PART-A-PHYSICS

SECTION-I(i)

1) A solid cylinder and a solid sphere, having same mass M and radius R, roll down the same inclined plane from top without slipping. They start from rest. The ratio of velocity of the solid cylinder to that of the solid sphere, with which they reach the ground, will be :

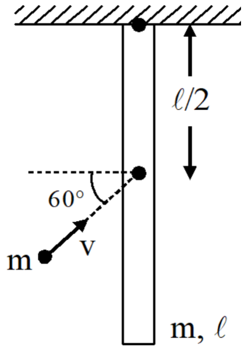
(A) $\sqrt{\frac{5}{3}}$

(B) $\sqrt{\frac{4}{5}}$

(C) $\sqrt{\frac{3}{5}}$

(D) $\sqrt{\frac{14}{15}}$

2) A thin rod of mass m and length l is hinged to a ceiling and it is free to rotate in a vertical plane. A particle of mass m, moving with speed v strikes it as shown in the figure and gets stick with the rod.



The value of v, for which the rod becomes horizontal after collision is

(A) $\frac{56}{3}g\ell$

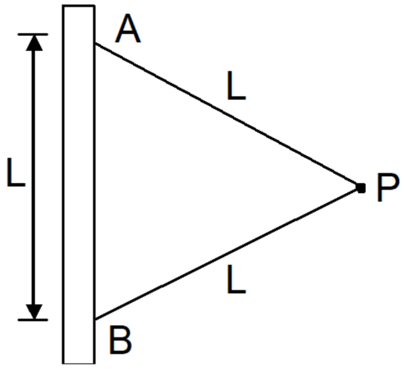
(B) $\frac{56}{3}\sqrt{g\ell}$

(C) $\sqrt{\frac{56}{3}g\ell}$

(D) $\sqrt{2g\ell}$

3) A particle P of mass m is attached to a vertical axis by two strings AP and BP of length ℓ each. The separation AB = ℓ. P rotates around the axis with an angular velocity ω. The tensions in the two

strings are T_1 and T_2. Choose which option is incorrect.



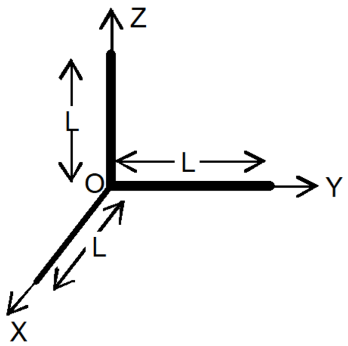
(A) $T_1 = T_2$

(B) $T_1 + T_2 = m\omega^2\ell$

(C) $T_1 - T_2 = 2\ mg$

(D) BP will remain taut only if $\omega \geqslant \sqrt{\frac{2g}{\ell}}$

4) Three thin rods each of length L and mass M are placed along X, Y and Z-axes in such a way that one end of each of the rods is at the origin. The moment of inertia of this system about Z-axis is



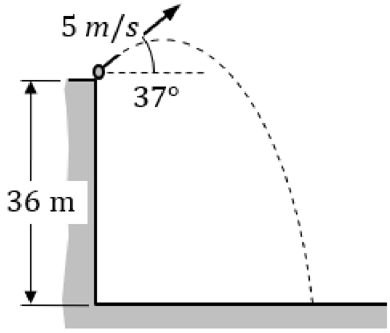
(A) $\frac{2ML^2}{3}$

(B) $\frac{4ML^2}{3}$

(C) $\frac{5ML^2}{3}$

(D) $\frac{ML^2}{3}$

5) A ball is thrown from the top of 36 *m* high tower with velocity 5 *m*/*s* at an angle of 37° above the horizontal as shown. Its horizontal range on the ground is closest to [take $g = 10\ m/s^2$]



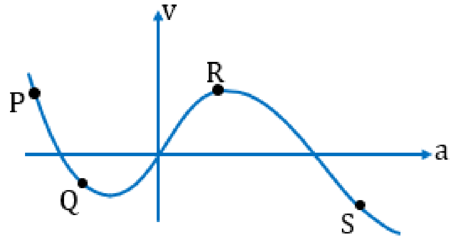
(A) 12 m

(B) 18 m

(C) 24 m

(D) 30 m

6) Acceleration-velocity graph of a moving particle is shown in figure. The particle is



(A) speeding up at P

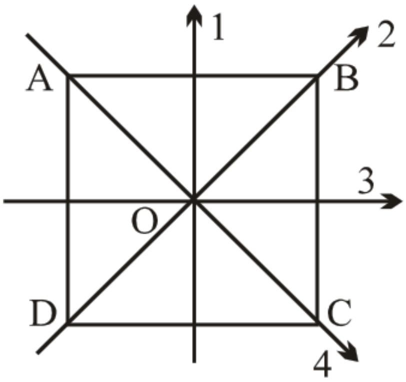
(B) speeding up at Q

(C) speeding up at S

(D) speeding down at R

SECTION-I(ii)

1) ABCD is a square plate with centre O. The moments of inertia of the plate about the perpendicular axis through O is I and about the axes 1, 2, 3 & 4 are I_1, I_2, I_3 & I_4 respectively. It follows that :-

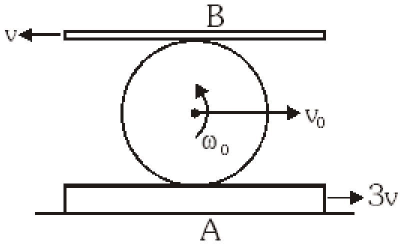


(A) $I_2 = I_3$

(B) $I = I_1 + I_4$

(C) $I = I_2 + I_4$

(D) $I_1 = I_3$

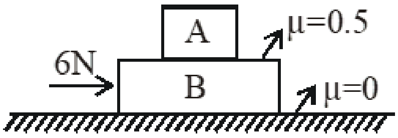
2) The disc of radius r is confined to roll without slipping at A and B. If the plates have the velocities shown, then 

(A) linear velocity $v_0 = v$

(B) angular velocity of disc is $\frac{3v}{2r}$

(C) angular velocity of disc is $\frac{2v}{r}$

(D) None of these

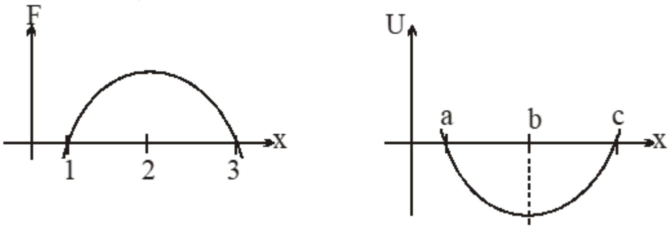
3) Block A of mass 1 kg is kept on block B of mass $2kg$ which is kept on smooth surface as shown in figure. At t = 0 both blocks are at rest and a force of $6N$ is applied on block B. Friction coefficient between A and B is 0.5. Which of the following is/are correct :- 

(A) Acceleration of both the blocks is $2m/s^2$

(B) Work done by friction (in ground frame) on A is zero from t = 0 to t = 2 sec

(C) Friction force on A is $2N$

(D) Kinetic energy of A at t = 2 sec is $8J$

4) A particle is subjected to a conservative force as seen in the graphs, which of the following are correct. 

