All India Aakash Test Series for JEE (Main)-2021

TEST-2 - Code-C

Test Date : 10/11/2019

ANSWERS

PHYSICS		CHEMISTRY		MATHEMATICS	
1.	(2)	26.	(2)	51.	(2)
2.	(1)	27.	(1)	52.	(1)
3.	(1)	28.	(3)	53.	(1)
4.	(4)	29.	(1)	54.	(4)
5.	(1)	30.	(3)	55.	(2)
6.	(2)	31.	(4)	56.	(2)
7.	(3)	32.	(1)	57.	(1)
8.	(2)	33.	(1)	58.	(3)
9.	(4)	34.	(1)	59.	(3)
10.	(3)	35.	(2)	60.	(3)
11.	(2)	36.	(3)	61.	(4)
12.	(1)	37.	(2)	62.	(3)
13.	(2)	38.	(4)	63.	(4)
14.	(1)	39.	(2)	64.	(2)
15.	(4)	40.	(2)	65.	(1)
16.	(4)	41.	(2)	66.	(3)
17.	(3)	42.	(2)	67.	(1)
18.	(4)	43.	(3)	68.	(2)
19.	(3)	44.	(3)	69.	(1)
20.	(2)	45.	(3)	70.	(3)
21.	(60)	46.	(38)	71.	(27)
22.	(45)	47.	(64)	72.	(08)
23.	(10)	48.	(20)	73.	(20)
24.	(18)	49.	(20)	74.	(05)
25.	(50)	50.	(14)	75.	(05)

HINTS & SOLUTIONS

PART - A (PHYSICS)

1. Answer (2)

Hint : $V_{\text{APP}} = v - v\cos\left(\frac{\pi}{6}\right)$

Sol. : Velocity of approach $v - v\cos\left(\frac{\pi}{6}\right)$

$\Rightarrow \quad V_{\text{APP}} = v\left(1 - \frac{\sqrt{3}}{2}\right)$

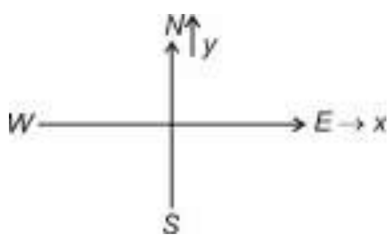
$\therefore \quad T = \frac{2a}{v\left(2-\sqrt{3}\right)}$

$\therefore$ distance travelled $s = vT = \frac{2a}{2-\sqrt{3}}$

2. Answer (1)

Hint : $\vec{v}_{w,m} = \vec{v}_{w,gr} - \vec{v}_{w,gr}$

Sol. :



$\vec{v}_{w,gr} = -v\hat{i}$

$\vec{v}_{w,gr} = at\,\hat{j}$

$\therefore \quad \vec{v}_{w,m} = -v\hat{i} - at\,\hat{j}$

to man the direction of wind become south-west

then $|\vec{v}| = |\vec{a}|t \quad \Rightarrow \quad t = \frac{|\vec{v}|}{|\vec{a}|}$

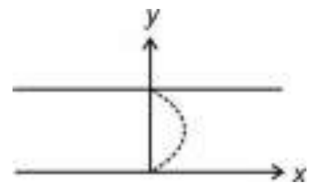
3. Answer (1)

Hint : $\vec{v}_{b,\,gr} = u\,\hat{j} + \left(\frac{2v_0}{d}\right)y\,\hat{i}$ (upto half width)

Total drift will be double of the drift upto half width.

Sol. : Velocity profile of river is as shown in figure.

$\therefore \quad \vec{v}_{b,\,gr} = u\,\hat{j} + \left(\frac{2v_0}{d}\right)y\,\hat{i}$



$\therefore \quad y = ut$ and $dx = \int\left(\frac{2v_0}{d}\right)ut\,dt$

$\therefore \quad \left(X_{\text{half}}\right) = \frac{2v_0}{d}\cdot u \cdot \frac{1}{2}\cdot\frac{d^2}{4u^2}$

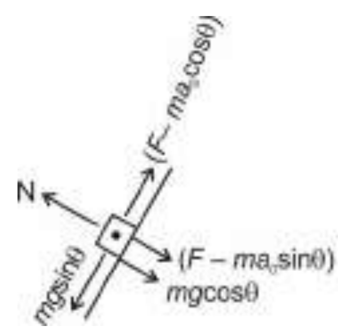
$\Rightarrow \quad \left(X_{\text{half}}\right) = \frac{v_0 d}{4u}$

$\therefore \quad X = \frac{v_0 d}{2u}$

4. Answer (4)

Hint : $a_0 = \frac{F}{M+m}$ forces on m with respect to M along the plane must be zero.

Sol. :



for m w.r.t. M

$a_0 = \frac{F}{M+m}$

$\Rightarrow \quad mg\sin\theta = (F - ma_0)\cos\theta$

$\Rightarrow \quad mg\tan\theta = F - \frac{mF}{M+m}$

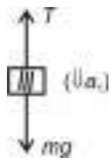
$\Rightarrow \quad mg\tan\theta = \frac{FM}{M+m}$

$\Rightarrow \quad F = \frac{(M+m)}{M}mg\tan\theta$

5. Answer (1)

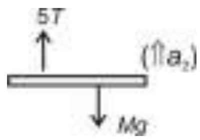
Hint : Constraints motion $a_m = 5a_M$

Sol. : For (m)



$\therefore \quad mg - T = ma_1 \quad \ldots(i)$

For (M)



$\Rightarrow \quad 5T - Mg = Ma_2 \quad \ldots(ii)$

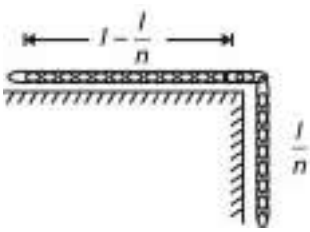
$a_1 = 5a_2$

$\Rightarrow \quad mg = m(5a_2) + T \quad \ldots(iii)$

6. Answer (2)

Hint : Total driving force must be able to overcome the maximum resistive force.

Sol. :



$$\mu\frac{m}{l}\left(l-\frac{l}{n}\right)g = \left(\frac{m}{l}\right)\frac{l}{n}\cdot g$$

$$\Rightarrow \quad \frac{\mu}{l}\left|\frac{n-1}{n}\right|l = \frac{1}{n}$$

$$\Rightarrow \quad \mu = \frac{1}{n-1}$$

7. Answer (3)

Hint : Same range at $\theta = \theta$ and $90 - \theta$

Sol. : Same range at θ and $90 - \theta$

$$\therefore \quad R = \frac{2u^2\sin\theta\cdot\cos\theta}{g}$$

$$\therefore \quad T_1 = \frac{2u\sin\theta}{g} \quad \text{and} \quad T_2 = \frac{2u\cos\theta}{g}$$

$$\therefore \quad T_1T_2 = \frac{4u^2\sin\theta\cos\theta}{g^2} = \frac{2}{g}\left(\frac{u^2\sin^2\theta}{g}\right)$$

$$\Rightarrow \quad T_1T_2 = \frac{2R}{g}$$

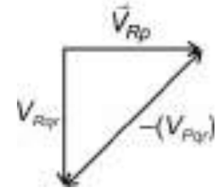
$$\Rightarrow \quad T_1T_2 \propto R$$

8. Answer (2)

Hint : $\vec{V}_{Rp} = \vec{V}_{Rqr} - \vec{V}_{Pqr}$

Sol. : $\vec{V}_{Rp} = \vec{V}_{Rqr} + \vec{V}_{Qrp} : \vec{V}_{Rqr} - \vec{V}_{Pqr}$

$\therefore$



9. Answer (4)

Hint : When speed of A and C are same along respective shown direction. Then block B comes to rest.

Sol. : $v_C = 3t$ and $\frac{dv_A}{dt} = 12t$

$\therefore \quad v_A = 6t^2$

So $\quad v_A = v_C$

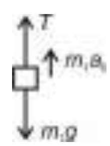
$\Rightarrow \quad t = \frac{1}{2}$

10. Answer (3)

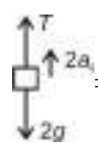
Hint : W.r.t. ground m_1 should have zero acceleration.

Sol. : Let M moves with a_0 acceleration.

Then FBD of m_1 and m_2 w.r.t pulley.

For (m_1):  $\Rightarrow \quad T + m_1a_0 - m_1g = m_1a_0$

$\Rightarrow \quad T = g$

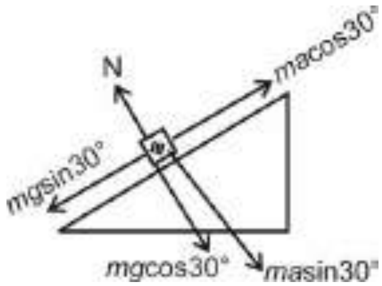
For (M_2):  $\Rightarrow \quad 2g - T - 2a_0 = 2a_0 \quad \Rightarrow a_0 = \frac{g}{4}$

For (M) $\Rightarrow \frac{2T}{M} = a_0 \quad \Rightarrow 2g = \frac{Mg}{4} \quad \Rightarrow M = 8$ kg

11. Answer (2)

Hint : Find the acceleration of block w.r.t. wedge along the inclined plane.

Sol. :



$ma\cos30° - mg\sin30° = ma'$

$\Rightarrow \quad 10\sqrt{3}\cdot\frac{\sqrt{3}}{2} - \frac{10}{2} = a'$

$\Rightarrow \quad a' = 10$ m/s^2

$\therefore \quad \frac{1}{2}\times 10\times t^2 = 1$

$t = \frac{1}{\sqrt{5}}$ sec.

