PART-1 : PHYSICS

SECTION-I

1) Distance of the centre of mass of a solid uniform cone from its vertex is z_0. If the radius of its base is R and its height is h then z_0 is equal to :-

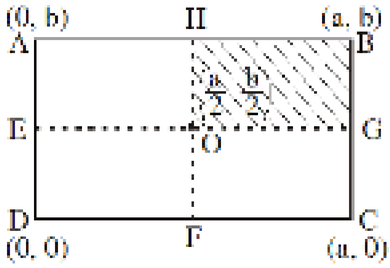
(A) $\frac{5h}{8}$

(B) $\frac{3h^2}{8R}$

(C) $\frac{h^2}{4R}$

(D) $\frac{3h}{4}$

2) A uniform rectangular thin sheet ABCD of mass M has length a and breadth b, as shown in the figure. If the shaded portion HBGO is cut-off, the coordinates of the centre of mass of the remaining portion will be :-



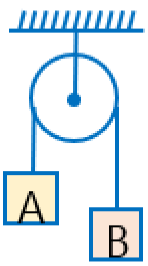
(A) $\left(\frac{2a}{3}, \frac{2b}{3}\right)$

(B) $\left(\frac{5a}{3}, \frac{5b}{3}\right)$

(C) $\left(\frac{3a}{4}, \frac{3b}{4}\right)$

(D) $\left(\frac{5a}{12}, \frac{5b}{12}\right)$

3) In the arrangement shown in the figure, m_A = 2 kg and m_B = 1 kg. String is light and inextensible.



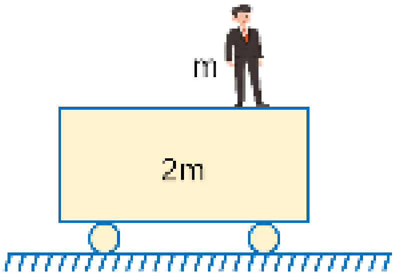
Find the acceleration of centre of mass of both the blocks. Neglect friction everywhere.

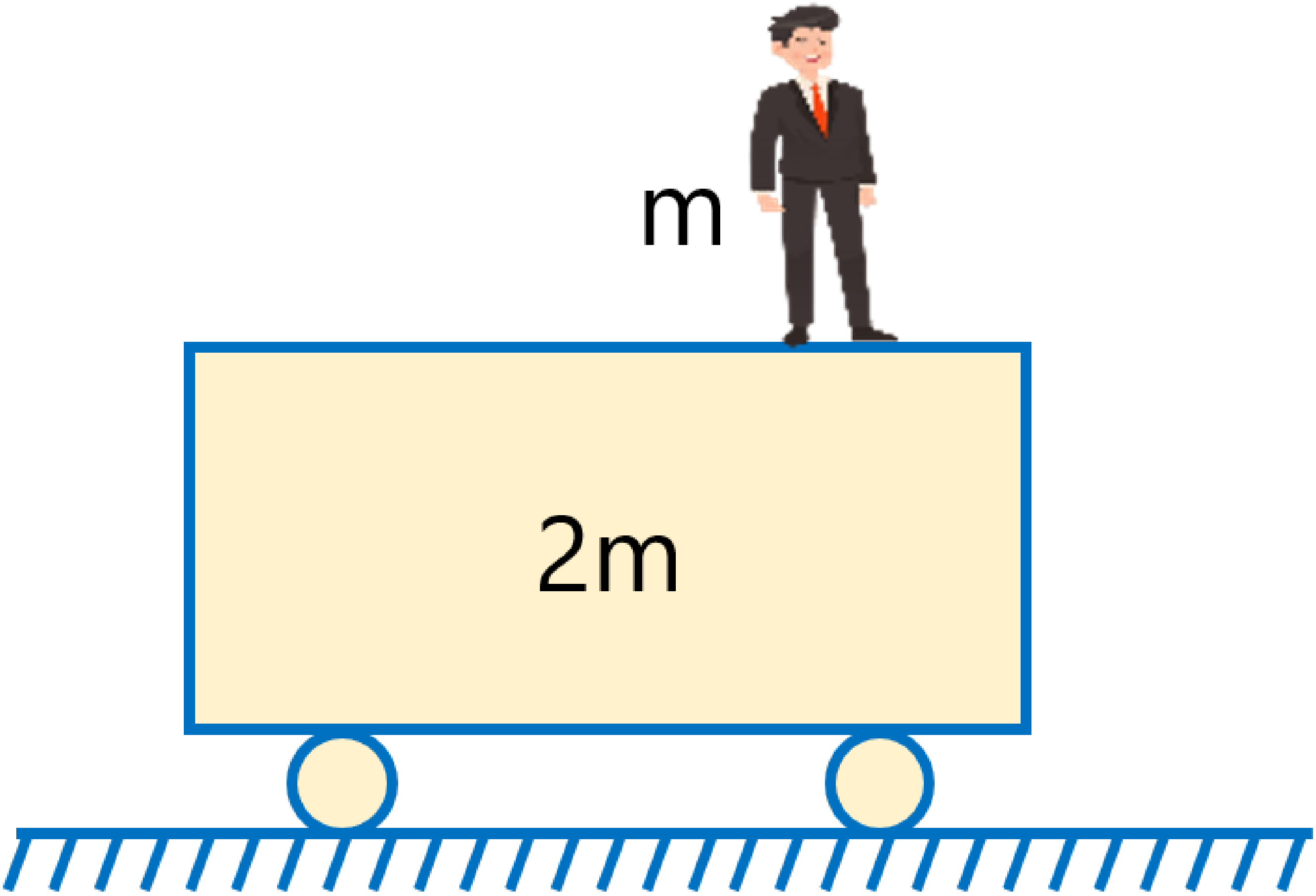
(A) g/3 downwards

(B) g/9 downwards

(C) g/3 upwards

(D) g/9 upwards

4) A man is standing on a cart of mass double the mass of man. Initially cart is at rest. Now man jumps horizontally with relative velocity 'u' with respect to cart. Then work done by internal forces of the man during the process of jumping will be : 



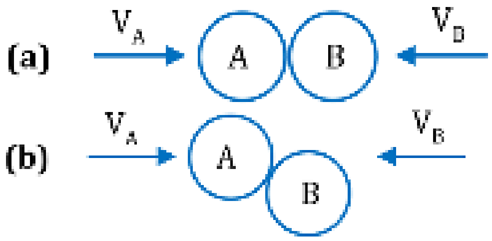
(A) $\frac{1}{2}mu^2$

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

(C) mu^2

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

5) Two bodies, A and B, collide as shown in figures a and b below. Circle the true statement :



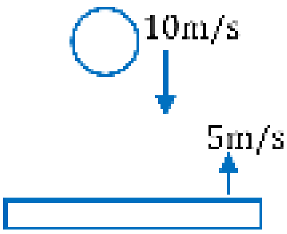
(A) They exert equal and opposite forces on each other in (a) but not in (b).

(B) They exert equal and opposite force on each other in (b) but not in (a).

(C) They exert equal and opposite force on each other in both (a) and (b).

(D) The forces are equal and opposite to each other in (a), but only the components of the forces parallel to the velocities are equal in (b).

6) A ball of mass 1kg strikes a heavy platform, elastically, moving upwards with a velocity of 5m/s. The speed of the ball just before the collision is 10m/s downwards. Then the impulse imparted by the platform on the ball is :-



(A) 15 N – s

(B) 10 N – s

(C) 20 N – s

(D) 30 N – s

7) If both the blocks as shown in the given arrangement are given together a horizontal velocity towards right. If a_{cm} be the subsequent acceleration of the centre of mass of the system of blocks then a_{cm} equals

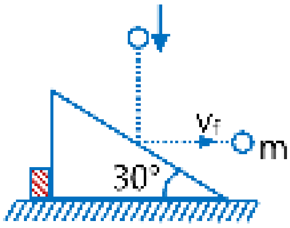
(A) 0 m/s^2

(B) $\frac{5}{3}$ m/s^2

(C) $\frac{7}{3}$ m/s^2

(D) 2 m/s^2

8) As shown in the figure a body of mass m moving vertically with speed 3 m/s hits a smooth fixed inclined plane and rebounds with a velocity v_f in the horizontal direction. If ∠ of inclined is 30°, the

velocity v_f will be 

(A) 3 m/s

(B) $\sqrt{3}$ m/s

(C) $\frac{1}{\sqrt{3}}$ms

(D) this is not possible

9) A smooth sphere is moving on a horizontal surface with a velocity vector $(2\hat{i}+2\hat{j})/s$ immediately before it hit a vertical wall. The wall is parallel to vector $\hat{j}$ and coefficient of restitution between the sphere and the wall is $e=\frac{1}{2}$. The velocity of the sphere after it hits the wall is

(A) $\hat{i}-\hat{j}$

(B) $-\hat{i}+2\hat{j}$

(C) $-\hat{i}-\hat{j}$

(D) $2\hat{i}-\hat{j}$

10) A ball of mass m hits the floor with a speed v making an angle of incidence θ = 45° with the normal to the floor. If the coefficient of restitution $e=\frac{1}{\sqrt{2}}$, then the speed of the reflected ball and the angle of reflection are :-

(A) $\frac{\sqrt{3}}{2}v, \tan^{-1}\sqrt{2}$

(B) $\frac{\sqrt{3}}{2}v, \tan^{-1}\sqrt{3}$

(C) $\frac{2\sqrt{3}}{5}v, \tan^{-1}\sqrt{3}$

(D) $\frac{\sqrt{3}}{5}v, \tan^{-1}\sqrt{2}$

11) Find position vectors of mass center of a system of three particle of masses 1 kg, 2 kg and 3 kg located at position vectors $\vec{r}_1=\left(4\hat{i}+2\hat{j}-3\hat{k}\right)$m, $\vec{r}_2=\left(\hat{i}-4\hat{j}+2\hat{k}\right)$m and $\vec{r}_3=\left(2\hat{i}-2\hat{j}+\hat{k}\right)$m respectively.