(A) Particle is in stable equilibrium at point 3 and b.

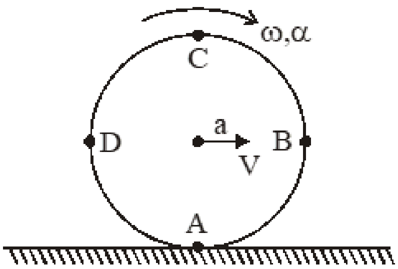
(B) Particle is in neutral equilibrium at point b and 2.

(C) No power is delivered by the force to the particle at 1, 3, and b.

(D) Particle has maximum kinetic energy at position b.

5) A circular disc of radius R rolls without slipping on a rough horizontal surface. At the instant shown its linear velocity is V, linear acceleration a, angular velocity ω and angular acceleration α. Four points A, B, C and D lie on its circumference such that the diameter AC is vertical and BD

horizontal then choose the correct option(s).



(A) $V_B = \sqrt{V^2 + (R\omega)^2}$

(B) $V_C = V + R\omega$

(C) $a_A = \sqrt{(a - R\alpha)^2 + (\omega^2 R)^2}$

(D) $a_D = \sqrt{(a - \omega^2 R)^2 + (R\alpha)^2}$

6) If a projectile explodes in mid air, then just before and just after explosion, choose **correct** option(s) :-

(A) Conservation of momentum is applicable.

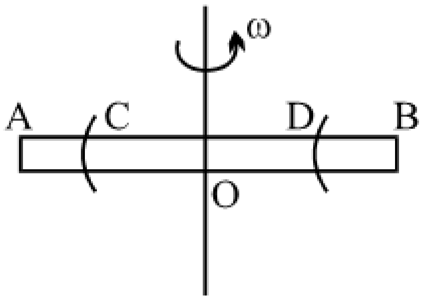
(B) Path of the centre of mass of the projectile must be same original parabola till any one part of it, hits the ground.

(C) Energy released during explosion is equal to increase in kinetic energy of the projectile.

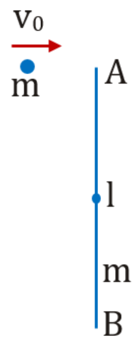
(D) Conservation of momentum is not applicable.

SECTION-III

1) A rigid horizontal smooth rod *AB* of mass 0.75 *kg* and length 40 *cm* can rotate freely about a fixed vertical axis through its mid-point *O*. Two rings each of mass 1 *kg* are initially at rest at a distance of 10 *cm* from *O* on either side of the rod. The rod is set in rotation with an angular velocity of 30 radians per second. Find the velocity of each ring along the length of the rod in m/s when they reach the ends of the rod.



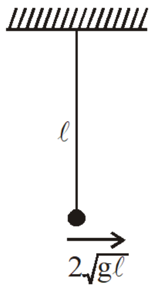
2) A mass *m* travelling at speed v_0 strikes perpendicularly to a stick of mass *m* and length ℓ = 1.2*m*, which is initially at rest as shown in the figure. The mass collides completely inelastically with the stick at one of its ends, and sticks to it. The location of point from end *A* (in *cm*) which is at



0 0

instantaneous rest just after collision is x . Value of x /10 is

3) One end of a string of length $\ell = \frac{14}{9}$m is fixed and a mass of 1 kg is tied to the other end. The ball is given a velocity $2\sqrt{g\ell}$ at the bottom most point as shown in figure. The string is cut when the ball becomes horizontal. Find the distance (in m) travelled till it stop for the 1st time (Take $\pi = \frac{22}{7}$)



4) The vertical height y and horizontal distance x of a projectile on a certain planet are given by x = (3t)m, $y = (4t - 6t^2)$ m where t is in seconds. Find the speed of projection (in m/s).

5) The position of a particle moving along x-axis varies with time t according to relation $x = (6t - t^2 + 36)$ m where t is in seconds. Find the length of time interval in seconds during which the particle is moving along positive x-direction.

PART-B-CHEMISTRY

SECTION-I(i)

1) If the four tubes of a car are filled to the same pressure with N_2, O_2, H_2 and He separately then which one will be filled first :

(A) N_2
(B) O_2
(C) H_2
(D) He

2) 2.5 mL of $\frac{2}{5}$ M weak monoacidic base ($K_b = 1 \times 10^{-12}$ at 25°C) is titrated with $\frac{2}{15}$ M HCl in water at 25°C. The concentration of $H^{\oplus}$ at equivalence point is

($K_w = 1 \times 10^{-14}$ at 25°C)

(A) 3.7×10^{-13} M

(B) 3.2×10^{-7} M

(C) 3.2×10^{-2} M

(D) 2.7×10^{-2} M

3) Which one of the following has highest pH:-

(A) Distilled water

(B) 1 M NH_3

(C) 1 M NaOH

(D) Water saturated with chlorine

4) How many litres of oxygen at 1atm & 273 K will be required to burn completely 2.2 g of propane (C_3H_8)

(A) 11.2 L

(B) 22.4 L

(C) 5.6 L

(D) 44.8 L

5) In acidic medium, potassium dichromate acts as an oxidant according to the equation :
$Cr_2O_7^{2\ominus} + 14H^{\oplus} + 6e^{\ominus} \rightarrow 2Cr^{3\oplus} + 7H_2O$
What is the equivalent weight of $K_2Cr_2O_7$ (mol. wt.= M) ?

