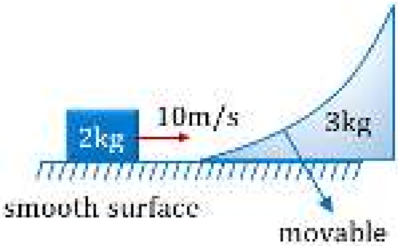
PART-A-PHYSICS

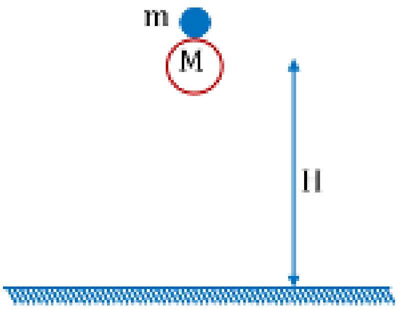
SECTION-I(i)

1) Block of mass "2 kg" is moving with 10 m/s. Later on "2 kg" block climbs on the wedge having mass of 3 kg placed on smooth surface as shown in figure. Find work done by the normal force acting by the block on the wedge till 2 kg block comes to rest with respect to wedge.:



(A) 0 joule
(B) 12 joule
(C) –8 joule
(D) 24 joule

2) A small ball of mass m is placed on a super ball of mass M and the two balls are dropped from height H (H is very large compared to radius of balls). How high (in m) does small ball rise after collision? All collisions are head on elastic and (m << M). (H = 1 m and g = 10 m/s^2)



(A) 3
(B) 9
(C) 11
(D) 15

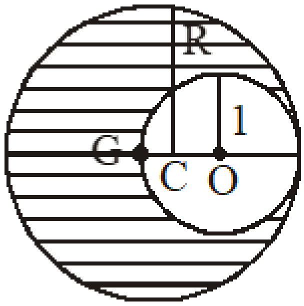
3) Three identical particles moving with velocities $v_0\hat{i}$, $-3v_0\hat{j}$ and $5v_0\hat{k}$ collide successively with each other in such a way that they form a single particle. The velocity of resultant particle in i, j, k form is

(A) $v_0\left(\hat{i}-3\hat{j}+5\hat{k}\right)$
(B) $\frac{v_0}{3}\left(\hat{i}-3\hat{j}+5\hat{k}\right)$

(C) $\frac{v_0}{2}\left(\hat{i}-3\hat{j}+5\hat{k}\right)$

(D) $\frac{v_0}{3}\left(\hat{i}+3\hat{j}+5\hat{k}\right)$

4) As shown in figure, when a spherical cavity (centred at O) of radius 1 is cut out of a uniform sphere of radius R (centred at C), the centre of mass of remaining (shaded) part of sphere is at G, i.e,



on the surface of the cavity. R can be determined by the equation :

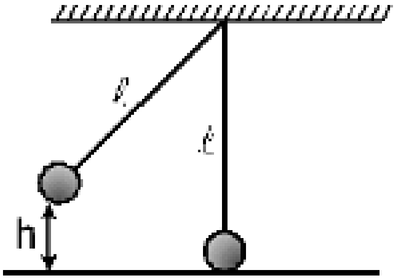
(A) $(R^2 - R + 1)(2 - R) = 1$

(B) $(R^2 + R - 1)(2 - R) = 1$

(C) $(R^2 + R + 1)(2 - R) = 1$

(D) $(R^2 - R - 1)(2 - R) = 1$

5) In the arrangement shown, the pendulum on the left is pulled aside. It is then released and allowed to collide with other pendulum which is at rest. A perfectly inelastic collision occurs and the system rises to a height 1/4 h. The ratio of the masses of the pendulum is :



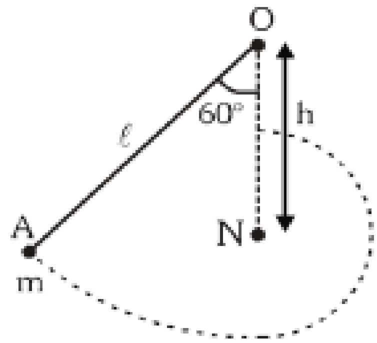
(A) 1

(B) 2

(C) 3

(D) 4

6) A particle of mass m attached to the end of string of length ℓ is released from the initial position A as shown in the figure. The particle moves in a vertical circular path about O. When it is vertically below O, the string makes contact with nail N placed directly below O at distance h and rotates



around it. If the particle just complete the vertical circle about N, then

(A) $h = \frac{3\ell}{5}$

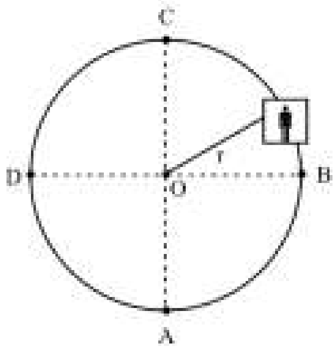
(B) $h = \frac{2\ell}{5}$

(C) $h = \frac{\ell}{5}$

(D) $h = \frac{4\ell}{5}$

SECTION-I(ii)

1) A machine, in an amusement park, consists of a cage at the end of one arm, hinged at O. The cage revolves along a vertical circle of radius r about its hinge O with constant linear speed v = $\sqrt{gr}$. The cage is so attached that the man of weight 'w' standing on a weighing machine, inside the cage, is



always vertical. Then :

(A) The weight reading at A is greater than the weight reading at C by 2w.

(B) The weight reading at D = w

(C) The ratio of the weight reading at C to that at A = 0

(D) The ratio of the weight reading at A to that at B = 2

2) A particle of mass 4m which is at rest explodes into three fragments. Two of the fragments each of mass m are found to move with a speed v each in mutually perpendicular directions along x and y axis.

