Master JEE CLASSES
Kukatpally, Hyderabad.

IIT-JEE-MAINS PAPER-6 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 **Mathematics, Physics** and **Chemistry** 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:

Trigonometric Equations (30%); Determinant (70%)

PHYSICS:

Projectile motion on inclined planes, relative velocity (Relative velocity 1D,2D,Rate of approach and rate of separation, condition for collision of two projectiles, relative motion of one projectile with respect to another projectile,rain problems,river boat problems,air craft wind problems etc..)

CHEMISTRY:

Chemical Equilibrium: Equilibrium involving physical processes: solid - liquid; liquid - gas and solid - gas. General characteristics of equilibrium involving physical process, Equilibrium involving chemical processes, characteristics of equilibrium state, Law of mass action, equilibrium constant, characteristics of equilibrium constant, Kp, Kcrelation,Lechatlier's principle - factors effecting equilibrium concentration, pressure, temperature and effect of catalyst, principle applied for synthesis of ammonia and sulphur trioxide and other typical reactions, Thermodynamics of equilibrium constant. Significance of ΔG and ΔG° in chemical equilibrium(70%)

Enthalpy of reaction - different types of enthalpies, Hess's law, Effect of temperature on enthalpy of reaction - Kirchoff's equation, Hess's law and its applications, Determination of enthalpy of hydration of CuSO4, Resonance energy,Limitations of first law of thermodynamics; Second law of Thermodynamics; Carnot cycle, efficiency of thermodynamic system,Entropy - physical significance, expressions in all types of processes ,Gibb's free energy - physical significance, spontneity of processes(30%)

MATHS

1. For all values of θ,

$$\begin{vmatrix} \sin\theta & \cos\theta & \sin 2\theta \\ \sin\left(\theta+\frac{2\pi}{3}\right) & \cos\left(\theta+\frac{2\pi}{3}\right) & \sin\left(2\theta+\frac{4\pi}{3}\right) \\ \sin\left(\theta-\frac{2\pi}{3}\right) & \cos\left(\theta-\frac{2\pi}{3}\right) & \sin\left(2\theta-\frac{4\pi}{3}\right) \end{vmatrix} =$$

1) 0 2) 1

3) 2 4) -1

2. If a ≠ p, b ≠ q, c ≠ r and $\begin{vmatrix} p & b & c \\ a & q & c \\ a & b & r \end{vmatrix} = 0$.

Then find the value of

$$\frac{p}{p-a}+\frac{q}{q-b}+\frac{r}{r-c}=$$

1) 1 2) 2

3) 3 4) 4

3. The maximum value of

$$\begin{vmatrix} 1+\sin^2 x & \cos^2 x & 4\sin 2x \\ \sin^2 x & 1+\cos^2 x & 4\sin 2x \\ \sin^2 x & \cos^2 x & 1+4\sin 2x \end{vmatrix}$$ is

…………….

1) 0 2) 2

3) 4 4) 6

4. If $\begin{vmatrix} x & x+y & x+y+z \\ 2x & 3x+2y & 4x+3y+2z \\ 3x & 6x+3y & 10x+6y+3z \end{vmatrix} = 64$,

then x=.........

1) 1 2) 4

3) -1 4) 2

5. The number of positive integral solutions

of the equation $\begin{vmatrix} x^3+1 & x^2y & x^2z \\ xy^2 & y^3+1 & y^2z \\ xz^2 & yz^2 & z^3+1 \end{vmatrix} = 11$

is

1) 0 2) 6

3) 3 4) 12

6. The value of

$$\begin{vmatrix} a^2 & a & 1 \\ \cos nx & \cos(n+1)x & \cos(n+2)x \\ \sin nx & \sin(n+1)x & \sin(n+2)x \end{vmatrix}$$ is

independent of

1) n 2) a

3) x 4) None of these

7. The value of the determinant

$$\begin{vmatrix} a-b & b-c & c-a \\ x-y & y-z & z-x \\ p-q & q-r & r-p \end{vmatrix} \text{ is:}$$