(A) M

(B) M/2

(C) M/3

(D) M/6

6) For the reaction $2NO_{2(g)} \rightleftharpoons 2NO_{(g)} + O_{2(g)}$, ($K_c = 1.8 \times 10^{-6}$ at 184° C) (R = 0.831 kJ(mol.K)) When K_p and k_c are compared at 184°C it is found that

(A) K_p is less than K_c

(B) K_p is greater than K_c

(C) Whether K_p is greater than, less than or equal to K_c depends upon the total gas pressure

(D) $K_p = K_c$

SECTION-I(ii)

1) **INCORRECT** order of bond angle is :-

(A) $OCl_2 > SF_2$

(B) $H_2O > OF_2$

(C) SO_4^{2-} > CF_4

(D) $NF_3 > NH_3$

2) Which of the following statements are true for these given species : N_2, CO, $CN^{\ominus}$ and $NO^{\oplus}$.

(A) All species are paramagnetic

(B) The species are isoelectronic

(C) All the species have dipole moment

(D) All the species are linear

3) Which of the following statement(s) is/are correct ?

(A) the pH of 1.0×10^{-8} M solution of HCl is 8

(B) the conjugate base of $H_2PO_4^-$ is HPO_4^{2-}

(C) autoprotolysis constant of water increases with temperature

(D) when a solution of a weak monoprotic acid is titrated against a strong base, at half - neutralization point pH = (1/2) pK_a.

4) The equilibrium of which of the following reactions will not be disturbed by the addition of an inert gas at constant volume?

(A) $H_2\,(g)+I_2\,(g) \rightleftharpoons 2HI(g)$

(B) $N_2O_4(g) \rightleftharpoons 2NO_2\,(g)$

(C) $CO(g) + 2H_2\,(g) \rightleftharpoons CH_3OH(g)$

(D) $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$

5) The change in orbit angular momentum corresponding to an electron transition inside a hydrogen atom can be

(A) $\frac{h}{4\pi}$

(B) $\frac{h}{\pi}$

(C) $\frac{h}{2\pi}$

(D) $\frac{h}{8\pi}$

6) A bottle of oleum is labelled as 109%. Which of the following statement is/are correct for this oleum sample?

(A) It contains 40% of free SO_3 by weight.

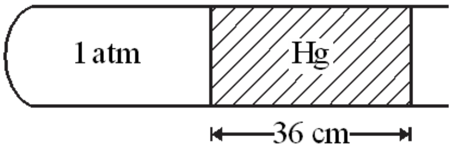
(B) 1.0g of this sample approximately requires 22.25 mL of 0.5 M−NaOH solution for complete neutralization.

(C) 0.5 g of this sample approximately requires 111.2 mL of 0.1 N−$Ba(OH)_2$ solution for complete neutralization.

(D) When 500 g water is added to 100 g of this sample, the resulting solution becomes m in H_2SO_4 $\left(\frac{109}{49}\right)$

SECTION-III

1) Air is trapped in a horizontal gas tube by 36cm mercury column as shown below :



If the tube is held vertical keeping the open end up, length of air column shrink to 19cm. What is the length (in cm) by which the mercury column shifts down ?

2) In the following reaction

$xZn + yHNO_3(dil) \rightarrow aZn(NO_3)_2 + bH_2O + cNH_4NO_3$

What is the sum of the coefficients (a + b + c) ?

3) 0.15 mole of pyridinium chloride has been added into 500 cm^3 of 0.2 M pyridine solution. What is the pH of the resulting solution assuming no change in volume. (K_b for pyridine = 1.5×10^{-9})

4) Find number of moles of Na_3PO_4 which contain as many ions as are present in 1368 gm of $Al_2(SO_4)_3$.

(Assuming complete dissociation of salt and no reaction with H_2)

5)

How many compounds are polar, planar and central atom is sp^3d hybridised

(a) PCl_3F_2 (b) PF_3Cl_2 (c) XeF_2 (d) ClF_3

(e) BrF_5 (f) $I_3^{\ominus}$ (g) SF_4 (h) S_3O_9

PART-C-MATHEMATICS

SECTION-I(i)

1) The value of $(0.2)^{\log_{\sqrt{5}}\left(\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+.....\infty\right)}$ is equal to

(A) 4

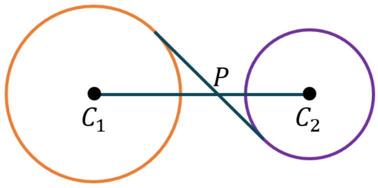
(B) 6

(C) 8

(D) 2

2) In the figure given, two circles with centres C_1 and C_2 are 35 units apart, i.e. $C_1 C_2 = 35$. The radii of the circles with centres C_1 and C_2 are 12 and 9 respectively. If P is the intersection of $C_1 C_2$ and a

common internal tangent to the circles, then □(C_1P) equals



(A) 18
(B) 20
(C) 12
(D) 15

3) If $\left(a, \frac{1}{a}\right)$, $\left(b, \frac{1}{b}\right)$, $\left(c, \frac{1}{c}\right)$ & $\left(d, \frac{1}{d}\right)$ are four distinct points on a circle of radius 4 units, then abcd is equal to

(A) 4
(B) 16
(C) 1
(D) 2

4) If the sum of the slopes of the lines given by $x^2 - 2cxy - 7y^2 = 0$ is four times their product, then c has the value

(A) –2
(B) –1
(C) 2
(D) 1

5) A ray of light passing through the point A(1,2) is reflected at a point B on the x-axis and then passes through (5,3). Then the equation of AB is

(A) $5x + 4y = 13$
(B) $5x - 4y = -3$
(C) $4x + 5y = 14$
(D) $4x - 5y = -6$

6)

$y = x^2 - 6x + 5$, $x \in [2,4]$, then

(A) least value of y is –3
(B) least value of y is 3
(C) greatest value of y is 4
(D) greatest value of y is –3

SECTION-I(ii)

1) Which of the following is/are True?
The circles $x^2+y^2 - 6x - 6y + 9 = 0$ and $x^2 + y^2 + 6x + 6y + 9 = 0$ are such that

(A) they do not intersect

(B) they touch each other

(C) their exterior common tangents are parallel.

(D) their interior common tangents are perpendicular.

2) If $a^2 + 9b^2 – 4c^2 = 6ab$ then the family of lines $ax + by + c = 0$ are concurrent at

(A) (1/2, 3/2)

(B) (–1/2, –3/2)

(C) (–1/2, 3/2)

(D) (1/2, –3/2)

3) The sides of a right triangle form a G.P. The tangent of the smallest angle is

(A) $\sqrt{\frac{\sqrt{5}+1}{2}}$

(B) $\sqrt{\frac{\sqrt{5}-1}{2}}$

(C) $\sqrt{\frac{2}{\sqrt{5}+1}}$

(D) $\sqrt{\frac{2}{\sqrt{5}-1}}$

4) $5 \sin^2 x + \sqrt{3} \sin x \cos x + 6 \cos^2 x = 5$ if

(A) $\tan x = -1/\sqrt{3}$

(B) $\sin x = 0$

(C) $x = n\pi + \pi/2, n \in I$

(D) $x = n\pi + \pi/6, n \in I$

5) If $L = \cos^2 84° + \cos^2 36° + \cos 36° \cos 84°$
$M = \cot 73° \cot 47° \cot 13°$
$N = 4\sin 156° \sin 84° \sin 36°$, then which of the following option(s) is(are) correct ?

