Master JEE CLASSES

Kukatpally, Hyderabad.

IIT-JEE-MAINS PAPER-3 **Max.Marks:360**

IMPORTANT INSTRUCTIONS:

1) Immediately fill in the particulars on this page of the Test Booklet with Blue/Black Ball Point Pen. Use of pencil is strictly prohibited.
2) The test is of 3 hours duration.
3) The Test Booklet consists of 90 questions. The maximum marks are 360.
4) There are three parts in the question paper A, B, C consisting of **Chemistry, Maths** and **Physics** having 30 questions in each part of equal weight age. Each question is allotted 4 (four) marks for correct response.
5) Candidates will be awarded marks as stated above in instruction No. 4 for correct response of each question. (1/4) (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
6) There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 5 above.

SYLLABUS

MATHS:

Matrices (30%); 2-D GEOMETRY: Distance Formula, Section formula, Finding various Centres with given vertices of a triangle, Area of Triangle, Collinearity of Points, Locus (Simple problems), Translation and Rotation of axes (70%)

PHYSICS:

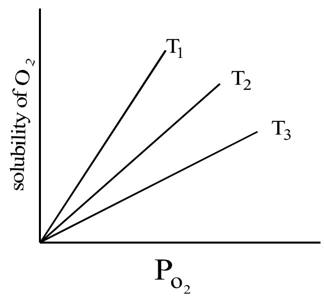
Constraint equations, Problems in NLM without friction (Including spring problems)(70%)

Newton's Laws Of Motion (Without Friction): Cause of motion, cause for the change of motion, Newton's first law, qualitative definition of force, inertia and mass, types of inertia, Newton's second law, quantitative definition of force, definition of unit force, dimensional formula and SI units of force, Newton's third law, action and reaction, Internal and external forces in case of system of objects, Discussion on cancellation of action and reaction forces, Inertial and non inertial frames of reference and pseudo force, Problems on simple application of NLM - Atwood machine, Lift problems, spring balance, weighing machine etc, EXCLUDE : The problems involving constraints like multiple pulley & multiple contact problems(30%)

CHEMISTRY: Liquid Solutions and Colligative Properties: Henry's law, Vapour pressure, Ideal solution, Determination of molecular weight by relative lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmtoic pressure(including Vant-hoff factor) (70%), Buffer solutions, INDICATORS, salt hydrolysis, Solubility of sparingly soluble salts and solubility product(30%),

CHEMISTRY

01.



Which of these relations is correct

1) $T_1 < T_2 < T_3$ 2) $T_3 > T_1 > T_2$

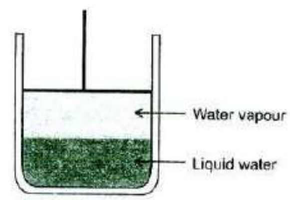
3) $T_1 > T_2 > T_3$ 4) $T_1 = T_2 = T_3$

02. Given at 350K $P_A^o = 300$ torr and $P_B^o = 800$ torr, the composition of the mixture having a normal boiling point of 350 K is:

1) $X_A = 0.08$ 2) $X_A = 0.06$

3) $X_A = 0.04$ 4) $X_A = 0.02$

03. The vapour pressure of water at 20^0C is 17.54 mmHg. What will be the vapour pressure of the water in the apparatus shown after the piston is lowered, decreasing the volume of the gas above the liquid to one half of its initial volume (assume temperature constant).



1) 8.77 mmHg

2) 17.54 mmHg

3) 35.08 mmHg

4) between 8.77 and 17.54 mmHg

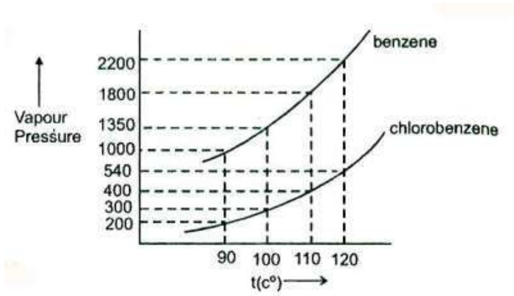
04. A sample of air is saturated with benzene (vapor pressure = 100 mmHg at 298 K) at 298 K, 750 mm Hg pressure. If it is isothermally compressed to one third of its initial volume, the final pressure of the system is

1) 2250 torr 2) 2150 torr

3) 2050 torr 4) 1950 torr

05. Assuming the formation of an ideal solution, determine the boiling point of a mixture containing 1560 g benzene (molar mass = 78) and 1125 g chlorobenzene

(molar mass = 112.5) using the following against an external pressure of 1000 Torr.



1) $90^0\ C$ 2) $100^0\ C$

3) 110^0 4) $120^0\ C$

06. Barium ions, CN^- and Co^{2+} form an ionic complex. If that complex is supposed to be 75% ionized in water with vant Hoff factor 'i' equal to four, then the coordination number of Co^{2+} in the complex can be:

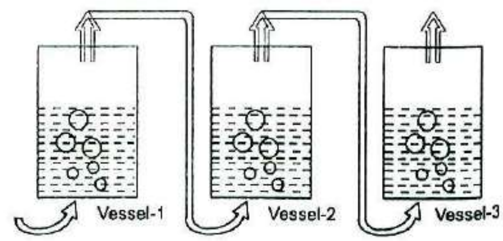
1) Six

2) Five

3) Four

4) Six and Four both

07. Dry air is slowly passed through three solutions of different concentrations, C_1, C_2 *and* C_3; each containing (non volatile) NaCl as solute and water as solvent, as shown in Fig. If the vessel 2 gains weight and the vessel 3 loses weight, then



1) $C_2 > C_3$ 2) $C_1 < C_2$

3) $C_1 < C_3$ 4) Both (1) and (2)

08. When only a little quantity of $HgCl_2(s)$ is added to excess KI(aq) to obtain a clear solution, which of the following is true for this solution ? (no volume change on mixing). The reaction is

$4KI(aq) + HgCl_2(s) \rightarrow K_2[HgI_4](aq.) + 2KCI(aq.)$

1) Its boiling and freezing points remains same

2) Its boiling point is lowered

3) Its vapour pressure become lower

4) Its freezing point is lowered.

09. For a solution of 0.849 g of mercurous chloride in 50 g of $HgCl_2(\ell)$ the freezing point depression is 1.24^0C. K_f for $HgCl_2$ is 34.3K-kg/mol. What is the state of mercurous chloride in $HgCl_2$? $(Hg = 200, Cl = 35.5)$

1) as Hg_2Cl_2 molecules
2) as $HgCl$ molecules
3) as Hg^+ and Cl^- ions
4) as Hg_2^{2+} *and* Cl^- ions

10. Two beakers, one containing 20 ml of a 0.05 M aqueous solution of a non-volatile, non electrolyte and the other, the same volume of 0.03 M aqueous solution of NaCl, are placed side by side in a closed enclosure. What are the volumes in the two beakers when equilibrium is attained? Volume of the solution in the first and second beaker are respectively.

1) 21.8 mL and 18.2 mL
2) 18.2 mL and 21.8 mL
3) 20 mL and 20 mL
4) 17.1 mL and 22.9 mL

11. Inulin $(C_6H_{10}O_5)_n$ is dissolved in a suitable solvent and the osmotic pressure π of the solution of various concentration $\left(in\ kg/m^3\right)$ is measured at 20^0C. The slope of a plot of π against c is found to be 8.134×10^{-3} (Sl units) The molecular weight of the Inulin (in kg/mol) is:

1) 4.8×10^5 2) 9×10^5
3) 293×10^3 4) 8.314×10^5

12. Which has maximum freezing point?

1) 6g urea solution in 100g H_2O
2) 6g acetic acid solution in 100g H_2O
3) 6g sodium chloride in 100g H_2O
4) All have equal freezing point

13. Select correct statements:

a) The fundamental cause of all colligative properties is the higher entropy of the solution relative to that of the pure solvent

b) The freezing point of hydrogen fluoride solution is larger than that of equimolal hydrogen chloride solution

c) 1 M glucose solution and 0.5 M NaCl solution are isotonic at a given temperature

1) only a   2) only b

3) only c   4) a,b, c

14. The vapour pressure of a pure liquid A is 40 mmHg at 310 K. The vapour pressure of this liquid in a solution with liquid B is 32 mmHg. Mole fraction of A in the solution, if it obeys Raoult's law is:

1) 0.8   2) 0.5

3) 0.2   4) 0.4

15. Depression of freezing point of 0.01 molal aq. CH_3COOH solution is 0.02046^o. 1 molal urea solution freezes at $(-1.86^o C)$. Assuming molality equal to molarity, pH of CH_3COOH solution is:

1) 2   2) 3

3) 3.2   4) 4.2

16. A 0.50 molal solution of ethylene glycol in water is used as coolant in a car. If the freezing point constant of water is 1.86^o per molal, at which temperature will the mixture freeze?

1) 1.56^o C   2) -0.93^o C

3) -1.86^o C   4) 0.93^o C

17. During depression of freezing point in a solution the following are in equilibrium:

1) Liquid solvent, solid solvent

2) Liquid solvent, solid solute

3) Liquid solute, solid solute

4) Liquid solute, solid solvent

18. Which of the following aqueous solutions will show maximum freezing point.

1) 0.4M $K_2Fe[Fe(CN)_6]$

2) 500 ml of 0.2 $BaCl_2$ solution mixed with 500 ml of 0.4M Na_2SO_4 solution

3) 0.3M glucose solution

4) 0.1M $Ba_3(PO_4)_2$ solution.

19. pH of a saturated solution of silver salt of monobasic acid HA is found to be 9. Select the option(s) which is / are correct. Given: $K_a(HA)=10^{-10}$

a) Solubility of the silver salt is 1.1×10^{-5} mol / lit

b) Solubility product of the silver salt is $1.1\times10^{-11} M^2$

c) Concentration of Ag^+ in the solution will be greater than that of A^-.

1) only a,b 2) only b,c

3) only a,c 4) a,b, c

20. 100 ml aqueous 0.1 molar $M(CN)_2$ (80% ionized) solution is mixed with 100 ml of 0.05 molar H_2SO_4 solution (80% ionized). What is the pH of the resultant solution at 25^0C ? (Assume no hydrolysis of M^{+2},

K_b of $CN^-=10^{-6}$)

1) 6 2) 8

3) 9 4) 7

21. What is the maximum concentration of Mg^{+2} that can be introduced into a solution containing 0.1 M NH_3 and 0.01 M NH_4^+ without causing precipitation of $Mg(OH)_2$? K_b of $NH_3=10^{-6}$, K_{sp} of $Mg(OH)_2=1.2\times10^{-12}$

1) 0.012 M 2) 0.24 M

3) 0.024 M 4) 0.048M

22. If K_{sp} of $PbSO_4$ is 4×10^{-10}, then what is the loss in wt. of $PbSO_4$ if it is washed with 5 lit of water.

(mol.wt of $PbSO_4=303$ g / mol)

1)6.06 mg 2) 12.12 mg

3) 30.3 mg 4) 0.1 mg

23. For a series of indicators, the colours and pH range over which colour change takes place are as follows

Indicator	Colour change over Ph range
U	Yellow to blue pH 0.0 to 1.6
V	red to yellow pH 2.8 to 4.1
W	red to yellow pH 4.2 to 5.8

X	yellow to blue pH 6.0 to 7.7
Y	colourless to red pH 8.2 to 10.0

Which of the following statements is correct?