1) 0

2) $abc+pqr+xyz$

3) $(a-x)(y-z)(r-p)$

4) abc

8. If $\begin{vmatrix} x & 3 & 6 \\ 3 & 6 & x \\ 6 & x & 3 \end{vmatrix} = \begin{vmatrix} 2 & x & 7 \\ x & 7 & 2 \\ 7 & 2 & x \end{vmatrix} = \begin{vmatrix} 4 & 5 & x \\ 5 & x & 3 \\ x & 4 & 5 \end{vmatrix} = 0$

then x is equal to

1) 9 2) -9

3) 0 4) 5

9. If

$$\begin{vmatrix} x^3+4x & x+3 & x-2 \\ x-2 & 5x & x-1 \\ x-3 & x+2 & 4x \end{vmatrix} = ax^5+bx^4+cx^3+dx^2+ex+f,$$

be an identity in x, where a,b,c,d,e,f are independent of x, then the value of f is

1) 0 2) 15

3) 17 4) 13

10. If the determinant

$$\begin{vmatrix} b-c & c-a & a-b \\ b'-c' & c'-a' & a'-b' \\ b''-c'' & c''-a'' & a''-b'' \end{vmatrix} = m\begin{vmatrix} a & b & c \\ a' & b' & c' \\ a'' & b'' & c'' \end{vmatrix},$$

where $\begin{vmatrix} a & b & c \\ a' & b' & c' \\ a'' & b'' & c'' \end{vmatrix} \neq 0$

then the value of ‘ m ‘ is

1) 0 2) 2

3) -1 4) 1

11. If $D_1 = \begin{vmatrix} 1 & 1 & 1 \\ x^2 & y^2 & z^2 \\ x & y & z \end{vmatrix}$ *and* $D_2 = \begin{vmatrix} 1 & 1 & 1 \\ yz & xz & xy \\ x & y & z \end{vmatrix}$,

then

1) $D_1 = D_2$ 2) $D_1 = -D_2$

3) $D_1 = -2D_2$ 4) $D_2 = 2D_1$

12. If

$$\begin{vmatrix} a+b+2c & a & b \\ c & b+c+2a & b \\ c & a & c+a+2b \end{vmatrix} = K(a+b+c)^3,$$

then K is equal to

1) 1 2) 2

3) 4 4) 6

13. If [ ] denote the greatest integer less than or equal to the real number consideration and $-1\le x<0, 0\le y<1, 1\le z<2,$ then the value of the determinant $\begin{vmatrix} [x]+1 & [y] & [z] \\ [x] & [y]+1 & [z] \\ [x] & [y] & [z]+1 \end{vmatrix}$ is

1) [x] 2) [y]

3) [z] 4) none of these

14. The largest value of a third-order determinant whose elements are 1 or -1 is _____

1) 0 2) 2

3) 4 4) 6

15. If $\Delta_1 = \begin{vmatrix} a_1^2+b_1+c_1 & a_1a_2+b_2+c_2 & a_1a_3+b_3+c_3 \\ b_1b_2+c_1 & b_2^2+c_2 & b_2b_3+c_3 \\ c_3c_1 & c_3c_2 & c_3^2 \end{vmatrix}$ and $\Delta_2 = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$, then $\frac{\Delta_1}{\Delta_2}$ is equal to

1) $a_1b_2c_3$

2) $a_1a_2a_3$

3) $a_3b_2c_1$

4) $a_1b_1c_1 + a_2b_2c_2 + a_3b_3c_3$

16. If α,β,γ are different from 1 and are the roots of $ax^3+bx^2+cx+d=0$ and $(\beta-\gamma)(\gamma-\alpha)(\alpha-\beta)=\frac{25}{2}$, then the determinant $\Delta = \begin{vmatrix} \frac{\alpha}{1-\alpha} & \frac{\beta}{1-\beta} & \frac{\gamma}{1-\gamma} \\ \alpha & \beta & \gamma \\ \alpha^2 & \beta^2 & \gamma^2 \end{vmatrix}$