12. Answer (1)

Hint : Range = (Time of flight) × (Horizontal speed)

Sol. : $\vec{v} = a\hat{i} + (b - ct)\hat{j}$

$\Rightarrow \quad$ time of flight $= \frac{2b}{c}$

$\therefore \quad R = \frac{2ab}{c}$

13. Answer (2)

Hint : $F^2 + (W\sin\alpha)^2 = (\mu W\cos\alpha)^2$

Sol. : $F^2 + (W\sin\alpha)^2 = (\mu W\cos\alpha)^2$

$\Rightarrow \quad F^2 = 4W^2\cos^2\alpha\cdot\frac{\sin^2\alpha}{\cos^2\alpha} - W^2\sin^2\alpha = 3W^2\sin^2\alpha$

$\Rightarrow \quad F = \sqrt{3}\,W\sin\alpha$

14. Answer (1)

Hint : Normal force by weighing machine is the reading.

Sol. : $N = 50(16)\cos60° = 50\times16\times\frac{1}{2}$

$\Rightarrow \quad N = 400$ newton

$\therefore \quad$ Reading = 40 kg.

15. Answer (4)

Hint : It will be elongated for any value of $M > 0$.

Sol. : It will be elongated for any value of $M > 0$.

16. Answer (4)

Hint : Uniform circular motion

Sol. : Particle is in circular motion with speed 5 × 20 = 100 m/s

17. Answer (3)

Hint : Limiting friction appears at both the surface.

Sol. : $F = \mu_2(m_1 + m_2)g + \mu_1 m_1 g$

$\Rightarrow \quad F = \frac{2}{10}\times10(3) + \frac{1}{10}\times1\times10$

$\Rightarrow \quad F = 6 + 1 = 7$ N

18. Answer (4)

Hint : $\frac{(F + F\cos\theta) - (Mg - F\sin\theta)\mu}{M} = a_0$

Sol. : $\frac{(F + F\cos\theta) - (Mg - F\sin\theta)\mu}{M} = a_0$

$\Rightarrow \quad a_0 = \frac{10\left(1+\frac{4}{5}\right) - \left(10 - 10\times\frac{3}{5}\right)\frac{1}{2}}{1}$

$\Rightarrow \quad a_0 = \frac{18-2}{1} = 16$ m/s^2

19. Answer (3)

Hint : $fr_{\max} = \mu\left(g + \frac{g}{4}\right)M_2$; limiting friction will appear between M_1 and M_2.

Sol. : $fr_{\max} = \frac{1}{5}\left(\frac{5g}{4}\right)2 = 5$ N

$\therefore \quad$ Acceleration of M_2 w.r.t. lift

$a_2 = \frac{5}{2} = 2.5$ m/s^2

And acceleration of M_1 w.r.t lift

$a_2 = \frac{F-5}{8} = \frac{25}{8}$ m/s^2

20. Answer (2)

Hint : $\frac{dv}{dt} = -\frac{\mu mg}{m} = -\mu g$

Sol. : $\frac{dv}{dt} = -\mu g$

From figure: $-\mu g = -\frac{8}{4}$

$\Rightarrow$ $\mu g = 2$

$\Rightarrow$ $\mu = 0.2$

21. Answer (60)

Hint : Limiting friction at the contact of *C* and ground is minimum.

Sol. : $fr_{max}(AB) = 90$ N

$fr_{max}(BC) = 80$ N;

$fr_{max}(C.\text{ground}) = 60$ N

So, motion starts at the interface of ground and block *C*. And all the blocks will move together at applied force of 60 N.

22. Answer (45)

Hint : $R = \frac{4^2 \sin 2\theta}{g}$

Sol. : $R = \frac{4^2 \cdot \sin 2\theta}{g} = 30$

$\therefore$ $\sin 2\theta = \frac{30 \times 10}{100 \times 100} = \frac{3}{100}$

$\theta \approx 0.86°$

$\therefore$ $\tan\theta = \frac{y}{30 \text{ m}} = y = 30 \times 100 \times \tan\theta$

$\Rightarrow$ $y = 45$ cm

23. Answer (10)

Hint : $R_{max} = \frac{u^2}{g(1+\sin\theta)}$

Sol. : $u^2 = R_{max} . g(1 + \sin\theta)$

$\Rightarrow$ $u^2 = 5 \times 10 \times \left(1 + \frac{4}{5}\right)$

$\Rightarrow$ $u^2 = 5 \times 10 \times \frac{9}{5}$

$\Rightarrow$ $u = 3\sqrt{10}$ m/s

24. Answer (18)

Hint : Collision time $T = \frac{40}{m}$

Sol. : Time of collision $T = \frac{40}{24}$sec

$\Rightarrow$ $T = \frac{5}{3}$sec

$\Rightarrow$ $V_B = \frac{30 \times 3}{5} = 18$ m/s

25. Answer (50)

Hint : $T = \frac{mv^2}{R}$

Sol. : $T = \frac{mv^2}{R}$

$= \frac{2 \times (5)^2}{1}$

= 50 N

PART - B (CHEMISTRY)

26. Answer (2)

Hint : Lattice formation between gaseous cation and anion are energy releasing process, Cl has –ve E.G.E.

Sol. : $\underset{(g)}{Cl} + e^- \longrightarrow \underset{(g)}{Cl^-}$ electron gain enthalpy

$\underset{(g)}{\overset{+}{Na}} + \underset{(g)}{Cl^-} \longrightarrow \underset{(s)}{NaCl}$ lattice energy.

27. Answer (1)

Hint : Lattice energy $\propto$ charge density on ions.

Sol. : Order for magnitude of lattice energy should be

$MgO > MgF_2 > LiF > NaCl > KI$

28. Answer (3)

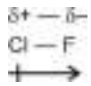
Hint : In a covalent bond, the two electrons are placed in between the nuclei of both the atoms.

Sol. : Both the electrons are under the influence of both nuclear charges.

29. Answer (1)

Hint : Consider the dipole moment of the respective molecule.

Sol. : In Cl — F molecule, fluorine is more electronegative

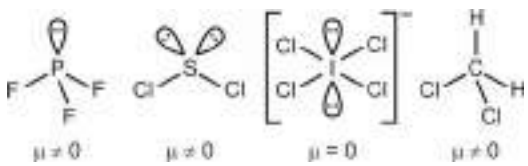


$\therefore$ correct orientation is $\left|\begin{matrix} \overset{+}{F} — Cl^{-} \\ F — Cl \end{matrix}\right|$

30. Answer (3)

Hint : For non-polar molecule, dipole moment $\mu = 0$.

Sol. :



31. Answer (4)

Hint : As the number of unpaired electrons increases, magnetic moment increases.

Sol. : C_2 – Diamagnetic

C_2^- – Paramagnetic

All other processes will result into decrease in magnetic moment.

32. Answer (1)

Hint : Characteristic of an hybrid orbital depends upon the % of *s*-character.

Sol. : $\because$ The *s*-orbitals are spherical, lower in energy and close to the nucleus, its % increase in hybrid orbital cause bulkiness and shortening of the orbital.

33. Answer (1)

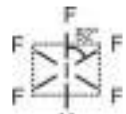
Hint : p_x, p_y and p_z orbitals are required to form tetrahedral geometry along with *s*-orbitals.

Sol. : n*s* orbital can combine with n*p* orbitals as they are close in energy.

34. Answer (1)

Hint : Bond angle can be predicted by VSEPR theory.

Sol. :



35. Answer (2)

Hint : Nodal planes can be identified by overlapping of orbitals.

Sol. :

Orbital	Nodal Plane(s)
σ^*1s	1
$1s$	0
Pure *p*-orbital	1
$\sigma 1s$	0
$\sigma 2s$	0

36. Answer (3)

Hint : 2 g of H_2 = 1 mol

32 g of O_2 = 1 mol

20 g of Ne = 1 mol

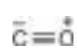
Sol. : Pressure, K.E. $\propto$ temperature

Most probable speed $\propto \sqrt{\frac{T}{M}}$

37. Answer (2)

Hint : Formal charge is the charge assigned to an atom in a molecule, assuming that electrons in all chemical bonds are shared equally between atoms, regardless of relative electronegativity.

Sol. : In CO molecule there is bond order equal to 3 in between C and O.



38. Answer (4)

Hint : The angle between h_1 and h_2 is 120°

Sol. : sp^2 hybrid orbitals have bond angle equal to 120°

39. Answer (2)

Hint : $\because\ P_{O_2} = x_{O_2} \times P_{Total}$

Sol. : $x_{O_2} = \dfrac{P_{O_2}}{P_{Total}} = \dfrac{0.2}{16} = \dfrac{1}{80}$

Mole percent of $O_2 = x_{O_2} \times 100$

$= 1.25\ \%$

40. Answer (2)

Hint : Gas liquifies at higher pressure for $T < T_c$

Sol. : At point ‘d’ only liquid phase is present.

At point ‘a’ only gaseous phase is present.

At point ‘c’ and ‘b’ gas is in equilibrium with liquid.

41. Answer (2)

Hint : SiO_2 – Si is sp^3 hybridised

CH_4 – C is sp^3 hybridised

Sol. : BH_3 – B is sp^2

B_2H_6 – B is sp^3

CO_2 – C is sp

SO_2 – S is sp^2

XeO_2F_2 – Xe is sp^3d

XeF_4 – Xe is sp^3d^2

42. Answer (2)

Hint : Coulombic forces are responsible for the formation of NaCl.

Sol. : Coulombic forces are inversely proportional to r^2.