1) Indicator V could be used to find the equivalence point for 0.1 M acetic acid and 0.1 M ammonium hydroxide (ammonia solution) titration

2) Indicator Y could be used to distinguish between 0.1 M and 0.001 M NaOH solutions in water.

3) Indicator X could be used to distinguish between solutions of ammonium chloride and sodium acetate.

4) Indicator W would be suitable for use in determining the concentration of acetic acid by strong base titration.

24. The pH of the mixture of 25 ml of 0.01M of CH_3COOH $\left(K_a \text{ of } CH_3COOH = 5\times10^{-5}\right)$ and 25 ml of 0.01M of NaOH solution is

1) 7 2) 8

3) 10.25 4) 9.125

25. During the titration of a weak diprotic acid (H_2A) against a strong base $(NaOH)$, the pH of the solution half –way to the first inflection point and that at the first inflection point are given respectively by

1) pK_1 and $pK_1 + pK_2$

2) $\sqrt{K_1 c_a}$ and $\frac{pK_1 + pK_2}{2}$

3) pK_1 and $\frac{pK_1 + pK_2}{2}$

4) $pK_1 + pK_w$ and $\frac{pK_1 + pK_2}{pK_w}$

26. A 0.10 M solution of fluoride ions is gradually added to a solution containing Ba^{2+}, Ca^{2+}, and Pb^{2+} ions, each at a concentration of 1×10^{-3} M. In what order, from first to last, will the precipitates of BaF_2, CaF_2 and PbF_2 form?

	K_{sp}
BaF_2	1.8×10^{-7}
CaF_2	1.5×10^{-10}
PbF_2	7.1×10^{-7}

1) CaF_2, PbF_2, BaF_2 2) BaF_2, CaF_2, PbF_2

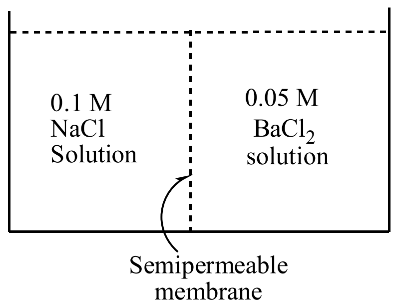
3) PbF_2, BaF_2, CaF_2 4) CaF_2, BaF_2, PbF_2

27. If solubility of Hg_2Cl_2 is s, then K_{sp} is

1) $4s^2$ 2) $4s^3$

3) s^3 4) $4s^4$

28. In the given figure, with passage of time, the concentration is expected to change as



1) Concentration of NaCl increases

2) Concentration of $BaCl_2$ increases

3) both concentrations remain unchanged

4) both concentrations decrease

29. Which statement about the composition of the vapour over an ideal 1:1 molar mixture of benzene and toluene is correct? Assume the temperature is constant at 25^0C.

Vapour Pressure Data,

Benzene 75 mmHg

toluene 22 mmHg

1) The vapour will contain a higher percentage of benzene

2) The vapour will contain a higher percentage of toluene.

3) The vapour will contain equal amounts of benzene and toluene

4) Not enough information is given to make a prediction.

30. Moles of K_2SO_4 to be dissolved in 12 mol water to lower its vapour pressure by 10 mm of Hg at a temperature at which vapour pressure of pure water is 50 mm is :

1) 3 mol 2) 2 mol

3) 1 mol 4) 0.5 mol

MATHS

31. *A,* B and C are n-rowed square matrices and if A = B + C, C^2 = O and for $n \in N$,

$A^{n+1} = B^n [B + (n + 1) C]$, when

1) BC = CB. 2) AC=B

3)A=BC 4)NONE

32. All the elements of a square matrix A of order n are non-negative. If a_{ij}, $\forall i \neq j$, is the least non-negative value of the function. f(x) = $x^2 + 2x - 1$ and tr (A) = l, then maximum value of |A| will be

1) l^n 2) $(n)^n$

3) $\left(\frac{1}{n}\right)^n$ 4) $\ln(n)^n$

33. If every element of a square non singular matrix A is multiplied by k and the new matrix is denoted by B then $|A^{-1}| and |B^{-1}|$ are related as

1) $|A^{-1}| = K|B^{-1}|$ 2) $|A^{-1}| = \frac{1}{K}|B^{-1}|$

3) $|A^{-1}| = K^n|B^{-1}|$ 4) $|A^{-1}| = K^{-n}|B^{-1}|$

34. Area formed by $|2x-3|+|2y+6| = 8$ is

1)4 2)32

3)16 4)6

35. A, B, C are three matrices of the same order such that any two are symmetric and remaining 3rd one is skew symmetric. Now X = ABC + CBA and Y = ABC - CBA, then $(XY)^T$ is

1) symmetric 2)skew symmetric

3) I -XY 4) -YX

36. The point (4, 1) undergoes the following three transformations successively.

(i) Reflection about the line $y = x$

(ii) Translation through a distance 2 units along the positive direction of x- axis

(iii) Rotation through an angle $\frac{\pi}{4}$ about the origin in the anticlockwise direction.

The final position of the point is given by the coordinates

1) $\left(\frac{1}{\sqrt{2}}, \frac{7}{\sqrt{2}}\right)$ 2) $\left(-2, 7\sqrt{2}\right)$

3) $\left(-\frac{1}{\sqrt{2}}, \frac{7}{\sqrt{2}}\right)$ 4) $\left(\sqrt{2}, 7\sqrt{2}\right)$

37. Line L has intercepts a and b on the coordinate axes, when the axes are rotated through a given angle; keeping the origin fixed, the same line has intercepts p and q, then

1) $a^2+b^2=p^2+q^2$

2) $\frac{1}{a^2}+\frac{1}{b^2}=\frac{1}{p^2}+\frac{1}{q^2}$

3) $a^2+p^2=b^2+q^2$

4) $\frac{1}{a^2}+\frac{1}{p^2}=\frac{1}{b^2}+\frac{1}{q^2}$

38. A ray of light coming from the point (1, 2) is reflected at a point A on the x-axis and then passes through the point (5, 3). The coordinates of the point A are

1) $\left(\frac{13}{5}, 0\right)$ 2) $\left(\frac{5}{13}, 0\right)$

3) $(-7, 0)$ 4) none of these

39. Two rods of lengths a and b slide along the x-axis and y-axis respectively in such a manner that their ends are concyclic. The locus of the centre of the circle passing through the end points is

1) $4\left(x^2+y^2\right)=a^2+b^2$

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

3) $4\left(x^2-y^2\right)=a^2-b^2$

4) $x^2-y^2=a^2-b^2$

40. If a line segment AM=a moves in the XY plane and always parallel to OX so that the left end point A slides along the circle $x^2+y^2=a^2$, the locus of M is

1) $x^2+y^2=4a^2$

2) $x^2+y^2=2ax$

3) $x^2+y^2=2ay$

4) $x^2+y^2-2ax-2ay=0$

41. The coordinates of point P are (a,b) where a is root of the equation $x^2+x-42=0$ and b is integral root of the equation $x^2+ax+\left(a^2-37\right)=0$.

The co ordinates P can be

1) $(6,4)$ 2) $(-7,4)$

3) $(-7,-3)$ 4) $(6,-3)$

42. If the points $A(3,4), B(7,12)$ and $P(x,x)$ are such that $(PA)^2 > (PB)^2 > (AB)^2$ then the integral value of x can be

1) 7 2) 12

3) 10 4) 20

43. $A_{i+1}, B_{i+1}, C_{i+1}$ be the points which divides respectively the sides B_iC_i, C_iA_i, A_iB_i of triangle $A_iB_iC_i$ internally in the ratio 2:3 for all i=1,2,3……if $A_1 = (3,4), B_1 = (0,2), C_1 = (6,-3)$ then the centroid of the triangle $A_8B_8C_8$ is

1) $(3,1)$ 2) $\left(\frac{3}{2^7},1\right)$

3) $\left(\frac{1}{3},1\right)$ 4) $\left(\frac{1}{3^7},\frac{1}{2^7}\right)$

44. A variable line "L" is drawn through 0(0,0) to meet the lines L_1 and L_2 given by $y-x-10=0$ and $y-x-20=0$ at the points A and B respectively.
A point P is taken on 'L' such that $\frac{2}{OP}=\frac{1}{OA}+\frac{1}{OB}$ then the locus of P is

1) $3x+3y=40$ 2) $3x+3y+40=0$

3) $3x-3y=40$ 4) $3y-3x=40$

45. A rod of length l moves such that its ends A and B always lie on the lines $3x-y+5=0$ and $y+5=0$ respectively. The locus of the point P, which divides AB internally in the ratio 2:1, is $l^2=\frac{1}{k}(ax-by-5)^2+9(y+3)^2$ then

1) K=4,a+b=6 2) $k=3, a+b=5$

3) $a+b=0, k=2$ 4) $K=1, a+b=4$

46. A line cuts the x-axis at $A(7,0)$ and the y- axis at $B(0,-5)$.A variable line PQ is drawn perpendicular to AB cutting the x-axis at P and Y-axis at Q. If AQ and BP intersect at R and the locus of R is $x^2+y^2-ax+by=0$ then

1) a=7,b=5 2) a=-7,b=3

3) a=3,b=6 4) a=1,b=-1

47. Let $A(2,-3)$ and $B(-2,1)$ be vertices of a $\Delta^{le} ABC$ if the centroid of this triangle moves on the line $2x+3y=1$, then the locus of the vertex C is the line

1) $2x+3y=9$ 2) $2x-3y=7$

3) $3x+2y=5$ 4) $3x-2y=3$

48. The coordinate axes are rotated through an angle 22^0 about the origin, If the equation $4x^2+12xy+9y^2+6x+9y+2=0$ changes to $ax^2+2hxy+by^2+2gx+2fy+c=0$ then

1) $\frac{h}{a}=\frac{3}{5}$ 2) $\frac{h}{c}=3$

3) $\frac{g}{c}=\frac{1}{2}$ 4) $\frac{a}{c}=4$

49. The coordinate axes are rotated through an angle θ about the origin in anticlock wise sense, If the equation $2x^2+3xy-6x+2y-4=0$ changes to $ax^2+2hxy+by^2+2gx+2fy+c=0$ then a+b=

1)1 2)0

3)2 4)3

50. $A_1,A_2,A_3.....A_n$ are n points whose coordinates are $(x_1,y_1),(x_2,y_2),(x_3,y_3).....(x_n,y_n).A_1A_2$ is bisected at $G_1.G_1A_3$ divided in the ratio 1:2 at $G_2.G_2A_4$ is divided in the ratio 1:3 at G_3 and so on until all the points are exhausted. Then the coordinates of the final point so obtained is

1) $\left(\frac{lx_1+mx_2+kx_3}{l+m+k},\frac{ly_1+my_2+ky_3}{l+m+k}\right)$

2) $\left(\frac{\sum x_1}{n-1},\frac{\sum y_1}{n-1}\right)$

3) $\left(\frac{\sum x_i}{\sum i},\frac{\sum y_i}{\sum i}\right)$

4) $\left(\frac{\sum x_i}{n},\frac{\sum y_i}{n}\right)$

51. Let $S_1,S_2,.....$ be the squares such that for each $n\geq 1$ the length of the side S_n is equal to length of the diagonal of S_{n+1}. If the length of the side of S_1 is 10 cm, then the least value of n for which area of $S_n<1$sq.cm given by