1) $\frac{25d}{2a}$ 2) $\frac{25d}{a}$

3) $\frac{-25d}{(a+b+c+d)\times 2}$ 4) $-\frac{25d}{2a}$

17. If A=$\begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$ then $|A^{2017}-5A^{2015}|=$

1) 0 2) 1

3) 4 4) 16

18. If p,q,r are in A.P. then the

$\begin{vmatrix} a^2+2^{n+1}+2p & b^2+2^{n+2}+3q & c^2+p \\ 2^n+p & 2^{n+1}+q & 2q \\ a^2+2^n+p & b^2+2^{n+1}+2q & c^2-r \end{vmatrix}=$

1) $2p+a^2+b^2+c^2$ 2) 0

3) 1 4) 2

19. $\begin{vmatrix} x_1 & y_1 & 1 \\ ax_1+bx_2+cx_3 & ay_1+by_2+cy_3 & a+b+c \\ -ax_1+bx_2+cx_3 & -ay_1+by_2+cy_3 & -a+b+c \end{vmatrix} =$

1) 0

2) 1

3) $a(x_1+x_2+x_3)$

4) $b(y_1+y_2+y_3)+c$

20. The number of values of θ in $\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$ such that $\theta \neq \frac{n\pi}{5}$ for $n=0,\pm1,\pm2$ and $\tan\theta=\cot 5\theta$ as well as $\sin 2\theta=\cos 4\theta$ is

1) 1 2) 2

3) 3 4) 4

21. The equation

$2\cos^2\frac{x}{2}.\sin^2 x = x^2+\frac{1}{x^2}; 0\le x\le\frac{\pi}{2}$ has.

1) One real solution

2) No solution

3) More than one real solution

4) None of these

22. The general solution of the equation $\sin^{50}x-\cos^{50}x=1$ *is* _______

1) $2n\pi+\frac{\pi}{2}$ 2) $2n\pi+\frac{\pi}{3}$

3) $n\pi\pm\frac{\pi}{2}$ 4) $n\pi+\frac{\pi}{3}$

23. General solution of the equation $(\sqrt{3}-1)\sin\theta+(\sqrt{3}+1)\cos\theta=2$ is________

1) $2n\pi\pm\frac{\pi}{4}+\frac{\pi}{12}$

2) $n\pi+(-1)^n.\frac{\pi}{4}+\frac{\pi}{12}$

3) $2n\pi\pm\frac{\pi}{4}-\frac{\pi}{12}$

4) $n\pi+(-1)^n.\frac{\pi}{4}-\frac{\pi}{12}$

24. The solution of $\sin^8 x+\cos^8 x=\frac{17}{32}$ is ………………

1) $\frac{n\pi}{2}\pm\frac{\pi}{8}$ 2) $n\pi\pm\frac{\pi}{4}$

3) $n\pi\pm\frac{\pi}{8}$ 4) No solution

25. Total number of solutions of $\sin\pi x=\left|\ln|x|\right|$ is

1) 2 2) 4

3) 6 4) 8

26. For $0 < \theta < \pi / 2,$ the number of solutions of

$$\sum_{m=1}^{6} \operatorname{cosec}\left(\theta + \frac{(m-1)\pi}{4}\right)\operatorname{cosec}\left(\theta + \frac{m\pi}{4}\right) = 4\sqrt{2}$$

is

1) 1 2) 0

3) 2 4) 3

27. The most general values of θ which satisfies both the equations $\tan\theta = -1$ and $\cos\theta = \frac{1}{\sqrt{2}}$ is

1) $n\pi + 7\frac{\pi}{4}$ 2) $2n\pi + \frac{7\pi}{4}$

3) $n\pi + (-1)^n \frac{7\pi}{4}$ 4) $\frac{7n\pi}{4}$

28. If $\cos\theta\cos 2\theta\cos 3\theta = \frac{1}{4}$ for $0 < \theta < \pi$ then $\theta =$

1) $\frac{\pi}{7}, \frac{5\pi}{7}, \pi$

2) $\frac{\pi}{2}, \frac{\pi}{4}, \frac{3\pi}{4}, \frac{\pi}{6}, \frac{5\pi}{6}$

3) $\frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}, \frac{2\pi}{3}, \frac{\pi}{3}$