43. Answer (3)

Hint : According to kinetic theory of gases, gaseous molecule are hard spheres, and there is no force of attraction or repulsion between them.

Sol. : When the particles are close to each other, they have no force of attraction or repulsion between them.

44. Answer (3)

Hint : According to kinetic theory of gases there is no interaction between the molecules.

Sol. : There is no release of heat during mixing and volume change on mixing of two ideal gases is zero.

45. Answer (3)

Hint : SI unit of surface tension is N/m.

Sol. : Particles on the surface has net attractive force.

46. Answer (38)

Hint : $\because$ PV = nRT

$w = \dfrac{P \times V \times M}{RT}$

Sol. : $w = \dfrac{7.6 \times 0.3 \times 4}{0.08 \times 300}$

= 0.38 gm

47. Answer (64)

Hint : $\because\ \dfrac{rate_1}{rate_2} = \sqrt{\dfrac{M_2}{M_1}}$

Sol. : $\dfrac{10 \times 10^{-6}}{8 \times 10^{-6}} = \sqrt{\dfrac{100}{M_x}}$

$M_x = 64$

48. Answer (20)

Hint : Pressure $\propto$ number of moles [at constant T, V].

Sol. : Initial number of moles of gas = 10 + 1

= 11

	N_2	+	$3H_2$	$\rightarrow$	$2NH_3$
Initial	1 mol		10 mol		0
Final	0		10 – 3 = 7 mol		2 mol

Final number of moles = 9 mol

49. Answer (20)

Hint : $CO + \frac{1}{2}O_2 \longrightarrow CO_2$

$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$

Sol. : KOH absorbs CO_2 only

$\therefore$ Volume of CO_2 = volume of CO = 15 ml

$\therefore$ 25 ml of H_2 is in the mixture.

$\therefore$ 20 ml of O_2 is required.

50. Answer (14)

Hint : 760 mmHg = 1 atm.

Sol. : Total pressure = 0.9 atm + 50 mmHg

= 734 mmHg

PART - C (MATHEMATICS)

51. Answer (2)

Hint : 3cosecθ – 4secθ = $5\left[\frac{3}{5}\text{cosec}\theta - \frac{4}{5}\sec\theta\right]$

$= 5\left[\frac{\sin 3\theta}{\sin\theta} - \frac{\cos 3\theta}{\cos\theta}\right]$.

Sol. : 3cosecθ – 4secθ

$$= 5\left[\frac{\frac{3}{5}\cos\theta - \frac{4}{5}\sin\theta}{\sin\theta \cdot \cos\theta}\right]$$

$$= 10\left[\frac{\sin 3\theta \cdot \cos\theta - \cos 3\theta \cdot \sin\theta}{2\sin\theta \cdot \cos\theta}\right]$$

$$= 10\left[\frac{\sin 2\theta}{\sin 2\theta}\right]$$

= 10

52. Answer (1)

Hint : Put x = 2cosθ and solve for θ

Sol. : Let x = 2cosθ

$$2\cos\theta = \sqrt{2 + \sqrt{2 - 2\sin\frac{\theta}{2}}}$$

$$\Rightarrow \quad 2\cos\theta = \sqrt{2 + \sqrt{2 - 2\cos\left(\frac{\pi}{2} - \frac{\theta}{2}\right)}}$$

$$\Rightarrow \quad 2\cos\theta = \sqrt{2 + 2\sin\left(\frac{\pi}{4} - \frac{\theta}{4}\right)}$$

$$\Rightarrow \quad 2\cos\theta = \sqrt{2 + 2\cos\left(\frac{\pi}{4} + \frac{\theta}{4}\right)}$$

$$\Rightarrow \quad 2\cos\theta = 2\cos\left(\frac{\pi}{8} + \frac{\theta}{8}\right)$$

$$\Rightarrow \quad \frac{7\theta}{8} = \frac{\pi}{8}$$

$$\Rightarrow \quad \theta = \frac{\pi}{7}$$

53. Answer (1)

Hint : $x^2 + y^2 = a^2 + b^2$

Sol. : $a\sin\theta + b\cos\theta = x$ …(i)

$a\cos\theta - b\sin\theta = y$ …(ii)

By squaring and adding

$a^2 + b^2 = x^2 + y^2$

Now, $\frac{x+b}{y+a} + \frac{y-a}{x-b} = \frac{x^2+y^2-a^2-b^2}{(y+a)(x-b)} = 0$

54. Answer (4)

Hint : Put tanθ = x $\Rightarrow$ $\frac{2x^2}{1-x^2} = 1$

Sol. : $\frac{2\tan\theta}{1-\tan^2\theta} \cdot \tan\theta = 1$

$\Rightarrow$ $3\tan^2\theta = 1$

$$\Rightarrow \quad \tan^2\theta = \left(\frac{1}{\sqrt{3}}\right)^2$$

$$\Rightarrow \quad \theta = n\pi \pm \frac{\pi}{6}$$

$$\Rightarrow \quad \theta = \frac{(6n \pm 1)\pi}{6} \qquad (n \in z)$$

55. Answer (2)

Hint : $\sqrt{x-4}$ and $\sqrt{x}$ must be integer.

Sol. : $\cos\left(\pi\sqrt{x-4}\right)\cdot\cos\left(\pi\sqrt{x}\right)=1$

$\Rightarrow$ $\cos\left(\pi\sqrt{x-4}\right)=\cos\left(\pi\sqrt{x}\right)=1$ or

$\cos\left(\pi\sqrt{x-4}\right)=\cos\left(\pi\sqrt{x}\right)=-1$

$\Rightarrow$ $\sqrt{x-4}$ and $\sqrt{x}$ both should be integers.

$\Rightarrow$ $x = 4$ is only possible solution.

56. Answer (2)

Hint : $\sin x \le \cos^2 x$ and $\sin x \in (0, 1)$ and $\cos x \in (0, 1)$

Sol. : $\log_{\cos x}(\sin x) \ge 2$

$\Rightarrow$ $\sin x \le \cos^2 x$

$\Rightarrow$ $\sin^2 x+\sin x-1\le 0$

$\sin x\in\left[\frac{-1-\sqrt{5}}{2},\frac{-1+\sqrt{5}}{2}\right]$

But $\sin x > 0$

So, $\sin x\in\left(0,\frac{-1+\sqrt{5}}{2}\right]$

57. Answer (1)

Hint : $\frac{3\tan x}{1-\tan^2 x}=2$

Sol. : $\log_2\left(\frac{3\sin x}{\cos x(1+\tan x)(1-\tan x)}\right)=2$

$\Rightarrow$ $\frac{3\tan x}{1-\tan^2 x}=2$

$\Rightarrow$ $2\tan^2 x+3\tan x-2=0$

$\Rightarrow$ $\tan x=\frac{1}{2}$ or -2

but $-1 < \tan x < 1$ (domain)

So, $\tan x=\frac{1}{2}$

58. Answer (3)

Hint : $f(x)=\frac{5}{2}+2\left[\cos x-\frac{1}{2}\right]^2$

Sol. : $f(x) = 3 + 2\cos^2 x - 2\cos x$

$=\frac{5}{2}+2\left(\cos x-\frac{1}{2}\right)^2$

So, $M=\frac{5}{2}+\frac{9}{2}=7$ and $m=\frac{5}{2}$

59. Answer (3)

Hint : $1 + \sin x = 2\cos^2 x \Rightarrow 2\sin^2 x + \sin x - 1 = 0$

Sol. : $\frac{1+\sin x}{\cos x}=2\cos x$

$\Rightarrow$ $1 + \sin x = 2\cos^2 x$

$\Rightarrow$ $2\sin^2 x + \sin x - 1 = 0$

$\Rightarrow$ $\sin x=\frac{1}{2},-1$

$\Rightarrow$ $x=\frac{\pi}{6},\frac{5\pi}{6},\frac{3\pi}{2}$

But at $x=\frac{3\pi}{2}$, $\tan x$ and $\sec x$ are not defined.

So, $x=\frac{\pi}{6}$ and $\frac{5\pi}{6}$

60. Answer (3)

Hint : $\sin x = \pm 1$ or $\cos x = 1$

Sol. : $\cos^7 x - (1 - \sin^2 x)(1 + \sin^2 x) = 0$

$\Rightarrow$ $\cos^2 x\left[\cos^5 x-1-\sin^2 x\right]=0$

$\Rightarrow$ $\cos^2 x = 0$ or $\cos^5 x = 1 + \sin^2 x$

$\Rightarrow$ $x=\pm\frac{\pi}{2}$ $\quad$ $\cos x = 1$

$x = 0$

61. Answer (4)

Hint : $2B = (2A + B) - (2A - B)$

Sol. : $\tan(2B) = \tan((2A + B) - (2A - B))$

$\Rightarrow$ $\tan 2B=\frac{\tan(2A+B)-\tan(2A-B)}{1+\tan(2A+B)\cdot\tan(2A-B)}$

$=\frac{\frac{1}{2}-\frac{1}{3}}{1+\frac{1}{2}\cdot\frac{1}{3}}$

$=\frac{1}{7}$

62. Answer (3)

Hint : $\frac{\cos\alpha}{\cos\beta} = \frac{1}{3}$ (Now use componendo and dividendo).