(A) $L<1$

(B) $M>\tan 2$

(C) $N > \sin\frac{\pi}{4}$

(D) $0 < LMN$

6) If U = {1,2,3,4,5,6,7,8}, A = {1,2,3,5,6} and B = {2,3,4,7,8} which of the following are correct

(A) $A \cup B = U$

(B) $B - A = \{1,5,6\}$

(C) $A' \cup B = \{2,3,4,7,8\}$

(D) $(A - B)' = \{2,3,4,7,8\}$

SECTION-III

1) If f(x) is polynomial of degree 4 such that f(1)=1, f(2)=2, f(3)=3, f(4)=4 & f(0)=1 find f(5).

2) If in a triangle ABC, right angle at B, $s - a = 3$ and $s - c = 2$, then the value of $a + c$ is

3) If the points $(\lambda, -\lambda)$ lies inside the circle $x^2 + y^2 - 4x + 2y - 8 = 0$, then number of integers in the range of λ is

4) If (α, β) is a point on the circle whose centre is on the x-axis and which touches the line $x + y = 0$ at $(2, -2)$, then find the greatest integral value of 'α'.

5) Find number of integral values of λ if $(\lambda, \lambda + 1)$ is an interior points of ΔABC, where $A \equiv (0, 3)$, $B \equiv (-2, 0)$ and $C \equiv (6, 1)$.

ANSWER KEYS

PART-A-PHYSICS

SECTION-I(i)

Q.	1	2	3	4	5	6
A.	**D**	**C**	**A**	**A**	**A**	**B**

SECTION-I(ii)

Q.	7	8	9	10	11	12
A.	**A,B,C,D**	**A,C**	**A,C,D**	**A,C,D**	**A,B,C**	**A,B,C**

SECTION-III

Q.	13	14	15	16	17
A.	**3**	**8**	**4**	**5**	**3**

PART-B-CHEMISTRY

SECTION-I(i)

Q.	18	19	20	21	22	23
A.	**C**	**D**	**C**	**C**	**D**	**B**

SECTION-I(ii)

Q.	24	25	26	27	28	29
A.	**C,D**	**B,D**	**B,C**	**A,B,C,D**	**B,C**	**A,C**

SECTION-III

Q.	30	31	32	33	34
A.	**9**	**8**	**5**	**5**	**1**

PART-C-MATHEMATICS

SECTION-I(i)

Q.	35	36	37	38	39	40
A.	**A**	**B**	**C**	**C**	**A**	**D**

SECTION-I(ii)

Q.	41	42	43	44	45	46
A.	**A,C,D**	**C,D**	**B,C**	**A,C**	**A,B,C,D**	**A,C,D**

SECTION-III

Q.	47	48	49	50	51
A.	**6**	**7**	**4**	**6**	**2**

SOLUTIONS

PART-A-PHYSICS

1)

$$V = \sqrt{\frac{2gH}{1 + k^2/R^2}}$$

$$\frac{V_{cylinder}}{V_{sphere}} = \sqrt{\frac{(1 + k^2/R^2)_{sphere}}{(1 + k^2/R^2)_{cylinder}}}$$

$$= \sqrt{\frac{1 + 2/5}{1 + 1/2}} = \sqrt{\frac{7}{5} \times \frac{2}{3}} = \sqrt{\frac{14}{15}}$$

2)

Conservation of angular momentum about the hinge and conservation of mechanical energy.

3)

$T_1 \cos 30 + T_2 \cos 30 = mw^2 \text{ x } \frac{L\sqrt{3}}{2}$

$T_1 + T_2 = m\,L\,w^2$

$T_1 \sin 30 - T_2 \sin 30 - Mg = 0$

$T_1 - T_2 = 2mg$

$2T_2 = m\,L\,w^2 - 2Mg$ □ $T_2 = 0$

$mLw^2 = 2\,Mg$

$$w = \sqrt{\frac{2g}{L}}$$

4)

$I = 0 + I_1 + I_2$

$$= 0 + 2\left(\frac{ML^2}{3}\right) = \frac{2ML^2}{3}$$

5)

$u_y = 3$, $u_x = 4$

Range $= u_x t$

$-36 = 3t - 5t^2 \Rightarrow t = 3s$

Range $= 4 \times 3 = 12\ m$

6)

Speeding up if v and a have same sign and speeding down if v and a have opposite sign.

7)

$I_1 = I_2 = I_3 = I_4$ & $I = I_1 + I_3$

8) $v_A = w_0R - v_0 = v$

$\omega_0R - v_0 = v$ ...(i)

$v_B = \omega_0 R + v_0 = 3v$ ...(ii)

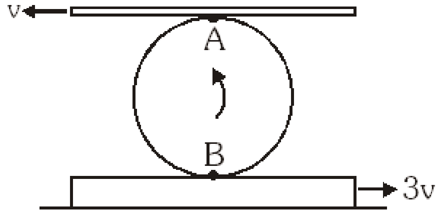
From equation (i) and (ii)

$2\omega_0R = 4V$

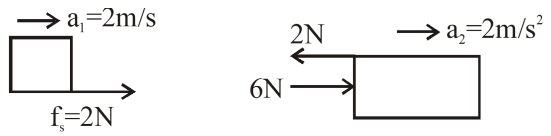
$\Rightarrow \omega_0R = 2v$

$\omega^0 = \frac{2v}{R}$

From (1) $v_0 = v$



9)



Work done by friction on $A \neq 0$

$V = 2 \times 2 = 4\ m/s$

$K.E.\ A = \frac{1}{2} \times 1 \times 4^2 = 8J$

10)

(A) $F = 0$ (equilibrium)