4) $\frac{2n\pi}{3} : n \in Z$ or $n\pi + \frac{\pi}{4}; n \in Z$

29. If the equation $((\cos p)-1)x^2 + (\cos p)x + \sin p = 0$ in the variable x has real roots then p can take any value in the interval

1) $(0, 2\pi)$ 2) $(-\pi, 0)$

3) $\left(\frac{-\pi}{2}, \frac{\pi}{2}\right)$ 4) $(0, \pi)$

30. $\frac{\sin^3\theta - \cos^3\theta}{\sin\theta - \cos\theta} - \frac{\cos\theta}{\sqrt{1+\cot^2\theta}} - 2\tan\theta\cot\theta = -1$

if

1) $\theta \in \left(0, \frac{\pi}{2}\right)$ 2) $\theta \in \left(\frac{\pi}{2}, \pi\right)$

3) $\theta \in \left(\pi, \frac{3\pi}{2}\right)$ 4) $\theta \in \left(\frac{3\pi}{2}, 2\pi\right)$

space for rough work

PHYSICS

31. A ball is thrown at speed v from zero height on a level ground. At what angle with horizontal should the ball be thrown so that the area under the trajectory is maximum.

1) 30º 2) 45º
3) 60º 4) 37º

32. A ball falls from height h. It bounces off a surface at height y(with no loss in speed). The surface is inclined at 45º, so that the ball bounces off horizontally. What should y be so that the ball travels a maximum horizontal distance?

1) $\frac{h}{2}$ 2) $\frac{h}{3}$
3) $\frac{2h}{3}$ 4) $\frac{h}{4}$

33. Point A moves uniformly with velocity v so that the vector $\vec{v}$ is continually 'aimed' at point B which in its turn moves recti-linearly and uniformly with velocity u<v. At the initial moment of time $\vec{v} \perp \vec{u}$ and the points are separated by a distance l. How soon will the points converge?

1) $\frac{vl}{(v^2-u^2)}$ 2) $\frac{ul}{(v^2-u^2)}$
3) $\frac{ul}{(u^2-v^2)}$ 4) $\frac{ul}{(u^2+v^2)}$

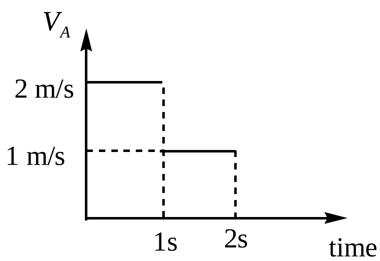
34. A ball is thrown from the edge of a cliff of height h=14.4 m with a speed of 12m/s. At what inclination angle with horizontal should it be thrown so that it travels a maximum horizontal distance when it hits the ground? Assume that the ground is below the cliff level.($g=10m/s^2$)

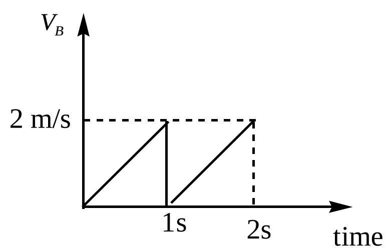
1) 45º 2) 60º
3) 30º 4) None of these

35. A, B & C are three objects each moving with constant velocity. A's speed is 10 m/sec in a direction $\overrightarrow{PQ}$. The velocity of B relative to A is 6 m/sec at an angle of, $\cos^{-1}(15/24)$ to $\overrightarrow{PQ}$. The velocity of C relative to B is 12 m/sec in a direction $\overline{QP}$, then find the magnitude of the velocity of C

1) 6 m/sec 2) 4 m/sec
3) 5 m/sec 4) 10 m/sec

36. Two particles A and B start moving from the same point on the X-axis. The velocity versus time graph for the particle is as shown in figure. The maximum relative separation between the two particles will be equal to