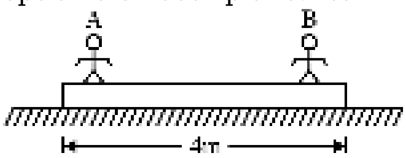
(A) Magnitude of x component of momentum of 2m after the explosion is mv

(B) Magnitude of y component of momentum of 2m after the explosion is mv

(C) Energy released in the process is $\frac{3}{2}mv^2$

(D) Energy released in the process is $\frac{3}{4}mv^2$

3) In the arrangement shown two men A and B of mass 50kg and 60 kg respectively are standing on the ends of a plank of mass 90 kg. Plank is kept on a smooth plane. Now man starts moving and exchange their positions on the plank. Then



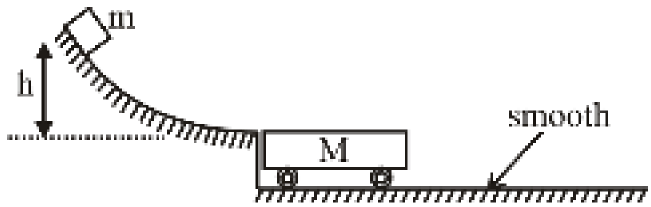
(A) The distance moved by centre of mass of the system A + B + plank is 20 cm

(B) The distance moved by plank is 20 cm

(C) The distance moved by man A with respect to ground is 420cm

(D) The distance moved by man B with respect to ground is 600 cm.

4) A cart of mass M length L stands just at the end of a slope as shown in figure. A small block of mass m is released from rest at height h, block slides on cart and comes to rest with respect to cart at the edge of cart. Friction exists between cart and block and all the surfaces are smooth. Coefficient of friction is μ :-



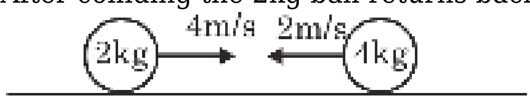
(A) Time for which block moves on cart is $\frac{\sqrt{2gh}\,M}{\mu g(m+M)}$.

(B) Net workdone by kinetic friction is –μmgL.

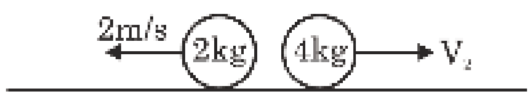
(C) Final velocity of centre of mass of block and cart is $\frac{m\sqrt{2gh}}{m+M}$.

(D) Net impulse on cart is $\frac{mM\sqrt{2gh}}{m+M}$.

5) Two balls of masses 2kg and 4kg are moved towards each other with velocities 4m/s and 2m/s respectively on a frictionless surface. After colliding the 2kg ball returns back with velocity 2 m/s. Then select the correct statement(s) :-



Just before collision



Just after collision

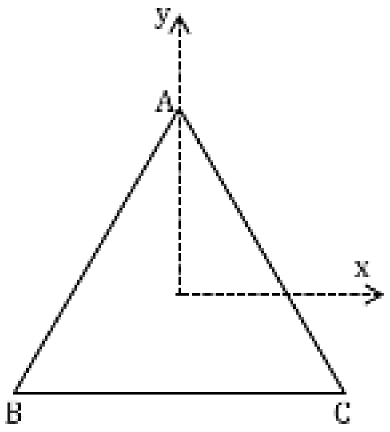
(A) Coefficient of restitution is 0.5.

(B) Impulse of deformation is 8N-S.

(C) Maximum potential energy of deformaton is 24 joule.

(D) Impulse of reformation is 8N-S.

6) A uniform wire frame ABC is in the shape of an equilateral triangle in xy-plane. The centroid is the origin :-



(A) If AB is removed, the centre of mass of the remaining figure is in second quadrant.

(B) If AC is removed, the centre of mass of the remaining figure is in first quadrant.

(C) If BC is removed, the centre of mass of the remaining figure is in fourth quadrant.

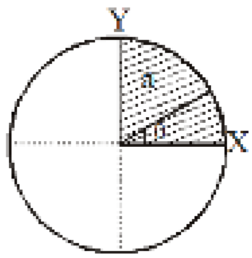
(D) If AB is removed, the centre of mass of the remaining figure is in fourth quadrant.

SECTION-III

1) A bob of mass m, suspended by a string of length ℓ_1 is given a minimum velocity required to complete a full circle in the vertical plane. At the highest point, it collides elastically with another bob of mass m suspended by a string of length ℓ_2, which is initially at rest. Both the strings are mass-less and inextensible. If the second bob, after collision acquires the minimum speed required to complete a full circle in the vertical plane, the ratio $\frac{\ell_1}{\ell_2}$ is.

2) Two cars initially at rest are free to move in the x direction. Car A has mass 4 kg and car B has mass 2 kg. They are tied together, compressing a spring in between them. When the spring holding them together is burned, car A moves off with a speed of 2 m/s. With what speed does car B leave.

3) The disc of mass M with uniform surface mass density is shown in the figure. The centre of mass of the quarter disc (the shaded area) is at the position $\left(\frac{x}{3}\frac{a}{\pi}, \frac{x}{3}\frac{a}{\pi}\right)$ where x is ________. (Round off to the Nearest Integer) [a is radius as shown in the figure]



4) The distance of centre of mass from end A of a one dimensional rod (AB) having linear mass

density $\rho = \rho_0\left(1 - \frac{x^2}{L^2}\right)$ kg/m and length L (in meter) is $\frac{3L}{\alpha}$ m. The value of α is .... (where x is the distance form end A)

5) A block moving horizontally on a smooth surface with a speed of 40 ms^{-1} splits into two equal parts. If one of the parts moves at 60 ms^{-1} in the same direction, then the fractional change in the kinetic energy will be x : 4 where x = __________.

PART-B-CHEMISTRY

SECTION-I(i)

1) Ion having highest hydration enthalpy among the given alkaline earth metal ions is:

(A) Be^{2+}

(B) Ba^{2+}

(C) Sr^{2+}

(D) Ca^{2+}

2) Which of the following salts on heating gives a mixture of two gases ?