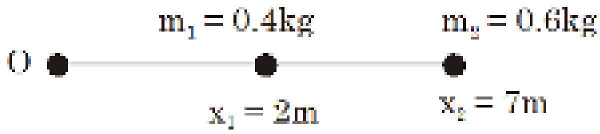
(A) $2\hat{i}-2\hat{j}+\frac{2}{3}\hat{k}$

(B) $\hat{i}-\hat{j}+\frac{2}{3}\hat{k}$

(C) $2\hat{i}+2\hat{j}-\frac{2}{3}\hat{k}$

(D) $4\hat{i} - 4\hat{j} + \frac{4}{3}\hat{k}$

12) A system consists of two masses connected by a massless rod lies along x-axis. The distance of



centre of mass from O is

(A) 2 m
(B) 3 m
(C) 5 m
(D) 7 m

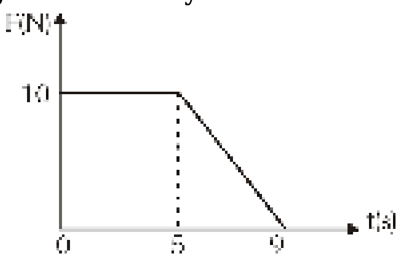
13) A 2.0 kg particle has a velocity of $\vec{v}_1 = \left(2.0\hat{i} - 3.0\hat{j}\right)$ m/s, and a 3.0 kg particle has a velocity $\vec{v}_2 = \left(1.0\hat{i} + 6.0\hat{j}\right)$ m/s. velocities of both the particles in centroidal frame are

(A) $3.4\hat{i} - 7.8\hat{j}$ & $\left(2.4\hat{i} + 2.6\hat{j}\right)$
(B) $1.6\hat{i} - 3.4\hat{j}$ & $-\left(0.4\hat{i} + 2.6\hat{j}\right)$
(C) $0.6\hat{i} - 5.4\hat{j}$ & $\left(-0.4\hat{i} + 3.6\hat{j}\right)$
(D) $0.3\hat{i} - 0.4\hat{j}$ & $-\left(0.2\hat{i} + 2.6\hat{j}\right)$

14) The figure shows the positions and velocities of two particles. If the particles move under the mutual attraction of each other, then the position of centre of mass at t =1 s is

(A) x = 5m
(B) x = 6m
(C) x = 3m
(D) x = 2m

15) A body of mass 4 kg is acted on by a force which varies as shown in the graph below. The



momentum acquired is

(A) 280 N-s
(B) 140 N-s
(C) 70 N-s

(D) 210 N–s

16) A particle of mass m is tied to a light string and rotated with a speed v along a circular path of radius r. If T = tension in the string and mg = gravitational force on the particle then the actual forces acting on the particle are :

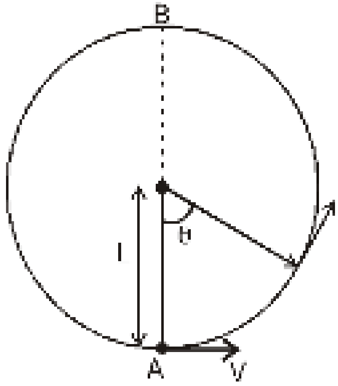
(A) mg and T only

(B) mg, T and an additional force of $\frac{mv^2}{r}$ directed inwards.

(C) mg, T and an additional force of $\frac{mv^2}{r}$ directed outwards.

(D) only a force $\frac{mv^2}{r}$ directed outwards.

17) A bob of mass M is suspended by a massless string of length L. The horizontal velocity V at position A is just sufficient to make it reach the point B. The angle θ at which the speed of the bob is



half of that at A, satisfies Figure :

(A) $\theta = \frac{\pi}{4}$

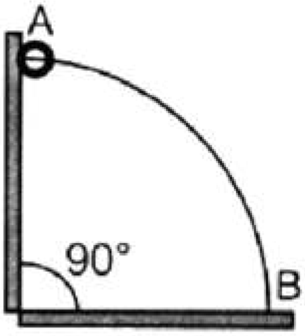
(B) $\frac{\pi}{4} < \theta < \frac{\pi}{2}$

(C) $\frac{\pi}{2} < \theta < \frac{3\pi}{4}$

(D) $\frac{3\pi}{4} < \theta < \pi$

18)

A wire, which passes through the hole in a small bead, is bent in the form of quarter of a circle. The wire is fixed vertically on ground as shown in the figure. The bead is released from near the top of the wire and it slides along the wire without friction. As the bead moves from A to B, the force it applies on the wire is–



(A) always radially outwards

(B) always radially inwards

(C) radially outwards initially and radially inwards later

(D) radially inwards initially and radially outwards later

19) A particle of mass m moving in the x direction with speed 2υ is hit by another particle of mass 2m moving in the y direction with speed υ. If the collisions perfectly inelastic , the percentage loss in the energy during the collision is close to :

(A) 56 %

(B) 62%

(C) 44%

(D) 50%

20) Velocity of a particle of mass 2 kg varies with time t according to the equation $\vec{v} = (2t\hat{i} + 4\hat{j})$ m/s. Here t is in seconds. Find the impulse imparted to the particle in the time interval from t = 0 to t = 2 s.

(A) $8\hat{i}$ N − s

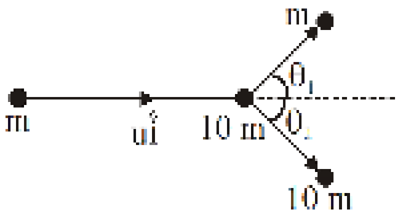
(B) $10\hat{i}$ N − s

(C) $12\hat{i}$ N − s

(D) $16\hat{i}$ N − s

SECTION-II

1) A particle of mass m is moving along the x-axis with initial velocity $u\hat{i}$. It collides elastically with a particle of mass 10 m at rest and then moves with half its initial kinetic energy (see figure). If



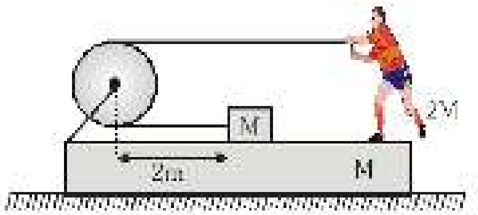
$\sin\theta_1 = \sqrt{n}\sin\theta_2$ then value of n is _______.

2) The centre of mass of a solid hemisphere of radius 8 cm is X cm from the centre of the flat surface. Then value of x is ________ .

3) Two point mass 36 g and 72 g are located at coordinates (2 cm, 0) and (5 cm, 0). The x-coordinate

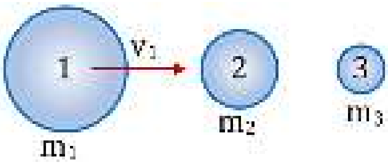
(in cm) of centre of mass will be at :

4) A block of mass M is tied to one end of a massless rope. The other end of the rope is in the hands of a man of mass 2M as shown in the figure. The block and the man are resting on a rough wedge of mass M as shown in the figure. The whole system is resting on a smooth horizontal surface. The man pulls the rope. Pulley is massless and frictionless. What is the displacement (in m) of the wedge when the block meets the pulley? (Man does not leave his position during the pull)



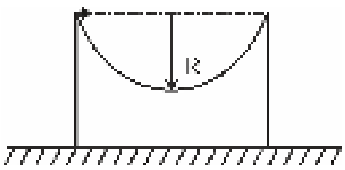
5) A block of wood of mass 9.8 kg is suspended by a string. A bullet of mass 200 gm strikes horizontally with a velocity of $100 ms^{-1}$ and gets embedded in it. The maximum height attained by the block is: ($g = 10 ms^{-2}$)

6) The centres of the spheres 1, 2 and 3 lie on a single straight line. Sphere 1 is moving with an (initial) velocity v_1 directed along this line and hits sphere 2. Sphere 2, acquiring after collision a velocity v_2, hits sphere 3. Both collisions are absolutely elastic. What must be the mass of sphere 2 (in kg) for the sphere 3 to acquire maximum velocity (The masses m_1 and m_3 of spheres 1 and 3 are 9 kg and 1kg respectively)?



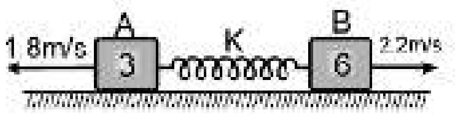
7) A block of mass 1 kg moving with a speed of $4 ms^{-1}$, collides with another block of mass 2 kg which is at rest. The lighter block comes to rest after collision. The loss in KE (in J) of the system is :-

8) A particle of mass m Released from top of wedge. Mass of wedge is 4m. All the surface assumed to be frictionless and radius of circle R = 16 meter then find speed of particle when it reach at lowest point.



9) A car with a gun mounted on it is kept on horizontal friction less surface. Total mass of car, gun and shell is 50 kg. Mass of each shell is 1 kg. If shell is fired horizontally with relative velocity 100 m/sec with respect to gun. what is the recoil speed of car after second shot ?

10) Two blocks A (3 kg) and B (6 kg) are connected by a spring of stiffness 512 N/m and placed on a smooth horizontal surface. Initially the spring is in natural length. Velocity 1.8 m/s and 2.2 m/s are imparted to A and B in opposite direction. The maximum extension of the spring will be 5α cm.

Find α. 