1) 7 2) 8

3) 9 4) 10

52. If the square ABCD where $A(0,0),B(2,0),C(2,2)$ and $D(0,2)$ undergoes the following three transformations successively

i) $f_1(x,y)\rightarrow(y,x)$

space for rough work

ii) $f_2(x,y) \to (x+3y, y)$

iii) $f_3(x,y) \to \left(\frac{x-y}{2}, \frac{x+y}{2}\right)$

Then the final figure is

1) Square 2) parallelogram

3) Rhombus 4) rectangle

53. The variable line drawn through the point the point (1,3) meets the x-axis at A and y-axis at B. If the rectangle OAPB is completed .Where "O" in the origin, then locus of "P" is

1) $\frac{1}{y}+\frac{3}{x}=1$ 2) $x+3y=1$

3) $\frac{1}{x}+\frac{3}{y}=1$ 4) $3x+y=1$

54. The straight line passing through the point (8,4) and cuts y-axis at B x-axis at A. The locus of mid point of AB is

1) $xy+2x+4y=64$

2) $xy-2x-4y=0$

3) $xy-4x-2y+8=0$

4) $xy+4x+2y=72$

55. P and Q are two variable points on the axes of x and y respectively such that $|OP|+|OQ|=a$, then the locus of foot of perpendicular from origin on PQ is

1) $(x-y)(x^2+y^2)=axy$

2) $(x+y)(x^2+y^2)=axy$

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

4) $(x+y)(x^2-y^2)=axy$

56. Given $P=(a,0)\ and\ Q=(-a,0)$ and R is a variable point on one side of the line PQ such that $\angle RPQ-\angle RQP=2\alpha$. The locus of the point R is

1) $x^2+y^2+2xy\cot 2\alpha=a^2$

2) $x^2-y^2+2xy\tan 2\alpha=a^2$

3) $x^2+y^2-2xy\tan 2\alpha=a^2$

4) $x^2-y^2+2xy\cot 2\alpha=a^2$

57. If $\sum_{i=1}^{4}(x_i^2+y_i^2)\le 2x_1x_3+2x_2x_4+2y_2y_3+2y_1y_4$ the points $(x_1,y_1),(x_2,y_2),(x_3,y_3),(x_4,y_4)$ are

1) The vertices of a rectangle

2) Collinear

3) The vertices of a trapezium

4) Rhombus

58. Through the point $p(\alpha,\beta)$, where $\alpha\beta>0$, the straight line $\frac{x}{a}+\frac{y}{b}=1$ is drawn so as to form a triangle of area S with the axes. If ab>0, then the least value of S is

1) $\alpha\beta$ 2) $2\alpha\beta$

3) $3\alpha\beta$ 4) none

59. The maximum area of the triangle whose sides a,b, and c satisfy $0\le a\le 1, 1\le b\le 2\ and\ 2\le c\le 3$ is

1)1 2)1/2

3)2 4) 3/2

60. If A, B and C are the angles of a triangle, then the matrix is

$$A=\begin{pmatrix}\sin 2A & \sin C & \sin B\\ \sin C & \sin 2B & \sin A\\ \sin B & \sin A & \sin 2C\end{pmatrix} is$$

1) Singular 2) non –singular

3) Idempotent 4) null matrix

PHYSICS

61. Let $\vec{u}$ be the initial velocity of a particle and $\vec{F}$ be the resultant force acting on it. Given

(A) If $\vec{u}\times\vec{F}=0$ and $\vec{F}$ is constant then the particle may retrace its path

(B) If $\vec{u}.\vec{F}=0$ and $\vec{F}$ is constant then the particle trajectory is parabola with increasing speed.

(C) If $\vec{u}\times\vec{F}=0$ and $\vec{F}$ is constant the particles travels along a straight line.

Then

1) A and B are only correct

2) A, B and C are correct

3) Band C are only correct

4) A, B and C are wrong

62. A ball is projected vertically up from the floor of a room. The ball experiences air resistance that is directly proportional to the speed of the ball. Just before hitting the ceiling the speed of the ball is 10m/s and its retardation is '2g'. The ball rebounds from the ceiling without any loss of speed and falls on the floor in 2

sec after making the impact with the ceiling. The height of the building is ($g=10ms^{-2}$)

1) 15m   2) 25m

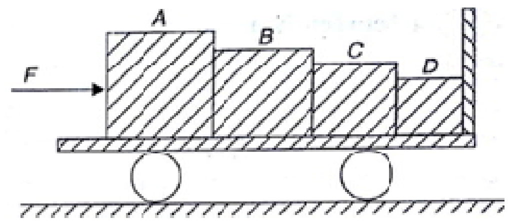
3) 30m al ground   4) 20m

63. N identical carts are connected to each other using strings of negligible mass. A pulling force F is applied on the first car and the system moves without friction along a horizontal ground. The tension in the string connecting 4^{th} and 5^{th} carts is twice the tension in the string connecting 8^{th} and 9^{th} cart. The number of carts is

1) 16   2) 12

3) 20   4) 8

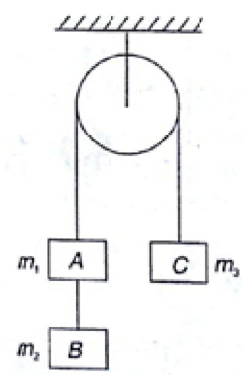
64. A toy cart has a mass of 4kg and is kept on a smooth horizontal surface. Four blocks A, B, C and D of masses 2kg, 2kg, 1kg and 1kg respectively have been placed on the cart as shown in the figure. A horizontal force F=40N is applied on the block A as shown. The contact force between the block D and the front vertical wall of the cart is



1) 16N   2) 20N

3) 24N   4) 8N

65. Three blocks A, B and C are placed in an ideal Atwood machine as shown in the figure. When the system is released from rest it was found that the tension in the string connecting A and C was more than thrice the tension in the string connecting A and B. The masses of the blocks A, B and C are m_1, m_2 and m_3 respectively. Then pick out the INCORRECT option of the following.



1) m_3 can have any finite value

2) $m_1 > 2m_2$

3) The ratio of the tensions in the strings mentioned above depends on m_3

4) All the blocks have same acceleration in magnitude

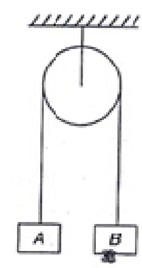
66. In an ideal Atwood machine having only two blocks on either side of pulley the sum of two masses is constant. If the string can sustain a tension equal to $\frac{24}{30}$ of the weight of the sum of the two masses the least acceleration of the masses would be (in ms^{-2}) ($g=10ms^{-2}$)

1) 2
2) 5
3) 4
4) 10

67. A load of 'W' Newton is to be raised vertically through a height 'h' using a light rope. The greatest tension that the rope can bear is 'ηW' (η>1). The least time of ascent if it is required that the load starts from rest and must come to rest when it reaches the height 'h' is

1) $\sqrt{\frac{4\eta h}{g(\eta-1)}}$
2) $\sqrt{\frac{4\eta h}{g(\eta+1)}}$
3) $\sqrt{\frac{2\eta h}{g(\eta+1)}}$
4) $\sqrt{\frac{2\eta h}{g(\eta-1)}}$

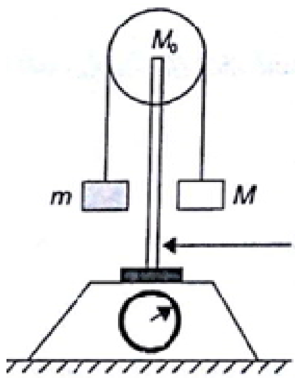
68. In the arrangement shown the system is in equilibrium. Mass of the block A is M and that of insect clinging to the block B is 'm'. The pulley is ideal and string is light. The insect loses the contact with the block B and begins to fall. The time after which the separation between the block B and insect becomes L is



1) $\sqrt{\frac{(2M-m)L}{Mg}}$
2) $\sqrt{\frac{(M-m)L}{Mg}}$
3) $\sqrt{\frac{4(M-m)L}{Mg}}$
4) $\sqrt{\frac{(M-m)L}{2Mg}}$

69. A pulley mounted on a stand which is placed on a weighing scale. The

combined mass of the stand and the pulley is M_0. A light string passes over the smooth pulley and the two masses m and M (>m) are connected to its free ends as shown. The reading of the weighing scale when the two masses are left free to move is



1) $\frac{4Mmg}{M+m}+M_0 g$ 2) $\frac{2Mmg}{M+m}+M_0 g$

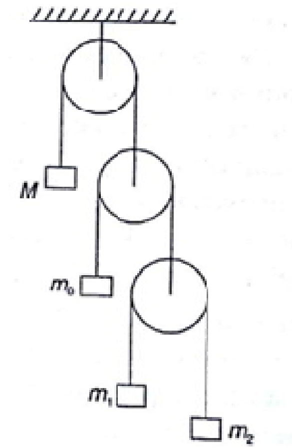
3) $\frac{4Mmg}{M+m}-M_0 g$ 4) $\frac{2Mmg}{M+m}-M_0 g$

70. A block is slides down a smooth inclined plane of angle of inclination θ. The maximum value of its horizontal component of acceleration is

1) $g\cos\theta$ 2) g/2

3) $\frac{g\cos\theta}{2}$ 4) g/4

71. In the given arrangement all strings and pulleys are light. When the system was released it was observed that M and m_0 do not move. Then pick out the INCORRECT option of the following.



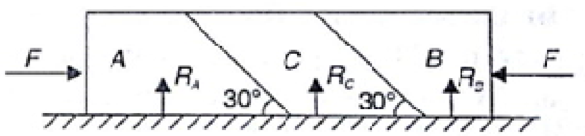
1) $M = \frac{8m_1m_2}{m_1+m_2}$

2) $m_0 = \frac{4m_1m_2}{m_1+m_2}$

3) If the string just above m_2 is cut all remaining masses fall with different accelerations

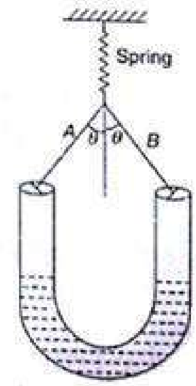
4) If the string just above m_2 is cut all remaining masses fall with same acceleration

72. Three blocks A,B and C each of mass 'm' are placed on a smooth horizontal table. All the other surfaces of contact are also smooth. A horizontal force 'F' is on each of the blocks A and B as shown. The ratio of normal forces exerted by the ground on A, B and C is $\left(F=\frac{mg}{2\sqrt{3}}\right)$



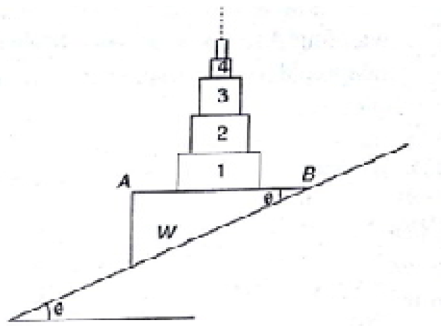
1) 1:1:1 2) 1:2:3
3) 3:1:2 4) 2:1:3

73. A U-shaped container has uniform cross sectional area 'S'. It is suspended vertically with the help of a spring and two strings A and B as shown in the figure. The spring and the strings are light. When water of density 'd' is poured slowly in to the container it is observed that the level of water remained unchanged with respect to the ground. The spring constant of spring is



