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A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec: Sr.Super60_NUCLEUS & STERLING_BT　　**Paper -1(Adv-2021-P1-Model**　　**Date: 24-09-2023**

Time: 09.00Am to 12.00Pm　　**RPTA-08**　　**Max. Marks: 180**

KEY SHEET

PHYSICS

1	**A**	2	**C**	3	**B**	4	**D**	5	**0.16**	6	**1.53**
7	**0.67**	8	**0.33**	9	**2.50**	10	**1.26**	11	**BD**	12	**A**
13	**ABC**	14	**ABD**	15	**AC**	16	**BD**	17	**7**	18	**3**
19	**2**										

CHEMISTRY

20	**B**	21	**C**	22	**D**	23	**D**	24	**5**	25	**4.2**
26	**2**	27	**9**	28	**5**	29	**3**	30	**ABCD**	31	**ABCD**
32	**BCD**	33	**BCD**	34	**ABCD**	35	**ABCD**	36	**2**	37	**4**
38	**5**										

MATHEMATICS

39	**B**	40	**D**	41	**B**	42	**A**	43	**18**	44	**4**
45	**0**	46	**11**	47	**2**	48	**3**	49	**BC**	50	**BC**
51	**BC**	52	**BC**	53	**ACD**	54	**ACD**	55	**0**	56	**9**
57	**6**										

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SOLUTIONS

PHYSICS

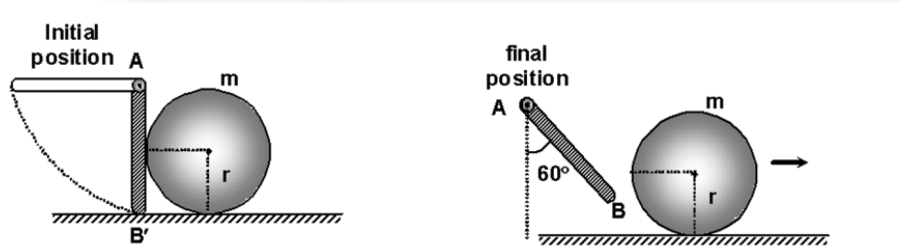
1) KEY – A

Using conservation of mechanical energy

$$mg\frac{L}{2}=\frac{1}{2}\frac{ML^2}{3}\omega_0^2$$

$$\Rightarrow \omega_0=\sqrt{\frac{3g}{L}},\ \omega=\sqrt{\frac{3g}{2L}}=\sqrt{\frac{3g}{2\sqrt{2r}}}$$

$$L=\sqrt{2r}$$



Using the definition of e

$$(L-r)\omega_0=v-\omega(L-r)$$

$$v=(L-r)(\omega_0+\omega)=(L-r)\omega\left(\sqrt{2}+1\right)=r\omega=\sqrt{\frac{3gr}{\sqrt{2}}}$$

$$r=\frac{6\sqrt{2}}{10}m$$

$$v=\sqrt{\frac{3\times10\times6\times\sqrt{2}}{2\sqrt{2}\times10}}=3m/s$$

Using COAM

$$I\omega_0=I\omega+mv(L-r)$$

$$I(\omega_0-\omega)=m(\omega_0+\omega)(L-r)^2$$

$$\frac{ML^2}{3}(\omega_0-\omega)=m(\omega_0+\omega)(L-r)^2$$

$$\frac{M}{m}=\frac{3(L-r)^2}{L^2(\omega_0-\omega)}=\frac{3}{2}$$

2) KEY – C

Let a be the acceleration

$F-\mu mg=ma$ --------(1)

Taking torques about 'c'

$\mu mg\left[\frac{l}{2}\right]+F\left[\frac{l}{2}\right]=N\frac{l}{2}$ --------(2)

And $\sum F_Y=0\Rightarrow N=mg$ -------(3)

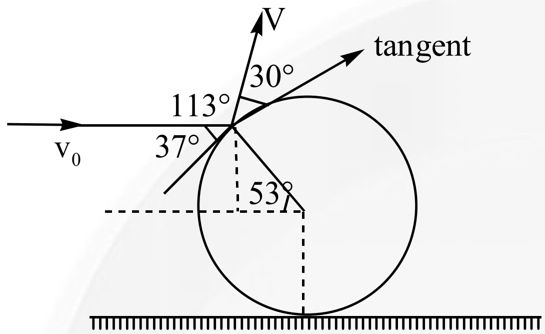
Simplifying 1, 2 and 3

$a = g[1-2\mu]$

3) KEY – B

Tangential speed is unchanged $\Rightarrow v_0 \cos 37° = v \cos 30°$

$$\Rightarrow v_0 \times \frac{4}{5} = v \times \frac{\sqrt{3}}{2} \Rightarrow 8v_0 = 5\sqrt{3}v$$



4) KEY – D

Angular momentum equation about point of impart.