(A) $Ba(NO_3)_2$

(B) $NaNO_3$

(C) KNO_3

(D) $RbNO_3$

3) Given

(A) $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$; $\Delta H_1^{\theta} = -x\, kJ\, mol^{-1}$

(B) $C(graphite) + O_2(g) \rightarrow CO_2(g)$; $\Delta H_2^{\theta} = -y\, kJ\, mol^{-1}$

The ΔH^{θ} for the reaction

$C(graphite) + \frac{1}{2} O_2(g) \rightarrow CO(g)$ is

(A) $\frac{x - 2y}{2}$

(B) $\frac{x + 2y}{2}$

(C) $\frac{2x - y}{2}$

(D) 2y – x

4) Standard enthalpy of formation is zero for

(A) $C_{diamond}$

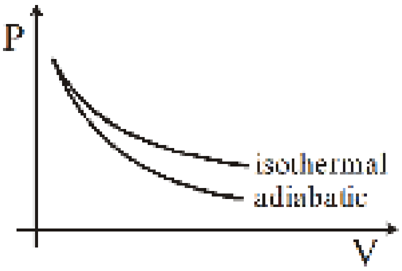
(B) $Br_{(g)}$

(C) $C_{graphite}$

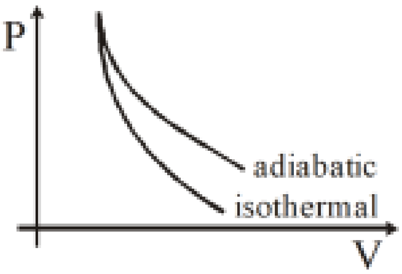
(D) $O_{3(g)}$

5) The correct figure representing isothermal and adiabatic expansions of an ideal gas from a particular initial state is :

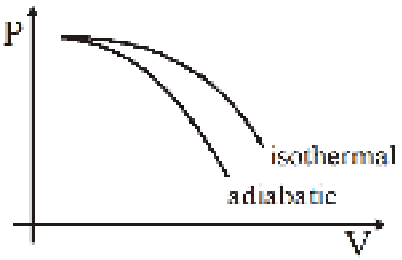
(A)



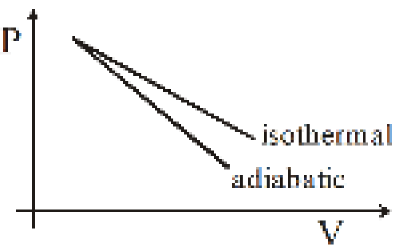
(B)



(C)



(D)



6) The milliequivalents of H_3PO_4 in 120 mL of 1.5 M H_3PO_4 solution in a reaction where it undergoes complete neutralization is :

(A) 180

(B) 360

(C) 540

(D) 60

SECTION-I(ii)

1) A dilute solution of H_2SO_4 is made by adding 5 mL of 3N H_2SO_4 to 245 mL of water. Find the normality and molarity of the diluted solution.

(A) Normality = 0.06 N
(B) Molarity = 0.03 M
(C) Normality = 0.03 N
(D) Molarity = 0.06 M

2) Heat of reaction depend upon :

(A) Physical state of reactants and products
(B) Whether the reaction is carried out at constant pressure or at constant volume
(C) Method by which the final products are obtained from the reactants
(D) Temperature of the reaction

3) 100 ml of 0.4 M -acidified $KMnO_4$ solution may be decolourised completely by

(A) 200 ml 1N - $K_2Cr_2O_7$ solution
(B) 300 ml 0.5M - H_2O_2 solution
(C) 100 ml 0.8N - KI solution
(D) 75 ml 1.4 N - $H_2C_2O_4$ solution

4) Intensive properties are

(A) Density
(B) Entropy
(C) Boiling point
(D) Heat capacity

5) For a diatomic gas which options is/are correct :

(A) $\gamma = 1.40$
(B) $C_P = \frac{7R}{2}$
(C) $C_V = \frac{5R}{2}$
(D) $\gamma = 1.67$

6) Which is/are not correct configuration of s–block elements :

(A) [Ar] $3d^{10}$ $4s^2$
(B) [Ar] $3d^{10}$ $4s^1$
(C) [Ar]) $4s^2$
(D) [Ar] $4s^1$

SECTION-III

1) How many moles of hydrocarbon are produced by hydrolysis of 1 mole of magnesium allylide ?

2) Find the number of compounds from the following in which the element in the anionic part is in the minimum oxidation state of it

LiH, Mg_3Bi_2, Al_4C_3, Ca_3P_2, BaO_2

3) Metallic tin in the presence of HCl is oxidized by $K_2Cr_2O_7$ to stannic chloride, $SnCl_4$. What volume (in litre) of deci-normal dichromate solution would be reduced by 11.9 gm of tin [Sn = 119]

4) Find out the n_{factor} of IO_3^- in the following disproportionation reaction.

$$I_2 \xrightarrow{OH^-} IO_3^- + I^-$$

5) At 0°C, water and ice are at equilibrium at 1 atm pressure. The value of ΔH_{fusion} for ice is (in kJ/mole). (Given $\Delta S_{freezing}$ of water at 1 atm & 273 K is –20 JK mol)

Fill your answer to nearest integer value

PART-C-MATHEMATICS

SECTION-I(i)

1) If 5, 5r, $5r^2$ are the lengths of the sides of a triangle, then r cannot be equal to

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

(B) $\frac{3}{4}$

(C) $\frac{5}{4}$

(D) $\frac{7}{4}$

2) Let ABC be a right triangle with length of side AB = 3 and hypotenuse AC = 5. If D is a point on BC such that $\frac{BD}{DC} = \frac{AB}{AC}$, then AD is equal to

(A) $\frac{4\sqrt{3}}{3}$

(B) $\frac{3\sqrt{5}}{2}$

(C) $\frac{4\sqrt{5}}{3}$

(D) $\frac{5\sqrt{3}}{4}$

3) Let $A(1,1)$, $B(-4,3)$, $C(-2,-5)$ be vertices of a triangle ABC, P be a point on side BC, Δ_1 and Δ_2 be the areas of triangle APB and ABC. Respectively. If $\Delta_1 : \Delta_2 = 4:7$, then the area enclosed by the lines AP, AC and the x-axis is

(A) $\frac{1}{4}$
(B) $\frac{3}{4}$
(C) $\frac{1}{2}$
(D) 1

4) In an isosceles triangle ABC, the vertex A is (6, 1) and the equation of the base BC is 2x + y = 4. Let the point B lie on the line x + 3y = 7. If (α, β) is the centroid ΔABC, then $15(\alpha+\beta)$ is equal to

(A) 39
(B) 41
(C) 51
(D) 63

5) The equation of the straight line passing through the point (4, 3) and making intercepts on the coordinate axes whose sum is –1 is

(A) $\frac{x}{2}+\frac{y}{3}=-1$ and $\frac{x}{-2}+\frac{y}{1}=-1$
(B) $\frac{x}{2}-\frac{y}{3}=-1$ and $\frac{x}{-2}+\frac{y}{1}=-1$
(C) $\frac{x}{2}+\frac{y}{3}=1$ and $\frac{x}{2}+\frac{y}{1}=1$
(D) $\frac{x}{2}-\frac{y}{3}=1$ and $\frac{x}{-2}+\frac{y}{1}=1$