1) 2Sdg 2) Sdg
3) Sdg/2 4) None

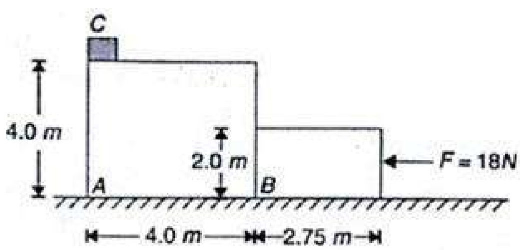
74. A triangular wedge 'W' having mass M is placed on an inclined plane with its face AB horizontal. Inclination of the incline is θ. On the horizontal surface of the wedge there is a lies an infinite tower of rectangular blocks. Blocks 1, 2, 3, 4…… have masses M,M/2,M/4,M/8,…..respectively. All the surfaces of contact are smooth. The contact force between the blocks 1 and 2 is



1) $\frac{Mg\cos^2\theta}{1+\sin^2\theta}$ 2) $\frac{Mg\cos^2\theta}{1+2\sin^2\theta}$

3) $\frac{2Mg\cos\theta}{1+2\sin^2\theta}$ 4) None

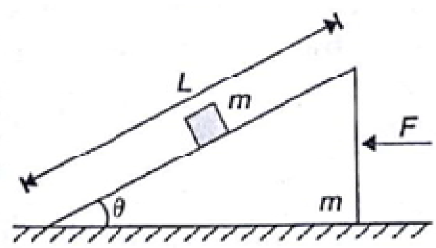
75. Blocks A and B have dimensions as shown in the figure and their masses are 8kg and 1kg respectively. A small block C of mass 0.5kg is placed on the top left corner of block A. All the surfaces of contact are smooth. A horizontal force F=18N is applied on the block B at time t=0. The time after which the block C will touch the ground is (take $g=10ms^{-2}$)



1) 2.9 sec 2) 3.9 sec

3) 4 sec 4) 2 sec

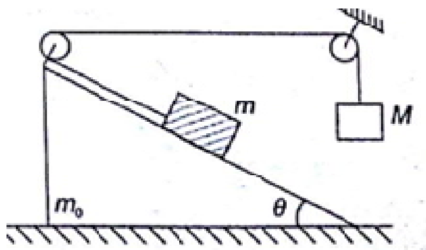
76. A wedge of mass 'm' is placed on a horizontal smooth table. A block of same mass is placed at the midpoint of smooth inclined surface having length 'L' as shown in the figure. If $\theta=45^0$ and the body is released and simultaneously a constant horizontal force is applied on the wedge as shown. The value of the force F is 1.5 times the value for which the block remains at rest with respect to the wedge. Then the time after which the block will come out of the inclined surface is



1) $\sqrt{\frac{3L}{g\sqrt{2}}}$ 2) $\sqrt{\frac{3L}{2g}}$

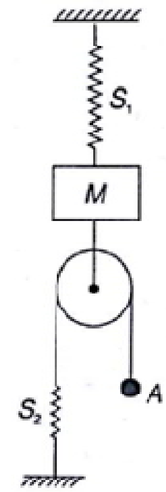
3) $\sqrt{\frac{L}{g\sqrt{2}}}$ 4) $\sqrt{\frac{\sqrt{2}L}{g}}$

77. In the system shown in the figure all the surfaces of contact are smooth and the string and pulley are light and the pulley is frictionless. $\theta=37^0$. When released from rest it was found that the wedge of mass $m_0$doenot move. The value of M/m is



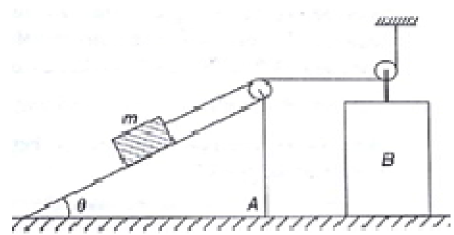
1) 0.2 2) 0.4
3) 5 4) 2.5

78. In the system shown in the figure the two springs S_1 and S_2 have force constant 'K' each. Initially the system is in equilibrium with spring S_1 stretched and the spring S_2 relaxed. The end A of the string is pulled down slowly through a distance 'L'. The distance by which the block of mass 'M' moves is



1) 2L/3 2) 2L/5
3) L/2 4) L/5

79. In the system shown all the surface of contact are smooth and the pulleys are ideal and the string is light. Block on the incline surface of A is 'm'. Mass of A and B are respectively '4m' and '2m'. The acceleration of the wedge 'A' when the system is released from rest is



1) 6g/47 2) 9g/47
3) 3g/47 4) 2g/47

80. A person applies a constant force $\vec{F}$ on a particle of mass 'm' and finds that the particle moves in a circle of radius 'r' with a uniform speed 'v' as seen (in the plane of motion) from an inertial frame of reference. Select the correct statement

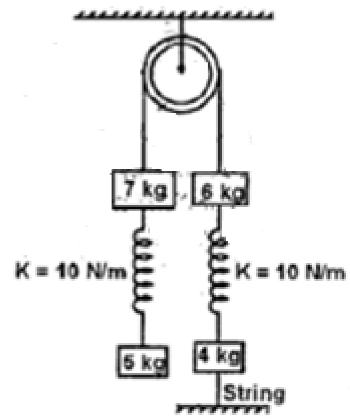
1) This is not possible

2) There are other forces acting on the particle

3) The resultant of the other forces is $\frac{mv^2}{r}$ directed towards the center

4) The resultant of the other forces varies in direction not in magnitude

81. In the given diagram the pulley is friction less and massless. Both the springs are having same force constant 10N/m. Initially with the string attached to the ground the total system is at rest. Now the string is cut, then immediately after cutting the string pick out the INCORRECT option of the following.



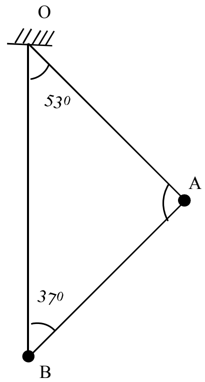
1) Acceleration of 7kg block is zero

2) Acceleration of 5kg block is zero

3) Acceleration of 6kg block is 100/6 ms^{-2}

4) Acceleration of 4kg block is $5ms^{-2}$

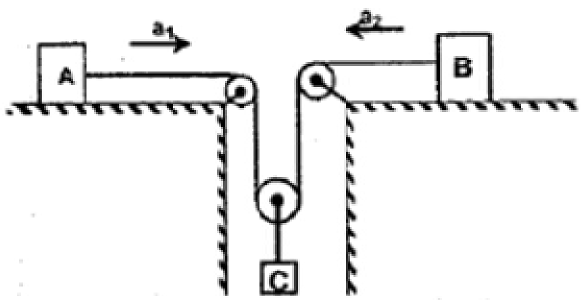
82. In the figure there are two particles A and B each of mass 'm'. A is connected to the ceiling by a light inextensible string OA and B is connected to A by light inextensible string AB. Initially the line OB is vertical. System is released from rest. Initial accelerations of A and B are α and β respectively. Then the value of $\frac{5\alpha}{2\beta}$ is



1) 2 2) 1

3)3 4) 4

83. Two blocks A and B are kept on smooth surfaces having accelerations $a_1 = 3t$ ms^{-2} and $a_2 = 4t^2$ ms^{-2} respectively. Block C is attached to massless and frictionless pulley as shown in the figure. Then at time t=2 sec (Assume initially the system is at rest)



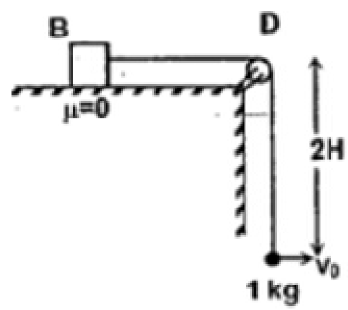
1) Velocity of block C is 25/6 ms^{-1}

2) Velocity of the block C is 30 ms^{-1}

3) Acceleration of the block C will be 11ms^{-2}

4) Acceleration of the block C will be 7 ms^{-2}

84. In the system shown in the figure a block B of negligible mass is connected to a particle of mass 1kg with non-stretchable string. Now the hanging particle is given a velocity $\sqrt{8gH}$ horizontally when the system is at rest. The initial acceleration of block B is '4K' ms^{-2}. The value of K is(g=10ms^{-2}, H=2m)

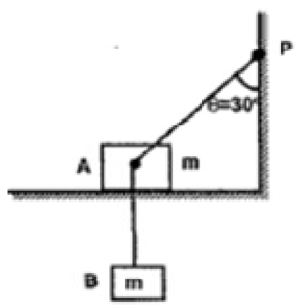


1) 4 2) 5

3) 7 4) 6

85. Block A is on a frictionless horizontal table. A massless and inextensible string fixed at one end passes over a smooth nail fixed with the block A. The other end

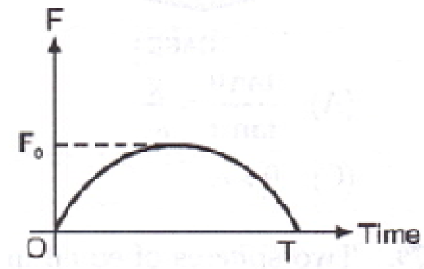
is connected to block B of mass m as shown in the figure. Initially the block B is held at rest so that θ=30^0. The magnitude of the acceleration of the block B just after the it is released is -------ms^{-2}(take g=10ms^{-2})



1) 2   2) 4

3) 3   4) 5

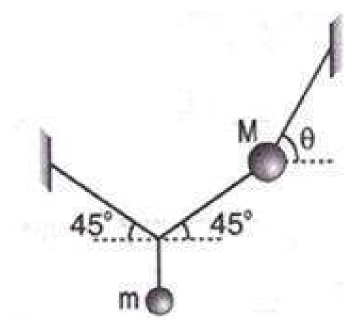
86. A particle of mass *m*, initially at rest, is acted upon by a variable force F for a brief interval of time T. It begins to move with a velocity *u* after the force stops acting. F is shown in the graph as a function of time. The curve is an ellipse.



1) $u = \frac{\pi F_0^2}{2m}$ 2) $u = \frac{\pi T^2}{8m}$

3) $u = \frac{\pi F_0 T}{4m}$ 4) $u = \frac{F_0 T}{2m}$

87. Two masses *m* and M are attached with strings as shown. For the system to be in equilibrium we have

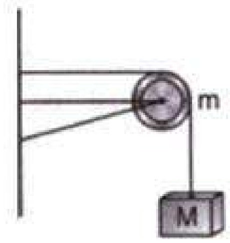


1) $\tan\theta = 1 + \frac{2M}{m}$ 2) $\tan\theta = 1 + \frac{2m}{M}$

3) $\tan\theta = 1 + \frac{M}{2m}$ 4) $\tan\theta = 1 + \frac{m}{2M}$

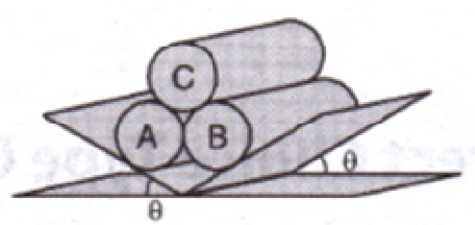
88. A string of negligible mass going over a clamped pulley of mass *m* supports a block of mass M as shown in the figure.