Sol. :

$\because \quad \frac{\cos\alpha}{\cos\beta} = \frac{1}{3}$

$\Rightarrow \quad \frac{\cos\beta - \cos\alpha}{\cos\beta + \cos\alpha} = \frac{3-1}{3+1}$

$\Rightarrow \quad \frac{2\sin\left(\frac{\alpha-\beta}{2}\right)\cdot\sin\left(\frac{\alpha+\beta}{2}\right)}{2\cos\left(\frac{\alpha-\beta}{2}\right)\cdot\cos\left(\frac{\alpha+\beta}{2}\right)} = \frac{1}{2}$

$\Rightarrow \quad \tan\left(\frac{\alpha+\beta}{2}\right)\cdot\tan\left(\frac{\alpha+\beta}{2}\right) = \frac{1}{2}$

63. Answer (4)

Hint : $\sin 2A + \sin 2B = 2\sin(A + B) . \cos(A - B)$

$= -2\sin C . \cos(A - B)$

Sol. :

$\sin 2A + \sin 2B - \sin 2C = 2\sin(A + B) . \cos(A + B) - \sin 2C$

$= -2\sin C . \cos(A - B) - 2\sin C . \cos C$

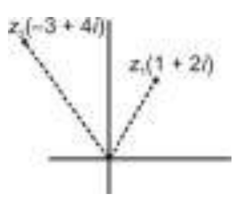
$= -2\sin C\, [\cos(A - B) + \cos(2\pi - (A + B))]$

$= -2\sin C[2\cos A . \cos B] = -4\cos A\cos B\sin C$

64. Answer (2)

Hint : $\arg(1 + 2i) < \arg(z) < \arg(-3 + 4i)$

Sol. :



$\arg(z_1) > \frac{\pi}{4}$

$\arg(z_2) < \frac{3\pi}{4}$

and $\arg(z_1) < \arg(z) < \arg(z_2)$

The only possible value of $\arg(z)$ is $\frac{\pi}{2}$

65. Answer (1)

Hint : Let $\frac{z_1}{z_2} = z$ then find $|z|$.

Sol. : Let $\frac{z_1}{z_2} = z$

$z + \frac{1}{z} = 1$

$\Rightarrow \quad z^2 - z + 1 = 0$

$\Rightarrow \quad z = \frac{1 \pm \sqrt{3}i}{2}$

$\Rightarrow \quad \frac{z_1}{z_2} = \frac{1 \pm \sqrt{3}i}{2}$

$\Rightarrow \quad \left|\frac{z_1}{z_2}\right| = 1 \Rightarrow |z_1| = |z_2|$

66. Answer (3)

Hint : $|z_1| = |z_3| = 3$ and $|z_2| = \frac{2}{\sqrt{3}}$.

Sol. : $|z_1| = |z_3| = 3$ and $|z_2| = \frac{2}{\sqrt{3}}$.

$\frac{1}{\left|\sqrt{z_1}\right|} + \left|\sqrt{z_3}\right| = \frac{1}{\sqrt{3}} + \sqrt{3} = \frac{4}{\sqrt{3}} = 2|z_2|$

67. Answer (1)

Hint : $a = -3, -2, 6, 7$

Sol. :

Let α, β are the integer roots of the equation, then $\alpha + \beta = a$ and $\alpha.\beta = a + 3$

$\Rightarrow \quad \alpha + \beta = \alpha\beta - 3$

$\Rightarrow \quad \beta = \frac{\alpha+3}{\alpha-1}$

$\Rightarrow \quad \beta = 1 + \frac{4}{\alpha-1}$

Here α is an integer and $(\alpha - 1)$ must divide 4,

So, $\alpha = 2, 0, 3, -1, 5, -3$

So two roots of the equation may be;

(2, 5), (0, –3), (3, 3) or (–1, –1)

$\because \quad a$ = sum of roots

Then possible values of a are 7, 6, –3, –2.

68. Answer (2)

Hint : $2\left(x^2+\frac{1}{x^2}\right)-7\left(x+\frac{1}{x}\right)+9=0$,

put $x+\frac{1}{x}=t$

Sol. :

$2(x^4 + 1) - 7(x^3 + x) + 9x^2 = 0$

$\Rightarrow \quad 2\left(x^2+\frac{1}{x^2}\right)-7\left(x+\frac{1}{x}\right)+9=0$

$\Rightarrow \quad 2\left(x+\frac{1}{x}\right)^2-7\left(x+\frac{1}{x}\right)+5=0$

$\Rightarrow$ Let $x+\frac{1}{x}=t$

$\Rightarrow \quad 2t^2 - 7t + 5 = 0$

$\Rightarrow \quad t=1$ or $\frac{5}{2}$

When $x+\frac{1}{x}=1$

$\Rightarrow \quad x=\frac{1}{2}\pm\frac{\sqrt{3}}{2}i$ (Imaginary roots)

When $x+\frac{1}{x}=\frac{5}{2}$

$\Rightarrow \quad x=2, \frac{1}{2}$ (Real roots)

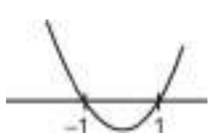
69. Answer (1)

Hint : $D>0 \cap f(1)>0 \cap f(-1)>0 \cap -\frac{b}{2a} \in (-1,\ 1)$

Sol. :

Let $f(x) = 4x^2 - 2x + a$

$\because$ $f(x) = 0$ has two distinct real roots in $(-1, 1)$, then



(i) $D > 0$

$\Rightarrow \quad 4 - 16a > 0$

$\Rightarrow \quad a \in \left(-\infty, \frac{1}{4}\right)$

(ii) $f(-1) > 0$

$\Rightarrow \quad 4 + 2 + a > 0$

$\Rightarrow \quad a \in (-6, \infty)$

(iii) $f(1) > 0$

$\Rightarrow \quad 4 - 2 + a > 0$

$\Rightarrow \quad a \in (-2, \infty)$

(iv) $-1 < -\frac{b}{2a} < 1$

$\Rightarrow \quad -1 < \frac{1}{4} < 1$ (Always true)

So, $a \in \left(-2, \frac{1}{4}\right)$

Possible integral values of a are –1 and 0.

70. Answer (3)

Hint : $f(x) \geq 0$

Sol. :

Let $f(x) = ax^2 + bx + 32$

The graph of $y = f(x)$ does not cut the x-axis at two distinct points.

Also $f(0) > 0$, so graph of $f(x)$ always remains on or above the x-axis.

So, $f(x) \geq 0$ for all $x \in R$

$\Rightarrow \quad f(4) \geq 0$

$16a + 4b + 32 \geq 0$

$4a + b \geq -8$

71. Answer (27)

Hint : $(3\sin\theta - 4\cos\theta)(3\cos\theta + 4\sin\theta)$

$= -\frac{7}{2}\sin\theta - 12\cos\theta$

Sol. : $(3\sin\theta - 4\cos\theta)(3\cos\theta + 4\sin\theta)$

$= -12(\cos^2\theta - \sin^2\theta) - 7(\sin\theta.\cos\theta)$

$= -\frac{1}{2}[24\cos 2\theta + 7\sin 2\theta]$

$\because$ Range of $a\sin\theta + b\cos\theta$ is $\left[-\sqrt{a^2+b^2}, \sqrt{a^2+b^2}\right]$

So maximum value of given expression is $\frac{1}{2}\sqrt{24^2+7^2} = \frac{25}{2}$

72. Answer (08)

Hint : Use $\cos\theta\cdot\cos(60°-\theta)\cdot\cos(60°+\theta) = \frac{1}{4}\cos 3\theta$

Sol. :

$\cos 6°\cdot\sin 18°\cdot\sin 24° = \cos 6°\cdot\cos 66°\cdot\sin 18°$

$= \frac{\cos 6°\cdot\cos 66°\cdot\cos 54°\cdot\sin 18°}{\cos 54°}$

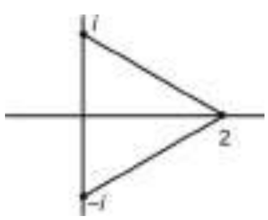
$= \frac{1}{4}\frac{\cos 18°\cdot\sin 18°}{\sin 36°}$

$= \frac{1}{8}$

73. Answer (20)

Hint : $z = i, -i, 2.$

Sol. :



$z(z-1)^2 = 2$

$\Rightarrow \quad z^3 - 2z^2 + z - 2 = 0$

$\Rightarrow \quad (z-2)(z^2+1) = 0$

$z = 2, \pm i$

area of triangle $= \frac{1}{2}(2)(2)$

$= 2$

74. Answer (05)

Hint : Consider the roots $n-2$, $n-1$, n, $n+1$ and $n+2$.