$F = \frac{-dU}{dx} = 0$

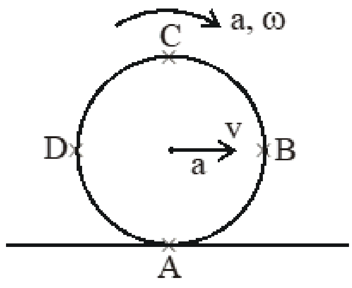
and $\frac{d^2U}{dx^2} < 0$

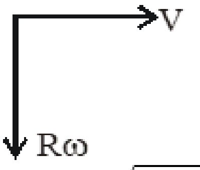
(C) At 1 and 3

$F = \frac{dU}{dx} = 0$ (No power delivered)

11)

(A) For point B





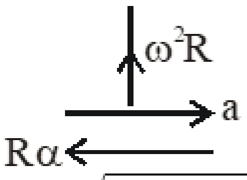
$\Rightarrow V_B = \sqrt{V^2 + (R\omega)^2}$

(B) For point C

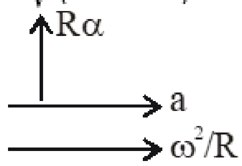
$\rightarrow V$

$\rightarrow R\omega$ Þ $V_C = V + R\omega$

(C) For point A



$a_A = \sqrt{(a - -R\alpha)^2 + (\omega^2 R)^2}$



(D)

$\Rightarrow a_D = \sqrt{(a - -R\omega^2)^2 + (R\alpha)^2}$

12)

$F_{ext} = 0 \Rightarrow P =$ conserved

13)

$\left(\frac{M_r\ell^2}{12} + 2m_P(0.1)^2\right)\omega_1 = \left(\frac{M_r\ell^2}{12} + 2m_P(0.2)^2\right)\omega_2$

$\Rightarrow \left(\frac{0.75 \times 0.4 \times 0.4}{12} + 2 \times 1 \times (0.1)^2\right) 30 = \left(\frac{0.75 \times 0.4 \times 0.4}{12} + 2 \times 1 \times (0.2)^2\right)\omega_2$

$\Rightarrow \omega_2 = 10 \text{rad/s}$

$KE_i = KE_f$

$\Rightarrow \frac{1}{2} I_1 \omega_1^2 = \frac{I}{2}\omega_2^2 + 2 \times \frac{1}{2} MV^2$

$v = 3 m/s$

14)

$mv_0 \frac{\ell}{4} = I_{cm}\omega$

$mv_0\frac{\ell}{4} = \frac{5}{24}m\ell^2\omega$

$\omega = \frac{6}{5}\frac{v_0}{\ell}$ ....(i)

$mv_0 = 2mv_c$

$v_c = \frac{v_0}{2}$ ....(ii)

$v_P = v_C - \omega x = 0$

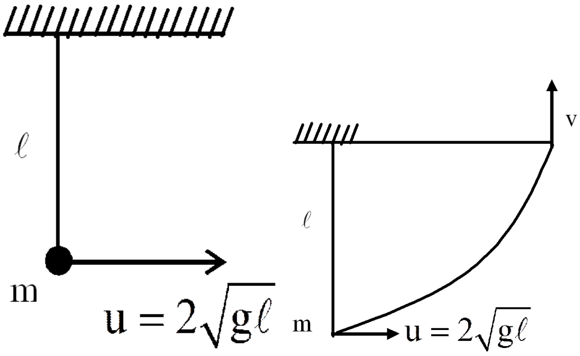
$x = \frac{v_c}{\omega} = \frac{5\ell}{12}$

Distance of P from A is $x^0 = x + \frac{\ell}{4}$

$x_0 = \frac{8\ell}{18} = 80\text{cm}$

$\frac{x_0}{10} = 8$.

15)



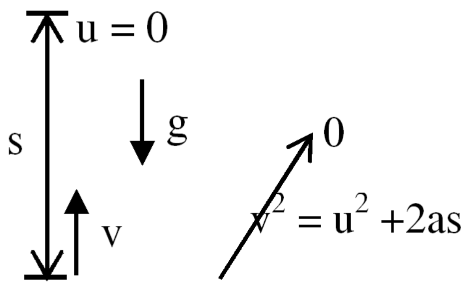
$mg\ell(-1) = \frac{1}{2}mv^2 - \frac{1}{2}mv^2$

$-2g\ell = v^2 - u^2$

$-2g\ell = v^2 - 4g\ell$

$\boxed{2g\ell = v^2}$

$\boxed{v = \sqrt{2g\ell}}$



$0 = 2g\ell + 2(-g)(s)$

$2gs = 2g\ell$

$\boxed{S = \ell}$

Total distance $= \frac{\pi\ell}{2} + \ell$

$= \ell\left(\frac{\pi}{2} + 1\right)$

$= \frac{14}{9}\left(\frac{22}{7 \times 2} + 1\right)$

$= \frac{14}{9} \times \left(\frac{18}{7}\right)$

$\boxed{D = 4m}$

16)

$v_x = \frac{dx}{dt} = 3$

At $t = 0$, $\vec{u} = u_x\hat{i} + u_y\hat{j} = 3\hat{i} + 4\hat{j}$

$v_y = \frac{dy}{dt} = 4 - 12t$

Speed of projection = $u = \sqrt{3^2 + 4^2} = 5\ m/s$

17)

$v = \frac{dx}{dt} = 6 - 2t > 0 \Rightarrow t < 3$

So particle moves in $+x$ direction during $0 \leqslant t \leqslant 3$.

PART-B-CHEMISTRY

18) The gas which have maximum rate of diffusion will be filled first

And rate of diffusion or effusion $\propto \frac{1}{\sqrt{M}}$

so H_2 will be filled first.

so Ans. C

19)

$BOH + HCl \rightarrow BCl + H_2O$

At eq. point volume of HCl req.

$2.5 \times \frac{2}{5} = \frac{2}{15} \times V$

V = 7.5 ml

$BOH \quad + \quad HCl \quad \rightarrow \quad BCl \quad + \quad H_2O$

1 mmoles 1 mmoles 1 mmoles

× × Conc. = $\frac{1 \times 10^{-3}}{10 \times 10^{-3}} = 0.1$

$B^{\oplus} \quad + \quad H_2O \quad \rightleftharpoons \quad BOH \quad + \quad H^{\oplus}$

0.1

0.1–0.1h 0.1h 0.1h

$K_h = \frac{kw}{Kb} = \frac{(0.1h)^2}{0.1(1-h)}$

□ $10^{-2} = \frac{0.1 \times h^2}{1-h}$

$\Rightarrow \quad 10^{-2} - 10^{-2}\ h = 10^{-1}h^2$

On solving quadratic

h = 0.2701

$\Rightarrow \quad [H^{\oplus}] = 2.7\times10^{-2}$ M.