PART-2 : CHEMISTRY

SECTION-I

1) At 27 °C, heat of fusion of a compound is 2930 J/mol. Entropy change is

(A) 9.77 J/mol/K
(B) 10.77 J/mol/K
(C) 9.07 J/mol/K
(D) 0.977 J/mol/K

2) The reaction, $MgO(s) + C(s) \rightarrow Mg(S) + CO(g)$, for which $\Delta_r H° = + 491.1$ kJ mol^{-1} and $\Delta_r S° = 198.0$ JK^{-1} mol^{-1}, is not feasible at 298 K. Temperature above which reaction will be feasible is :-

(A) 1890.0 K
(B) 2480.3 K
(C) 2040.5 K
(D) 2380.5 K

3) The correct relationship between free energy and equilibrium constant for a reaction is

(A) $\Delta G^0 = -RT \ln K$
(B) $\Delta G^0 = RT \ln K$
(C) $\Delta G^0 = -2.303 RT \ln K$
(D) $\Delta G^0 = 2.303 RT \log K$

4) At 320 K, a gas A_2 is 20% dissociated to A(g). The standard free energy change at 320 K and 1 atm in J mol^{-1} is approximately : (R = 8.314 JK^{-1} mol^{-1}; $\ell n\, 2 = 0.693$; $\ell n\, 3 = 1.098$)

(A) 4281
(B) 4763
(C) 2068
(D) 1844

5) The purpose of addition of gypsum in the cement is -

(A) To slow down the process of setting of the cement
(B) To fasten the process of setting of the cement
(C) Not to affect the process of setting of the cement by any means
(D) None of these

6) The amount of $BaSO_4$ formed upon mixing 100 mL of 20.8% $BaCl_2$ solution with 50 mL of 9.8% H_2SO_4 solution will be :
(Ba = l37, Cl = 35.5, S=32, H = l and O = 16)

(A) 33.2 g
(B) 11.65 g
(C) 23.3 g
(D) 30.6 g

7) The oxidation number of phosphorus in $Ba(H_2PO_2)_2$ is :

(A) +3
(B) +2
(C) +1
(D) –1

8) The oxidation state of Cr in $[Cr(NH_3)_4Cl_2]^+$ is -

(A) +2
(B) +3
(C) 0
(D) +1

9) Which of the following is a redox :-

(A) $2NaAg(CN)_2 + Zn \rightarrow Na_2Zn\ (CN)_4 + 2\ Ag$
(B) $BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$
(C) $N_2O_5 + H_2O \rightarrow 2HNO_3$
(D) $AgNO_3 + KI \rightarrow AgI + KNO_3$

10) In the reaction, $xHI + yHNO_3 \rightarrow NO + I_2 + H_2O$

(A) x = 3, y = 2
(B) x = 2, y = 3
(C) x = 6, y = 2
(D) x = 6, y = 1

11) The number of mole of $KMnO_4$ that will be needed to react with one mole of sulphite ion in acidic solution is :

(A) 2/5
(B) 3/5
(C) 4/5
(D) 1

12) An element A in a compound ABD has oxidation number A^{n-}. It is oxidised by $Cr_2O_7^{2-}$ in acid

medium. In the experiment 1.68×10^{-3} moles of $K_2Cr_2O_7$ were used for 3.26×10^{-3} moles of ABD. The new oxidation number of A after oxidation is :-

(A) 3

(B) 3 – n

(C) n – 3

(D) +n3

13) 50 mL of 0.5 M oxalic acid is needed to neutralize 25 mL of sodium hydroxide solution. The amount of NaOH in 50 mL of the given sodium hydroxide solution is :

(A) 4 g

(B) 2 g

(C) 8 g

(D) 1 g

14) In the reaction, $3Mg + N_2 \rightarrow Mg_3N_2$, incorrect statement is :

(A) Mg is reduced

(B) Mg is oxidised

(C) N_2 is oxidised

(D) Both (A) and (C)

15) Which of the following equation represents a reaction that provides the heat of formation of ethane (CH_3CH_3)?

(A) $2\ C(s) + 6\ H(g) \rightarrow CH_3CH_3(g)$

(B) $2\ C(s) + 3\ H_2(g) \rightarrow CH_3CH_3(g)$

(C) $CH_2 = CH_2(g) + 2\ H_2(g) \rightarrow CH_3CH_3(g)$

(D) $CH{\equiv}CH(g) + 2\ H_2O(g) \rightarrow CH_3CH_3(g) + O_2(g)$

16) The enthalpy of formation of methane(g) at constant pressure is –18,500 cal/mol at 27°C. The enthalpy of formation at constant volume would be

(A) –19,700 cal

(B) –17,900 cal

(C) –18,498.8 cal

(D) –18,500 cal

17) Given that standard enthalpy of formation of CH_4, C_2H_4 and C_3H_8 are –17.9, 12.5, –24.8 kCal/mol. The ΔH for $CH_4 + C_2H_4 \rightarrow C_3H_8$ at standard conditions is :

(A) – 55.2 kCal

(B) – 30.2 kCal

(C) 55.2 kCal

(D) – 19.4 kCal

18) For a reversible process at equilibrium, the change in entropy may be expressed as:

(A) $\Delta S = Tq_{rev}$

(B) $\Delta S = \frac{q_{rev}}{T}$

(C) $\Delta S = \frac{T}{\Delta H}$

(D) $\Delta S = \Delta G$

19) In which of the following reactions do you expect to have a decrease in entropy?

(A) $Fe(s) \rightarrow Fe(l)$

(B) $2\ Fe(s) + 3/2\ O_2(g) \rightarrow Fe_2O_3\ (s)$

(C) $HF(l) \rightarrow HF(g)$

(D) $2\ H_2O_2(l) \rightarrow 2\ H_2O(l) + O_2(g)$

20) For which of the following processes, ΔS is negative?

(A) C(diamond) → C(graphite)

(B) $N_2(g,\ 273\ K) \rightarrow N_2(g,\ 300K)$

(C) $H_2(g) \rightarrow 2H(g)$

(D) $N_2(g,\ 1\ atm) \rightarrow N_2(g,\ 5\ atm)$

SECTION-II

1) Two ends of a rod are kept at 227ºC and 127ºC. When 2000 cal of heat flows in this rod, then the change in entropy is_____cal/k.

2) An ideal gas undergoes expansion from A(10 atm, 1 litre) to B(1 atm, 10 litre), first against 5 atm and then against 1 atm isothermally. Calculate “q” (in litre-atm)

3) What is the total number of intensive properties in the given list?
(i) Internal energy
(ii) Molar volume
(iii) Molar entropy
(iv) Volume
(v) Entropy
(vi) Density
(vii) Gibb's free energy
(viii) Boiling point
(ix) Molality
(x) Specific heat capacity

4) Calculate the work done by the system, when 40 J heat is supplied to it, the internal energy of system increase 32 J.

5) An aq. solution of 0.5M $KMnO_4$ is divided into two parts. One part of it requires 125 ml of 1.5M aq. solution of oxalate ions in acidic medium, while another part requires 270 ml of 0.5M aq. solution of iodide ions in neutral medium which are converted into I_2 only. Calculate total volume (in L) of the initial $KMnO_4$ solution.

6) 10 mL of sulphuric acid solution (specific gravity = 1.84) contains 98 % by weight of pure acid. Calculate the volume (in mL) of 2 N NaOH solution required to just neutralize the acid.

7)

How many electrons are involved in the following redox reaction ?
$Cr_2O_7^{2-} + Fe^{2+} + C_2O_4^{2-} \rightarrow Cr^{3+} + Fe^{3+} + CO_2$ (Unbalanced)

8) How many millilitres of 0.02 M $KMnO_4$ solution would be required to exactly titrate 25.00 ml of 0.2 M $Fe(NO_3)_2$ solution.

9) How many of the following alkali metals form coloured paramagnetic compound as major product on burning with excess of O_2 ? Li, Na, K, Rb, Cs

10) In the coordination compound, $K_4[Ni(CN)_6]$, the oxidation state of nickel is :

PART-3 : MATHEMATICS

SECTION-I

1) In triangle ABC, if $\cot\frac{A}{2} = \frac{b+c}{a}$, then triangle ABC must be
[Note: All symbols used have usual meaning in ΔABC.]

(A) isosceles
(B) equilateral
(C) right angled
(D) isosceles right angled

2) In a Δ ABC, A : B : C = 3 : 5 : 4.
Then $a + b + c\sqrt{2}$ is equal to

(A) 2b
(B) 2c
(C) 3b
(D) 3a

3) Angles A, B and C of a triangle ABC are in A.P.