The force on the pulley by the clamp is given by



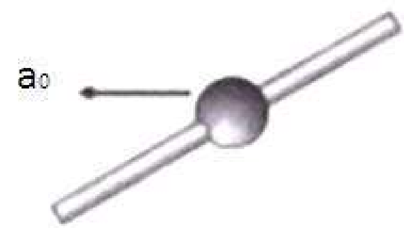
1) $\sqrt{2}Mg$
2) $\sqrt{2}mg$
3) $\left[\sqrt{(M+m)^2+m^2}\right]g$
4) $\left[\sqrt{(M+m)^2+M^2}\right]g$

89. Three identical rigid circular cylinders A, B and C arranged on smooth inclined surfaces as shown in figure. The least value of θ that prevents the arrangement from collapsing is



1) $\tan^{-1}\left(\frac{1}{2}\right)$
2) $\tan^{-1}\left(\frac{1}{2\sqrt{3}}\right)$
3) $\tan^{-1}\left(\frac{1}{3\sqrt{3}}\right)$
4) $\tan^{-1}\left(\frac{1}{4\sqrt{3}}\right)$

90. A bead of mass *m* is fitted on a rod and can move on it without friction. Initially the bead is at the middle of the rod and the rod moves translationally in a horizontal plane with an acceleration a_0 in a direction forming an α with the rod. The acceleration of bead with respect to rod is



1) $g\sin\alpha$
2) $(g+a_0)\sin\alpha$
3) $g\sin\alpha + a_0\cos\alpha$
4) $g\sin\alpha - a_0\cos\alpha$

Master JEE CLASSES

Kukatpally, Hyderabad.

IIT-JEE-MAINS PAPER-3

Max. Marks: 360

KEY SHEET

CHEMISTRY

1	**1**	2	**1**	3	**2**	4	**3**	5	**2**	6	**2**
7	**4**	8	**2**	9	**1**	10	**2**	11	**3**	12	**1**
13	**4**	14	**1**	15	**2**	16	**2**	17	**1**	18	**3**
19	**4**	20	**2**	21	**1**	22	**3**	23	**3**	24	**2**
25	**3**	26	**4**	27	**2**	28	**2**	29	**1**	30	**3**

MATHS

31	**1**	32	**3**	33	**3**	34	**2**	35	**4**	36	**3**
37	**2**	38	**1**	39	**3**	40	**2**	41	**2**	42	**4**
43	**1**	44	**4**	45	**1**	46	**1**	47	**1**	48	**2**
49	**3**	50	**4**	51	**2**	52	**2**	53	**3**	54	**2**
55	**2**	56	**4**	57	**1**	58	**2**	59	**1**	60	**1**

PHYSICS

61	**2**	62	**4**	63	**2**	64	**1**	65	**3**	66	**1**
67	**4**	68	**1**	69	**1**	70	**2**	71	**3**	72	**3**
73	**1**	74	**2**	75	**1**	76	**1**	77	**1**	78	**2**
79	**1**	80	**2**	81	**3**	82	**1**	83	**3**	84	**2**
85	**1**	86	**3**	87	**1**	88	**4**	89	**3**	90	**4**

SOLUTIONS:
CHEMISTRY

1. $P = K_m X$

As $T \uparrow K_m \uparrow$ i.e. $\frac{1}{K_m} \downarrow \Rightarrow \text{slope} \downarrow$

$\therefore T_3 > T_2 > T_1$

2. $P_A^0 = 300$ torr

$P_B^0 = 800$ torr

Normal boiling point $\Rightarrow$ $P_s = P_{atm} = 760$ torr

$760 = 300X_A + 800(1 - X_A)$

$500X_A = 40$

$X_A = \frac{40}{500} = 0.08$

3. $p^o = 17.54$

After $V_2 = \frac{v}{2}$, V.P of H_2O does not change

vapour corresponding to $\frac{v}{2}$ and $P = 17.54$ mm and $T = 20^0C$ is converted to liquid

4. $P_{air} = 750 = P_{dryair} + P_{benzene}$

$\Rightarrow P_{dryair} = 750 - 100 = 650$

On making volume 1/3[rd], P_{dryair} becomes

3 times $\Rightarrow P^1 = 650 \times 3 = 1950$

new $P_{air} = 1950 + P_{benzene}$ = 1950+1000

= 2050 torr

5. $n_{benzene} = \frac{1560}{78} = 20$

$n_{chlorobenzene} = \frac{112.5}{112.5} = 10$

Boiling point $\Rightarrow P_s = P_{ext} \Rightarrow 1000 = P_B + P_{CB}$

$1000 = \frac{2}{3} \times P_B^0 + \frac{1}{3} \times P_{CB}^0$

$3000 = 2P_B^0 + P_{CB}^0 \qquad (\text{at that } T)$

at 90^0C, $2\times1000+200\neq3000$

at 100^0C, $2\times1350+300\neq3000$

at 110^0C, $2\times1800+400\neq3000$

at 120^0C, $2\times2200+540\neq3000$

$\therefore 100^0C$

6. $i=1+(n-1)\alpha$

$4=1+(n-1)0.75$

$(n-1)\frac{3}{4}=3\Rightarrow n=5=\text{no. of ions}$

$B_a^a\left[Co(CN)_x\right]_b$

$2a+(2-x)b=0-\quad(1)\qquad(0x.\ nos.)$

$a+b=5\ -\quad(2)\qquad(\text{from } n=5)$

$\Rightarrow 2(a+b)-bx=0$

$2\times5-bx=0\Rightarrow bx=10\ -\ (3)$

Value of b $\in$ a, b, x are integers is 2 or 1

i.e. x = 5 or 10

$\therefore$ Ans = 5

7. If P_1, P_2 and P_3 are vapour pressure of solutions in vessel 1,2 and 3 respectively. After passing

through vessel-1, pH_2O in dry air is P_1. After passing through vessel – 2, pH_2O is P_2. Given vessel-

2 gains weight.

$\Rightarrow P_2<P_1$

similarly vessel-3 loses weight $\Rightarrow P_3>P_2$

$P_1>P_2\Rightarrow C_1<C_2$

$P_3>P_2\Rightarrow C_3<C_2$

$\therefore$ Both (1) and (2) are correct

8. $4KI_{(aq)}+HgCl_{2(s)}\rightarrow K_2\left[HgI_4\right]_{(aq)}+2KCl_{(aq)}$

Total Conc. of ions initially = $(4\times2)C=8C$

Total Conc. of ions finally = $(1\times 3)C+(2\times 2)C=7C$

$\therefore$ conc. of solutions decreases

Hence boiling point decreases

Freezing point decreases

Vapour pressure increases

9. $\Delta T_f = ik_f m$

$$i=\frac{1.24\times\left(\frac{50}{1000}\right)}{34.3\times\left(\frac{0.849}{271}\right)}<1\Rightarrow \text{association}$$

$$\Rightarrow Hg_2Cl_2$$

10. Transfer happens till V.P are equal

i.e effective conc are equal

if x is volume transferred from beaker 1 to 2

$$\Rightarrow\left(\frac{0.05\times 20}{20-x}\right)=2\times\left(\frac{0.03\times 20}{20+x}\right)$$

$$(20+x)=(24-1.2x)$$

$$x=\frac{2}{1.1}=1.8\text{mL}$$

$\therefore$ Final volume in beaker 1 = $20-1.8=18.2$ mL

Beaker 2= 20+1.8 = 21.8 mL

11. $\pi = CST$

$$\pi=\frac{n}{v}ST=\frac{W_{(kg)}}{V_{(m^3)}}\times\frac{ST}{M}$$

$$\therefore \text{slope} = \frac{ST}{M}\Rightarrow\frac{8.314\times 293}{M_{(kg/mol)}}=8.314\times 10^{-3}$$

$$\Rightarrow M = 293\times 10^{3}\text{kg/mol}$$

12. max freezing point $\Rightarrow$ min effective conc.

1) $\frac{6}{60}=0.1\text{mol}$

2) $\frac{6}{60}(1+\alpha)=0.1(1+\alpha)\text{mol}$

3) $\frac{6}{36.5}\times 2=0.3$

13. 2) HF is a weaker acid $\Rightarrow$ lower conc $\Rightarrow$ higher F.P

3) effective conc. of both is 1M

14. $P\overset{0}{A} = 40 \qquad P_A = 32$

$P_A = P\overset{0}{A} X_A = 40X_A \Rightarrow X_A = 0.8$

15. $\Delta T_f = iK_f m$

$0.02046 = i \times k_f \times 0.01$ - (1) (CH_3COOH)

$1.86 = K_f \times 1$ - (2) (urea)

$i = \frac{0.02046}{1.86 \times 0.01} = 1 + \alpha$

$\Rightarrow \alpha = 0.1$

$[H^+] = c\alpha = 0.01 \times 0.1 = 10^{-3}$

pH = 3

16. $\Delta T_f = k_f m$

$= 1.86 \times 0.5 = 0.93^0$

$\therefore T_f = 0 - 0.93 = -0.93^0 C$

17. Conceptual

18. max. freezing point $\Rightarrow$ less effective conc.

1) $0.4 \times 4 = 1.6M$

2) $BaSO_4$ is ppted out. Left over ions :

$[Cl^-] = 0.2$

$[SO_4^{2-}] = 0.1$

$[Na^+] = 0.4$

0.7 M

3) 0.3 M

4) $0.1 \times 5 = 0.5M$

$\therefore (3)$

19. $AgA_{(s)} \rightleftharpoons Ag^+ + A^-$

$\qquad x \qquad x - y$

$$A^- + H_2O \rightleftharpoons HA + OH^-$$
$$x-y \qquad y \qquad y$$

$$x(x-y) = Ksp \; ; \frac{y^2}{(x-y)} = \frac{k_w}{k_a} = \frac{10^{-14}}{10^{-10}} = 10^{-4}$$

$$\left[OH^-\right] = \frac{10^{-14}}{10^{-9}} = 10^{-5}$$

$$\Rightarrow y = 10^{-5}$$

$$\frac{\left(10^{-5}\right)^2}{\left[A^-\right]} = 10^{-4}$$

$$\left[A^-\right] = \frac{10^{-10}}{10^{-4}} = 10^{-6} = (x-y)$$

$$\Rightarrow x = 10^{-6} + 10^{5} = 1.1 \times 10^{-5} = \left[Ag^+\right]$$

$$\left[Ag^+\right]\left[Ag^-\right] = 1.1 \times 10^{-5} \times 10^{-6}$$

$$= 1.1 \times 10^{-11}$$

$$\left[Ag^+\right] > \left[A^-\right]$$

20. mmoles of $M(CN)_2 = 10$

mmoles of $H_2SO_4 = 5$

$$M(CN)_2 \rightleftharpoons M^{+2} + 2CN^-$$

$$10(1-0.08) \quad 10 \times 0.8 \quad 2 \times 10 \times 0.8$$

= 2 8 16

$$H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$$

$$5(1-0.8) \quad 2 \times 5 \times 0.8 \quad 5 \times 0.8$$

= 1 8 4

$$H^+ + CN^- \rightarrow HCN$$

8 16

-8 -8 +8

----

8 8

$\therefore$ it's a buffer of HCN

$pH = pK_a + \log\frac{CN^-}{HCN} = (14-6) + \log 1$

$= 8$

21. buffer poH= $pK_b + \log\frac{[NH_4^+]}{[NH_3]}$

$= 6 + \log\frac{0.01}{0.1} = 5$

$[OH^-] = 10^{-5}$

$[Mg^{+2}][OH^-]^2 \le Ksp$

$\Rightarrow [Mg^{+2}] \le \frac{(1.2\times10^{-12})}{10^{-10}} = 1.2\times10^{-2}$