6) If the three distinct lines $x+2ay+a=0, x+3by+b=0$ and $x+4ay+a=0$ are concurrent, then the point (a, b) lies on

(A) circle
(B) straight line
(C) parabola
(D) hyperbola

SECTION-I(ii)

1)

One diagonal of a square is the portion of the line $\sqrt{3}x+y=2\sqrt{3}$ intercepted by the axes. Then an extremity of the other diagonal is

(A) $\left(1+\sqrt{3}, \sqrt{3}-1\right)$
(B) $\left(1+\sqrt{3}, \sqrt{3}+1\right)$
(C) $\left(1-\sqrt{3}, \sqrt{3}-1\right)$

(D) $\left(1-\sqrt{3}, \sqrt{3}+1\right)$

2) Equation of straight line cutting off intercept –1 on y-axis and being equally inclined to the axes is/are

(A) $y=\frac{1}{\sqrt{2}}x-1$

(B) y = x - 1

(C) $y=-\frac{1}{\sqrt{2}}x-1$

(D) y = -x - 1

3) If the locus of the mid point of the intersection points of the lines $y=mx+2, y=-mx+3$ and $y=\frac{1}{m}x+m, y=-\frac{1}{m}x+2$ is $4x=\frac{1}{(ay-b)}+(ay-b)(c-ay)$, then

(A) a = 4

(B) b = 7

(C) c = 9

(D) a = 8

4) A point moves in the xy plane such that the sum of its distances from the coordinate axes is always equal to 2, then

(A) Equation of locus is |x| + |y| = 2

(B) Area enclosed by locus of this point is 8

(C) Shortest distance of the point from origin is $\sqrt{2}$

(D) Shortest distance of point from origin is 2

5) If sides of a triangle are $L_1 : x + 3y = 2$, $L_2 : x + y = 0$ & $L_3 : 3x - y = 16$ then

(A) Orthocentre of triangle is (1, –5)

(B) Orthocentre of triangle is (5, –1)

(C) Circumcentre of triangle is $\left(\frac{3}{2}, \frac{-3}{2}\right)$

(D) Circumcentre of triangle is (3, –3)

6) In a triangle PQR, let ∠PQR = 30° and the sides PQ and QR have lengths $10\sqrt{3}$ and 10, respectively. Then, which of the following statement(s) is (are) TRUE ?

(A) ∠QPR = 45°

(B) The area of the triangle PQR is $25\sqrt{3}$ and ∠QRP = 120°

(C) The radius of the incircle of the triangle PQR is $10\sqrt{3}-15$

(D) The area of the circumcircle of the triangle PQR is 100π.

SECTION-III

1) If the inradius in a right angled triangle with integer sides is 5, the greatest area is 66λ then the value of λ is

2) If $a^2 (s - a) + b^2 (s - b) + c^2 (s - c) = \lambda R\Delta \left(1 + 4\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}\right)$ then find the value of λ ?
[**Note:** All symbols used have usual meaning in triangle ABC.]

3) A triangle has side lengths 18, 24 and 30. Find the area of the triangle whose vertices are the incentre, circumcentre and centroid of the triangle.

4) If the points $\left(\frac{a^3}{a-1}, \frac{a^2-3}{a-1}\right), \left(\frac{b^3}{b-1}, \frac{b^2-3}{b-1}\right)$ and $\left(\frac{c^3}{c-1}, \frac{c^2-3}{c-1}\right)$ are collinear for three distinct values a, b, c and $a \neq 1$, $b \neq 1$ and $c \neq 1$, then find the value of abc– (ab + bc + ac) + 3 (a + b + c).

5) T is the area of region enclosed by the locus of point (x, y) which moves such that $2|x| + |y| = 4$, then the number of prime number(s) less than T

ANSWER KEYS

PART-A-PHYSICS

SECTION-I(i)

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

SECTION-I(ii)

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

SECTION-III

Q.	13	14	15	16	17
A.	5	4	4	8	1

PART-B-CHEMISTRY

SECTION-I(i)

Q.	18	19	20	21	22	23
A.	A	A	A	C	A	C

SECTION-I(ii)

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

SECTION-III

Q.	30	31	32	33	34
A.	1	4	4	5	5

PART-C-MATHEMATICS

SECTION-I(i)

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

SECTION-I(ii)

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

SECTION-III

Q.	47	48	49	50	51
A.	5	4	3	0	6

SOLUTIONS

PART-A-PHYSICS

1)

$2 \times 10 = 5 \times v$
$v = 4\ m/s$
$\omega_N = \frac{1}{2} \times 3 \times 16 = 24\ J$

2)

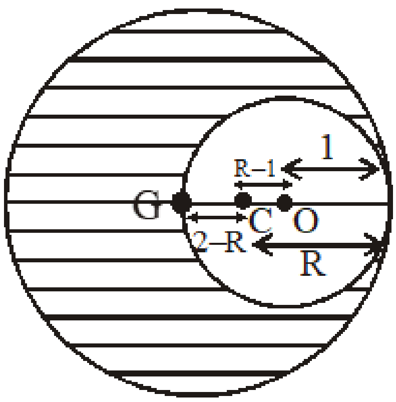
After all collisions $v_m = 3\sqrt{2gH}$

3)

$\vec{F}_{ext} = 0 \Rightarrow \Delta\vec{P} = 0$
$Mv_0\hat{i} - 3Mv_0\hat{j} + 5Mv_0\hat{k} = 3Mv$
$v = \frac{v_0}{3}\hat{i} - v_0\hat{j} + \frac{5}{3}v_0\hat{k}$

4)

By concept of *COM*
$m_1R_1 = m_2R_2$
Remaining mass × (2–*R*) = cavity mass × (*R*–1)
$\left(\frac{4}{3}\pi R^3\rho - \frac{4}{3}\pi 1^3\rho\right)(2-R) = \frac{4}{3}\pi 1^3\rho \times (R-1)$