If $\frac{b}{c} = \sqrt{\frac{3}{2}}$, then $\angle A$ is equal to

(A) $\frac{\pi}{6}$
(B) $\frac{\pi}{4}$
(C) $\frac{5\pi}{12}$
(D) $\frac{\pi}{2}$

4) In triangle *ABC* , if
$\sin^3 A + \sin^3 B + \sin^3 C = 3 \sin A . \sin B . \sin C$,
then triangle is

(A) obtuse angled
(B) right angled
(C) acute angled
(D) equilateral

5) In a triangle ABC, the sides a, b, c are roots of
$x^3 - 11x^2 + 38x - 40 = 0$. If $\sum \left(\frac{\cos A}{a}\right) = \frac{p}{q}$ then
the least value of (p + q) where p, q ∈ N is equal to

(A) 10
(B) 15
(C) 20
(D) 25

6) A circle is inscribed in a right triangle ABC, right angled at C. The circle is tangent to the segment AB at D and length of segments AD and DB are 7 and 13 respectively. Area of triangle ABC is equal to

(A) 91
(B) 96
(C) 100
(D) 104

7) The ratio of the area of n-sided regular polygon, circumscribed about a circle, to the area of the regular polygon of equal number of sides inscribed in the circle is 4 : 3. The value of n is equal to

(A) 3
(B) 6
(C) 9
(D) 10

8) If in triangle ABC, A ≡ (1,10),
circumcentre ≡ $\left(-\frac{1}{3}, \frac{2}{3}\right)$ and orthocentre ≡ $\left(\frac{11}{3}, \frac{4}{3}\right)$
then the co-ordinates of mid-point of side opposite to A is

(A) (1,–11/3)

(B) (1,5)

(C) (1,–3)

(D) (1,6)

9) Let A(2,–3) and B(–2,1) be vertices of a ΔABC. If the centroid of ΔABC moves on the line 2x + 3y = 1, then the locus of the vertex C is

(A) 2x + 3y = 9

(B) 2x –3y = 7

(C) 3x + 2y = 5

(D) 3x –2y = 3

10) Let S be the set of all triangles in the xy-plane, each having one vertex at the origin and the other two vertices lie on coordinate axes with integral coordinates. If each triangle in S has area 50 sq. units, then the number of elements in the set S is

(A) 9

(B) 18

(C) 32

(D) 36

11) Given the points A(0, 4) and B(0, –4), the equation of the locus of the point P such that |AP –BP| = 6 is

(A) $9x^2 - 7y^2 + 63 = 0$

(B) $9x^2 - 7y^2 - 63 = 0$

(C) $7x^2 - 9y^2 + 63 = 0$

(D) $7x^2 - 9y^2 - 63 = 0$

12) If x_1, y_1 are the roots of $x^2 + 8x - 20 = 0$, x_2, y_2 are the roots of $4x^2 + 32x - 57 = 0$ and x_3, y_3 are the roots of $9x^2 + 72x - 112 = 0$, then the points, (x_1, y_1), (x_2, y_2) and (x_3, y_3)

(A) are collinear

(B) form an equilateral triangle

(C) form a right angled isosceles triangle

(D) form an isosceles triangle

13)

Locus of centroid of the triangle whose vertices are (acost, asint), (bsint, –bcost) and (1, 0), where t is a parameter, is

(A) $(3x + 1)^2 + (3y)^2 = a^2 - b^2$

(B) $(3x - 1)^2 + (3y)^2 = a^2 - b^2$

(C) $(3x - 1)^2 + (3y)^2 = a^2 + b^2$

(D) $(3x + 1)^2 + (3y)^2 = a^2 + b^2$

14) If the straight lines, $ax + amy + 1 = 0$, $bx + (m + 1) by + 1 = 0$ and $cx + (m + 2)cy + 1 = 0$, $m \neq 0$ are concurrent then a,b,c are in

(A) A.P. only for m = 1

(B) A.P. for all m

(C) G.P. for all m

(D) H.P. for all m

15) In a triangle ABC, side AB has the equation
$2x + 3y = 29$ and the side AC has the equation,
$x + 2y = 16$. If the mid- point of BC is (5,6) then the equation of BC is

(A) $x - y = -1$

(B) $5x - 2y = 13$

(C) $x + y = 11$

(D) $3x - 4y = -9$

16) A straight-line L through the point (3, –2) is inclined at an angle 60° to the line $\sqrt{3}x + y = 1$. If L also intersect the x-axis, then the equation of L is

(A) $y + \sqrt{3}x + 2 - 3\sqrt{3} = 0$

(B) $y - \sqrt{3}x + 2 + 3\sqrt{3} = 0$

(C) $\sqrt{3}y - x + 3 + 2\sqrt{3} = 0$

(D) $\sqrt{3}y + x - 3 + 2\sqrt{3} = 0$

17) If a variable line drawn through the intersection of the lines $\frac{x}{3} + \frac{y}{4} = 1$ and $\frac{x}{4} + \frac{y}{3} = 1$, meets the coordinate axes at A and B, ($A \neq B$), then the locus of the midpoint of AB is

(A) $14(x + y)^2 - 97(x + y) + 168 = 0$

(B) $6xy = 7(x + y)$

(C) $7xy = 6(x + y)$

(D) $4(x + y)^2 - 28(x + y) + 49 = 0$

18) If a straight line passing through the point P(–3, 4) is such that its intercepted portion between the coordinate axes is bisected at P, then its equation is

(A) $x - y + 7 = 0$

(B) $3x - 4y + 25 = 0$

(C) $4x + 3y = 0$

(D) $4x - 3y + 24 = 0$

19) 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) $4x - 5y = -6$

20) If the image of point P(2, 3) in a line L is Q(4, 5) then, the image of point R(0, 0) in the same line is

(A) (4, 5)
(B) (2, 2)
(C) (3, 4)
(D) (7, 7)

SECTION-II

1) The sides of a triangle ABC lie on the lines $3x + 4y = 0$, $4x + 3y = 0$ and $x = 3$. Let (h, k) be the centre of circle inscribed in ΔABC. Then the value of (h + k) is

2) Number of values of m for which the lines
$x + y - 1 = 0$, $(m - 1)x + (m^2 - 7)y - 5 = 0$ &
$(m - 2)x + (2m - 5)y = 0$ are concurrent; are

3) If the line $x + 2y = k$ passes through the point which divides the line segment joining the points (1, 1) and (2, 4) in the ratio 3 : 2 internally, then k equal to

4) If the points with coordinates (a, 0) and (0, b) are equidistant from the points (1, 4) and (9, 0) then $\frac{(a-b)}{10}$ equals

5) If $(0,\alpha)$ lies inside the triangle formed by the lines
$y + 3x + 2 = 0$, $3y - 2x - 5 = 0$ and $4y + x - 14 = 0$
then sum of all the integral values of α is

6) The ratio in which the line joining points A(8, 9) and B(7, –4) is divided by x-axis is $\lambda : 1$ then λ is

7) If vertex of a triangle are (–1, 0), (–1, 3) and (0, 3). If co-ordinate of orthocenter is (a, b), then The sum of square of roots of $x^2 + ax - b = 0$ is

8) In a ΔABC (with usual notations) let a : b : c = 4 : 5 : 6 then $\frac{8r}{7R}$ is

9) In ΔABC with usual notation $(a + b)^2 = c^2 + ab$ & if maximum value of (8cosAcosB) is λ, then $\frac{\lambda}{4}$ is equal to

10) In ΔABC (with usual notations), if a = 80, b = 40 & $\angle C = \frac{\pi}{3}$, then ∠A is $\frac{2\pi}{\lambda}$. Find 'λ'.

ANSWER KEYS

PART-1 : PHYSICS

SECTION-I

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A.	**D**	**D**	**B**	**D**	**C**	**D**	**D**	**B**	**B**	**A**	**A**	**C**	**C**	**B**	**C**	**A**	**D**	**D**	**A**	**A**

SECTION-II

Q.	21	22	23	24	25	26	27	28	29	30
A.	**10.00**	**3.00**	**4.00**	**0.50**	**0.2**	**3.00**	**4.00**	**16.00**	**4.04**	**5.00**

PART-2 : CHEMISTRY

SECTION-I

Q.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A.	**A**	**B**	**A**	**A**	**A**	**B**	**C**	**B**	**A**	**C**	**A**	**B**	**A**	**D**	**B**	**B**	**D**	**B**	**B**	**D**

SECTION-II

Q.	51	52	53	54	55	56	57	58	59	60
A.	**20.00**	**13.00**	**6.00**	**8.00**	**0.24**	**184.00**	**6.00**	**50.00**	**3.00**	**2.00**

PART-3 : MATHEMATICS

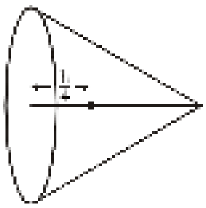
SECTION-I

Q.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
A.	**C**	**C**	**C**	**D**	**D**	**A**	**B**	**A**	**A**	**D**	**A**	**A**	**C**	**D**	**C**	**B**	**C**	**D**	**A**	**D**

SECTION-II

Q.	81	82	83	84	85	86	87	88	89	90
A.	**0.00**	**0.00**	**7.20**	**1.20**	**5.00**	**2.25**	**7.00**	**0.50**	**1.50**	**4.00**

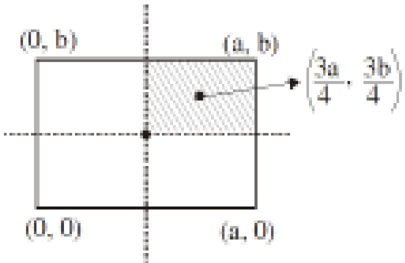
PART-1 : PHYSICS

1) 

for solid cone c.m. is $\frac{h}{4}$ from base

so $z^0 = h - \frac{h}{4} = \frac{3h}{4}$

2)

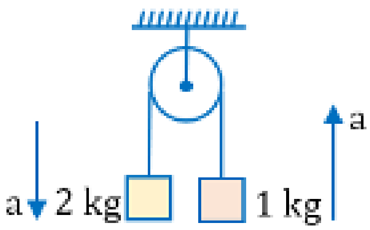


$$x = \frac{M\frac{a}{2} - \frac{M}{4} \times \frac{3a}{4}}{M - \frac{M}{4}}$$

$$= \frac{\frac{a}{2} - \frac{3a}{16}}{\frac{3}{4}} = \frac{\frac{5a}{16}}{\frac{3}{4}} = \frac{5a}{12}$$

$$y = \frac{M\frac{b}{2} - \frac{M}{4} \times \frac{3b}{4}}{M - \frac{M}{4}} = \frac{5b}{12}$$

3)



$$a = \frac{2g - 1g}{3} = g/3$$

$$a_{cm} = \frac{2a - 1 \times a}{3} = \frac{a}{3} = \frac{g}{9}$$

4)

Work done by internal forces is equal to change in kinetic energy of the system.