20)

pH = 14

21) $C_3H_8 \quad + \quad 5O_2 \rightarrow 3CO_2 + 4H2O$

2.2 gm $\downarrow$

$= \frac{2.2}{44}$moles $\quad (5 \times 0.05)$ moles

= 0.05 moles $\quad$ = 0.25 moles

Now apply PV = nRT for O_2

$1 \times V = 0.25 \times 0.0821 \times 273$

V = 5.6 litre

22)

$Cr_2O_7^{2\ominus} + 14H^{\oplus} + 6e^{\ominus} \longrightarrow 2Cr^{3\oplus} + 7H_2O.$

$\Rightarrow$ v.f. ($Cr_2O_7^{2\ominus}$) = 6

$\Rightarrow$ equivalent weight of $Cr_2O_7^{2\ominus} = \frac{M}{6}$

23)

$K_p = K_c (RT)^{Dn} \quad Dn = 3 - 2 = 1.$

$K_p = K_c (0.0831 \times 457)^1 . K_p > K_c.$

24) (A) $OCl_2 > SF_2$ (Due to steric crowding in OCl_2)

(B) $H_2O > OF_2$ (Due to EN of surrounding atom)

(C) $SO_4^{2-} = CF_4$ (both are regular tetrahedron)

(D) $NF_3 < NH_3$ (Due to EN of surrounding atom)

25)

$N_2 \Rightarrow$ BO = 3, $14e^{\ominus}$ Diamagnetic $\mu = 0$ non-polar

CO $\Rightarrow$ BO = 3, $14e^{\ominus}$ Diamagnetic $\mu \neq 0$ polar

$CN^- \Rightarrow$ BO = 3, $14e^{\ominus}$ Diamagnetic $\mu \neq 0$ polar

$NO^+ \Rightarrow$ BO = 3, $14e^{\ominus}$ Diamagneticamagnetic $\mu \neq 0$ polar

For homo nuclear diatomic molecule electron should be filled in the order

$\sigma_{1s}\ \sigma^*_{1s}\sigma_{2s}\ \sigma^*_{2s}\ \left(\pi_{2px} = \pi_{2py}\right) \sigma_{2pz}\ \left(\pi^*_{2px} = \pi^*_{2py}\right) \sigma^*_{2pz}$

For electrons = 14

$\sigma^2_{1s}\ \sigma^{*2}_{1s}\ \sigma^2_{2s}\ \sigma^{*2}_{2s}\ \left(\pi^2_{2px} = \pi^2_{2py}\right) \sigma^2_{2pz}$

Correct option is B and D.

26)

pH of acidic solution < 7 at 25ºC.
At half neutralisation it will be acidic buffer, pH = pKa.

27)

If addition of inert gas takes place at constant volume, equilibrium remain undisturbed.

28)

$mvr_1 = \frac{n_1h}{2\pi}$ and $mrv_2 = \frac{n_2h}{2\pi}$

$mv\,(r_2 - r_1) = (n_2 - n_1)\frac{h}{2\pi}$

$(n_2 - n_1)$ is an integer value.

29)

(A) 9 gm of water is added to 100 gm of oleum to get 109 gm H_2SO_4.

$H_2O + SO_3 \rightarrow H_2SO_4$

18 80

$9 \rightarrow 40$

 Free SO_3 = 40%

(B) 1 gm of this sample will produce 1.09 gm H_2SO_4.

 moles of $H_2SO_4 = \frac{1.09}{98}$

 moles of H^+ = moles of OH^-

$\Rightarrow \frac{1.09}{98} \times 2 = 0.5 \times \frac{V\,(ml)}{1000}$

$\Rightarrow V = 44.5$ ml [So, incorrect]

(D) 109 gm H_2SO_4 and 491 gm water.

Molality = $\frac{109 \times 1000}{98 \times 491}$

30) P final = $1 + \frac{36}{76} = \frac{112}{76}$ final height = 19cm

P initial = 1atm, initial length = hi cm

according to Boyle's Law

$P_iv_i = P_fv_f$

$= 1 \times hi.A = \frac{112}{76} \times 19A$

hi = 28cm

The length by which the Hg column shifts down = hi - hf = 28 - 19 = 9cm

31)

Balance the equation by any method

$4Zn + 10HNO_3 \rightarrow 4Zn(NO_3)_2 + 3H_2O + NH_4NO_3$

 a + b + c = 4 + 3 + 1 = 8

32)

$[\text{Pyridinium Chloride}] = \frac{0.15 \times 1000}{500} = 0.3\ M$ [Pyridine] = 0.2 M

A mixture of pyridine and its salt pyridinium chloride forms a basic buffer and therefore

$$pOH = -\log K_b + \log\frac{[\text{Salt}]}{[\text{Base}]}$$

$$pOH = -\log\left(1.5 \times 10^{-9}\right) + \log\frac{0.30}{0.20}$$

$pOH = -\log 1.5 - \log 10^{-9} + \log 1.5$

$pOH = 9$ $pH = 14 - 9$ $pH = 5$

33)

Ions in $Al_2(SO_4)_3$ = $\frac{1368}{342} \times N_A \times 5 = 20 \times N_A$

Ions in Na_3PO_4 = (n moles) $\times N_A \times 4$

$\Rightarrow n \times N_A \times 4 = 20 \times N_A \Rightarrow n = 5$ moles.

34)

(a)	PCl_3F_2	Non polar	Non planar	sp^3d
(b)	PCl_2F_3	Polar	Non planar	sp^3d
(c)	XeF_2	Non polar	Planar	sp^3d
(d)	ClF_3	Polar	Planar	sp^3d
(e)	BrF_5	Polar	Non planar	sp^3d^2
(f)	I_3^-	Non polar	Planar	sp^3d
(g)	SF_4	Polar	Non planar	sp^3d
(h)	S_3O_9	Non polar	Non planar	sp^3

only ClF_3 satisfying all three conditions.