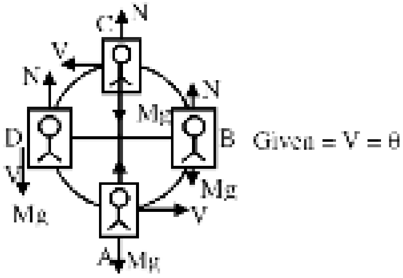


$(R^3 - 1)(2 - R) = R - 1$
$(R^2 + R + 1)(2 - R) = 1$

6) $\frac{1}{2}mv^2 =$ mg L(1 – cos 60°)
$\Rightarrow$ $v = \sqrt{gL}$ ......(1)
Since particle just completer a circle of radius L – h, we have
$v = \sqrt{5g(L-h)}$ ....(2)
from (1) and (2) we have
gL = 5g(L – h)

$\Rightarrow h = \frac{4}{5}L$

7)



weight reading at A

$N_A - Mg = \frac{mV^2}{R}$

$N_A = Mg + \frac{MgR}{R} = 2Mg = 2w$

At point C

$Mg - N_C = \frac{mv^2}{R}$

$N_C = mg - mg = 0$

So, weight reading at A is greater than the weight reading at C by 2w.

$\frac{\text{At point D}}{N = Mg}$

$\frac{\text{At point B}}{N_B = mg = W}$

$\frac{N_A}{N_B} = \frac{2w}{w} = 2$

8) From momentum conservation

$mv\hat{i} + mv\hat{j} + 2m\vec{v}' = 0$

$\Rightarrow \vec{v}' = \left(\frac{-\hat{i}-\hat{j}}{2}\right)v$

$\Rightarrow |v'| = \frac{v}{\sqrt{2}}$

energy released = $\frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}2m\frac{v^2}{2} = \frac{3}{2}mv^2$

9)

Since external force on the system (A + B + plank) is horizontal direction is zero therefor centre of mass of the system remain at rest.

Let displacement of plank is x, than

60(4 – x) – 50(4 + x) = 90°x

40 = 200x

x = 0.2 m

10) $0 = \sqrt{2gh} - \mu g\left(1 + \frac{m}{M}\right)t$

$$t = \frac{\sqrt{2gh}M}{\mu g(m+M)}$$

$$v_{cm} = \frac{m \times \sqrt{2gh} + M \times 0}{m+M}$$

$$\text{Impulse} = Mv_f - M \times 0 = Mm\frac{\sqrt{2gh}}{m+M}$$

11)

Conserving linear momentum

$4v_2 - 2 \times 2 = 2 \times 4 - 4 \times 2$

$V_2 = 1$ m/s

Impulse = $|\Delta P|$

$= |0 - 4 \times 2| = 8$

Coefficient of restitution $e = \frac{2+1}{4+2} = \frac{1}{2}$

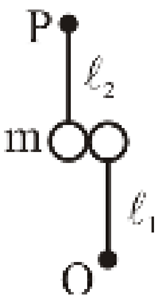
Maximum potential energy

$$U_{max} = \frac{1}{2} \times 2 \times 4^2 + \frac{1}{2} \times 4 \times 2^2$$

$= 24$J

12)

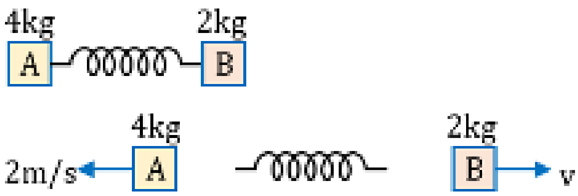
CM gets shifted towards more mass.



13)

$$\sqrt{9\ell_1} = \sqrt{5g\ell_2} \Rightarrow \frac{\ell_1}{\ell_2} = 5$$

14)



System $(A + B + \text{Spring})$

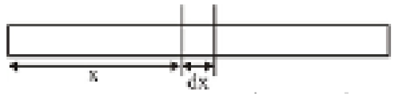
$\Rightarrow \quad F_{ext} = 0 \Rightarrow 2v - 2 \times 4 = 0$

$\Rightarrow \quad v = 4\ m/s = v_B$

15)

C.O.M of quarter disc is at $\frac{4a}{3\pi}, \frac{4a}{3\pi}$
= 4

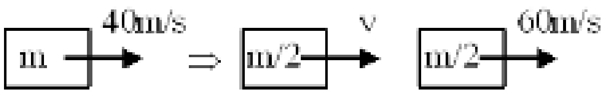
16)



$dm = \lambda \cdot dx = \lambda_0\left(1 - \frac{x^2}{\ell^2}\right)$

$$X_{cm} = \frac{\int x dm}{\int dm_\ell} = \frac{\lambda_0 \int_0^\ell \left(x - \frac{x^3}{\ell^2}\right) dx}{\int_0^\ell \lambda_0 \left(1 - \frac{x^2}{\ell^2}\right) dx} = \frac{\frac{\ell^2}{2} - \frac{\ell^4}{4\ell^2}}{\ell - \frac{\ell^3}{3\ell^2}} = \frac{3\ell}{8}$$

17)



$p_i = p_f$

$m \times 40 = \frac{m}{2} \times v + \frac{m}{2} \times 60$

$40 = \frac{v}{2} + 30$

$\Rightarrow v = 20$ m/s

$(K.E.)_I = \frac{1}{2}m \times (40)^2 = 800\,m$

$(K.E.)_f = \frac{1}{2}\frac{m}{2}.(20)^2 + \frac{1}{2}.\frac{m}{2}(60)^2 = 1000$ m

$|\Delta K.E| = |1000m - 800m| = 200m$

$\frac{\Delta K.E.}{(K.E.)_I} = \frac{200m}{800m} = \frac{1}{4} = \frac{x}{4}$

$x = 1$

PART-B-CHEMISTRY

18)

Hydration enthalpy $\propto \frac{1}{\text{size}}$
Down the group as size increases hydration enthalpy decreases
Order : $Be^{2+} > Mg^{+2} > Ca^{+2} > Sr^{+2} > Ba^{+2}$

19)

$Ba(NO_3)_2 \xrightarrow{\Delta} BaO + 2NO_2 + \frac{1}{2}O_2$; Alkali metal nitrates gives only O_2 gas.
Alkali metal nitrates give only O_2 on heating below 500ºC according to following reaction,

$MNO_3 \rightarrow MNO_2 + \frac{1}{2}O_2$

20)

Target equation

$C(graphite) + \frac{1}{2} O_{2(g)} \rightarrow CO_{(g)}$ ...(i) ΔH

$C(graphite) + O_{2(g)} \rightarrow CO_{2(g)}$ ...(ii) $\Delta H_1 = -y$ kJ/mole

$CO_{2(g)} \rightarrow CO_{(g)} + \frac{1}{2} O_{2(g)}$ ...(iii) $\Delta H_2 = \frac{x}{2}$ kJ/mole

eq. (i) = eq.(ii) + eq (iii)

$\therefore \Delta H = \frac{x}{2} - y = \frac{x-2y}{2}$

21)

$\Delta H_f[C(graphite)] = 0$

$\Delta H_f^\circ[Br_2(\ell)] = 0$

$\Delta H_f^\circ[O_2(g)] = 0$

22)

Adiabatic curve is always sleeper than isothermal curve.