22. $PbSO_4 \rightleftharpoons Pb^{+2}$

$S^2 = 4\times10^{-10}$

$S = 2\times10^{-5} mol/lit$

$\therefore$ solubility in 5 lit of $H_2O = 2\times10^{-5}\times5$

i.e weight = $303\times10^{-4} = 0.0303gm$

= $30.3mg$

23. 1) pH at eq pt of CH_3COOH & $NH_4OH = 7$ (beyond range)

2) pH of 0.1 M NaOH = 13 $\rightarrow$ red

0.001M NaOH = 11 $\rightarrow$ red

3) $NH_4Cl \rightarrow$ acidic, $CH_3COONa \rightarrow$ basic

$\Rightarrow$ yellow $\Rightarrow$ blue

4) CH_3COOH titration gives basic solu at eq pt

$\therefore$ W not suitable

24. $[CH_3COO^-]$ at eq pt = $\frac{0.01}{2} = 0.005M$

pH= $7 + \left(\frac{pKa + \log C}{2}\right)$

$= 7 + \left(\frac{5 - \log 5 - 3 + \log 5}{2}\right)$

$= 7 + 1 = 8$

25. 1^{st} Inflection pt $\Rightarrow$ 1^{st} neutralization pt

half way $\Rightarrow \left[HA^-\right] = \left[H_2A\right]$

$$\Rightarrow pH = pKa_1 + \log\frac{\left[HA^-\right]}{\left[H_2A\right]} = pKa_1$$

at neutralization pt, only HA^- is present

$$\Rightarrow pH = \frac{pKa_1 + pKa_2}{2}$$

26. $\left[F^-\right]$ req for ppth of

1) $BaF_2 = \sqrt{\frac{Ksp}{\left[Ba^{+2}\right]}} = \sqrt{\frac{1.8\times10^{-7}}{10^{-3}}}$

2) $CaF_2 = \sqrt{\frac{1.5\times10^{-10}}{10^{-3}}}$

3) $PbF_2 = \sqrt{\frac{7.1\times10^{-7}}{10^{-3}}}$

$\therefore$ $\left[F^-\right]$ req for $CaF_2 < BaF_2 < PbF_2$

$\therefore CaF_2$ ppts 1^{st}

27. $HgCl_{2(s)} \rightleftharpoons Hg_2^{2+} + 2Cl^-$

$\qquad\qquad\qquad s \qquad\quad 2s$

$Ksp = (s)(2s)^2$

$= 4s^3$

28. effective conc. of NaCl sol $= 0.1\times2 = 0.2M$

effective conc. of $BaCl_2$ $soln = 0.05\times3 = 0.15M$

$\therefore \pi_{Nacl} > \pi_{Bacl_2}$

$\Rightarrow$ Solvent flows from $BaCl_2$ to NaCl sol

$\Rightarrow$ Conc. $BaCl_2 \uparrow$ & Conc. of $NaCl\downarrow$

29. $X_B = 1/2 \qquad X_T = 1/2$

$P_B^0 = 75 \qquad P_T^0 = 22$

$$\frac{Y_B}{Y_T} = \left(\frac{P_B^0}{P_T^0}\right)\left(\frac{X_B}{X_T}\right) = \frac{75}{22}\times\frac{1}{1} \quad > 1$$

$\Rightarrow Y_B > Y_T$

30. If moles of $K_2SO_4 = x$

$$RLVP = \frac{10}{50} = \frac{3x}{3x+12}$$

$3x + 12 = 15x$

$x = 1$

MATHS

31. $A^2 = B[B+2C]\ \ (B+C)^2 = B[B+2C] \Rightarrow BC = CB$

32. $tr = (A) = a_{11} + a_{22} + a_{33} + ...a_{nn} \geq n\sqrt[n]{a_{11}a_{22}a_{33}.........a_{nn}} = n\sqrt[n]{|A|}$

33. $B = KA|B| = K^n |A|$

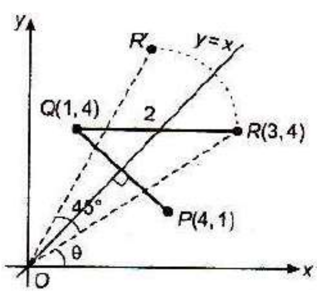
$$\frac{1}{|B^{-1}|} = \frac{K^{-n}}{|A^{-1}|} \Rightarrow |A^{-1}| = K^n |B^{-1}|$$

34. Conceptual

35. $(XY)^T = Y^T X^T = -YX\ SINCE\ X^T = X\ \ Y^T = -Y$

36. Image of the point P about the line $y = x$ is $Q(1, 4)$

$\therefore$ Transformation through a 2 units along the positive direction of $x-axis$, then new point



$R(1+2, 4)$ ie, R(3, 4)

$\therefore\ \ OR = OR' = 5$

and $\tan\theta = 4/3$

$$\therefore \sin\theta = \frac{4}{5}\ \ and\ \ \cos\theta = \frac{3}{5}$$

Then , final position of the point is $[(OR'\cos(\pi/4+\theta), OR'\sin(\pi/4+\theta))]$

$$\Rightarrow\left[5\left(\left\{\frac{1}{\sqrt{2}}\cos\theta-\frac{1}{\sqrt{2}}\sin\theta\right\}\right),5\left(\frac{1}{\sqrt{2}}\cos\theta+\frac{1}{\sqrt{2}}\sin\theta\right)\right]$$

$$\Rightarrow\left(-\frac{1}{\sqrt{2}},\frac{7}{\sqrt{2}}\right)$$

37. Equation of L is $\frac{x}{a}+\frac{y}{b}=1$ and let the axis be rotated through an angle θ and let (X, Y) be the new coordinates of any point $P(x, y)$ in the plane, then $x = X\cos\theta - Y\sin\theta$, $y = X\sin\theta - Y\cos\theta$, the equation of the line with reference to original coordinates is $\frac{x}{a}+\frac{y}{b}=1$

ie, $\frac{X\cos\theta-Y\sin\theta}{a}+\frac{X\sin\theta+Y\cos\theta}{b}=1$ ………………(i)

and with reference to new coordinates is

$\frac{X}{p}+\frac{Y}{q}=1$ ……………………(ii)

Comparing Eqs. (i) and (ii), we get

$\frac{\cos\theta}{a}+\frac{\sin\theta}{b}=\frac{1}{p}$ ……………………(iii)

$\frac{-\sin\theta}{a}+\frac{\cos\theta}{b}=\frac{1}{q}$ ……………………(iv)

Squaring and adding Eqs. (iii) and (iv), we get

$$\frac{1}{a^2}+\frac{1}{b^2}=\frac{1}{p^2}+\frac{1}{q^2}$$

38. Let the coordinates of A be (a, 0). Then the slope of the reflected ray is

$\frac{3-0}{5-a}=\tan\theta(say)$ …………………..(i)

Then the slope of the incident ray

$=\frac{2-0}{1-a}=\tan(\pi-\theta)$ ……………………(ii)

From Eqs. (i) and (ii),

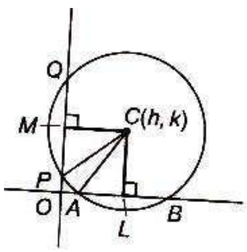
$$\tan\theta+\tan(\pi-\theta)$$

$$\Rightarrow \quad \frac{3}{5-a}+\frac{2}{1-a}=0$$

$$\Rightarrow \quad 3-3a+10-2a=0;\ a=\frac{13}{5}$$

Thus, the coordinate of A is $\left(\frac{13}{5},\ 0\right)$

39. Let $C(h,\ k)$ be the centre of the circle passing through the end points of the rod AB and PQ of lengths a and b respectively, CL and CM be perpendiculars from C on AB and PQ respectively. Then CA=CP (radii of the same circle)



$$\Rightarrow\ k^2+\frac{a^2}{4}=h^2+\frac{b^2}{4}\ (\because\ AL=a/2\ and\ MP=b/2)$$

$$\Rightarrow 4\left(h^2-k^2\right)=a^2-b^2$$

40. Let $\angle AOL=\theta$

$$\therefore\ A\equiv(a\cos\theta,\ a\sin\theta)$$

$$\therefore\ M\equiv(a+a\cos\theta,\ a\sin\theta)$$

$$x=a+a\cos\theta$$

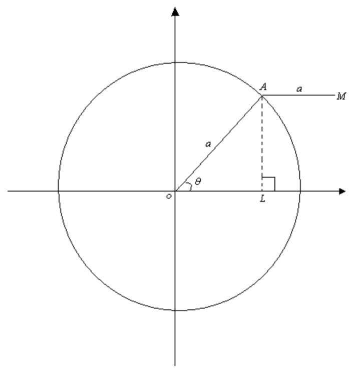
$$\Rightarrow (x-a)=a\cos\theta \qquad ....(i)$$

$$and \qquad y=a\sin\theta \qquad ....(ii)$$

From Eqs. (i) and (ii),

$$(x-a)^2+y^2=a^2$$

$\Rightarrow \quad x^2 + y^2 - 2ax = 0$



$\Rightarrow \quad x^2 + y^2 = 2ax$

41. $a^2 + a - 42 = 0$

$a = -7 \; or \; 6$

If $a = -7 \therefore b = 4 \; or \; 3$

$\therefore P(-7,4) \; or \; (-7,3)$

If $a = 6$ not possible

42. $(pA)^2 > (pB)^2$

$\Rightarrow x > 7$

$(pB)^2 > (AB)^2$

$(x-7)^2 + (x-12)^2 > 80$

$x = 20$ satisfies

43. centroid remains same for all triangles

44. I) $\dfrac{x}{\cos\theta} = \dfrac{y}{\sin\theta} = r$ putting in L_1 we get

$\dfrac{1}{OA} = \dfrac{\sin\theta - \cos\theta}{10}$;putting in L_2 we get

$\dfrac{1}{OB} = \dfrac{\sin\theta - \cos\theta}{10}$ let $p(h,k)$ and op = r we get

$\dfrac{2}{r} = \dfrac{\sin\theta - \cos\theta}{10} + \dfrac{\sin\theta - \cos\theta}{20}; 3y - 3x = 40$

II) $r^2 = \dfrac{200}{(\sin\theta - \cos\theta)^2}$ hence locus in $(y-x)^2 = 200$

45. A point on y+5 =0 is $B(\beta,-5), p(x,y)$ divides AB in the ratio 2:1,

$$x=\frac{d+2\beta}{3}, y=\frac{3\alpha-5}{3} \therefore \alpha=\frac{3y+5}{3}$$

$$\beta=\frac{9x-3y-5}{6}$$

But $l^2=AB^2=(\alpha-\beta)^2+(3\alpha+10)^2$

Or $l^2=\frac{1}{4}(3x-3y-5)^2+9(y+3)^2$

46. p is the ortho center of ΔABQ

$\therefore \angle BRA=90^o$

R lies on the circle with AB as a diameter

$\therefore$ the locus of R is the circle

$(x-0)(x-7)+(y+5)(y-0)=0$

Or, $x^2+y^2-7x+5y=0$

47. Let (x,y) be coordinate of vertex C and (x_1,y_1) be coordinates of centroid of the triangle.

$$x_1=\frac{x_1+2-2}{2} \textit{ and } y_1=\frac{y-3+1}{3}$$

$$x_1=\frac{x}{3} \textit{ and } y_1=\frac{y-2}{3}$$

The centroid (x_1,y_1) lies on the line $2x+3y=3$ So, x_1 and y_1 satisfies the equation of line

$2x_1+3y_1=1$

$$2\left(\frac{x}{3}\right)+3\left(\frac{y-2}{3}\right)=1$$

$2x+3y=9$,which is the required locus of the vertex C.