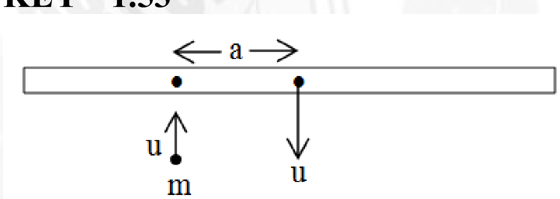
$$mv_0 \frac{L}{2}\cos\theta = \frac{mL^2}{12}\omega - mv\frac{L}{2}\cos\theta$$

$$\Rightarrow \frac{\omega L}{6} = (v_0 + v)\cos\theta \Rightarrow \omega = \frac{6(v_0+v)\cos\theta}{L}$$

5) KEY – 0.16

Conceptual

6) KEY – 1.53



Let v_1 and v_2 be the velocities of rod and particle respectively (vertically downward)

Impulse on rod $= -3mv_1 + 3mu$ ……….. (1)

Impulse on particle $= mv_2 + mu$ ……….. (2)

Equate eqs (1) and (2) we get

$$2u = 3v_1 + v_2 \quad \text{……….. (3)}$$

Angular impulse = change in ang., momentum

$$J \times a = I\omega$$

$$(mv_2 + mu)a = \frac{3m \times (4a)^2}{12}\omega$$

$$v_2 + u = 4a\omega \quad \text{……… (4)}$$

Also, apply Newton's law on collision along the line of impulse.

$$v_2 - (v_1 - a\omega) = 2u$$

$$v_2 - v_1 + a\omega = 2u \qquad \text{..........} (5)$$

Solving, we get

$$v_1 = \frac{3}{19}u; \quad v_2 = \frac{29}{19}u; \quad \omega = \frac{12u}{19a}$$

7) **KEY – 0.67**

Applying conservation of angular momentum

$$(I+2I)\omega' = I.2\omega + 2I.\omega \text{ or } \omega' = \frac{I(2\omega)+2I(\omega)}{3I} = \frac{4\omega}{3} \text{-----------(i)}$$

Now $\omega' = \omega + \frac{\tau}{2I}t$ --------------(ii)

From equation (i) and (ii) $\tau = 2I\omega/3t$

If τ is the average frictional torque and the relative motion occurs for time t, then τ is the angular impulse imparted to each disc but in the opposite sense

Now, we can write that $\tau.t = I(\omega' - 2\omega)$ or $\tau.t = 2I(\omega' - \omega)$

Each of the above equation gives $\tau = 2I\omega/3t$

8) **KEY – 0.33**

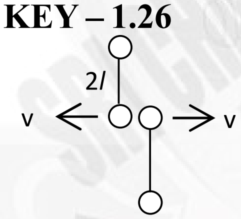
Loss in the kinetic energy $\Delta K = K_i - K_f$

$$= \left[\frac{1}{2}\times I\times(2\omega)^2 + \frac{1}{2}\times 2I\times\omega^2\right] - \frac{1}{2}(I+2I)\left(\frac{4\omega}{3}\right)^2 = \frac{I\omega^2}{3}$$

9) **KEY – 2.50**

Conceptual

10) **KEY – 1.26**



;

$w = \frac{v}{l}$; $\quad t = \frac{\pi}{w} = \frac{\pi}{v/l} = \frac{\pi l}{v}$

11) **KEY – BD**

For P : About A or B

$$L_i = L_f \Rightarrow mv\frac{\ell}{2} = \frac{m\ell^2}{3}\omega_P \Rightarrow \omega_P = \frac{3v}{2\ell}$$

For Q : About A

$$L_i = L_f \Rightarrow mv\frac{\ell}{2} + \frac{m\ell^2}{12}\omega = \frac{m\ell^2}{3}\omega_1 \Rightarrow \omega_1 = \left(\frac{v}{2} + \frac{\omega\ell}{12}\right)\frac{3}{\ell} = \frac{3v}{2\ell} + \frac{\omega}{4}$$

$\therefore \omega_1 > \omega_P \Rightarrow$ Option (A) is wrong and (B) is correct.