23)

milli equivalent of H_3PO_4 = V(mL) × M × v.f. = 120 × 1.5 × 3 = 540

24)

$N_1V_1 = N_2V_2$

$3 \times 5 = N_2 \times 250$

so $N_2 = 0.06$ N,

Now, v.f. of $H_2SO_4 = 2$

so, molarity = $\frac{0.06}{2}$ = 0.03 M

26) Eq. of $KMnO_4$ used = $100 \times 10^{-3} \times 0.4 \times 5 = 0.2$ eq

We need at least 0.2 equivalents of reducing agent

(A) $K_2Cr_2O_7$ is not a reducing agent

(B) $H_2O_2 \rightarrow O_2$

eq. of $H_2O_2 = 300 \times 10^{-3} \times 0.5 \times 2 = 0.3$ eq.

(C) Eq. of KI = $100 \times 10^{-3} \times 0.8 = 0.08$ eq.

(D) Eq. of $H_2C_2O_4 = 75 \times 10^{-3} \times 1.4 = 0.105$ eq.

27)

Density, Boiling point independent on the quantity of matter

28)

diatomic gas

DOF ⇒ f = 5

$C_V = \frac{fR}{2}$, $C_P = C_V + R$

$C_V = \frac{5R}{2}$, $C_P = \frac{7R}{2}$

$\gamma = \frac{C_P}{C_V} = \frac{7}{5} = 1.4$

29)

Configurations given in options (A) and (B) are of d-block elements as last electron enters in d-subshell.

32) $K_2\overset{+6}{Cr_2}O_7 + Sn \xrightarrow{HCl} Cr^{+3} + \overset{+6}{Sn}Cl_4$

n.f = |3 – 6| × 2   n.f = |4 – 0|

$\boxed{\text{decinormal} = \frac{1}{10}N}$, dichromate solution = $K_2Cr_2O_7$

equivalent of O.A = equivalent of R.A.

equivalent of $K_2Cr_2O_7$ = equivalent of S_n

N × v = moles × n.f

$\frac{1}{10} \times V = \frac{11.9}{119} \times 4$

v = 4 lt

33) $I_2 \xrightarrow{OH^-} IO_3^- + I^-$

$\downarrow$

n_f of $IO_3^- = 5$

34)

$\Delta S = \frac{\Delta H_{fusion}}{T_f} = \frac{-\Delta H_{Freeezing}}{T_f}$

ΔH = + 20 × 273

= 5460 = 5.4 kJ/mol

PART-C-MATHEMATICS

35)

Case-1

$5 + 5r > 5r^2$

$r^2 - r - 1 < 0$

$\Rightarrow \left(r - \frac{1+\sqrt{5}}{2}\right)\left(r - \frac{1-\sqrt{5}}{2}\right) < 0$

$\Rightarrow r \in \left(\frac{1-\sqrt{5}}{2}, \frac{1+\sqrt{5}}{2}\right)$

Case-2

$5r^2 + 5r > 5$

$\Rightarrow r^2 + r - 1 > 0$

$\Rightarrow r < \frac{-1-\sqrt{5}}{2}$, $r > \frac{-1+\sqrt{5}}{2}$

Case-3

$5 + 5r^2 > 5r$

$\Rightarrow r^2 - r + 1 > 0$

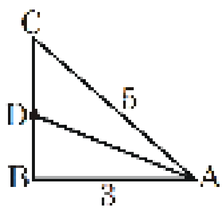
$r \in R$

from case-1, case-2 and case-3

$r \in \left(\frac{\sqrt{5}-1}{2}, \frac{\sqrt{5}+1}{2}\right)$

Option (4) is correct.

36)

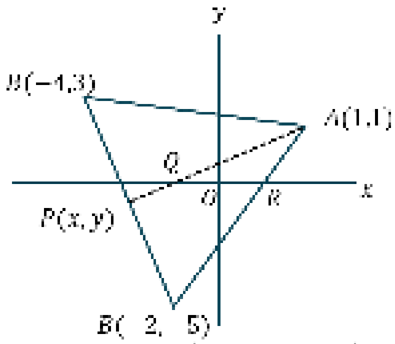


 $AB^2 + BC^2 = AC^2$
$\Rightarrow 9 + BC^2 = 25 \Rightarrow BC = 4$
Given that $\frac{BD}{DC} = \frac{AB}{AC} = \frac{3}{5}$
Let BD = 3k & DC = 5k
 BD + DC = BC = 4
$\Rightarrow 3k + 5k = 4 \Rightarrow k = \frac{1}{2}$
 $BD = \frac{3}{2}$
In ΔABD :
$AD^2 = AB^2 + BD^2$

$\Rightarrow AD = \sqrt{9 + \frac{9}{4}} = \frac{\sqrt{45}}{2}$

Hence $AD = \frac{3\sqrt{5}}{2}$

37)



Given $\Delta_1 = \frac{1}{2}\begin{vmatrix} x & y & 1 \\ 1 & 1 & 1 \\ -4 & 3 & 1 \end{vmatrix}$

& $\Delta_2 = \frac{1}{2}\begin{vmatrix} 1 & 1 & 1 \\ -4 & 3 & 1 \\ -2 & -5 & 1 \end{vmatrix}$

Given $\frac{\Delta_1}{\Delta_2} = \frac{4}{7} \Rightarrow \frac{-2x - 5y + 7}{36} = \frac{4}{7}$

$\Rightarrow 14x + 35y = -95$ ...(1)