1) $\frac{1}{2}m$ 2) $\frac{3}{4}m$

3) $\frac{5}{4}m$ 4) None

37. Three particles are initially kept at the vertices A, B and C of a triangle with $\underline{|A} = 120^0$ and $\underline{|B} = \underline{|C} = 30^0$. They simultaneously start moving and will simultaneously meet at the incentre(point of intersection of angular bisectors) of ΔABC and then stop. The ratio of average velocities of the particles is

1) $\sin 15^0 : \cos 30^0 : \cos 30^0$

2) $\cos 15^0 : \sin 30^0 : \sin 30^0$

3) $\tan 15^0 : \tan 30^0 : \tan 30^0$

4) $\cot 15^0 : \cot 30^0 : \cot 30^0$

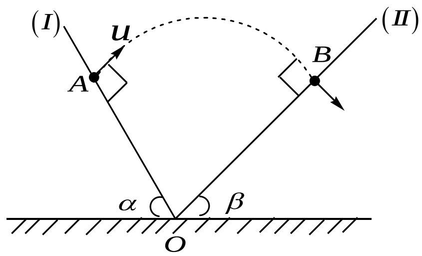
38. Two particles start simultaneously from the same point and move along two straight lines, one with uniform velocity v and other with a uniform acceleration a. If $\alpha\left(< 90^0\right)$ is the angle between the lines of motion of two particles then the least value of relative velocity will be at time

1) $\left(\frac{v}{a}\right)\sin\alpha$ 2) $\left(\frac{v}{a}\right)\cos\alpha$

3) $\left(\frac{v}{a}\right)\tan\alpha$ 4) $\left(\frac{v}{a}\right)\cot\alpha$

39. Two inclined planes (I) and (II) have inclination α and β respectively with horizontal, (where $\alpha + \beta = 90^0$) intersect each other at point O as shown in figure.

A particle is projected from point A with velocity u along a direction perpendicular to plane (I). If the particle strikes plane (II) perpendicular at B, then



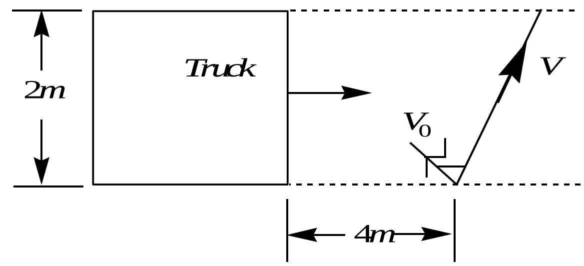
1) time of flight $= \dfrac{u}{g\sin\beta}$

2) time of flight $= \dfrac{u}{g\sin\alpha}$

3) distance $OB = \dfrac{u^2}{g\sin\beta}$

4) distance $OB = \dfrac{u^2}{2g\sin\alpha}$

40. A 2m wide truck is moving with a uniform speed v_0 = 8 m/s along a straight horizontal road. A pedestrian starts to cross the road with a uniform speed v when the truck is 4 m away from him. The minimum value of v so that he can cross the road safely is (in m/s)



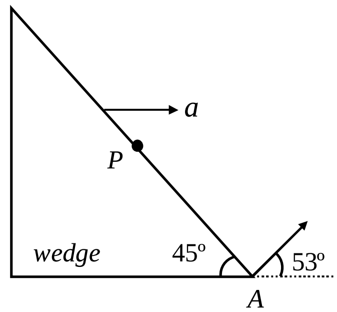
1) $\sqrt{5}$
2) $\sqrt{5/2}$
3) $\dfrac{8}{\sqrt{5}}$
4) none

41. The front windscreen of a car is inclined at an angle 30^o with the horizontal. Hailstones fall vertically downwards with a speed of $5\sqrt{3}$ m/s. The speed of the car so that hailstones are bounced back by the screen in vertically upward direction with respect to car is (Assume elastic collision of hailstones with wind screen)

1) 20 m/s
2) 10 m/s
3) 15 m/s
4) 5 m/s

42. A particle is projected from point A at an angle of 53^o with horizontal. At the same time wedge starts from rest and moves with constant acceleration a as shown. The value of a for which the particle

