30. BC
Sol. The gem – dihalide is obtained initially.

SECTION – B

31. (A) → (p,t); (B) → (q, r); (C) → (p,t); (D) → (q, t)
Sol. (A) Cathode : $Pb^{2+} + 2e^- \longrightarrow Pb(s)$

Anode : $2Cl^- \longrightarrow Cl_2(g) + 2e^-$

(B) Cathode : $H_2O + 2e^- \longrightarrow H_2(g) + 2OH^-$

Anode : $2Cl^- \longrightarrow Cl_2(g) + 2e^-$

(C) Cathode : $Ag^+ + e^- \longrightarrow Ag(s)$

Anode : $Ag(s) \longrightarrow Ag^+(aq) + e^-$

(D) Cathode : $2H_2O + 2e^- \longrightarrow H_2(g) + 2OH^-$

Anode : $2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$

32. (A) → (q,r); (B) → (q,s,t); (C) → (q,s); (D) → (p,r,s)
Sol. Fact based

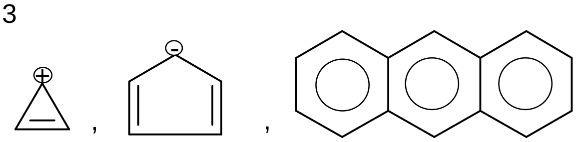
SECTION – C

33. 4
Sol. $Cd^{2+}_{(aq)}, \mathrm{Zn}^{2+}_{(aq)}, Ag^{+}_{(aq)}, Ni^{2+}_{(aq)}$

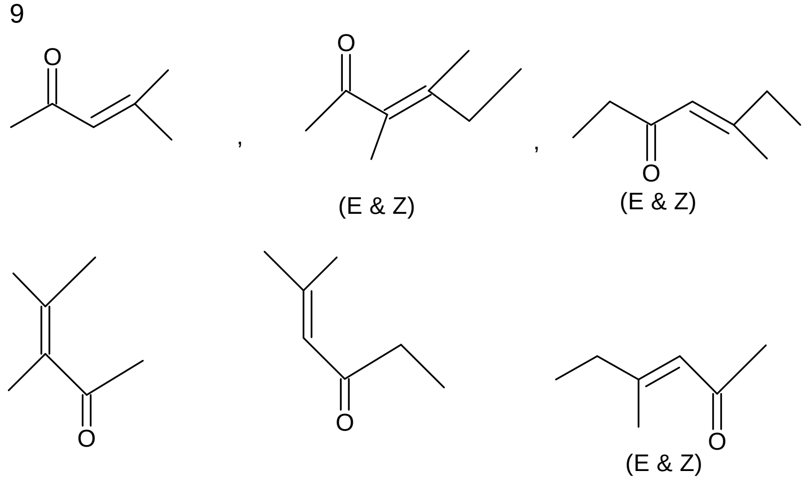
34. 1
Sol. x = 6, y = 6

35. 9
Sol. CH_3MgBr acts as both base and nucleophile.

36. 3
Sol.



37. 9
Sol.



38. 8
Sol. Facts

39. 7
Sol. Solubility of CuCl is higher than AgCl

$$\therefore \left[Cl^-\right] = \left[Cl^-\right]_{CuCl} = \sqrt{K_{sp} \text{ of } CuCl} = 10^{-3} M$$

$$\because K_{sp} \text{ of } AgCl = \left[Ag^+\right]\left[Cl^-\right]$$

$$1.6 \times 10^{-10} = \left[Ag^+\right] \times 10^{-3}$$

$$\left[Ag^+\right] = 1.6 \times 10^{-7} M$$

$$\therefore x = 7$$

40. 5

Sol. $r_g = \frac{1}{5}.r_{H_2}$

$$\frac{M_g}{M_{H_2}} = \left(\frac{r_{H_2}}{r_g}\right)^2 = (5)^2 = 25$$

$$M_g = 2 \times 25 = 50$$

$$10y = 50$$

$$\therefore y = 5$$

Mathematics

PART – III

SECTION – A

41. AD

Sol. $T_r(A)$ = sum of the roots
det(A) = product of the roots

42. AD

Sol. Let $P \equiv (\alpha, \beta)$ & foot of normal $\equiv \left(4t, \frac{4}{t}\right)$ so, $\frac{\beta - \frac{4}{t}}{\alpha - 4t} = t^2$

$\Rightarrow 4t^4 - \alpha t^3 + t\beta - 4 = 0$

Let t_1, t_2, t_3 & t_4 are roots

then $\sum 4t_1 + \sum \frac{4}{t_1} = \sum t_1^2$

$\alpha + \beta = \frac{\alpha^2}{16}$

Locus of P is $x^2 = 16(x + y)$

43. ABCD

Sol.