About B

$$L_i = L_f \Rightarrow \omega_2 = \frac{3v}{2\ell} - \frac{\omega}{4}$$

ω_2 is +ve as $\omega < \frac{6v}{\ell}$

$\therefore \omega_2 < \omega_P \Rightarrow$ Option (C) is wrong and (D) is correct.

12) As hinges are smooth the disc continue to rotate at ω so by work energy theorem we use

$$\frac{1}{2}\left(\frac{1}{3}m(2R)^2\right)\omega^2 + \frac{1}{2}m(2R\omega)^2 = \left(mg(2R) + mgR\right)\frac{1}{2}$$

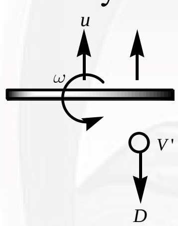
$$\Rightarrow 2R^2\omega^2 + \frac{2R^2\omega^2}{3} = \frac{3gR}{2} \Rightarrow \frac{8R\omega^2}{3} = \frac{3g}{2} \Rightarrow \omega = \sqrt{\frac{9g}{16R}}$$

13) KEY – ABC

The ball has V' component of its velocity perpendicular to the length of the rod immediately after the collision. u is the velocity of CM of the rod and ω is angular velocity of the rod just after collision. The ball strikes the rod with speed $v \cos 53^0$ in perpendicular direction and its component along the length of the rod after the collision is unchanged.

Using for the point of collision.

Velocity of separation = Velocity of approach



$$\frac{3V}{5} = \left(\frac{\omega l}{4} + u\right) + V' \qquad ....(1)$$

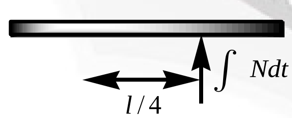
Conserving linear momentum (of rod + particle) in the direction $\perp$ to the rod,

$$mV\frac{3}{5} = mu - mV' \qquad ....(2)$$

$$0 = 0 + \left[u\frac{l}{4} - \frac{ml^2}{12}\omega\right] \Rightarrow u = \frac{\omega l}{3}$$

$$\Rightarrow u = \frac{24V}{55}, W = \frac{72V}{55l} \qquad ....(3)$$

Time taken to rotate by π angle, $t = \frac{\pi}{\omega}$



In the same time, distance travelled $= u_2 t = \frac{\pi l}{3}$

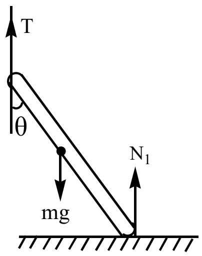
Using angular impulse-angular momentum equation,

$$\int Ndt\frac{l}{4} = \frac{ml^2}{4}.\frac{72V}{55l}\omega \qquad \left\{\because \int Ndt\frac{l}{4} = \frac{24mV}{55}\right\}$$

[using impulse-momentum equation on the rod $\int Ndt = mu = \frac{24mV}{55}$]

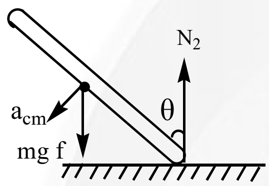
14) KEY – AD

$T + N_1 = mg$



$mg\dfrac{l}{2}\sin\theta - T\ l\sin\theta = 0$ $\quad\Rightarrow\quad T = mg/2,\ N_1 = mg/2$

$mg\dfrac{l}{2}\sin\theta = \dfrac{ml^2}{3}\propto$

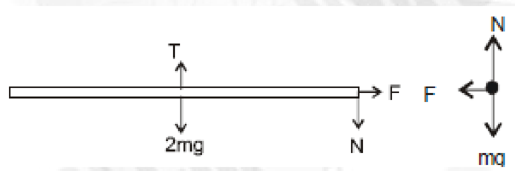


$\Rightarrow \quad \propto = \dfrac{3g\sin\theta}{2l} \qquad a_{cm} = \dfrac{l}{2}\propto = \dfrac{3g\sin\theta}{4}$

$mg - N_2 = m\left(a_{cm}\right)_y \quad = m\dfrac{3g}{4}\sin^2\theta$

$N_2 = mg\left[1 - \dfrac{3}{4}\sin^2\theta\right] \quad = \dfrac{Tmg}{16}$

15) KEY – AC



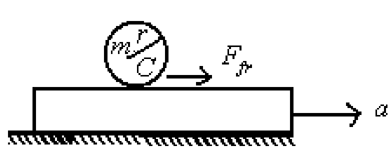
The FBD of the rod and the ball are shown. Applying $\tau = I\alpha$ about the C.M. of the rod, we have, $N\left(\dfrac{l}{2}\right) = \left(\dfrac{Ml^2}{12}\right)\alpha$

Writing Newton's IInd law in the vertical direction on the CM of the rod we have $T - N - 2mg = 0$ and writing Newton's II law in the vertical direction on the ball we have, $mg - N = m\left(\dfrac{l}{2}\right)\alpha$.