PART-C-MATHEMATICS

35)

$$0.2^{\log_{\sqrt{5}}\left[\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+\ldots\ldots\ldots\infty\right]}$$

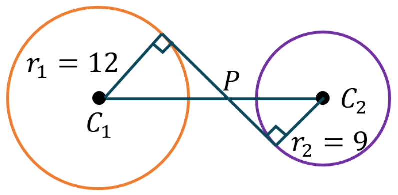
$$= 0.2^{\log_{\sqrt{5}}\left[\frac{1/4}{1-1/2}\right]}$$

$$= (0.2)^{\log_{\sqrt{5}}\left[\frac{1}{2}\right]}$$

$$= 5^{\log_{\sqrt{5}}2} = 2^2 = 4\ ]$$

36)

$$\frac{C_1P}{PC_2} = \frac{r_1}{r_2} = \frac{12}{9} = \frac{4}{3}$$



$\Rightarrow \dfrac{C_1P}{4} = \dfrac{PC_2}{3} = k$

$C_1P = 4k$, $C_2P = 3k \rightarrow C_1\,C_2 = C_1P + C_2P$

 $C_1\,C_2 = 35 = 4k + 3k$

$\Rightarrow k = 5 \Rightarrow C_1P = 4k = 20$

37)

Point $\left(t, \dfrac{1}{t}\right)$ lies on $x^2 + y^2 = 16 \Rightarrow t^2 + \dfrac{1}{t^2} = 16$

$\Rightarrow t^4 - 16t^2 + 1 = 0$ ...(i)

If roots are t_1, t_2, t_3, t_4 then

$t_1\,t_2\,t_3\,t_4 = 1$ ...(ii)

38)

Ans. (C)

$x^2 - 2cxy - 7y^2 = 0$

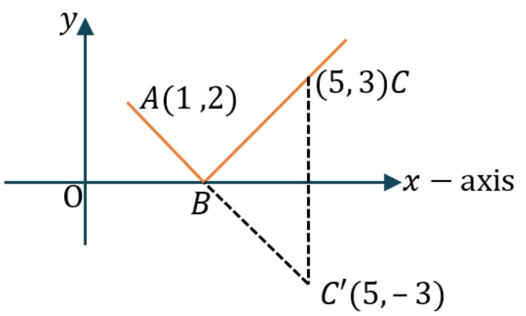
$m_1 + m_2 = 4m_1m_2$

$\Rightarrow -\dfrac{(-2c)}{-7} = 4\left(\dfrac{1}{-7}\right) \Rightarrow 2c = 4$

$c = 2$

39)

Ans. (A)



Equation of AC' is same as AB

$y + 3 = \dfrac{5}{-4}(x - 5) \Rightarrow 5x + 4y = 13$

40) $y = x^2 - 6x + 5$

$\Rightarrow y = (x - 3)^2 - 4$; $x \in [2, 4]$

* $y_{min.} = (x - 3)^2_{min.} - 4$; at $x = 3$

$\Rightarrow y_{min.} = 0 - 4$

$\Rightarrow y_{min.} = -4$

$\Rightarrow \boxed{y_{min} = -4\ ;\ \text{at } x = 3}$

* $y_{max.} = (x - 3)^2_{max.} - 4$; at x = 2 or 4

$\Rightarrow y_{max.} = 1 - 4$

$\Rightarrow \boxed{y_{max} = -3\ ;\ \text{at } x = 2 \text{ or } 4}$

41)

$S_1 : x^2 + y^2 - 6x - 6y + 9 = 0;$

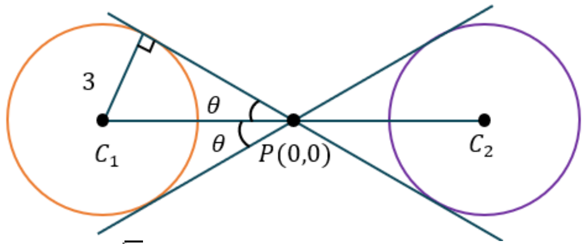
$S_2 : x^2 + y^2 + 6x + 6y + 9 = 0$

	S_1	S_2
Centre	$C_1(3,3)$	$C_2(-3,-3)$
Radius	$r_1 = 3$	$r_2 = 3$

$C_1C_2 = 6\sqrt{2};$

$r_1 + r_2 = 6;\ r_1 - r_2 = 0$

$C_1 C_2 > r_1 + r_2 \Rightarrow$ circles don't intersect



$PC_1 = 3\sqrt{2} \Rightarrow \theta = 45^\circ$

so, interior common tangents are perpendicular.

Note: Intersection point of interior common tangent divides the line joing centre of the circles internally in the ratio of radii.

42)

$a^2 - 6ab + 9b^2 = 4c^2$

$\Rightarrow (a - 3b)^2 = (2c)^2$

$\Rightarrow a - 3b - 2c = 0$ or $a - 3b + 2c = 0$

$\Rightarrow \left(-\frac{1}{2}, \frac{3}{2}\right)$ and $\left(\frac{1}{2}, -\frac{3}{2}\right)$.

43)

Case - I

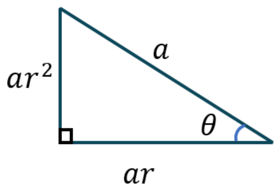
$r > 1$

$a^2 + a^2 r^2 = a^2 r^4 \Rightarrow r^4 - r^2 - 1 = 0$

$r^2 = \frac{\sqrt{5}+1}{2};\ r = \sqrt{\frac{\sqrt{5}+1}{2}}$

tangent of smallest angle = $\tan\theta = \frac{1}{r} = \sqrt{\left(\frac{2}{\sqrt{5}+1}\right)}$

Case - II



$0 < r < 1$

$a^2 = a^2 r^2 + a^2 r^4 \Rightarrow r^4 + r^2 - 1 = 0$

$r^2 = \dfrac{\sqrt{5}-1}{2}$; $r = \sqrt{\dfrac{\sqrt{5}-1}{2}}$

tangent of smallest angle = $\tan\theta = r = \sqrt{\dfrac{\sqrt{5}-1}{2}}$

44)

$5\sin^2 x + \sqrt{3}\sin x.\cos x + 6\cos^2 x = 5$

divided by $\cos^2 x$ both sides,

we have (considering $\cos^2 x \neq 0$)

$5\tan^2 x + \sqrt{3}\tan x + 6 = 5\sec^2 x$

$\Rightarrow 5\tan^2 x + \sqrt{3}\tan x + 6 = 5 + 5\tan^2 x$

$\Rightarrow \sqrt{3}\tan x = -1 \Rightarrow \tan x = \dfrac{-1}{\sqrt{3}}$

$\Rightarrow x = n\pi - \dfrac{\pi}{6}$; $n \in I$

If $\cos^2 x = 0$ Equation will be

$5(1 - \cos^2 x) + \sqrt{3}\sin x.\cos x + 6\cos^2 x = 5$

$\Rightarrow 5 = 5$ (true for $\cos^2 x = 0$)