X = no of dice showing even no.	P = probability
0	$\left(\frac{3}{6}\right)^5 = \left(\frac{1}{2}\right)^5$
1	${}^5C_1.\left(\frac{1}{2}\right).\left(\frac{1}{2}\right)^4 = \frac{5}{2^5}$
2	${}^5C_2.\left(\frac{1}{2}\right)^5 = \frac{10}{2^5}$
3	${}^5C_3.\left(\frac{1}{2}\right)^5 = \frac{10}{2^5}$
4	${}^5C_4.\left(\frac{1}{2}\right)^5 = \frac{5}{2^5}$
5	$\left(\frac{1}{2}\right)^5 = \left(\frac{1}{2}\right)^5$

$\mu = 1.\frac{5}{2^5} + 2.\frac{10}{2^5} + 3.\frac{10}{2^5} + 4.\frac{5}{2^5} + 5.\left(\frac{1}{2}\right)^5$

$= \frac{1}{2^5}[5 + 20 + 30 + 20 + 5] = \frac{80}{32} = \frac{5}{2} = 2.5$

$\sigma^2 = \frac{1}{25}[5 + 40 + 90 + 80 + 25] - \frac{25}{4}$

$= \frac{240}{32} - \frac{25}{4} = \frac{240 - 200}{32} = \frac{40}{32} = \frac{5}{4}$

$$\frac{1-\left(\frac{1}{2}\right)^5-\frac{5}{2^5}}{1-\left(\frac{1}{2}\right)^5}=\frac{32-1-5}{32-1}=\frac{26}{31}$$

44. ABCD

Sol. $\left[\ln x-\ln y-\frac{x}{y}-1\right]dy=\left[\ln y-\ln x-\frac{y}{x}-1\right](dx)$

$\ln\left(\frac{x}{y}\right)dy+\frac{y}{x}dx-dy=\ln\left(\frac{y}{x}\right)dx+\frac{x}{y}dy-dx$

$d\left(y\ln\left(\frac{x}{y}\right)\right)=d\left(x\ln\frac{y}{x}\right)$

So, a = 1, b = 1, c = 1, d = -1

45. CD

Sol. $g(x)=\lim_{n\to\infty}n\left(x^{\frac{2018}{n}}-x^{\frac{2019}{n}}\right)\ (\infty.0)$

Let $n=\frac{1}{t}$ as $n\to\infty, t\to 0$

$g(x)=\lim_{t\to 0}\frac{x^{2018t}-x^{2019t}}{t}\ \left(\frac{0}{0}\right)$

Apply L' hospital Rule
g(x) = -ln(x)

46. AB

Sol. $3\left|z-\frac{i}{3}\right|=\lambda|z+2|$

For λ = 3, it's a straight line, else circle

47. BCD

Sol. orthogonal straight lines $\Rightarrow$ 2 - λ = 0, λ = 2

$2h^2-3hk-2k^2=7$

$(2h+k)(h-2k)=7$

48. ABCD

Sol. *Groups* $(2, 2, 4)$ *or* $(2, 2, 3)$

$\left(\frac{8!}{2!2!4!2!}+\frac{8!}{2!3!3!2!}\right)3!$

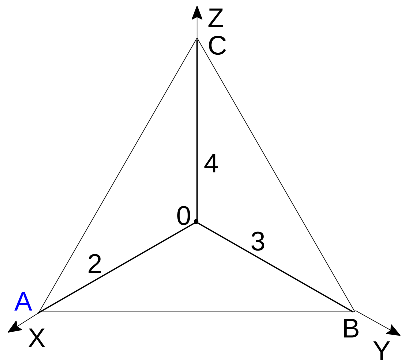
49. AB

Sol. Total ways

$3!\cdot 2!\cdot {}^4C_2\cdot 2!=144$

50. ABCD

Sol. $\left[ar(\Delta ABC)\right]^2=\left[ar(\Delta OAB)\right]^2+\left[ar(\Delta OBC)\right]^2+\left[ar(\Delta OCA)\right]^2$



If A & C are on positive axes & B is on negative axis then equation plane is $\frac{x}{2}+\frac{y}{-3}+\frac{z}{4}=1$

If A & B are on positive axes & C is on negative axis then equation of plane is $\frac{x}{2}+\frac{y}{3}+\frac{z}{-4}=1$

SECTION – B

51. $(A)\to(q),(B)\to(p),(C)\to(t),(D)\to(r)$

Sol. (A).