Sol. :

Sum of roots = $-a = 5n$

Sum of product of two roots, = $b = 10n^2 - 5$

Now $\frac{2a^2}{b+5} = \frac{2(-5n)^2}{10n^2} = 5$

75. Answer (05)

Hint : $a^b = 1 \Rightarrow a = 1$ or $b = 0$ or $a = -1$ and b is even

Sol. : If $(x^2-5x+5)^{x^2-12x+35} = 1$, then

(i) $x^2 - 12x + 35 = 0 \quad\Rightarrow\quad x = 5, 7$

(ii) $x^2 - 5x + 5 = 1 \quad\Rightarrow\quad x = 1, 4$

(iii) $x^2 - 5x + 5 = -1$ and $x^2 - 12x + 35$ is even

$\Rightarrow \quad x = 3$

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All India Aakash Test Series for JEE (Main)-2021

TEST-2 - Code-D

Test Date : 10/11/2019

ANSWERS

PHYSICS		CHEMISTRY		MATHEMATICS	
1.	(2)	26.	(3)	51.	(3)
2.	(3)	27.	(3)	52.	(1)
3.	(4)	28.	(3)	53.	(2)
4.	(3)	29.	(2)	54.	(1)
5.	(4)	30.	(2)	55.	(3)
6.	(4)	31.	(2)	56.	(1)
7.	(1)	32.	(2)	57.	(2)
8.	(2)	33.	(4)	58.	(4)
9.	(1)	34.	(2)	59.	(3)
10.	(2)	35.	(3)	60.	(4)
11.	(3)	36.	(2)	61.	(3)
12.	(4)	37.	(1)	62.	(3)
13.	(2)	38.	(1)	63.	(3)
14.	(3)	39.	(1)	64.	(1)
15.	(2)	40.	(4)	65.	(2)
16.	(1)	41.	(3)	66.	(2)
17.	(4)	42.	(1)	67.	(4)
18.	(1)	43.	(3)	68.	(1)
19.	(1)	44.	(1)	69.	(1)
20.	(2)	45.	(2)	70.	(2)
21.	(50)	46.	(14)	71.	(05)
22.	(18)	47.	(20)	72.	(05)
23.	(10)	48.	(20)	73.	(20)
24.	(45)	49.	(64)	74.	(08)
25.	(60)	50.	(38)	75.	(27)

HINTS & SOLUTIONS

PART - A (PHYSICS)

1. Answer (2)

Hint : $\frac{dv}{dt} = -\frac{\mu mg}{m} = -\mu g$

Sol. : $\frac{dv}{dt} = -\mu g$

From figure: $-\mu g = -\frac{8}{4}$

$\Rightarrow \quad \mu g = 2$

$\Rightarrow \quad \mu = 0.2$

2. Answer (3)

Hint : $fr_{\max} = \mu\left(g + \frac{g}{4}\right)M_2$; limiting friction will appear between M_1 and M_2.

Sol. : $fr_{\max} = \frac{1}{5}\left(\frac{5g}{4}\right)2 = 5\text{ N}$

$\therefore$ Acceleration of M_2 w.r.t. lift

$$a_2 = \frac{5}{2} = 2.5\text{ m/s}^2$$

And acceleration of M_1 w.r.t lift

$$a_2 = \frac{F-5}{8} = \frac{25}{8}\text{ m/s}^2$$

3. Answer (4)

Hint : $\frac{(F + F\cos\theta) - (Mg - F\sin\theta)\mu}{M} = a_0$

Sol. : $\frac{(F + F\cos\theta) - (Mg - F\sin\theta)\mu}{M} = a_0$

$$\Rightarrow \quad a_0 = \frac{10\left(1+\frac{4}{5}\right) - \left(10 - 10\times\frac{3}{5}\right)\frac{1}{2}}{1}$$

$$\Rightarrow \quad a_0 = \frac{18-2}{1} = 16\text{ m/s}^2$$

4. Answer (3)

Hint : Limiting friction appears at both the surface.

Sol. : $F = \mu_2(m_1 + m_2)g + \mu_1 m_1 g$

$$\Rightarrow \quad F = \frac{2}{10}\times 10(3) + \frac{1}{10}\times 1\times 10$$

$\Rightarrow \quad F = 6 + 1 = 7$ N

5. Answer (4)

Hint : Uniform circular motion

Sol. : Particle is in circular motion with speed $5 \times 20 = 100$ m/s

6. Answer (4)

Hint : It will be elongated for any value of $M > 0$.

Sol. : It will be elongated for any value of $M > 0$.

7. Answer (1)

Hint : Normal force by weighing machine is the reading.

Sol. : $N = 50(16)\cos 60° = 50\times 16\times\frac{1}{2}$

$\Rightarrow \quad N = 400$ newton

$\therefore \quad$ Reading = 40 kg.

8. Answer (2)

Hint : $F^2 + (W\sin\alpha)^2 = (\mu W\cos\alpha)^2$

Sol. : $F^2 + (W\sin\alpha)^2 = (\mu W\cos\alpha)^2$

$$\Rightarrow \quad F^2 = 4W^2\cos^2\alpha\cdot\frac{\sin^2\alpha}{\cos^2\alpha} - W^2\sin^2\alpha = 3W^2\sin^2\alpha$$

$$\Rightarrow \quad F = \sqrt{3}\,W\sin\alpha$$

9. Answer (1)

Hint : Range = (Time of flight) × (Horizontal speed)

Sol. : $\vec{v} = a\hat{i} + (b - ct)\hat{j}$

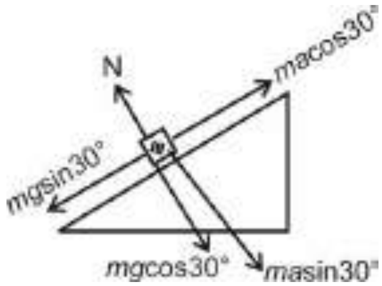
$\Rightarrow \quad$ time of flight $= \frac{2b}{c}$

$$\therefore \quad R = \frac{2ab}{c}$$

10. Answer (2)

Hint : Find the acceleration of block w.r.t. wedge along the inclined plane.

Sol. :



$ma\cos30° - mg\sin30° = ma'$

$\Rightarrow \quad 10\sqrt{3}\cdot\frac{\sqrt{3}}{2}-\frac{10}{2}=a'$

$\Rightarrow \quad a' = 10\text{ m/s}^2$

$\therefore \quad \frac{1}{2}\times10\times t^2=1$

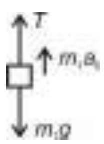
$t=\frac{1}{\sqrt{5}}\text{sec.}$

11. Answer (3)

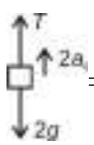
Hint : W.r.t. ground m_1 should have zero acceleration.

Sol. : Let M moves with a_0 acceleration.

Then FBD of m_1 and m_2 w.r.t pulley.

For (m_1):  $\Rightarrow \quad T+m_1a_0-m_1g=m_1a_0$

$\Rightarrow \quad T = g$

For (M_2):  $\Rightarrow \quad 2g-T-2a_0=2a_0 \quad \Rightarrow \quad a_0=\frac{g}{4}$

For (M) $\Rightarrow \quad \frac{2T}{M}=a_0 \quad \Rightarrow 2g=\frac{Mg}{4} \quad \Rightarrow \quad M=8\text{ kg}$

12. Answer (4)

Hint : When speed of A and C are same along respective shown direction. Then block B comes to rest.

Sol. : $v_C = 3t$ and $\frac{dv_A}{dt}=12t$

$\therefore \quad v_A = 6t^2$

So $\quad v_A = v_C$

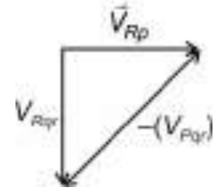
$\Rightarrow \quad t=\frac{1}{2}$

13. Answer (2)

Hint : $\vec{V}_{Rp}=\vec{V}_{Rqr}-\vec{V}_{Pqr}$

Sol. : $\vec{V}_{Rp}=\vec{V}_{Rqr}+\vec{V}_{Qrp}:\vec{V}_{Rqr}-\vec{V}_{Pqr}$

$\therefore$



14. Answer (3)

Hint : Same range at $\theta = \theta$ and $90 - \theta$

Sol. : Same range at θ and $90 - \theta$

$\therefore \quad R=\frac{2u^2\sin\theta\cdot\cos\theta}{g}$

$\therefore \quad T_1=\frac{2u\sin\theta}{g}$ and $T_2=\frac{2u\cos\theta}{g}$

$\therefore \quad T_1T_2=\frac{4u^2\sin\theta\cos\theta}{g^2}=\frac{2}{g}\left(\frac{u^2\sin^2\theta}{g}\right)$

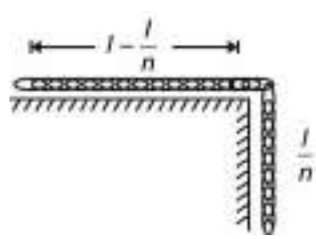
$\Rightarrow \quad T_1T_2=\frac{2R}{g}$

$\Rightarrow \quad T_1T_2 \propto R$

15. Answer (2)

Hint : Total driving force must be able to overcome the maximum resistive force.

Sol. :



$\mu\frac{m}{l}\left(l-\frac{l}{n}\right)g=\left(\frac{m}{l}\right)\frac{l}{n}\cdot g$

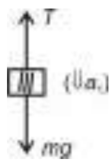
$\Rightarrow \quad \frac{\mu}{l}\left|\frac{n-1}{n}\right|l=\frac{1}{n}$

$\Rightarrow \quad \mu=\frac{1}{n-1}$

16. Answer (1)

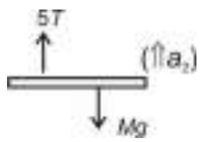
Hint : Constraints motion $a_m = 5a_M$

Sol. : For (m)



$\therefore \quad mg - T = ma_1 \quad \ldots$(i)

For (M)



$\Rightarrow \quad 5T - Mg = Ma_2 \quad \ldots$(ii)

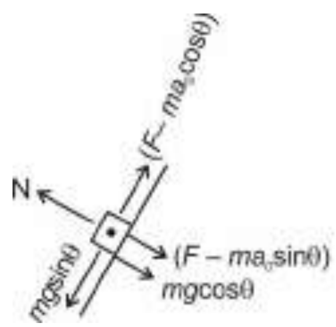
$a_1 = 5a_2$

$\Rightarrow \quad mg = m(5a_2) + T \quad \ldots$(iii)

17. Answer (4)

Hint : $a_0 = \dfrac{F}{M+m}$ forces on m with respect to M along the plane must be zero.