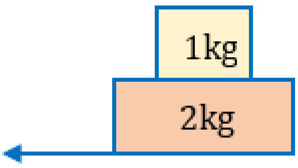
5)

Newton’s third law.

6)

Let velocity of ball after collision is V_1'
$V_1' = 2V_2 - V_1$ (V_2 is velocity of platform and V_1 is velocity of ball before collision)
$I = m(\vec{V}_1 - \vec{V}_1) = 30N - s$

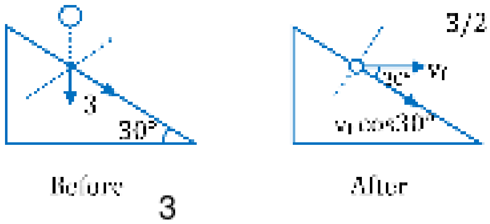
7)



$F_{ext} = f_k = \mu N = 0.2 \times 30 = 6N$

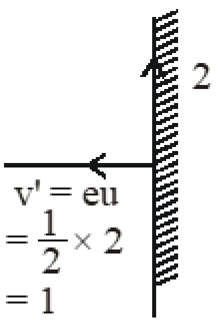
$a_{cm} = \frac{6}{3} = 2\ m/s^2$

8)



$v_f \cos 30° = \frac{3}{2} \quad \Rightarrow \quad v_f = \sqrt{3}$ m/s

9)

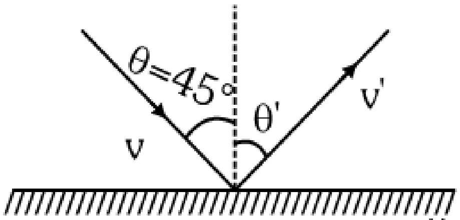


Smooth sphere $\Rightarrow f = 0 \Rightarrow v_y = 2\hat{j}\ m/s$ (unchanged)

$\vec{v}_f = -\hat{i} + 2\hat{j}$

10)

Since the floor exerts the force on the ball along the normal during collision so horizontal component of velocity remains same and only vertical component will change.



Therefore, $v' \sin \theta' = v \sin \theta = \frac{v}{\sqrt{2}}$

and $v' \cos \theta' = ev \cos \theta = \frac{1}{\sqrt{2}} v \times \frac{1}{\sqrt{2}} = \frac{v}{2}$

$\Rightarrow v'^2 = \frac{v^2}{2} + \frac{v^2}{4} = \frac{3}{4} v^2 \Rightarrow v' = \frac{\sqrt{3}}{2} v$

and $\tan \theta' = \sqrt{2} \Rightarrow \theta' = \tan^{-1} \sqrt{2}$

11)

From eq. , we have

$\vec{r}_c = \frac{\Sigma m_i \vec{r}_i}{M} \rightarrow$

$\vec{r}_c = \frac{1\left(4\hat{i} + 2\hat{j} - 3\hat{k}\right) + 2\left(\hat{i} - 4\hat{j} + 2\hat{k}\right) + 3\left(2\hat{i} - 2\hat{j} + \hat{k}\right)}{1 + 2 + 3}$

$= 2\hat{i} - 2\hat{j} + \frac{2}{3}\hat{k}$

12)

Location of com

$X_{com} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{(0.4)(2) + (0.6)(7)}{0.4 + 0.6}$

$= \frac{0.8 + 4.2}{1} = 5m$

13)

(a) Velocity of the mass center $\vec{v}_c = \frac{m_1 \vec{v}_1 + m_2 \vec{v}_2}{m_1 + m_2}$

$\vec{v}_c = \frac{m_1 \vec{v}_1 + m_2 \vec{v}_2}{m_1 + m_2} \rightarrow$

$\vec{v}_c = \frac{2\left(2.0\hat{i} - 3.0\hat{j}\right) + 3\left(1.0\hat{i} + 6.0\hat{j}\right)}{2 + 3} = \left(1.4\hat{i} + 2.4\hat{j}\right)_{m/s}$

(b) Velocity of the first particle in centroidal frame

$\vec{v}_{1/c} = \vec{v}_1 - \vec{v}_c \rightarrow$

$\vec{v}_{1/c} = \left(2.0\hat{i} - 3.0\hat{j}\right) - \left(1.4\hat{i} + 2.4\hat{j}\right) = 0.6\hat{i} - 5.4\hat{j}_{m/s}$

Velocity of the second particle in centroidal frame

$\vec{v}_{2/c} = \vec{v}_1 - \vec{v}_c \rightarrow$

$\vec{v}_{2/c} = \left(1.0\hat{i} + 6.0\hat{j}\right) - \left(1.4\hat{i} + 2.4\hat{j}\right) = -\left(0.4\hat{i} + 3.6\hat{j}\right)_{m/s}$

14)

Position of particle at t = 1 sec
1 kg mass is at x = 7m
another 1 kg max is at x = 5m

$X_{com} = \frac{1(7)+1(5)}{2} = 6$

x = 6m

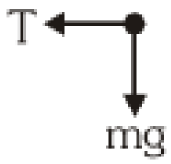
15)

Momentum acquired = Area (Δ↑)

$= 5 \times 10 + \frac{1}{2} \times 4 \times 10$

= 50 + 20 = 70 N-s

16)



Mg & T are real forces.

17) By energy conservation

$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mg\ell(1 - \cos\theta)$

$V^2 = U^2 - 2g\,(L - L\cos\theta)$

$\frac{5gL}{4} = 5gL - 2gL\,(1 - \cos\theta)$

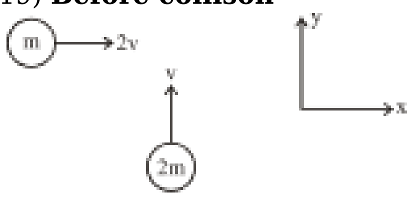
$5 = 20 - 8 + 8\cos\theta$

$\cos\theta = -\frac{7}{8}$

$\frac{3\pi}{4} < q < \pi$

18) Initially speed of bead is small hence outward centrifugal force on bead is less than radial inward component of mg. Hence force by bead on wire is radially inward.latter speed of bead is large hence outward centrifugal force on bead is greater than radial inward component of mg. Hence force by bead on wire is radially outward

19) **Before collison**



Kinetic energy = $\frac{1}{2}m(2v)^2 \times \frac{1}{2}2m(v)^2$

$= 3\,mv^2$

After collison

Applying momentum conservation for inelastic collision

$$2mv\hat{j} + m2v\hat{i} = 3m\vec{v}_f$$

$$|\vec{v}_f| = \sqrt{\frac{8}{9}}v$$

$$K_f = \frac{1}{2} \times 3m \times \left(v_f^2\right) = \frac{4mv^2}{3}$$

$$\% \Delta K = \frac{K_i - K_f}{K_i} = \frac{5mv^2/3}{3mv^2} = \frac{5}{9} = 56\%$$

20)

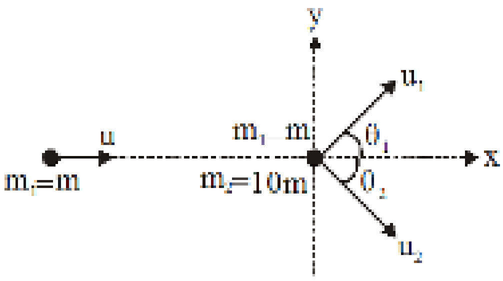
$\vec{v}_f = 4\hat{i} + 4\hat{j}$

$\vec{v}_i = 4\hat{j}$

impulse $= \Delta\vec{p} = m\Delta\vec{v}$

$= (4\hat{i} + 4\hat{j} - 4\hat{j})$

$= 8\hat{i}\ N - S$



21)

By momentum conservation along y :

$m_1u_1\sin\theta_1 = m_2u_2\sin\theta_2$

i.e. $mu_1\sin\theta_1 = 10mu_2\sin\theta_2$

$\Rightarrow \boxed{u_1 \sin\theta_1 = 10u_2 \sin\theta_2}$ .....(i)

$kf_{m_1} = \frac{1}{2}ki_{m_1}$ i.e., $\frac{1}{2}mu_1^2 = \frac{1}{2} \times \frac{1}{2}mu^2$

i.e. $\boxed{u_1 = \frac{u}{\sqrt{2}}}$ .....(ii)

Also collision is elastic : $k_i = k_f$

$$\frac{1}{2}mu^2 = \frac{1}{2}mu_1^2 + \frac{1}{2}.10m.u_2^2$$

$$\frac{1}{2}mu^2 = \frac{1}{2} \times \frac{1}{2}mu^2 + \frac{1}{2} \times 10m.u_2^2$$

$$\frac{1}{4}mu^2 = \frac{1}{2} \times 10 \times mu_2^2$$

$\boxed{u_2 = \frac{u}{\sqrt{20}}}$ ....(iii)

Putting (ii) & (iii) in (i)

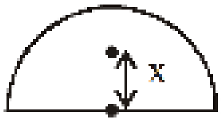
$$\frac{u}{\sqrt{2}}\sin\theta_1 = 10.\frac{u}{\sqrt{20}}\sin\theta_2$$

$\boxed{\sin\theta_1 = \sqrt{10}\sin\theta_2}$ → Hence n = 10

22)

$$x = \frac{3R}{8} = 3cm$$

x = 3



23)

Co-ordinates of com

$$X_{com} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2} = \frac{36 \times 2 + 72 \times 5}{36 + 72}$$

$$= \frac{72(1+5)}{108} = \frac{2 \times 6}{3} = 4 = 4.00$$

$$Y_{com} = \frac{m_1y_1 + m_2y_2}{m_1 + m_2} = 0$$

24)

Let the displacement will be x.