16) KEY – BD

$ma_c = F_{fr} \qquad I\propto = rF_{fr} = rma_c$

$a - a_c = \alpha r = \dfrac{rma_c}{I}r$ or, $a - a_c = \dfrac{mr^2 a_c}{\dfrac{mr^2}{2}} = 2a_c$



or, $3a_c = a,\ a_c = \dfrac{a}{3} = \dfrac{6}{3} = 2m/s^2$

So, $f_{FR} = \frac{ma}{3}$ so maximum value of this force is equal μmg

Hence $\mu mg = \frac{ma_{lim}}{3}$ or, $a_{\lim} = 3\mu g = 3 \times 0.3 \times 10 = 9m/s^2$

17) KEY – 7

$$I_1\omega_1 = I_2\omega_2 \Rightarrow 2\left[\frac{ML^2}{12}\omega_0\right] = \left[\frac{ML^2}{12} + \frac{ML^2}{12} + ML^2\right]\omega_2$$

$$\Rightarrow \frac{\omega_0}{6} = \frac{7}{6}\omega_2$$

$$\Rightarrow \omega_2 = \frac{\omega_0}{7}$$

18) KEY – 3

$$\int F\Delta t = mV_{cm} \qquad -(1)$$

$$\& \frac{l}{2}\int Fdt = I_{cm}\omega \qquad -(2)$$

$$\Rightarrow \frac{l}{2}.mV_{cm} = \frac{ml^2}{12}\omega$$

$$\Rightarrow V_{cm} = \frac{l\omega}{6}$$

Set 'T' be the time for one rotation

$$\therefore d_{cm} = V_{cm}T = \frac{l(2\pi/T)}{6}.T = \frac{l\pi}{3}$$

19) KEY – 2

Loss in PE=gain in KE

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$\Rightarrow mgh = \frac{1}{2}m(\omega r)^2 + \frac{1}{2}\left(\frac{2}{3}mr^2\right)\omega^2$$

$$m \times 10\left(\frac{3}{100}\right) = m\frac{5}{6} \times \left(\frac{30}{100}\right)^2 \omega^2 \Rightarrow \omega = 2rad/s$$

CHEMISTRY

20) KEY – B

Both reactant and product having same number of unpaired electrons, no change in the magnetic moment. (NCERT, MOT, Based).

21) KEY – C

Both reactantKHF_2 contain ionic, covalent, and H – bonding.

22) KEY – D

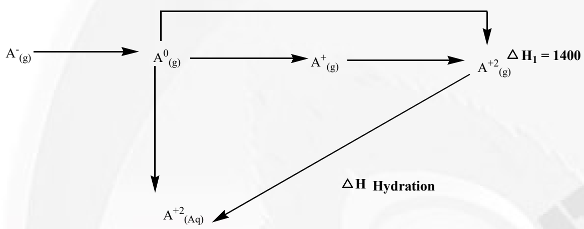
Highest EA element is Cl (NCERT orders table)

23) KEY - D

In isoelectronic ions increases the nuclear charge decrease the ionic radius order is $O^{-2} > F^- > Na^+ > Mg^{+2}$

$1.26A^0, 1.19A^0, 1.16A^0, 0.72A^0$.

24) KEY – 5



$A^+ + e^- \longrightarrow A^0_{(g)} \quad \Delta H_{eg} = -350$ KJ / mole, $\mathbf{A^0 \longrightarrow A^+_{(g)} + e^-} \quad \Delta H = +350$ KJ / mole

$\therefore IE_1$ of $A_{(g)}$=350 KJ / mole

$\therefore$ IE of A^+=950 – 350 = 600 KJ / mole

$\mathbf{A^+_{(g)} \longrightarrow A^{+2}_{(g)}} \quad \Delta H = 600$ KJ / mole, $\mathbf{A^{+2}_{(g)} + e^- \longrightarrow A^+_{(g)}} \quad \Delta H_{eg} = -600$ KJ / mole