48. $a=4, c=2, g=3, h=6$

49. $x=x\cos\theta-y sin\theta$

$y=x\sin\theta+y\cos\theta$

50. $$G_1=\left(\frac{x_1+x_2}{2},\frac{y_1+y_2}{2}\right)\Rightarrow G_2=\left(\frac{x_1+x_2+x_3}{3},\frac{y_1+y_2+y_3}{3}\right).........G_n=\left(\frac{\sum x_i}{n},\frac{\sum y_i}{n}\right)$$

51. $$\left(\frac{10}{\left(\sqrt{2}\right)^{n-1}}\right)^2<1\Rightarrow 100<2^{n-1}\Rightarrow n=8$$

52. under the transformations f_1, f_2 *and* f_3, $A(0,0)\rightarrow(0,0)\rightarrow(0,0)\rightarrow A_1(0,0)$

$B(2,0)\rightarrow(0,2)\rightarrow(6,2)\rightarrow B_1(2,4)\Rightarrow C(2,2)\rightarrow(8,2)\rightarrow C_1(3,5)$

$\Rightarrow D(0,2)\rightarrow(2,0)\rightarrow(2,0)\rightarrow D_1(1,1)$

Clearly $A_1B_1 \| D_1C_1 \| B_1C_1 \| A_1D_1$ *and* A_1C_1 is nor perpendicular to B_1D_1. Therefore $A_1B_1C_1D_1$ is parallelogram

53. let the line be $\frac{x}{a}+\frac{y}{b}=1$. If passes through $(1,3)\Rightarrow\therefore\frac{1}{a}+\frac{3}{b}=1\Rightarrow A(a,0)B(o,b)$

$\therefore$ The locus of $p(a,b) is (x,y).\Rightarrow\therefore\frac{1}{x}+\frac{3}{y}=1$

54. Let the equation of $AB\frac{x}{a}+\frac{y}{b}=1-(1)$. Let $p(h,k)$ locus of midpoint of AB. $a=2h, b=2k$

substitute in (1) $\Rightarrow\frac{x}{2h}+\frac{y}{2k}=1\Rightarrow\frac{1}{2}(kh+hy)=hk$ and passes through the point

$(x,y)=(8,4)$

$\Rightarrow\frac{1}{2}(8k+4h)=hk\Rightarrow 2h+4k=hk\Rightarrow 2x+4y=xy$. The locus of p is $xy-2x-4y=0$

55. Let $P(\alpha,0)Q(0,\beta)$. Equation of the circle passing through OPR is $x^2+y^2-\alpha x=0$

$\Rightarrow\alpha=\frac{x^2+y^2}{x}\Rightarrow III^{ly}\beta=\frac{x^2+y^2}{y}\Rightarrow|\alpha|+|\beta|=a\Rightarrow 0(0,0),P(\alpha,0),Q(0,\beta)$

Let $R(x,y)$ be a locus point slope of $OR\times slope\ of\ PR=-1$

$\Rightarrow\frac{y-0}{x-0}\times\frac{y-0}{x-a}=-1\Rightarrow y^2=x(\alpha-x)\Rightarrow y^2=x\alpha-x^2$

$\Rightarrow x^2+y^2-ax\Rightarrow\alpha=\frac{x^2+y^2}{x}\Rightarrow\beta=\frac{x^2+y^2}{y}$

Since $|\alpha|+|\beta|=a\Rightarrow\frac{x^2+y^2}{x}+\frac{x^2+y^2}{y}=a\Rightarrow(x^2+y^2)(x+y)=axy$

56. $\angle RQP=\theta\Rightarrow\angle RPQ=2\alpha+\theta\Rightarrow\tan\theta=\frac{y}{x+a}\Rightarrow\theta=\tan^{-1}\left(\frac{y}{x+a}\right)\Rightarrow\tan(2\alpha+\theta)=\frac{y}{a-x}$

$\Rightarrow 2\alpha+\theta,\tan^{-1}\left(\frac{y}{a-x}\right)\Rightarrow 2\alpha=\tan^{-1}\left(\frac{y}{a-x}\right)-\tan^{-1}\left(\frac{y}{a+x}\right)\Rightarrow 2\alpha=\tan^{-1}\left(\frac{\frac{y}{a-x}-\frac{y}{a+x}}{1+\frac{y}{a-x}.\frac{y}{a+x}}\right)$

$\Rightarrow\tan 2\alpha=\frac{y(a+x-a+x)}{a^2-x^2+y^2}\Rightarrow a^2-x^2+y^2=2xy\cot 2\alpha$

$\Rightarrow x^2 - y^2 - a^2 = -2xy\cot 2\alpha$

$\Rightarrow x^2 - y^2 + 2xy\cot 2\alpha - a^2 = 0$

57. Let $A \equiv (x_1, y_1), B \equiv (x_2, y_2), C \equiv (x_3, y_3), D \equiv (x_4, y_4)$

Given $x_1^2 + x_2^2 + x_3^2 + x_4^2 + y_1^2 + y_2^2 + y_3^2 + y_4^2 - 2x_1x_3 - 2x_2x_4 - 2y_2y_3 - 2y_1y_4 \le 0$

$x_1 = x_3, x_2 = x_4, y_2 = y_3, y_1 = y_4 \,(or)\, \frac{x_1 + x_2}{2} = \frac{x_3 + x_4}{2}\ and\ \frac{y_1 + y_2}{2} = \frac{y_4 + y_3}{2}$

Hence, AB and CD bisect each other. Therefore ABCD is a parallelogram

Also, $AB^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2 = (x_3 - x_4)^2 + (y_4 - y_3)^2 = CD^2$

Thus, ABCD is a parallelogram and AB = CD. Hence, it is a rectangle

58. $OA = OQ + QA = \alpha + \beta\cot\theta \Rightarrow OB = OR + RB = \beta + \alpha\tan\theta$

Now, the area of ΔOAB is $\frac{1}{2}(\alpha + \beta\cot\theta)(\beta + \alpha\tan\theta) = \frac{1}{2}(2\alpha\beta + \alpha^2\tan\theta + \beta^2\cot\theta)$

$= \frac{1}{2}\left(2\alpha\beta + \left(\alpha\sqrt{\tan\theta} - \beta\sqrt{\cot\theta}\right) + 2\alpha\beta\right) \ge \frac{1}{2}(2\alpha\beta + 2\alpha\beta) = 2\alpha\beta$

Least value of $s = 2\alpha\beta$

59. Let the verties be $O(0,0), A(\alpha,0), and\ B(\alpha_1, \beta_1), where\ 0 \le \alpha \le 1\ and\ 1 \le \alpha_1^2 + \beta_1^2 \le 4$

So, the area of ΔOAB is maximum where $\alpha = 1\ and\ (\alpha_1, \beta_1)\ is\ (2,0)$

In this case, a = 1, b = 2, and $c = \sqrt{5}$, which satisfies $2 \le c \le 3$

Therefore, the maximum area is 1.

60. $|A| = \sin 2A \sin 2B \sin 2C + 2\sin A \sin B \sin C - \sum \sin^2 A \sin 2A$

$|A| = \sin 2A \sin 2B \sin 2C + 2\sin A \sin B \sin C - \frac{1}{2}\sum (1 - \cos 2A)\sin 2A$

$|A| = \sin 2A \sin 2B \sin 2C + 2\sin A \sin B \sin C - \frac{1}{2}\sum (\sin 2A - \sin 2A \cos 2A) = 0$

4 least non negative value is 0

PHYSICS

61. Conceptual.

62. Just before the impact with ceiling retardation = 2g

$\Rightarrow$ If 'R' is the resistance then

$R + mg = 2mg \Rightarrow R = mg$

$\Rightarrow$ after impact the ball falls with constant velocity

$\Rightarrow H = 20m$

63. Acceleration $= a = \frac{F}{Nm}$, where 'm' is mass of each cart.

Let T, be the tension between 4th & 5th cart.

Considering last (N – 4) carts, $T_1 = (N-4)ma$

Similarly $T_2 = (N-8)ma$

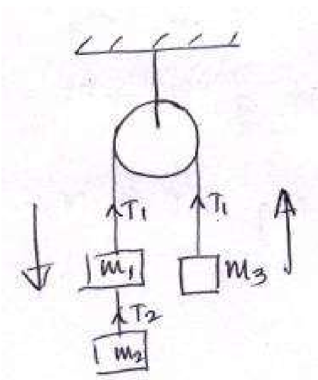
Given $T_1 = 2T_2$

$\Rightarrow N = 12$

64. Acceleration of system $= a = \frac{F}{\sum M} = \frac{40}{10} = 4ms^{-2}$

$\Rightarrow$ Contact force $= 4 \times 4 = 16N$

65. $(m_1 + m_2)g - T_1 = (m_1 + m_2)a \Rightarrow T_1 = (m_1 + m_2)(g-a)$



$T_2 = m_2(g-a)$

Given $T_1 > 3T_2$

$(m_1 + m_2) > 3m_2$

$m_1 > 2m_2$

The ratio of T_1 and T_2 is independent of mass m_3

66. Let the heavier mass be 'x' then other mass $= M - x$

$xg - T = xa$

$T - (M-x)g = (M-x)a$

Eliminating 'x'

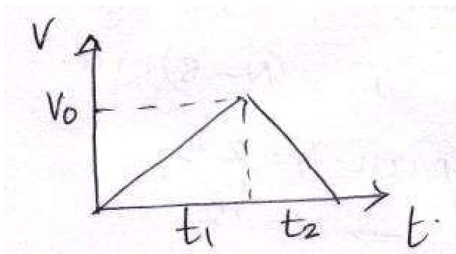
$$T\left[1 + \frac{g}{g-a} + \frac{a}{g-a}\right] = M(g+a)$$

$$\Rightarrow T = \frac{M\left(g^2 - a^2\right)}{2g}$$

$$T \le \frac{24}{50} Mg$$

$$\frac{M\left(g^2 - a^2\right)}{2g} \le \frac{24}{50} Mg$$

$$1 - \frac{a^2}{g^2} \le \frac{24}{25} \qquad \Rightarrow \frac{a^2}{g^2} \ge \frac{1}{25} \Rightarrow a_{Min} = \frac{g}{5}$$

67. 