$\Sigma F_{ext} = 0$

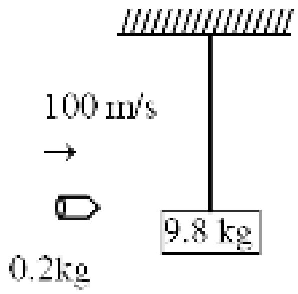
$\Delta x_{com} = 0$

$\Rightarrow m_{block}\,\Delta x_1 + m_{man}\,\Delta x_2 + m_{wedge}\,\Delta x_3 = 0$

M (x-2) + 2M (x) + Mx = 0

$$x = \frac{2M}{4M} = 0.5m$$

25)



Just Before collision

Using conservation of Linear momentum

$0.2 \times 100 + 0 = 10\,v \Rightarrow v = 2$ m/s

maximum height attained $= \dfrac{v^2}{2g} = \dfrac{(2)}{2 \times 10} = 0.2m$

26)

As $v_2 = \dfrac{2m_1}{m_1 + m_2}v_1$

$\therefore \quad v_3 = \frac{2m_2}{m_2+m_3}v_2 = \frac{4m_1m_2v}{(m_1+m_2)(m_2+m_3)}$

For maximum v_3, $\frac{dv_3}{dm_2} = 0$

$\Rightarrow m_2 = \sqrt{m_1m_3} = 3\ kg$

27)

Using conservation of linear momentum

$1 \times 4 + 0 = 1 \times 0 + 2 \times v$

$v = 2$m/s

Loss in k.e. of system = K.E.i – K.E.f

$= \frac{1}{2} \times 1 \times (4)^2 - \frac{1}{2} \times 2 \times (2)^2$

$= 8 - 4$

$= 4$ J

28) When particle reach at bottom.

From momentum conservation :

$mv_1 = 4mv_2$

$(v_1 = 4v_2)$

From energy conservation :

$mgR = \frac{1}{2}mv_1^2 + \frac{1}{2}4mv_2^2$

$gR = \frac{1}{2}v_1^2 + 2\left(\frac{v_1}{4}\right)^2$

$10 \times 16 = \frac{v_1^2}{2} + \frac{v_1^2}{8} = \frac{5v_1^2}{8}$

$v_1^2 = \frac{160}{5} \times 8 = 256$

$v_1 = 16$ m/s.

29) $100\left(\frac{1}{49} + \frac{1}{50}\right) = 4.04$ m/s

30) $\frac{1}{2}\mu V_{rel}^2 = \frac{1}{2}kx^2; \quad \mu = \frac{m_1 m_2}{m_1+m_2}$

$\frac{1}{2} \times \frac{3\times 6}{9} \times (1.8+2.2)^2 = \frac{1}{2} \times 512 \times x^2$

$x = \frac{1}{4}m = 25$ cm

8.5 Solution :→ $\frac{1}{2}\mu V_{rel}^2 = \frac{1}{2}kx^2$; $\mu = \frac{m_1 m_2}{m_1+m_2}$

$\cancel{\frac{1}{2}} \times \frac{3\times 6}{9} \times (1.8+2.2)^2 = \cancel{\frac{1}{2}} \times 512 \times x^2$

$x = \frac{1}{4}m = 25cm$

PART-2 : CHEMISTRY

32)

At equilibrium,

$T_{eq} = \frac{\Delta H}{\Delta S} = \frac{491.1 \times 1000}{198}$

= 2480.3 K

34)

Given that, $A_2 \rightleftharpoons 2A$

Initially, suppose $[A_2]$ = 1M and [A] = 0M

After 20% dissociation, 80% of A_2 will remain

$[A_2]$ = 0.8 M

The equilibrium constant

$K = \frac{[A]^2}{[A_2]} = \frac{[0.4]^2}{[0.8]} = 0.2$

$\Delta G° = -RT\ln K = -8.314 \times 320 \times \ln 0.2 = 4281$ J/mol

35)

The process of setting of the cement can be slowed down by addition of gypsum.

36)

$BaCl_2 \quad + \quad H_2SO_4 \rightarrow BaSO_4 + 2HCl$

$\frac{20.8}{100} \times 100 \qquad 50 \times \frac{9.8}{100}$

20.8 g $\qquad$ 4.9 gm

mol $\frac{20.8}{208} \qquad \frac{4.9}{98}$

mol 0.1 $\qquad$ .05 (L.R)

↓

0 $\quad$ .05 mol

= .05 × 238 = 11.65 gm

37) Fact

38)

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

39)

In this oxidation number of N is changing

40)

$xHI + yHNO_3 \longrightarrow NO + I_2 + H_2O$

$$\begin{bmatrix} (2I^- \rightarrow I_2 + 2e) \times 3 \\ (\overset{+5}{N}O_3^- + 3C \rightarrow \overset{+2}{N}O) \times 2 \end{bmatrix} \begin{matrix} .....(1) \\ .....(2) \end{matrix}$$

Adding (1) and (2)
$\Rightarrow 6I^- + 2NO_3^- \longrightarrow 2NO + 3I_2$
$6HI + 2HNO_3 \longrightarrow 2NO + 3I_2 + 4H_2O$
$\Rightarrow x = 6\ ,\ \ y = 2$

41)

$2KMnO_4 + 5SO_4^{-2} \rightarrow 2Mn^{2+} + 5SO_4^{2-}$

42)

n-factor of $K_2Cr_2O_7$ in acidic medium = 6.
$6 \times 1.68 \times 10^{-3} = x \times 3.26 \times 10^{-3}$
$x = 3$

43) $H_2C_2O_4 + 2NaOH \rightarrow Na_2C_2O_4 + 2H_2O$
m_{eq} of $H_2C_2O_4$ = m_{eq} NaOH
$50 \times 0.5 \times 2 = 25 \times M_{NaOH} \times 1$
∴ $M_{NaOH} = 2$ M
Now 1000 ml solution = 2×40 gram NaOH
∴ 50 ml solution = 4 gram NaOH

44)

Electronegative atom (N) is added to Mg & electropositive atom (Mg) is added to N_2.

45)

$2\ C(s) + 3\ H_2(g) \rightarrow CH_3CH_3(g)$
1 mole of C_2H_6 is formed from elements in their stable standard state.

47)

$CH_4 + C_2H_4 \rightarrow C_3H_8 : \Delta_rH°$
$\Delta_rH° = \Delta_fH°(C_3H_8) - [(\Delta_fH°(CH_4) + \Delta_fH°(C_2H_4)]$

$= -24.8 - [-17.9 + 12.5]$
$= -19.4$ kCal

48)

For reversible process at equilibrium $\Delta S = \frac{q_{rev}}{T}$

49)

(1) $S \rightarrow l$ entropy increases
(2) $\Delta n_g < 0$ entropy decreases
(3) $l \rightarrow g$ entropy increases
(4) $\Delta n_g > 0$ entropy increases

50)

In option (4) pressure is increased so randomness decrease, so ΔS is negative.

51) $\Delta s = \frac{2000}{100} = 20$

52)

$\Delta U = q + w$
$q = -w$
$w_1 = -5(2 - 1) = -5$
$w_2 = -1(10 - 2) = -8$
$q = -(w_1 + w_2)$
$= 13$

53) (ii), (iii), (vi), (viii), (ix) and (x)

54)

$\Delta U = q + W$
$q = 40J, \Delta U = 32J, W = ?$
$W = 32 - 40 = -8J$
–ve sign for the work done by the system.

55) $KMnO_4(0.5M)\ (V\ mL) \xrightarrow{\text{Acidic medium}} X\ mL$
$n_f = 5$
$5 \times x \times 0.5 = 1.5 \times 125 \times 2$
$x = 150$ mL
$KMnO_4(0.5M)\ (V\ mL) \xrightarrow{\text{Neutral medium}} Y\ mL$
$n_f = 3$
$3 \times x \times 0.5 = 0.5 \times 270 \times 1$
$y = 90$ mL

Total volume of $KMnO_4$ = 240 mL = 0.24 L

56) $1.84 \times 10 \times \frac{98}{100} \times \frac{1}{98} \times 2$
$= 2 \times V$
$V = 0.184$ L

57) $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{+3} + 7H_2O$ (4)

58)
$V_{KMnO4} = (25\text{mL})(0.2/0.1) = 50.00$ mL

59)

K, Rb, Cs form superoxide.