Equation of BC is $4x + y = -13$ ...(2)

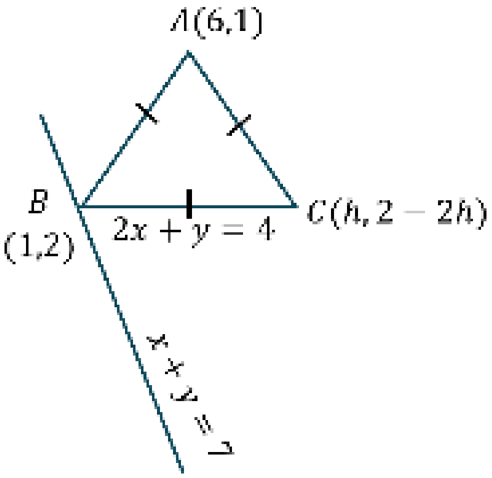
Solve equation (1) & (2)

Point $P\left(\frac{-20}{7}, \frac{-11}{7}\right)$

Here point $Q\left(\frac{-1}{2}, 0\right)$ & $R\left(\frac{1}{2}, 0\right)$

So Area of triangle $AQR = \frac{1}{2} \times 1 \times 1 = \frac{1}{2}$

38)



Point B(1, 2)
Now let C be (h, 4–2h)
(As C lies on 2x + y = 4)
$\because \Delta$ is isosceles with base BC
$\therefore AB = AC$

$\sqrt{25+1} = \sqrt{(6-h)^2 + (2h-3)^2}$

$\sqrt{26} = \sqrt{36 + h^2 - 12h + 4h^2 + 9 - 12h}$

$26 = 5h^2 - 24h + 45 \Rightarrow 5h^2 - 24h + 19 = 0$

$\Rightarrow 5h^2 - 5h - 19h + 19 = 0$

$h = \frac{19}{5}$ or h = 1

Thus $C\left(\frac{19}{5}, \frac{-18}{5}\right)$

Centroid $\left(\frac{6+1+\frac{19}{5}}{3}, \frac{1+2-\frac{18}{5}}{3}\right)$

$\left(\frac{35+19}{15}, \frac{15-18}{15}\right)$

$\left(\frac{54}{15}, \frac{-3}{15}\right)$

$\alpha = \frac{54}{15}; \beta = \frac{-3}{15}$

$15(\alpha + \beta) = 51$

39)

Here a + b = 1. Required line is

$\frac{x}{a} + \frac{y}{1-a} = 1$ ..... (i)

Since line (i) passes through (4, 3)

$\therefore \frac{4}{a} + \frac{3}{1-a} = 1 \Rightarrow 4 - 4a + 3a = a - a^2$

$\Rightarrow a^2 = 4 \Rightarrow a = \pm 2$

$\therefore$ Required lines are $\frac{x}{2} + \frac{y}{-1} = 1$ & $\frac{x}{-2} + \frac{y}{3} = 1$

40)

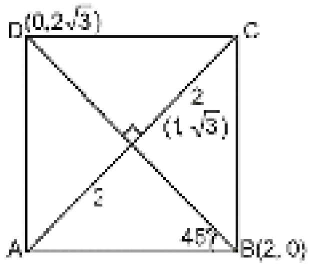
Ans. (B)

From condition of concurrency we get

$$\begin{vmatrix} 1 & 2a & a \\ 1 & 3b & b \\ 1 & 4a & a \end{vmatrix} = 0$$

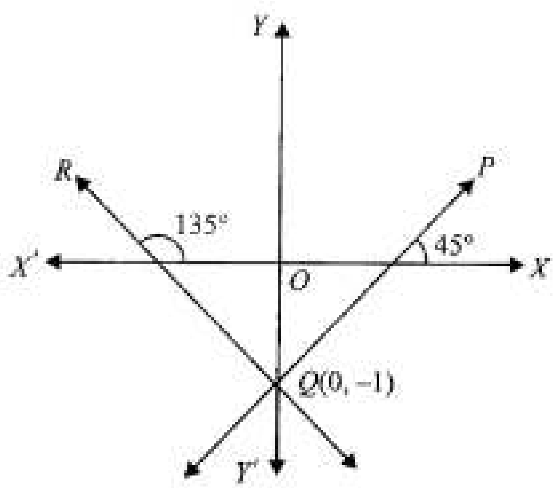
On solving this we get $2a(b - a) = 0 \Rightarrow a = 0, b = a$

(a, b) will lie on straight line



41) $\left(1 \pm 2\cos\frac{\pi}{6}, \sqrt{3} \pm 2\sin\frac{\pi}{6}\right)$

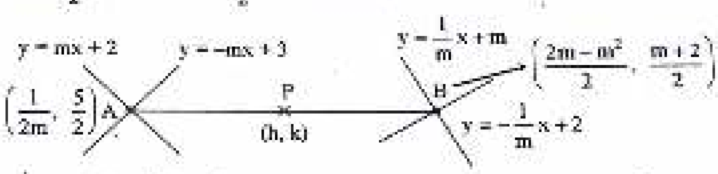
42)



So, its slope is either m = tan45º or m = tan135º, i.e.,
m = 1 or –1. It is given that c = –1. Hence, the equation of the lines are
y = x – 1 and y = –x – 1

43)

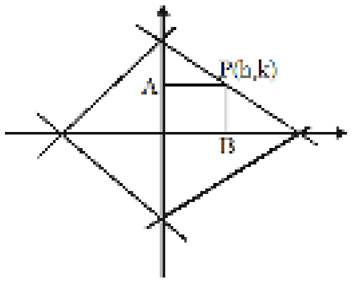
So $h = \dfrac{\frac{1}{2m} + \frac{2m - m^2}{2}}{2}$, $k = \dfrac{\frac{5}{2} + \frac{m+2}{2}}{2}$ eliminating m



$4x = \dfrac{1}{(4y-7)} + (4y-7)(9-4y)$

So, a = 4, b = 7, c = 9

44)