Sol. :



for m w.r.t. M

$$a_0 = \frac{F}{M+m}$$

$\Rightarrow \quad mg\sin\theta = (F - ma_0)\cos\theta$

$$\Rightarrow \quad mg\tan\theta = F - \frac{mF}{M+m}$$

$$\Rightarrow \quad mg\tan\theta = \frac{FM}{M+m}$$

$$\Rightarrow \quad F = \frac{(M+m)}{M} mg\tan\theta$$

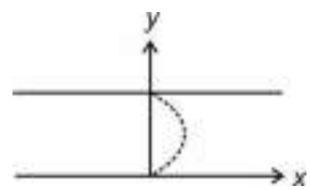
18. Answer (1)

Hint : $\vec{v}_{b,\,gr} = u\,\hat{j} + \left(\dfrac{2v_0}{d}\right) y\,\hat{i}$ (upto half width)

Total drift will be double of the drift upto half width.

Sol. : Velocity profile of river is as shown in figure.

$$\therefore \quad \vec{v}_{b,\,gr} = u\,\hat{j} + \left(\frac{2v_0}{d}\right) y\,\hat{i}$$



$$\therefore \quad y = ut \text{ and } dx = \int \left(\frac{2v_0}{d}\right) ut\, dt$$

$$\therefore \quad (X_{\text{half}}) = \frac{2v_0}{d} \cdot u \cdot \frac{1}{2} \cdot \frac{d^2}{4u^2}$$

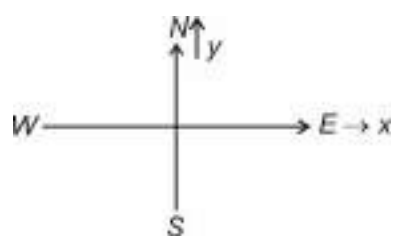
$$\Rightarrow \quad (X_{\text{half}}) = \frac{v_0 d}{4u}$$

$$\therefore \quad X = \frac{v_0 d}{2u}$$

19. Answer (1)

Hint : $\vec{v}_{w,\,m} = \vec{v}_{w,\,gr} - \vec{v}_{w,\,gr}$

Sol. :



$$\vec{v}_{w,\,gr} = -v\hat{i}$$

$$\vec{v}_{w,\,gr} = at\,\hat{j}$$

$$\therefore \quad \vec{v}_{w,\,m} = -v\hat{i} - at\,\hat{j}$$

to man the direction of wind become south-west

then $|\vec{v}| = |\vec{a}|t \quad \Rightarrow \quad t = \dfrac{|\vec{v}|}{|\vec{a}|}$

20. Answer (2)

Hint : $V_{APP} = v - v\cos\left(\frac{\pi}{6}\right)$

Sol. : Velocity of approach $v - v\cos\left(\frac{\pi}{6}\right)$

$\Rightarrow \quad V_{APP} = v\left(1 - \frac{\sqrt{3}}{2}\right)$

$\therefore \quad T = \frac{2a}{v(2-\sqrt{3})}$

$\therefore$ distance travelled $s = vT = \frac{2a}{2-\sqrt{3}}$

21. Answer (50)

Hint : $T = \frac{mv^2}{R}$

Sol. : $T = \frac{mv^2}{R}$

$= \frac{2\times(5)^2}{1}$

= 50 N

22. Answer (18)

Hint : Collision time $T = \frac{40}{\text{m}}$

Sol. : Time of collision $T = \frac{40}{24}\text{sec}$

$\Rightarrow \quad T = \frac{5}{3}\text{sec}$

$\Rightarrow \quad V_B = \frac{30\times 3}{5} = 18 \text{ m/s}$

23. Answer (10)

Hint : $R_{\max} = \frac{u^2}{g(1+\sin\theta)}$

Sol. : $u^2 = R_{\max} . g(1 + \sin\theta)$

$\Rightarrow \quad u^2 = 5\times 10\times\left(1+\frac{4}{5}\right)$

$\Rightarrow \quad u^2 = 5\times 10\times\frac{9}{5}$

$\Rightarrow \quad u = 3\sqrt{10}$ m/s

24. Answer (45)

Hint : $R = \frac{4^2 \sin 2\theta}{g}$

Sol. : $R = \frac{4^2\cdot\sin 2\theta}{g} = 30$

$\therefore \quad \sin 2\theta = \frac{30\times 10}{100\times 100} = \frac{3}{100}$

$\theta \approx 0.86°$

$\therefore \quad \tan\theta = \frac{y}{30\text{ m}} = y = 30\times 100\times\tan\theta$

$\Rightarrow \quad y = 45$ cm

25. Answer (60)

Hint : Limiting friction at the contact of *C* and ground is minimum.

Sol. : $fr_{\max}(AB) = 90$ N

$fr_{\max}(BC) = 80$ N;

$fr_{\max}(C.\text{ground}) = 60$ N

So, motion starts at the interface of ground and block *C*. And all the blocks will move together at applied force of 60 N.

PART - B (CHEMISTRY)

26. Answer (3)

Hint : SI unit of surface tension is N/m.

Sol. : Particles on the surface has net attractive force.

27. Answer (3)

Hint : According to kinetic theory of gases there is no interaction between the molecules.

Sol. : There is no release of heat during mixing and volume change on mixing of two ideal gases is zero.

28. Answer (3)

Hint : According to kinetic theory of gases, gaseous molecule are hard spheres, and there is no force of attraction or repulsion between them.

Sol. : When the particles are close to each other, they have no force of attraction or repulsion between them.

29. Answer (2)

Hint : Coulombic forces are responsible for the formation of NaCl.

Sol. : Coulombic forces are inversely proportional to r^2.

30. Answer (2)

Hint : SiO_2 – Si is sp^3 hybridised

CH_4 – C is sp^3 hybridised

Sol. : BH_3 – B is sp^2

B_2H_6 – B is sp^3

CO_2 – C is sp

SO_2 – S is sp^2

XeO_2F_2 – Xe is sp^3d

XeF_4 – Xe is sp^3d^2

31. Answer (2)

Hint : Gas liquifies at higher pressure for $T < T_c$

Sol. : At point 'd' only liquid phase is present.

At point 'a' only gaseous phase is present.

At point 'c' and 'b' gas is in equilibrium with liquid.

32. Answer (2)

Hint : $\because\ P_{O_2} = x_{O_2} \times P_{Total}$

Sol. : $x_{O_2} = \dfrac{P_{O_2}}{P_{Total}} = \dfrac{0.2}{16} = \dfrac{1}{80}$

Mole percent of $O_2 = x_{O_2} \times 100$

$= 1.25\ \%$

33. Answer (4)

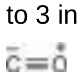
Hint : The angle between h_1 and h_2 is 120°

Sol. : sp^2 hybrid orbitals have bond angle equal to 120°

34. Answer (2)

Hint : Formal charge is the charge assigned to an atom in a molecule, assuming that electrons in all chemical bonds are shared equally between atoms, regardless of relative electronegativity.

Sol. : In CO molecule there is bond order equal to 3 in between C and O.



35. Answer (3)

Hint : 2 g of H_2 = 1 mol

32 g of O_2 = 1 mol

20 g of Ne = 1 mol

Sol. : Pressure, K.E. $\propto$ temperature

Most probable speed $\propto \sqrt{\dfrac{T}{M}}$

36. Answer (2)

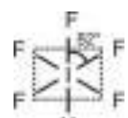
Hint : Nodal planes can be identified by overlapping of orbitals.

Sol. :

Orbital	Nodal Plane(s)
σ^*1s	1
$1s$	0
Pure *p*-orbital	1
$\sigma 1s$	0
$\sigma 2s$	0

37. Answer (1)

Hint : Bond angle can be predicted by VSEPR theory.

Sol. : 

38. Answer (1)

Hint : p_x, p_y and p_z orbitals are required to form tetrahedral geometry along with *s*-orbitals.

Sol. : n*s* orbital can combine with n*p* orbitals as they are close in energy.

39. Answer (1)

Hint : Characteristic of an hybrid orbital depends upon the % of *s*-character.

Sol. : $\because$ The *s*-orbitals are spherical, lower in energy and close to the nucleus, its % increase in hybrid orbital cause bulkiness and shortening of the orbital.

40. Answer (4)

Hint : As the number of unpaired electrons increases, magnetic moment increases.

Sol. : C_2 – Diamagnetic

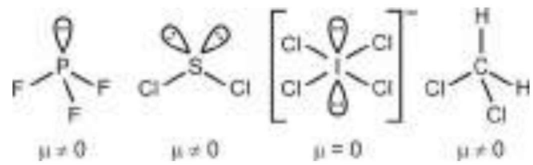
C_2^- – Paramagnetic

All other processes will result into decrease in magnetic moment.

41. Answer (3)

Hint : For non-polar molecule, dipole moment $\mu = 0$.

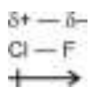
Sol. :



42. Answer (1)

Hint : Consider the dipole moment of the respective molecule.

Sol. : In Cl — F molecule, fluorine is more electronegative



$\therefore$ correct orientation is $\begin{vmatrix} \overset{+}{F} — Cl \\ F — \overset{-}{Cl} \end{vmatrix}$

43. Answer (3)

Hint : In a covalent bond, the two electrons are placed in between the nuclei of both the atoms.

Sol. : Both the electrons are under the influence of both nuclear charges.

44. Answer (1)

Hint : Lattice energy $\propto$ charge density on ions.

Sol. : Order for magnitude of lattice energy should be

$MgO > MgF_2 > LiF > NaCl > KI$

45. Answer (2)

Hint : Lattice formation between gaseous cation and anion are energy releasing process, Cl has –ve E.G.E.