-a = -600 $\Rightarrow$ a = 600 KJ / mole

$$\frac{a}{120} = \frac{600}{120} = 5KJ\ /\ mole$$

24) KEY – 4.2

According to the Hee's law

1400 = 950 + IE_1 of A^-

IE_1 of A^- = 1400-950 = $\frac{450}{(x)}$

IE of A^+ = 600 KJ / mole = y $\quad \Delta H_2 = IE_1 + IE_1 + \Delta H$ of hydration

$\therefore\ \Delta H$ of hydration = 700 – 950 = - 250 = - z$\therefore$ z = 250 KJ/mole

$$\therefore \frac{600+450}{250} = 4.2$$

25) KEY – 2

$O_2, O_2^-, O_2^{\oplus}$ B.O = 2.5

$O_2(B.O = 2 \quad \mu = 2.83Br)$

$O_2^-\ B.O = 1.5 \quad \mu = 1.73Br$

26) KEY – 9

$H_2^+,\ H_2^-,\ He_2^+,\ O_2^+, O_2^-, O_3, BF_3, CO_3^{-2}, C_6H_6$

27) KEY – 5

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$ClO_4^-, SO_4^{-2}, BeCl_2, {}^{\oplus}CH_3, NH_4^{\oplus}$

The species with out any lone pair of electron

28) KEY – 3

29) KEY = ABCD

In NO one e^- in π^*2py

In O_2 two unpaired e^- in $\pi^*2py = \pi^*2pz$

30) KEY = ABCD

Hybridization (H) = $\frac{1}{2}[V + M - c]$

For

(A) H = $\frac{1}{2}[8+4] = 6sp^3d^2$ *without L.P*

(B) H = $\frac{1}{2}[3+4+1] = 4sp^3$ *without L.P*

(C) H = $\frac{1}{2}[6+4] = 5sp^3d$ *withone L.P*

(D) H = $\frac{1}{2}(7+2+1) = 5$ *withthree L.P*

31) KEY = BCD

Properties of ionic compounds

32) KEY = BCD

B C – Due to diagonal relationship

D – Due to Lanthanide contraction.

33) KEY = ABCD

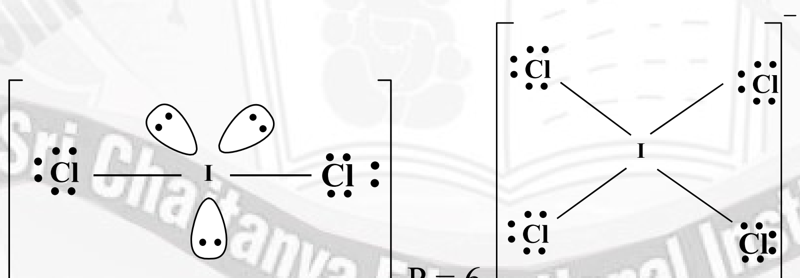
$B.E \propto Bond\ order \propto bond\ polarity \propto \frac{1}{radius} \propto (\text{S} - \text{character of hybrid orbitals})$

34) KEY = ABCD

Amphoteric metal oxides are amphoteric oxides.

35) KEY – 2

ICl_2^-



P = 6 Q = 8

Q – P = 8 – 6 = 2

37) KEY – 4

$$\% \text{I C} = \frac{\mu_{obs}}{\mu_{cal}} \times 100 = \frac{6.004 \times 10^{-30}}{9.17 \times 10^{-11} \times 1.6022610^{-19}} \times 100 = 40.9\% = x$$

$$\frac{x}{10} = \frac{40.9}{10} = 4.09 \cong 4$$

38) KEY - 6

83, 54, 34, 17, 48, 08.

MATHEMATICS

39) KEY – B

$l + m + n + p = 0$

$\lambda = -1$

$$\frac{3\overline{OA} + 2\overline{OB}}{3+2} = \frac{4\overline{OC} + \overline{OD}}{4+1}$$

40) KEY – D

Apply $S(\alpha,\beta,\gamma)$, $SA = SB = SC$, Also SA, SB, SC Coplanar

41) CONCEPTUAL

42) CONCEPTUAL

43) KEY – 18

$a + b + c = 0$, cases : $a, b, c = -2, 1, 1; -2, 0, 2; -1, 0, 1; -1, -1, 2$

44) KEY – 4

a = b = c

45) KEY – 0

Given $\overline{b \times c} = \overline{c} - \overline{a}$

$O = b.c - b.a$

$b.c = 0, b \times c.c = (c-a).c$

$a.c = |c|^2, |b \times c|^2 = |c-a|^2$

$|b|^2 \times |c|^2 = 11 - |c|^2$

46) KEY – 11

Given $\overline{b \times c} = \overline{c} - \overline{a}$

$O = b.c - b.a, b.c = 0$

$b \times c.c = (c-a).c, a.c = |c|^2$

$|b \times c|^2 = |c-a|^2, |b|^2 \times |c|^2 = 11 - |c|^2$

47) KEY – 2

Conceptual

48) KEY – 3

$$V = \frac{1}{3}(\text{Area of base})\text{height} = \frac{1}{3}\left(\frac{\sqrt{3}}{4}\right)\sqrt{1-\frac{1}{3}}$$