PA + PB = 2

|x| + |y| = 2

$\Rightarrow$ x + y = 2 → ℓ_1

x - y = 2 → ℓ_2

–x + y = 2 → ℓ_3

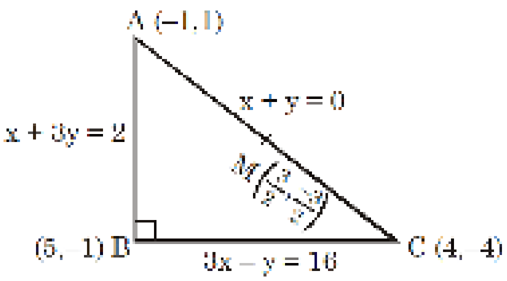
- x - y = 2 → ℓ_4

These lines form rhombus

Area of Rhombus = 4 area of Δ in Ist quadrant $= 4.\frac{1}{2}.2.2 = 8$

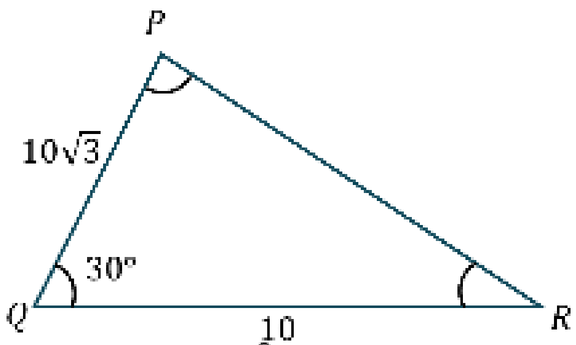
Shortest distance $= \frac{2}{\sqrt{2}} = \sqrt{2}$

45)



* Orthocentre : (5, –1)
* Circumcentre : $\left(\frac{3}{2}, \frac{-3}{2}\right)$

46)



$$\cos 30^\circ = \frac{\left(10\sqrt{3}\right)^2 + (10)^2 - (PR)^2}{2 \times 10\sqrt{3} \times 10}$$

$\Rightarrow$ PR = 10

$\because$ QR = PR

$\Rightarrow$ ∠PQR = ∠QPR

$\angle QPR = 30°$

(B) area of ΔPQR

$= \frac{1}{2} \times 10\sqrt{3} \times 10 \times \sin 30° = \frac{1}{2} \times 10 \times 10\sqrt{3} \times \frac{1}{2}$

$= 25\sqrt{3}$

$\angle QRP = 180° - (30° + 30°) = 120°$

(C) $r = \frac{\Delta}{S} = \frac{25\sqrt{3}}{\left(\frac{10+10+10\sqrt{3}}{2}\right)} = \frac{25\sqrt{3}}{10+5\sqrt{3}}$

$= 5\sqrt{3}.\left(2-\sqrt{3}\right) = 10\sqrt{3}-15$

(D) $R = \frac{a}{2\sin A} = \frac{10}{2\sin 30°} = 10$

 Area = $\pi R^2 = 100\pi$

47)

(i and ii) Let a, b and c (a < b < c) be the sides of given triangle.

Also, 2r = a + b – c

when r = 5 then (a, b) = (11, 60) (12,35) (15,20)

 Greatest area = $\frac{11 \times 60}{2}$ = 330 sq. unit

48)

L.H.S. = $\frac{1}{2}$ $[a^2(b + c - a) + b^2 (c + a - b) + c^2 (a + b - c)]$

$= \frac{1}{2}$ $[a(b^2 + c^2 - a^2) + b(c^2 + a^2 - b^2) + c (a^2 + b^2 - c^2)]$

$= \frac{1}{2}$ (2abc cosA + 2abc cosB + 2abc cosC)

$= abc\left(1+4\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}\right)$

$= 4R\Delta\left(1+4\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}\right)$

49)

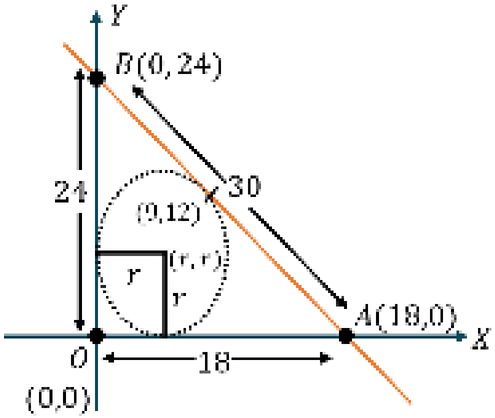
$24^2 + 18^2 = 30^2$

⇒ Right angle Δ

Circumcentre: Mid point of hypotenuse

0 (9, 12)

In centre :-



r = $\dfrac{\Delta}{S}$

= $\dfrac{\frac{1}{2}(18)\,(24)}{\frac{18+30+24}{2}}$ $\boxed{r = 6}$

then $I(6, 6)$ **Ans**

centroid :- $\left(\dfrac{0+18+0}{3}, \dfrac{0+0+24}{3}\right)$

$G(6, 8)$

Now the area of $\Delta = \dfrac{1}{2}\begin{vmatrix} 9 & 12 & 1 \\ 6 & 6 & 1 \\ 6 & 8 & 1 \end{vmatrix} = 3$

50)

Let equation of line is $\ell x + my + n = 0$ ...(i)

given $\left(\dfrac{a^3}{a-1}, \dfrac{a^2-3}{a-1}\right)$, $\left(\dfrac{b^3}{b-1}, \dfrac{b^2-3}{b-1}\right)$ and $\left(\dfrac{c^3}{c-1}, \dfrac{c^2-3}{c-1}\right)$ are collinear

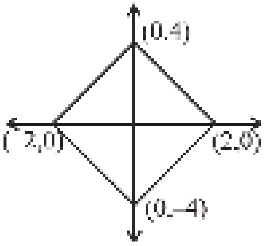
$\left(\dfrac{t^3}{t-1}, \dfrac{t^2-3}{t-1}\right)$ is general point which satisfies line (i)

$\ell\left(\dfrac{t^3}{t-1}\right) + m\left(\dfrac{t^2-3}{t-1}\right) + n = 0 \Rightarrow \ell t^3 + mt^2 + nt - (3m + n) = 0$

$a + b + c = -\dfrac{m}{\ell} \Rightarrow ab + bc + ac = \dfrac{n}{\ell} \Rightarrow abc = \dfrac{3m+n}{\ell}$

Now LHS = $abc - (ab + bc + ac) + 3(a + b + c) = \dfrac{(3m+n)}{\ell} - \dfrac{n}{\ell} + 3\left(\dfrac{-m}{\ell}\right) = 0$

51)



Area of rhombus = 16