Sol. : $\underset{(g)}{Cl} + e^- \longrightarrow \underset{(g)}{Cl^-}$ electron gain enthalpy

$\underset{(g)}{\overset{+}{Na}} + \underset{(g)}{Cl^-} \longrightarrow \underset{(s)}{NaCl}$ lattice energy.

46. Answer (14)

Hint : 760 mmHg = 1 atm.

Sol. : Total pressure = 0.9 atm + 50 mmHg

= 734 mmHg

47. Answer (20)

Hint : $CO + \frac{1}{2}O_2 \longrightarrow CO_2$

$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$

Sol. : KOH absorbs CO_2 only

$\therefore$ Volume of CO_2 = volume of CO = 15 ml

$\therefore$ 25 ml of H_2 is in the mixture.

$\therefore$ 20 ml of O_2 is required.

48. Answer (20)

Hint : Pressure $\propto$ number of moles [at constant T, V].

Sol. : Initial number of moles of gas = 10 + 1

= 11

	N_2	+ $3H_2$	$\rightarrow$ $2NH_3$
Initial	1 mol	10 mol	0
Final	0	10 – 3 = 7 mol	2 mol

Final number of moles = 9 mol

49. Answer (64)

Hint : $\because \frac{rate_1}{rate_2} = \sqrt{\frac{M_2}{M_1}}$

Sol. : $\frac{10 \times 10^{-6}}{8 \times 10^{-6}} = \sqrt{\frac{100}{M_x}}$

$M_x = 64$

50. Answer (38)

Hint : $\because$ PV = nRT

$w = \frac{P \times V \times M}{RT}$

Sol. : $w = \frac{7.6 \times 0.3 \times 4}{0.08 \times 300}$

= 0.38 gm

PART - C (MATHEMATICS)

51. Answer (3)

Hint : $f(x) \geq 0$

Sol. :

Let $f(x) = ax^2 + bx + 32$

The graph of $y = f(x)$ does not cut the x-axis at two distinct points.

Also $f(0) > 0$, so graph of $f(x)$ always remains on or above the x-axis.

So, $f(x) \geq 0$ for all $x \in R$

$\Rightarrow \quad f(4) \geq 0$

$16a + 4b + 32 \geq 0$

$4a + b \geq -8$

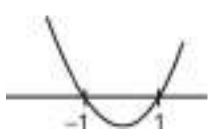
52. Answer (1)

Hint : $D > 0 \cap f(1) > 0 \cap f(-1) > 0 \cap -\dfrac{b}{2a} \in (-1, 1)$

Sol. :

Let $f(x) = 4x^2 - 2x + a$

$\because \quad f(x) = 0$ has two distinct real roots in $(-1, 1)$, then



(i) $D > 0$

$\Rightarrow \quad 4 - 16a > 0$

$\Rightarrow \quad a \in \left(-\infty, \dfrac{1}{4}\right)$

(ii) $f(-1) > 0$

$\Rightarrow \quad 4 + 2 + a > 0$

$\Rightarrow \quad a \in (-6, \infty)$

(iii) $f(1) > 0$

$\Rightarrow \quad 4 - 2 + a > 0$

$\Rightarrow \quad a \in (-2, \infty)$

(iv) $-1 < -\dfrac{b}{2a} < 1$

$\Rightarrow \quad -1 < \dfrac{1}{4} < 1$ (Always true)

So, $a \in \left(-2, \dfrac{1}{4}\right)$

Possible integral values of a are –1 and 0.

53. Answer (2)

Hint : $2\left(x^2 + \dfrac{1}{x^2}\right) - 7\left(x + \dfrac{1}{x}\right) + 9 = 0$,

put $x + \dfrac{1}{x} = t$

Sol. :

$2(x^4 + 1) - 7(x^3 + x) + 9x^2 = 0$

$\Rightarrow \quad 2\left(x^2 + \dfrac{1}{x^2}\right) - 7\left(x + \dfrac{1}{x}\right) + 9 = 0$

$\Rightarrow \quad 2\left(x + \dfrac{1}{x}\right)^2 - 7\left(x + \dfrac{1}{x}\right) + 5 = 0$

$\Rightarrow \quad$ Let $x + \dfrac{1}{x} = t$

$\Rightarrow \quad 2t^2 - 7t + 5 = 0$

$\Rightarrow \quad t = 1$ or $\dfrac{5}{2}$

When $x + \dfrac{1}{x} = 1$

$\Rightarrow \quad x = \dfrac{1}{2} \pm \dfrac{\sqrt{3}}{2} i$ (Imaginary roots)

When $x + \dfrac{1}{x} = \dfrac{5}{2}$

$\Rightarrow \quad x = 2, \dfrac{1}{2}$ (Real roots)

54. Answer (1)

Hint : $a = -3, -2, 6, 7$

Sol. :

Let α, β are the integer roots of the equation, then $\alpha + \beta = a$ and $\alpha.\beta = a + 3$

$\Rightarrow \quad \alpha + \beta = \alpha\beta - 3$

$\Rightarrow \quad \beta = \dfrac{\alpha+3}{\alpha-1}$

$\Rightarrow \quad \beta = 1 + \dfrac{4}{\alpha-1}$

Here α is an integer and $(\alpha - 1)$ must divide 4,

So, $\alpha = 2, 0, 3, -1, 5, -3$

So two roots of the equation may be;

(2, 5), (0, –3), (3, 3) or (–1, –1)

$\because \quad a$ = sum of roots

Then possible values of a are 7, 6, –3, –2.

55. Answer (3)

Hint : $|z_1| = |z_3| = 3$ and $|z_2| = \dfrac{2}{\sqrt{3}}$.

Sol. : $|z_1| = |z_3| = 3$ and $|z_2| = \dfrac{2}{\sqrt{3}}$.

$$\frac{1}{\left|\sqrt{z_1}\right|} + \left|\sqrt{z_3}\right| = \frac{1}{\sqrt{3}} + \sqrt{3} = \frac{4}{\sqrt{3}} = 2|z_2|$$

56. Answer (1)

Hint : Let $\dfrac{z_1}{z_2} = z$ then find $|z|$.

Sol. : Let $\dfrac{z_1}{z_2} = z$

$z + \dfrac{1}{z} = 1$

$\Rightarrow \quad z^2 - z + 1 = 0$

$\Rightarrow \quad z = \dfrac{1 \pm \sqrt{3}i}{2}$

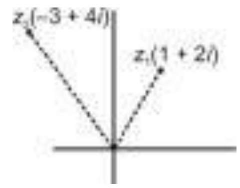
$\Rightarrow \quad \dfrac{z_1}{z_2} = \dfrac{1 \pm \sqrt{3}i}{2}$

$\Rightarrow \quad \left|\dfrac{z_1}{z_2}\right| = 1 \Rightarrow |z_1| = |z_2|$

57. Answer (2)

Hint : $\arg(1 + 2i) < \arg(z) < \arg(-3 + 4i)$

Sol. :



$\arg(z_1) > \dfrac{\pi}{4}$

$\arg(z_2) < \dfrac{3\pi}{4}$

and $\arg(z_1) < \arg(z) < \arg(z_2)$

The only possible value of $\arg(z)$ is $\dfrac{\pi}{2}$

58. Answer (4)

Hint : $\sin 2A + \sin 2B = 2\sin(A + B) . \cos(A - B)$

$= -2\sin C . \cos(A - B)$

Sol. :

$\sin 2A + \sin 2B - \sin 2C = 2\sin(A + B) . \cos(A + B) - \sin 2C$

$= -2\sin C . \cos(A - B) - 2\sin C . \cos C$

$= -2\sin C\, [\cos(A - B) + \cos(2\pi - (A + B))]$

$= -2\sin C[2\cos A . \cos B] = -4\cos A\cos B\sin C$

59. Answer (3)

Hint : $\dfrac{\cos\alpha}{\cos\beta} = \dfrac{1}{3}$ (Now use componendo and dividendo).

Sol. :

$\because \quad \dfrac{\cos\alpha}{\cos\beta} = \dfrac{1}{3}$

$\Rightarrow \quad \dfrac{\cos\beta - \cos\alpha}{\cos\beta + \cos\alpha} = \dfrac{3-1}{3+1}$

$\Rightarrow \quad \dfrac{2\sin\left(\dfrac{\alpha-\beta}{2}\right)\cdot\sin\left(\dfrac{\alpha+\beta}{2}\right)}{2\cos\left(\dfrac{\alpha-\beta}{2}\right)\cdot\cos\left(\dfrac{\alpha+\beta}{2}\right)} = \dfrac{1}{2}$

$\Rightarrow \quad \tan\left(\dfrac{\alpha+\beta}{2}\right)\cdot\tan\left(\dfrac{\alpha+\beta}{2}\right) = \dfrac{1}{2}$

60. Answer (4)

Hint : $2B = (2A + B) - (2A - B)$

Sol. : $\tan(2B) = \tan((2A + B) - (2A - B))$

$\Rightarrow \quad \tan 2B = \dfrac{\tan(2A+B)-\tan(2A-B)}{1+\tan(2A+B)\cdot\tan(2A-B)}$

$= \dfrac{\frac{1}{2}-\frac{1}{3}}{1+\frac{1}{2}\cdot\frac{1}{3}}$

$= \dfrac{1}{7}$

61. Answer (3)

Hint : $\sin x = \pm 1$ or $\cos x = 1$

Sol. : $\cos^7 x - (1 - \sin^2 x)(1 + \sin^2 x) = 0$

$\Rightarrow \quad \cos^2 x\left[\cos^5 x - 1 - \sin^2 x\right] = 0$

$\Rightarrow \quad \cos^2 x = 0$ or $\cos^5 x = 1 + \sin^2 x$

$\Rightarrow \quad x = \pm\dfrac{\pi}{2} \qquad \cos x = 1$

$x = 0$

62. Answer (3)

Hint : $1 + \sin x = 2\cos^2 x \Rightarrow 2\sin^2 x + \sin x - 1 = 0$

Sol. : $\dfrac{1+\sin x}{\cos x} = 2\cos x$

$\Rightarrow \quad 1 + \sin x = 2\cos^2 x$

$\Rightarrow \quad 2\sin^2 x + \sin x - 1 = 0$

$\Rightarrow \quad \sin x = \dfrac{1}{2}, -1$

$\Rightarrow \quad x = \dfrac{\pi}{6}, \dfrac{5\pi}{6}, \dfrac{3\pi}{2}$

But at $x = \dfrac{3\pi}{2}$, $\tan x$ and $\sec x$ are not defined.