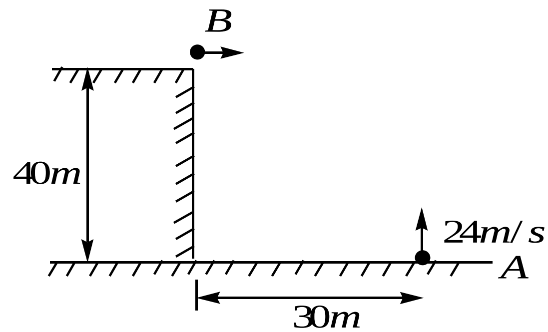
strikes the plane perpendicular to it at P is $\left(\tan 53^o = \frac{4}{3}\right)\left(g = 10 m/s^2\right)$



1) $10 m/s^2$ 2) $100 m/s^2$
3) $130 m/s^2$ 4) $140 m/s^2$

43. On an inclined plane two particles A and B are projected with same speed at the same angle with the horizontal, particle A down and particle B up the plane. If the ratio of time of flight of A and B is $\cot\theta$, where θ is the angle at which B is projected measured from inclined plane, find the angle at which particles are projected:
1) 90^0 2) 60^0
3) 30^0 4) 45^0

44. A ball 'A' is thrown vertically up with a speed of 24 m/s and at the same time another ball 'B' is thrown horizontally from a tower as shown. Assuming 2D motion find the speed of the ball B which will ensure that ball's will be collide in air.



1) 12m/s 2) 18 m/s
3) 21 m/s 4) 24 m/s

45. The current velocity (V) of a river is directly proportional with the distance (x) from its bank V is maximum in the middle and equals to v_0 ⊳. A boat is moving on the river with a constant velocity μ relative to the water and perpendicular to the current. Find the drift of the boat. Width of the river is 'C'
1) $\frac{v_0 C}{2\mu}$ 2) $\frac{v_0 C}{4\mu}$
3) $\frac{v_0 C}{\mu}$ 4) $\frac{v_0 C}{3\mu}$

46. A boat can travel at a speed of $3ms^{-1}$ on still water. A boatman wants to cross the river while covering the shortest possible distance. In what direction should he row with respect to the bank, if the speed of the water is $4ms^{-1}$?

1) making an angle of $\tan^{-1}\left(\frac{4}{3}\right)$ with the bank and he has to row down stream

2) making an angle of $\sin^{-1}\left(\frac{3}{4}\right)$ with the bank and he has to row down stream

3) making an angle of $\cos^{-1}\left(\frac{3}{4}\right)$ with the bank and he has to row up stream

4) making an angle of $\tan^{-1}\left(\frac{3}{4}\right)$ with the bank and he has to row up stream

47. Twelve persons are initially at the twelve corners of a regular polygon of twelve sides of side a. Each person now moves with uniform speed V in such a manner that 1 is always directed towards 2, 2 towards 3, 3 towards 4 and so on. The distance travelled by each person before they meet is

1) $\frac{2a}{2+\sqrt{3}}$ 2) $\frac{2a}{2-\sqrt{3}}$

3) $\frac{2a}{\sqrt{3}}$ 4) $\frac{a}{2+\sqrt{3}}$

48. A boat is moving towards east with velocity 4 m/s with respect to still water and river is flowing towards north with velocity 2 m/s and the wind is blowing towards north with velocity 6 m/s. The direction of the flag blown over by the wind hoisted on the boat is:

1) north-west

2) south-east

3) $\tan^{-1}(1/2)$ with east

4) north

49. An airplane pilot wants to fly from city A to city B which is 1000 km due north of city A. The speed of the plane in still air is 500 km/hr. The pilot neglects the effect

of the wind and directs his plane due north and 2 hours later find himself 300km due north-east of city B. The wind velocity is