$Let\ \vec{r}=a\hat{i}+b\hat{j}+c\hat{k}$

$|\vec{r}|=1\Rightarrow a^2+b^2+c^2=1$

$\lambda=\left[\vec{p}\,\vec{q}\,\vec{r}\right]=3a-7b-c$

$\lambda^2\ge\frac{59}{10}$

$\mu=\lambda_{\max}$

(D). $\vec{X}=\lambda\left(\vec{p}\times\vec{q}\right)$ & $\left|\vec{X}\right|=1$

52. $(A)\to(p,q,r,s),(B)\to(p,q,r),(C)\to(p,q,r,s,t),(D)\to(p,q)$

Sol. (A). $I=\int_0^{\frac{\pi}{4}}\sin^3 x\cdot\cos^3 x dx=\frac{1}{16}\int_0^{\frac{\pi}{3}}\sin^3 x dx=\frac{1}{24}$

(B). $I=\int_0^{\frac{\pi}{6}}0dx+\int_{\frac{\pi}{6}}^{\frac{5\pi}{6}}1dx+\int_{\frac{5\pi}{6}}^{\pi}0dx+\int_{\pi}^{\frac{7\pi}{6}}-1dx+\int_{\frac{7\pi}{6}}^{\frac{11\pi}{6}}-2dx+\int_{\frac{11\pi}{6}}^{4\pi}-1dx$

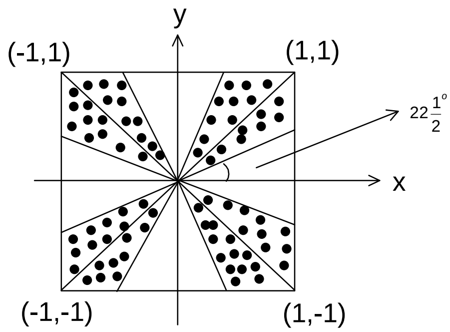
(C). $I=\int_{-3}^{1}\sin x dx=-2$

(D). $I=\int_0^1\frac{x^3+1-2}{x+1}dx=\int_0^1\left(x^2-x+1-\frac{2}{x+1}\right)dx$

SECTION – C

53. 2

Sol. A required area is the shaded region = $4\sqrt{2}\left(\sqrt{2}-1\right)$



54. 5

Sol. $\int_1^e \frac{x^3 \ln x + x^2 - x^2 + 2}{x^3 \ln x + x}dx = \int_1^e x dx - \int_1^e \frac{x^2 - 2}{x^3 \ln x + x}dx$

$\int_1^e x dx - \int_1^e \frac{\frac{1}{x} - \frac{2}{x^3}}{\ln x + \frac{1}{x^2}}dx$

55. 2

Sol. put 7 – x = t

then given equation becomes

$t^4 + 6t^2 - 7 = 0 \Rightarrow t = \pm 1$

$\Rightarrow 7 - x = \pm 1$

So x = 6 or 8

56. 4

Sol. Solve director circle of hyperbola with ellipse

57. 6

Sol. $\cos x + \sin x + \sin 2x + \cos 2x + \sin 3x = -1$

$\Rightarrow (\sin x + \sin 3x) + (\cos x + \sin 2x) = -(1 + \cos 2x)$

$\Rightarrow 4\sin x + 4\sin^3 x + \cos x(1 + 2\sin x) = -2\cos^2 x$

$\Rightarrow 4\sin x(1 - \sin^2 x) + 2\cos^2 x + \cos x(1 + 2\sin x) = 0$

$\Rightarrow (2\cos^2 x + \cos x)(1 + 2\sin x) = 0$

$So, cosx = 0, -\frac{1}{2}, \sin x = -\frac{1}{2}$

58. 2

Sol. K = 771

$P_{max} = 5$, $P_{min} = 3$

59. 5

Sol. Sum = $\frac{(2\times 1^2 - 3\times 1 + 1)^{11} + \left(2(-1)^2 - 3(-1) + 1\right)^{11}}{2}$

= $3 \times 6^{10} = 2^{10}.3^{11}$

60. 3

Sol. $I(\alpha, r) = \sqrt{(\alpha + \bar{\alpha})^2 - 4r}$