PART-3 : MATHEMATICS

61)

Given $\cot\frac{A}{2} = \frac{b+c}{a}$
From sine rule :
b = ksinB, c = ksinC & a = ksinA
$\cot\frac{A}{2} = \frac{k(\sin B + \sin C)}{k \sin A}$
$\frac{\cos A/2}{\sin A/2} = \frac{2\sin\left(\frac{B+C}{2}\right).\cos\left(\frac{B-C}{2}\right)}{2\sin\frac{A}{2}.\cos\frac{A}{2}}$
($\because$ B + C = π – A)
$2\cos^2\frac{A}{2} = 2\sin\left(\frac{\pi - A}{2}\right)\cos\left(\frac{B-C}{2}\right)$
$\cos^2\frac{A}{2} = \cos\frac{A}{2}\cos\left(\frac{B-C}{2}\right)$
$\Rightarrow \cos\frac{A}{2} = \cos\left(\frac{B-C}{2}\right)$
⇒ A = B – C ⇒ A + C = B
$\because$ A + B + C = 180°
⇒ 2B = 180° ⇒ B = 90°

62)

$\because A : B : C = 3 : 5 : 4$ $\therefore A = 45°, B = 75°, C = 60°$
Δ from Sine - rule
$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} = k \Rightarrow \frac{a}{\frac{1}{\sqrt{2}}} = \frac{b}{\frac{\sqrt{3}+1}{2\sqrt{2}}} = \frac{c}{\frac{\sqrt{3}}{2}} = k$ ($\because$ sin 75° = sin(45° + 30°))

Δ a = $\frac{k}{\sqrt{2}}$, b $\left(\frac{\sqrt{3}+1}{2\sqrt{2}}\right)$ k and c = $\frac{k\sqrt{3}}{2}$

a + b + c $\sqrt{2}$ = $\frac{k}{\sqrt{2}} + \left(\frac{\sqrt{3}+1}{2\sqrt{2}}\right)k + \left(\frac{k\sqrt{3}}{2}\right)\sqrt{2} = \frac{k}{2\sqrt{2}}\left[2+(\sqrt{3}+1)+2\sqrt{3}\right] = \frac{3k(\sqrt{3}+1)}{2\sqrt{2}}$ = 3b

63)

□ Angles A, B, C are in A.P.
⇒ 2B = A + C ...(1)
□ In a triangle A + B + C = 180° ...(2)
from (1) & (2) ⇒ 3B = 180° ⇒ $\boxed{B = 60^\circ}$
from sine rule

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

□ $\frac{b}{c} = \sqrt{\frac{3}{2}} \Rightarrow \frac{\sin B}{\sin C} = \sqrt{\frac{3}{2}}$

$\Rightarrow \frac{\sqrt{3}}{2\sin C} = \sqrt{\frac{3}{2}}$ (□ B = 60°)

$\Rightarrow \sin C = \frac{1}{\sqrt{2}} \Rightarrow \angle C = \frac{\pi}{4}$

□ A + B + C = π

$\Rightarrow A + \frac{\pi}{3} + \frac{\pi}{4} = \pi$

$\Rightarrow \angle A = \frac{5\pi}{12}$

64)

$\sin^3 A + \sin^3 B + \sin^3 C$ = 3sinAsinBsinC
property if $a^3 + b^3 + c^3 = 3abc$ then
a + b + c = 0 or a = b = c
⇒ sinA + sinB + sinC = 0 OR sinA = sinB = sinC
⇒ sinA + sinB + sinC = 0 OR A = B = C = 60°

$\Rightarrow 4\cos\frac{A}{2}\cos\frac{B}{2}\cos\frac{C}{2} = 0$

A or B or C = π (Not possible)

65)

a + b + c = 11
$\sum ab = 38$
abc = 40

$$\sum\frac{\cos A}{a} = \frac{\cos A}{a} + \frac{\cos B}{b} + \frac{\cos C}{c}$$

$$= \frac{b^2+c^2-a^2}{2abc} + \frac{a^2+c^2-b^2}{2abc} + \frac{a^2+b^2-c^2}{2abc}$$

$$= \frac{a^2+b^2+c^2}{2abc} = \frac{(a+b+c)^2 - 2\sum ab}{2abc}$$

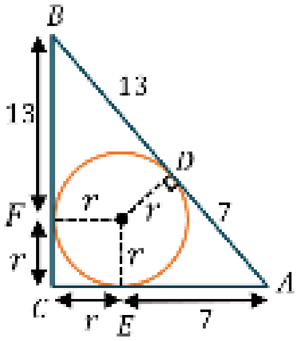
$= \frac{121-76}{80} = \frac{45}{80} = \frac{9}{16} = \frac{p}{q}$

p + q = 9 + 16 = 25.

66)

V.Imp. :

BF = BD = 13



AE = AD = 7

let CE = CF = r

Area of ΔABC

$= \frac{1}{2} AC \times BC$

$= \frac{1}{2} (7 + r)(13 + r)$

ar ΔABC $= \frac{1}{2} [r^2 + 20r + 91]$ ...(1)

Also $(r + 7)^2 + (13 + r)^2 = 20^2$

$2r^2 + 40r + 218 = 400$

$2r^2 + 40r = 182$

$r^2 + 20r = 91$

Put (2) in (1) ...(2)

arΔABC $= \frac{1}{2} [91 + 91] = 91$

67)

$\frac{\text{Area of regular polygon circumscribed}}{\text{Area of regular polygon inscribed}} = \frac{nr^2 \tan\frac{\pi}{n}}{\frac{1}{2}nr^2 \sin\frac{2\pi}{n}}$

$\Rightarrow \frac{2\tan\frac{\pi}{n}}{\sin\frac{2\pi}{n}} = \frac{4}{3}$

$\Rightarrow \cos^2\frac{\pi}{n} = \frac{3}{4}$

$\Rightarrow \frac{\pi}{n} = \frac{\pi}{6}$

$\Rightarrow \boxed{n = 6}$

68)

Let it be (a, b)

$\frac{2a+1}{3} = \frac{-\frac{2}{3}+\frac{11}{3}}{3} \Rightarrow a = 1$

$\frac{2b+10}{3} = \frac{\frac{4}{3}+\frac{4}{3}}{3}$

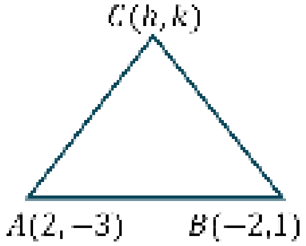
$\Rightarrow b = -\frac{11}{3}$

69)

Centroid $\equiv \left(\frac{h}{3}, \frac{k-2}{3}\right)$

Lies on line $2x + 3y = 1$

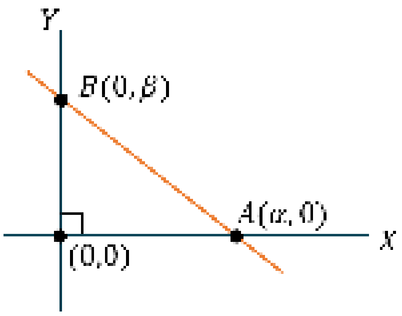
So, $\frac{2h}{3} + \frac{3(k-2)}{3} = 1$



$\Rightarrow 2h + 3k = 9$

$\Rightarrow 2x + 3y = 9$

70)



Let A(α,0) and B(0,β) be the vertices of the given triangle AOB

$\Rightarrow |\alpha\beta| = 100$

$\Rightarrow$ Number of triangles = 4 × (number of divisors of 100)

= 4 × 9 = 36

71)

$\left|\sqrt{x^2+(y-4)^2} - \sqrt{x^2+(y+4)^2}\right| = 6$

$2x^2+2y^2+32+2\sqrt{(x^2+(y-4)^2(x^2+(y+4)^2} = 36$

$\Rightarrow x^4 + x^2\,[2y^2 + 32] + (y^2 - 16)^2 = [2 - x^2 - y^2]^2$

$\Rightarrow x^4 + y^4 + 2x^2y^2 + 32x^2 - 32y^2 + 256$

$= 4 + x^4 + y^4 + 2x^2y^2 - 4x^2 - 4y^2$

$36x^2 - 28y^2 + 252 = 0$

$9x^2 - 7y^2 + 63 = 0$

72)

$x_1 + y_1 = -8$, $x_2 + y_2 = -8$, $x_3 + y_3 = -8$
Now Area of Δ formed by points
(x_1, y_1), (x_2, y_2), (x_3, y_3)

$$\Delta = \frac{1}{2}\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} = \frac{1}{2}\begin{vmatrix} x_1+y_1 & y_1 & 1 \\ x_2+y_2 & y_2 & 1 \\ x_3+y_3 & y_3 & 1 \end{vmatrix}$$

$$= \frac{1}{2}(-8)\begin{vmatrix} 1 & y_1 & 1 \\ 1 & y_2 & 1 \\ 1 & y_3 & 1 \end{vmatrix} = 0$$

 Points are collinear ⇒ hence option (A)

73) Let the locus of centroid be (h, K)
⇒ 3h = acost + bsint + 1 ; 3K = asint – bcost + 0
⇒ acost + bsint = 3h – 1 ...(1)
asint – bcost = 3K ...(2)
Now $(1)^2 + (2)^2$
⇒ $a^2 + b^2 = (3h - 1)^2 + (3K)^2$
⇒ locus : $(3x - 1)^2 + (3y)^2 = a^2 + b^2$

74)

$$\begin{vmatrix} a & am & 1 \\ b & mb+b & 1 \\ c & mc+2c & 1 \end{vmatrix} = 0$$

$C_2 \to C_2 - mC_1$

$$\Rightarrow \begin{vmatrix} a & 0 & 1 \\ b & b & 1 \\ c & 2c & 1 \end{vmatrix} = 0$$

a(b –2c) +1(2bc –bc) = 0
ab + bc = 2ac

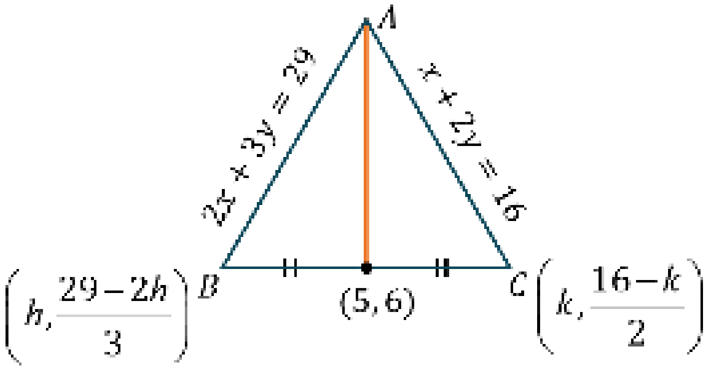
$$\Rightarrow \frac{2}{b} = \frac{1}{a} + \frac{1}{c}$$

75)