$PA^2 + PB^2 + PC^2 + PD^2 = 8r^2$

49) KEY – BC

$l + m + n + p = 0$

$\Rightarrow Tan\,\alpha + 2Tan\,\beta + 2Tan\,\gamma = 1$

$\Rightarrow \overline{u}.\overline{v} \le |\overline{u}|.|\overline{v}|$

$1 \le \sqrt{9}.\sqrt{\varepsilon Tan^2\alpha}$

Equality Holds at like vectors

50) KEY – BC

$\Delta = \begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}$ $\Delta = 0$ Solutions along a line a = b = c solutions lie across a plane

51) KEY – BC

Take P =(0 0 0)

$\overline{PQ} = i,\ \overline{PR} = i + j, \overline{PS} = j$

$Q' = \left(\frac{1}{2}, \frac{1}{2}, \frac{1}{2}\right)$

$Q = \left(1\ 0\ 0\right)$

$\overleftrightarrow{PQ'} \equiv \overline{r} = \overline{o} + t\left(i + j + \sqrt{2}k\right)$

$\overleftrightarrow{RS} \equiv \overline{r} = i + j + \alpha\left(i\right), S.D = \frac{\sqrt{2}}{\sqrt{3}}$

52) KEY – BC

Consider (0 0 0), (1 1 1) are opp – vertices of a pri – Diagonal of a cube

53) KEY – ACD

$\overrightarrow{AN} = \lambda\vec{c} + \left(1-\lambda\right)\overline{b} - \overline{a}$

$\overline{BP} = \lambda\vec{a} + \left(1-\lambda\right)\overline{c} - \overline{b}$

$\overline{CM} = \lambda.\overline{b} + \left(1-\lambda\right)\overline{a} - \overline{c}$

Area form by above three vectors

$0 = \frac{1}{2}\left|\overline{s}_1 \times \overline{s}_2\right|$

$= \frac{1}{2}\left|\left(\lambda\vec{c} + \left(1-\lambda\right)\overline{b} - \overline{a}\right) \times \left(\lambda\vec{a} + \left(1-\lambda\right)\overline{c} - \overline{b}\right)\right|$

$= \frac{1}{2}\left|\lambda^2 - \lambda + 1\right| \left(Area\ \ \Delta ABC\right)$

$= \frac{1}{2}\left|\lambda^2 - \lambda + 1\right|$

54) KEY – AC

$P\left(3r_1 + 5, -r_1 + 7, r_1 - 2\right)$

$Q\left(-3r_2 - 3, 2r_2 + 3, 4r_2 + 6\right)$

$D.R.S\ \ of\ \ \overline{PQ}$

$\equiv 2 : 7 : -5$

$\Rightarrow r_1 = -1, r_2 = -1$

55) KEY – 0

$$a \times (a \times b) = (a.b)\bar{a} - (a.a)\bar{b}$$

$$a \times (a \times (a \times b)) = -|a|^2 (a \times b)$$

……………………………………………………..

56) KEY – 9

$$|\bar{a} + \bar{b} + \bar{c}|^2 \geq 0$$

$$\Rightarrow 2\sum \bar{a}\,\bar{b} \geq -3$$

$$\Rightarrow |\bar{a} - \bar{b}|^2 + |\bar{b} - \bar{c}|^2 + |\bar{c} - \bar{a}|^2 \leq 9$$

57) KEY – 6

Let $lx + my + nz = p$

Be a variable plane

$$\Rightarrow \frac{1}{6}\begin{vmatrix} \frac{p}{l} & 0 & 0 \\ 0 & \frac{p}{m} & 0 \\ 0 & 0 & \frac{p}{n} \end{vmatrix} = 64$$

Also G(x y z) $= \left(\frac{p}{4l}, \frac{p}{4m}, \frac{p}{4n}\right) \Rightarrow xyz = 6$