So, $x = \dfrac{\pi}{6}$ and $\dfrac{5\pi}{6}$

63. Answer (3)

Hint : $f(x) = \dfrac{5}{2} + 2\left[\cos x - \dfrac{1}{2}\right]^2$

Sol. : $f(x) = 3 + 2\cos^2 x - 2\cos x$

$= \dfrac{5}{2} + 2\left(\cos x - \dfrac{1}{2}\right)^2$

So, $M = \dfrac{5}{2} + \dfrac{9}{2} = 7$ and $m = \dfrac{5}{2}$

64. Answer (1)

Hint : $\dfrac{3\tan x}{1-\tan^2 x} = 2$

Sol. : $\log_2\left(\dfrac{3\sin x}{\cos x(1+\tan x)(1-\tan x)}\right) = 2$

$\Rightarrow \quad \dfrac{3\tan x}{1-\tan^2 x} = 2$

$\Rightarrow \quad 2\tan^2 x + 3\tan x - 2 = 0$

$\Rightarrow \quad \tan x = \dfrac{1}{2}$ or -2

but $-1 < \tan x < 1$ (domain)

So, $\tan x = \dfrac{1}{2}$

65. Answer (2)

Hint : $\sin x \le \cos^2 x$ and $\sin x \in (0, 1)$ and $\cos x \in (0, 1)$

Sol. : $\log_{\cos x}(\sin x) \ge 2$

$\Rightarrow \quad \sin x \le \cos^2 x$

$\Rightarrow \quad \sin^2 x + \sin x - 1 \le 0$

$\sin x \in \left[\dfrac{-1-\sqrt{5}}{2}, \dfrac{-1+\sqrt{5}}{2}\right]$

But $\sin x > 0$

So, $\sin x \in \left(0, \dfrac{-1+\sqrt{5}}{2}\right]$

66. Answer (2)

Hint : $\sqrt{x-4}$ and $\sqrt{x}$ must be integer.

Sol. : $\cos\left(\pi\sqrt{x-4}\right)\cdot\cos\left(\pi\sqrt{x}\right) = 1$

$\Rightarrow \quad \cos\left(\pi\sqrt{x-4}\right) = \cos\left(\pi\sqrt{x}\right) = 1$ or

$\cos\left(\pi\sqrt{x-4}\right) = \cos\left(\pi\sqrt{x}\right) = -1$

$\Rightarrow \quad \sqrt{x-4}$ and $\sqrt{x}$ both should be integers.

$\Rightarrow \quad x = 4$ is only possible solution.

67. Answer (4)

Hint : Put $\tan\theta = x \Rightarrow \dfrac{2x^2}{1-x^2} = 1$

Sol. : $\dfrac{2\tan\theta}{1-\tan^2\theta}\cdot\tan\theta = 1$

$\Rightarrow \quad 3\tan^2\theta = 1$

$\Rightarrow \quad \tan^2\theta = \left(\dfrac{1}{\sqrt{3}}\right)^2$

$\Rightarrow \quad \theta = n\pi \pm \dfrac{\pi}{6}$

$\Rightarrow \quad \theta = \dfrac{(6n \pm 1)\pi}{6} \qquad (n \in z)$

68. Answer (1)

Hint : $x^2 + y^2 = a^2 + b^2$

Sol. : $a\sin\theta + b\cos\theta = x$ …(i)

$a\cos\theta - b\sin\theta = y$ …(ii)

By squaring and adding

$a^2 + b^2 = x^2 + y^2$

Now, $\dfrac{x+b}{y+a} + \dfrac{y-a}{x-b} = \dfrac{x^2+y^2-a^2-b^2}{(y+a)(x-b)} = 0$

69. Answer (1)

Hint : Put $x = 2\cos\theta$ and solve for θ

Sol. : Let $x = 2\cos\theta$

$$2\cos\theta = \sqrt{2+\sqrt{2-2\sin\frac{\theta}{2}}}$$

$$\Rightarrow \quad 2\cos\theta = \sqrt{2+\sqrt{2-2\cos\left(\frac{\pi}{2}-\frac{\theta}{2}\right)}}$$

$$\Rightarrow \quad 2\cos\theta = \sqrt{2+2\sin\left(\frac{\pi}{4}-\frac{\theta}{4}\right)}$$

$$\Rightarrow \quad 2\cos\theta = \sqrt{2+2\cos\left(\frac{\pi}{4}+\frac{\theta}{4}\right)}$$

$$\Rightarrow \quad 2\cos\theta = 2\cos\left(\frac{\pi}{8}+\frac{\theta}{8}\right)$$

$$\Rightarrow \quad \frac{7\theta}{8} = \frac{\pi}{8}$$

$$\Rightarrow \quad \theta = \frac{\pi}{7}$$

70. Answer (2)

Hint : $3\operatorname{cosec}\theta - 4\sec\theta = 5\left[\frac{3}{5}\operatorname{cosec}\theta - \frac{4}{5}\sec\theta\right]$

$= 5\left[\dfrac{\sin 3\theta}{\sin\theta} - \dfrac{\cos 3\theta}{\cos\theta}\right]$.

Sol. : $3\operatorname{cosec}\theta - 4\sec\theta$

$$= 5\left[\frac{\frac{3}{5}\cos\theta - \frac{4}{5}\sin\theta}{\sin\theta\cdot\cos\theta}\right]$$

$$= 10\left[\frac{\sin 3\theta\cdot\cos\theta - \cos 3\theta\cdot\sin\theta}{2\sin\theta\cdot\cos\theta}\right]$$

$$= 10\left[\frac{\sin 2\theta}{\sin 2\theta}\right]$$

$= 10$

71. Answer (05)

Hint : $a^b = 1 \Rightarrow a = 1$ or $b = 0$ or $a = -1$ and b is even

Sol. : If $\left(x^2-5x+5\right)^{x^2-12x+35} = 1$, then

(i) $x^2 - 12x + 35 = 0 \quad \Rightarrow \quad x = 5, 7$

(ii) $x^2 - 5x + 5 = 1 \quad \Rightarrow \quad x = 1, 4$

(iii) $x^2 - 5x + 5 = -1$ and $x^2 - 12x + 35$ is even

$\Rightarrow \quad x = 3$

72. Answer (05)

Hint : Consider the roots $n - 2$, $n - 1$, n, $n + 1$ and $n + 2$.

Sol. :

Sum of roots = $-a = 5n$

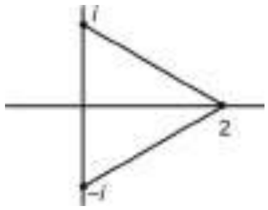
Sum of product of two roots, = $b = 10n^2 - 5$

Now $\dfrac{2a^2}{b+5} = \dfrac{2(-5n)^2}{10n^2} = 5$

73. Answer (20)

Hint : $z = i, -i, 2.$

Sol. :



$z(z-1)^2 = 2$

$\Rightarrow \quad z^3 - 2z^2 + z - 2 = 0$

$\Rightarrow \quad (z-2)(z^2+1) = 0$

$z = 2, \pm i$

area of triangle $= \frac{1}{2}(2)(2)$

$= 2$

74. Answer (08)

Hint : Use $\cos\theta \cdot \cos(60^\circ - \theta) \cdot \cos(60^\circ + \theta) = \frac{1}{4}\cos 3\theta$

Sol. :

$\cos 6^\circ \cdot \sin 18^\circ \cdot \sin 24^\circ = \cos 6^\circ \cdot \cos 66^\circ \cdot \sin 18^\circ$

$$= \frac{\cos 6^\circ \cdot \cos 66^\circ \cdot \cos 54^\circ \cdot \sin 18^\circ}{\cos 54^\circ}$$

$$= \frac{1}{4}\frac{\cos 18^\circ \cdot \sin 18^\circ}{\sin 36^\circ}$$

$$= \frac{1}{8}$$

75. Answer (27)

Hint : $(3\sin\theta - 4\cos\theta)(3\cos\theta + 4\sin\theta)$

$$= -\frac{7}{2}\sin\theta - 12\cos\theta$$

Sol. : $(3\sin\theta - 4\cos\theta)(3\cos\theta + 4\sin\theta)$

$= -12(\cos^2\theta - \sin^2\theta) - 7(\sin\theta.\cos\theta)$

$$= -\frac{1}{2}[24\cos 2\theta + 7\sin 2\theta]$$

$\because$ Range of $a\sin\theta + b\cos\theta$ is $\left[-\sqrt{a^2+b^2}, \sqrt{a^2+b^2}\right]$

So maximum value of given expression is $\frac{1}{2}\sqrt{24^2+7^2} = \frac{25}{2}$

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