Let $B \equiv \left(h, \frac{29-2h}{3}\right)$ & $C \equiv \left(k, \frac{16-k}{2}\right)$

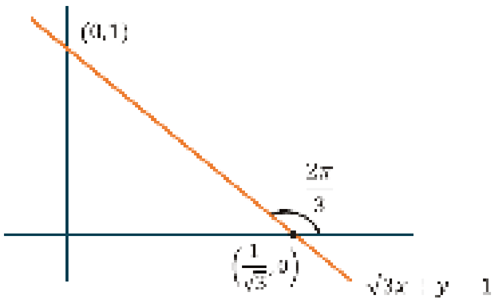
h + k = 10 & $\frac{29-2h}{3} + \frac{16-k}{2} = 12$

⇒ h = 4 & k = 6



B ≡ (4, 7) & C ≡ (6, 5)
Equation of BC ⇒ y –5 = –1(x –6)
⇒ x + y = 11

76)

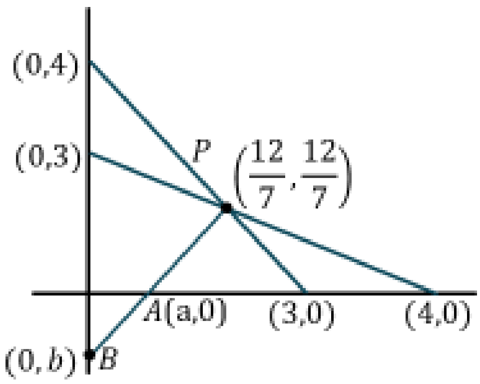


Line L has two possible slopes with inclination ; $\theta = \frac{\pi}{3}$, θ = 0

∴ equation of line L when $\theta = \frac{\pi}{3}$, $y + 2 = \sqrt{3}(x - 3)$, ⇒ $y - \sqrt{3}x + 2 + 3\sqrt{3} = 0$
equation of line L when θ = 0, y = –2 (rejected)
∴ required line L is y – $\sqrt{3}x$ + 2 + $3\sqrt{3}$ = 0

77)

Ans. (C)



Point of intersection of given line is $P\left(\frac{12}{7}, \frac{12}{7}\right)$
Equation of line *AB*
$\frac{x}{a} + \frac{y}{b} = 1$
It passes through P

$\therefore \dfrac{b+a}{ab} = \dfrac{7}{12}$

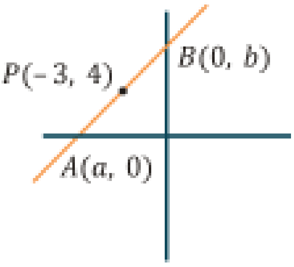
$a + b = \dfrac{7ab}{12} \Rightarrow 2\left(\dfrac{a}{2} + \dfrac{b}{2}\right) = \dfrac{4.7}{12}\left(\dfrac{a}{2}\dfrac{b}{2}\right)$

locus of mid point of *AB* in $x + y = \dfrac{7}{6}xy \Rightarrow 6(x + y) = 7xy$

78)

Let the line be $\dfrac{x}{a} + \dfrac{y}{b} = 1$

$(-3, 4) = \left(\dfrac{a}{2}, \dfrac{b}{2}\right)$

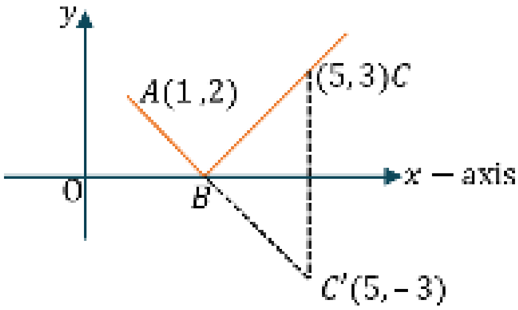


a = –6, b = 8

equation of line is 4x – 3y + 24 = 0

79)

Ans. (A)



Equation of *AC*' is same as *AB*

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

80)

Ans. (D)

Line PQ ⊥ Line L

∵ slope of line L = –1

mid-point of PQ is (3, 4) will lie on line L

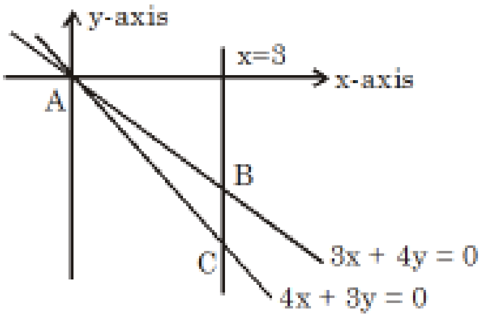
So, equation of line L is

(y – 4) = –(x – 3) ...(i)

Now image of point R(0, 0) in line L

$$\frac{x-0}{1}=\frac{y-0}{1}=\frac{-2(0+0-7)}{1+1}$$

x = 7, y = 7



81)

Equation of angle bisector of angle A is

$$\frac{3x+4y}{5}=\pm\frac{4x+3y}{5} \Rightarrow x=\pm y$$

⇒ Equation of angle bisector of A is y = –x

$\therefore$ (h, k) lies on it so h + k = 0

82)

$$\begin{vmatrix} 1 & 1 & -1 \\ m-1 & m^2-7 & -5 \\ m-2 & 2m-5 & 0 \end{vmatrix}=0$$

$m^3 - 4m^2 + 5m - 6 = 0$

$(m^2 - m + 2)(m - 3) = 0$

D < 0 of $m^2 - m + 2 = 0$

so, m = 3, but

at m = 3 lines are parellel , so no. of values of m is zero.

83)

$$\alpha=\frac{3\times 2+2\times 1}{3+2}=\frac{8}{5}$$

$$\beta=\frac{3\times 4+2\times 1}{3+2}=\frac{14}{5}$$

$\left(\frac{8}{5},\frac{14}{5}\right)$ lies on line x + 2y = k

$\therefore \frac{8}{5}+\frac{28}{5}=k$

$k=\frac{36}{5}=7.2$

84)

$(a - 1)^2 + 16 = (a - 9)^2$

$a^2 - 2a + 1 + 16 = a^2 + 81 - 18a$

$16a = 64 \Rightarrow \quad a = 4$

$(b - 4)^2 + 1 = 81 + b^2$

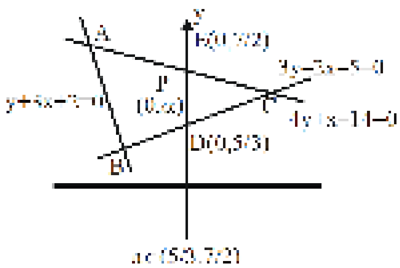
$\Rightarrow b^2 - 8b + 17 = 81 + b^2$

$\Rightarrow 8b = -64$

$\Rightarrow b = -8$

□ $a - b = 12$ ans.

85)



86)

$$P = \left(\frac{7\lambda + 8}{\lambda + 1}, \frac{-4\lambda + 9}{\lambda + 1}\right)$$

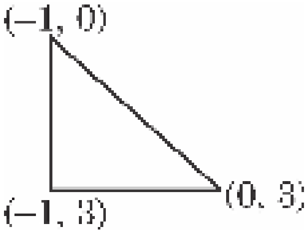
P is on x-axis

hence

$$\frac{9 - 4\lambda}{\lambda + 1} = 0$$

$$\lambda = \frac{9}{4} = 2.25$$

87)



Orthocenter (–1, 3) = (a, b)

a = –1, b = 3

88)

$$\frac{r}{R} = \frac{\Delta}{s.\frac{abc}{4\Delta}} = \frac{4\Delta^2}{s \cdot abc}$$

$$= \frac{4(s-a)(s-b)(s-c)}{abc}$$

$$s = \frac{15\lambda}{2} \Rightarrow \frac{4\left(\frac{15\lambda}{2} - 4\lambda\right)\left(\frac{15\lambda}{2} - 5\lambda\right)\left(\frac{15\lambda}{2} - 6\lambda\right)}{(4\lambda)(5\lambda)(6\lambda)}$$

$$= \frac{4 \cdot 7 \cdot 5 \cdot 3}{8 \cdot 4 \cdot 5 \cdot 6} = \frac{35}{80} = \frac{7}{16}$$

89)

$a^2 + b^2 + 2ab - c^2 - ab = 0$

$a^2 + b^2 - c^2 = - ab$

$$\frac{a^2+b^2-c^2}{2ab} = -\frac{1}{2}$$

$$\Rightarrow \begin{cases} \cos C = -\frac{1}{2} \\ \angle C = 120^\circ \Rightarrow A + B = 60^\circ \end{cases}$$

Now, $4(2\cos A \cos B) = 4\{\cos(A + B) + \cos(A - B)\}$

$$= 4\left\{\frac{1}{2} + \cos(A-B)\right\} = 2 + 4\cos(A-B)$$

$$\leqslant 2 + 4 = 6 = '\lambda'$$

$$\therefore \frac{\lambda}{4} = \frac{6}{4} = 1.50$$

$$\because \begin{cases} -1 \leqslant \cos(A-B) \leqslant 1 \\ \cos(A-B) = 1 = \cos 0^\circ \\ \text{so, } \angle A = \angle B = 30^\circ \end{cases}$$

90) $\tan\frac{A-B}{2} = \frac{a-b}{a+b}\cot\frac{C}{2}$

$\Rightarrow \tan\frac{A-B}{2} = \frac{40}{120}\cot\frac{\pi}{6} = \frac{1}{\sqrt{3}}$

$\Rightarrow A - B = \frac{\pi}{3}$ & $A + B = \pi - C = \frac{2\pi}{3}$

$\Rightarrow A = \frac{\pi}{2}$ & $B = \frac{\pi}{6}$