$$V_0 = a_1 t_1 = a_2 t_2$$

$$a_1 = \frac{(\eta - 1) w}{M} = (n-1) g$$

$a_2 = g$ when tension is zero

$$\Rightarrow V_0 = (\eta - 1) g t_1 = g t_2$$

$$\frac{1}{2} V_0 (t_1 + t_2) = h$$

$$\frac{1}{2}\left(t_1 + (\eta - 1) t_1\right)(\eta - 1) g t_1 = h$$

$$\Rightarrow \frac{1}{2}(\eta - 1) g \eta t_1^2 = h$$

$$\Rightarrow t_1 = \sqrt{\frac{2h}{g\eta(\eta - 1)}}$$

$$\Rightarrow t_{Min} = t_1 + t_2$$

$$= t_1 + (\eta - 1) t_1 = \eta t_1$$

$$\Rightarrow t_{Min} = \sqrt{\frac{2\eta h}{g(n-1)}}$$

68. $m_A = M$

$m_B = M - m$

Acceleration of B after the insect falls is

$a = \left(\dfrac{m_A - m_B}{m_A + m_B}\right) g$ upwards

$$a = \frac{mg}{2M - m}$$

Acceleration of insect is g

$$\Rightarrow a_{relative} = g + \frac{mg}{2M - m} = \frac{2Mg}{2M - m}$$

$$\Rightarrow t = \sqrt{\frac{2L}{a_{relative}}} = \sqrt{\frac{(2M - m)L}{Mg}}$$

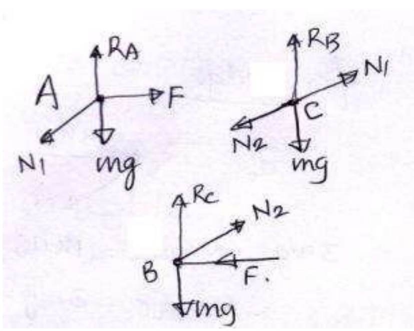
69. Conceptual.

70. Conceptual.

71. Tension in the string connecting m_1 and m_2 is $T = \frac{2m_1m_2}{m_1 + m_2}g$

$$\Rightarrow m_0 g = 2T \Rightarrow m_0 = \frac{4m_1m_2}{m_1 + m_2}$$

$$Mg = 4T \Rightarrow M = \frac{8m_1m_2}{m_1 + m_2}$$

72. 

For A: $N_1 \sin 30 = F \Rightarrow F = \frac{N_1}{2}$

$$\Rightarrow R_A = mg + N_1 \cos 30 = \frac{3mg}{2}$$

For B: $N_2 \sin 30 = F \Rightarrow F = \frac{N_2}{2}$

$$\Rightarrow R_B = mg - N_2 \cos 30 = \frac{mg}{2}$$

For C: $N_1 = N_2$

$$R_C + N_1 \cos 30 = mg + N_2 \cos 30$$

$$\Rightarrow R_C = mg$$

$$\Rightarrow R_A : R_B : R_C = 3:1:2$$

73. Mass of water added when the level rises by 'x' is

$m = 2sxd$ (x is w.r.t. container)

$\Rightarrow Kx = 2sx\,dg$

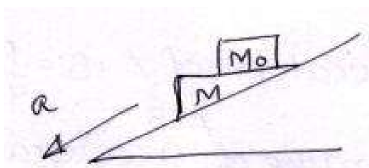
$\Rightarrow K = 2s\,dg$

74. Let the acceleration of the system is 'a'.

Sum of all the blocks is M_0.

$$M_0 = M\left[1 + \frac{1}{2} + \frac{1}{4} + ...\right]$$

$= 2M$



Let N_1 be the normal contact force between wedge & M_0.

Let N_2 be the normal contact force between wedge and inclined plane.

$\Rightarrow$ for wedge $N_2 = (N_1 + Mg)\cos\theta$

$(N_1 + Mg)\sin\theta = Ma$ .... (1)

For M_0

$M_0 g - N_1 = M_0 a \sin\theta$

$\Rightarrow 2Mg - N_1 = M_0 a \sin\theta$ .... (2)

Solving (1) and (2) $a = \dfrac{3g\sin\theta}{1 + 2\sin^2\theta}$

$\Rightarrow$ acceleration of blocks $a^1 = a\sin\theta = \dfrac{3g\sin^2\theta}{1 + 2\sin^2\theta}$

Considering mass of M (i.e. 1)

$Mg - N_{12} = Ma^1$

$\Rightarrow N_{12} = \dfrac{Mg\cos^2\theta}{1 + 2\sin^2\theta}$

75. Acceleration of $A + B = \dfrac{F}{9} = 2ms^{-2}$

In the frame of $A + B$ acceleration of 'C' is $2ms^{-2}$ towards right.

$\Rightarrow$ Time to travel 4m is

$t_1 = \sqrt{\frac{2(4)}{2}} = 2\sec$

Velocity of 'C' at this time is υ

$\upsilon = 2 \times 2 = 4ms^{-1}$

Now the block 'C' falls of the edge. In the frame considered time needed to fall 2m is

$t_2 = \sqrt{\frac{2.2}{10}} = \sqrt{0.4} = 0.63\sec$

Horizontal distance covered is $s = 4(0.63) + \frac{1}{2}2(0.63)^2$

$= 2.92m$

$2.92 > 2.75$

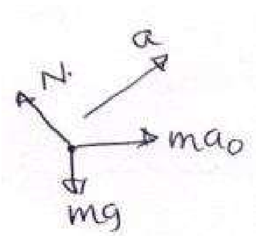
$\Rightarrow$ 'C' directly falls on ground.

$\Rightarrow t_2 = \sqrt{\frac{2.4}{10}} = \sqrt{0.8} = 0.9\sec$

$\Rightarrow t_1 + t_2 = 2.9\sec$

76. $F = 3mg$

For block

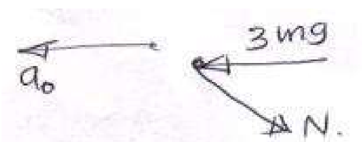


a_0 is acceleration of wedge.

In the frame of wedge $N = mg\cos\theta + ma_0\sin\theta$

$ma = ma_0\cos\theta - mg\sin\theta$

For wedge



$3mg - N\sin\theta = ma_0$

$\Rightarrow N\sin\theta = 3mg - ma_0$

Eliminating N and using $\sin\theta = \cos\theta = 45^o$

$$a_0 = \frac{5g}{3}$$

$$a = \frac{\sqrt{2}g}{3}$$

$$\Rightarrow \frac{1}{2} = \frac{1}{2}at^2$$

$$\Rightarrow t = \sqrt{\frac{3L}{\sqrt{2}g}}$$

77. Use free body diagram and apply the condition for static equilibrium.

78. Let initial extension of S_1 be x_0.

$$\Rightarrow Kx_0 = Mg$$

Let the extension of S_2 be x_2 and further extension in S_1 be x_1 when A moves down by L.

$$\Rightarrow 2x_1 + x_2 = L$$

For equilibrium of M

$$Kx_0 + Kx_1 = Mg + 2Kx_2$$

$$\Rightarrow x_1 = 2x_2$$

$$\Rightarrow x_2 = \frac{L}{5}, x_1 = \frac{2L}{5}$$

79. Use constraint equations and Newton's laws.

80. Conceptual.

81. Use Newton's laws of motion.

82. Conceptual.

83. Use constraint equations.

84. Conceptual.

85. Use constraint equations and Newton's laws.

86. Impulse is the area under F-t graph, as well as the change in momentum. So,

$$mu = \pi\left(\frac{F_0}{2}\right)\left(\frac{T}{2}\right)$$

$$\Rightarrow u = \frac{\pi F_0 T}{4m}$$

87. $mg = 2T \sin 45$

$\Rightarrow mg = \sqrt{2}T$ ….. (1)

$$T_1 \cos\theta = T\cos 45$$

$$\Rightarrow T_1\cos\theta = \frac{T}{\sqrt{2}} = \frac{mg}{2} \qquad \left\{\because T = \frac{mg}{\sqrt{2}}\right\}$$

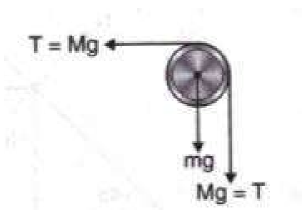
Further, $Mg + T\cos 45 = T_1 \sin\theta$

$$\Rightarrow T_1 \sin\theta = Mg + \frac{mg}{\sqrt{2}}\frac{1}{\sqrt{2}}$$

$$\Rightarrow T_1 \sin\theta = Mg + \frac{mg}{2} \qquad \text{..... (2)}$$

$$\Rightarrow \tan\theta = \frac{Mg + \frac{mg}{2}}{\frac{mg}{2}} = 1 + \frac{2M}{m} \qquad \text{(Divide (2) by (1))}$$

88.

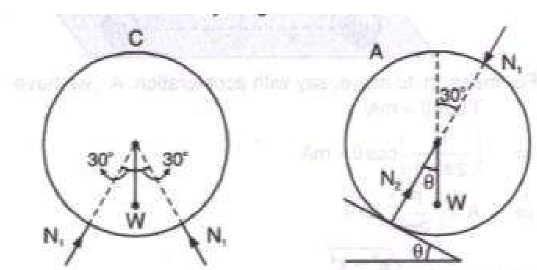


Three forces are acting on the pulley T (horizontally), T (vertically downward) and the weight of the pulley (also acting vertically downwards) i.e. Force Mg acts horizontally and $(M+m)g$ acts vertically downwards. So, total force acting on the pulley is

$$F_{net} = \sqrt{M^2 g^2 + (M+m)^2 g^2}$$

$$\Rightarrow F_{net} = \left[\sqrt{M^2 + (M+m)^2}\right] g$$

89. Let us draw the free body diagrams of C and A.



W = weight of each sphere

N_2 = normal reaction between A and inclined plane

N_1 = normal reaction between A and C

N_1 = normal reaction between B and C

Free body diagram of C

Resolving vertically $2N_1 \cos 30^o = W$

$\Rightarrow N_1 = \frac{W}{\sqrt{3}}$ ….. (1)

When the arrangement is on the point of collapsing, the reaction between A and B is zero.

Free body diagram of A

Resolving horizontally and vertically

$N_2 \sin\theta = N_1 \sin 30^o$

$\Rightarrow N_2 \sin\theta = \frac{W}{2\sqrt{3}}$ ….. (2)

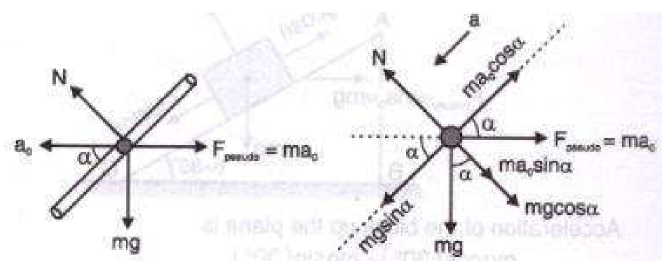
$N_2 \cos\theta = W + N_1 \cos 30^o = \frac{3W}{2}$ ….. (3)

Dividing (3) by (3), we get

$\tan\theta = \frac{1}{3\sqrt{3}}$

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

90.



$mg \sin\alpha - ma_0 \cos\alpha = ma$

$\Rightarrow a = g\sin\alpha - a_0 \cos\alpha$