 $\cos x = 0$

$\Rightarrow x = (2n+1)\dfrac{\pi}{2} = m\pi + \dfrac{\pi}{2};\ m \in I$

45)

$L = \dfrac{1}{2}\cos^2 84° + \cos^2 36° + \cos 36° \cos 84°$

Method-I

$L = \dfrac{1}{2}[2\cos^2 84° + 2\cos^2 36° + 2\cos 36° \cos 84°]$

$\Rightarrow L = \dfrac{1}{2}[1 + \cos 168° + 1 + \cos 72° + \cos(36° + 84°) + \cos(36° - 84°)]$

$\Rightarrow L = [2+\cos 168°+\cos 72°+\cos 120°+\cos 48°]$

Use : $2\cos^2\theta = 1 + \cos 2\theta$;

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

$\Rightarrow L = \dfrac{1}{2}\left[2 + 2\cos\left(\dfrac{168° + 72°}{2}\right)\cos\left(\dfrac{168° - 72°}{2}\right) + \cos 120° + \cos 48°\right]$

Use: $\cos C + \cos D = 2\cos\dfrac{C+D}{2}\cos\dfrac{C-D}{2}$

$= \dfrac{1}{2}\left[2 + 2 \times \left(\dfrac{-1}{2}\right)\cos 48° - \dfrac{1}{2} + \cos 48°\right] = \dfrac{3}{4} = L$

$= \dfrac{1}{2}\left[2 + 2\cos 120°.\cos 48° - \dfrac{1}{2} + \cos 48°\right]$

Method-II

$L = \cos^2 84° + 1 - \sin^2 36° + \frac{1}{2} 2\cos36°\cos84°$

$= 1 + \cos(84° + 36°)\cos(84° - 36°) + \frac{1}{2}[\cos120° + \cos48°]$

$= \frac{3}{4} + \cos120°.\cos48° + \frac{1}{2}\cos48° = \frac{3}{4}$

$L = \frac{3}{4} < 1$

$M = \cot73°.\cot47°.\cot13°$

$M = \cot(60° + 13°)\cot(60° - 13°)\cot13°$

$= \cot(3.13°) = \cot39°$

as $\cot45° < \cot39° \Rightarrow L < M$

$\tan2 < 0$

 $M > \tan2$

$N = 4\sin156°\sin84°\sin36°$

$N = 4\sin(180° - 156°)\sin84°\sin36°$

$= 4\sin24°.\sin(60° + 24°).\sin(60° - 24°)$

$= 4 \times \frac{1}{4}\sin(3 \times 24°) = \sin72° = \frac{\sqrt{5}-1}{4} > \sin45°$

$N > \sin\frac{\pi}{4}$

And; $LMN > 0$

46)

$U = \{1, 2, 3, 4, 5, 6, 7, 8\}$

$A = \{1, 2, 3, 5, 6\}$

$B = \{2, 3, 4, 7, 8\}$

$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8\} = U$

$B - A = B \cap A' = B - (A \cap B) = \{4, 7, 8\}$

$A' = U - A = \{4, 7, 8\}$

$A' \cup B = \{2, 3, 4, 7, 8\}$

$A - B = \{1, 5, 6\}$

$(A - B)' = U - (A - B) = \{2, 3, 4, 7, 8\}$

Option A, C, D are correct.

47)

According as question we can assume polynomial as

$f(x)=a(x-1)(x-2)(x-3)(x-4)+x$

In which $f(1)=1$, $f(2)=2$, $f(3)=3$, $f(4)=4$

Now $f(0)=1$ given

so $f(0)=a(-1)(-2)(-3)(-4)+0=1$

$a = \frac{1}{24}$

$f(x) = \frac{1}{24}(x-1)(x-2)(x-3)(x-4) + x$

$f(5) = \frac{1}{24}(5-1)(5-2)(5-3)(5-4) + 5$

$\Rightarrow \frac{1}{24} \times 4 \times 3 \times 2 \times 1 + 5$

$\Rightarrow 1 + 5 = 6$

48)

□ $s - a = 3$ ...(1)
and $s - c = 2$ ...(2)+
by (1) – (2), we get
$c - a = 1$
(1) + (2), we get $2s - a - c = 5 \Rightarrow b = 5$
$\because$ ΔABC is right angled at B
□ $a^2 + c^2 = 25$ ...(3)
□ $(c - a)^2 + 2ac = 25$
$ac = 12$ ...(4)
□ $a(1 + a) = 12 \Rightarrow a^2 + a - 12 = 0$
$\Rightarrow (a + 4)(a - 3) = 0$
$\Rightarrow a = 3$ and $c = 4$.

49)

If point $P(\lambda, -\lambda)$ lie inside the circle $x^2 + y^2 - 4x + 2y - 8 = 0$
□ Put $P(\lambda, -\lambda)$ in the equation of circle < 0
$\Rightarrow \lambda^2 + \lambda^2 - 4\lambda - 2\lambda - 8 < 0$
$\Rightarrow \lambda^2 - 3\lambda - 4 < 0$
$\Rightarrow (\lambda - 4)(\lambda + 1) < 0$

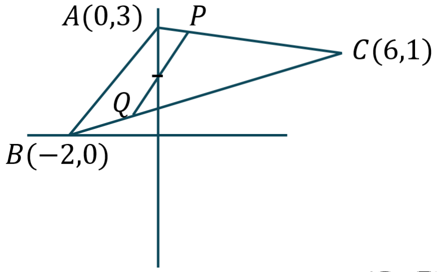
$\therefore \lambda \in (-1, 4)$

50)

$\because$ Equation of circle $(x - 2)^2 + (y + 2)^2 + \lambda(x + y) = 0$ ....(i)
$\because$ Centre lies on the x-axis
$\therefore \lambda = -4$ put in (i)
□ equation of circle is $x^2 + y^2 - 8x + 8 = 0$
(α, β) lies on it $\Rightarrow \beta^2 = -\alpha^2 + 8\alpha - 8 \geq 0$
□ greatest value of 'α' is $4 + 2\sqrt{2}$.

51)

Since $(\lambda, \lambda + 1)$ lies on $y = x + 1$
equation of $AB : 3x - 2y + 6 = 0$; $BC : x - 8y + 2 = 0$; $AC : x + 3y - 9 = 0$



Line $y = x + 1$ cuts AC at P $\left(\frac{3}{2}, \frac{5}{2}\right)$ cut BC at Q $\left(\frac{-6}{7}, \frac{1}{7}\right)$. Hence $\lambda \in \left(\frac{-6}{7}, \frac{3}{2}\right)$