1) 150km/hr at 45°N of E

2) 106km/hr at 45°N of E

3) 150 km/hr at 45°N of W

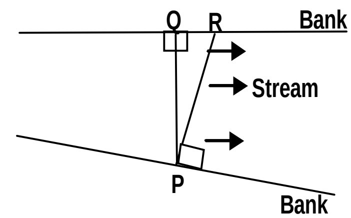
4) 106 km/hr at 45°N of W

50. A boat which has a speed of 5 km/h in still water crosses a river of width 1 km along the shortest possible path (zero drift) in 15min. The velocity of the river water in km per hour is

1) 1   2) 3

3) 4   4) $\sqrt{41}$

51. In a lake, stream flow direction is shown in the figure which is same every where. A man starting from the point P on the bank wants to move to the other bank in shortest time. He should swim



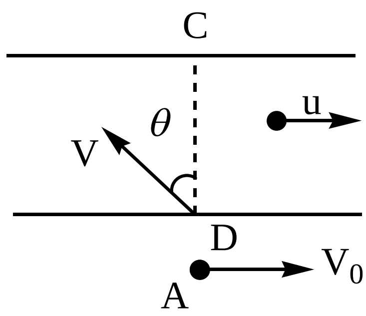
1) along PQ

2) along PR

3) in a direction in-between PQ and PR

4) in all cases he would reach at the same time

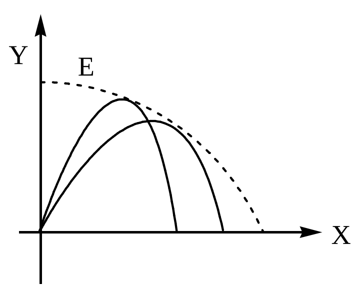
52. A boat is moving with velocity v = 2m/s w.r.t. river at an angle $\theta = 30^o$. Velocity of river is u = 4 m/s. A man at the bank is moving with velocity v_0 as shown in figure. Boat is moving perpendicularly to the bank w.r.t. the man then v_0 is



1) 1 m/s   2) 2 m/s

3) 3 m/s   4) 4 m/s

53. A number of projectiles each with same speed u are fired at different angles lying between 0º and 90º as shown. Neglecting air resistance and assuming g to be constant, then the equation of the envelop E of the parabolic tractories (as shown in figure) is



1) $y = \frac{u^2}{2g} - \frac{gx^2}{2u^2}$ 2) $y = \frac{gx^2}{2u^2} + \frac{u^2}{2g}$

3) $y = \frac{2u^2}{gx^2} - \frac{2g}{u^2}$ 4) $y = \frac{2u^2}{gx^2} + \frac{2g}{u^2}$

54. An airplane has to fly along a straight path from town A to town B, 500 km away. Town B is due east of town A and a strong wind blows from north to south at 300 km/hr. If the plane's airspeed is 900 km/hr, which of the following statements is true?

1) Trip time is $\frac{5}{3\sqrt{8}}$ hr.

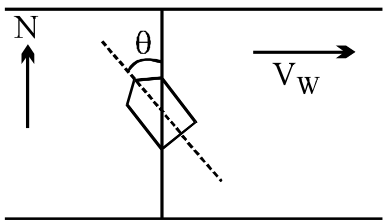
2) Plane's speed with respect to ground is 600 km/hr.

3) Plane's heading is 30° North of East.

4) None of the above

55. A boat is to go straight across a stream that is flowing at 5.0 km/h to east. The

boatman knows that his speed with respect to water is 10 km/h. The angle at which he must head the boat, and his speed relative to the shore will be



1) 0°, 10 km/hr 2) 60°, $5\sqrt{3}$ km/hr

3) 30°, $10\sqrt{3}$ km/hr 4) 30°, $5\sqrt{3}$ km/hr

56. Ram moves with a velocity of 10 m/s in west direction. Shyam moves a direction 23° East of North. Ram is 100 m away from Shyam in direction 53° East of North of him. What should be speed of Shyam so that he collides with Ram.

1) $4\sqrt{3}$ m/s 2)10 m/s

3) 12 m/s 4) none of these

57. Several particles are projected simultaneously in the same vertical plane from a fixed point O, all with the same initial speed but with different angles of projection with the horizontal

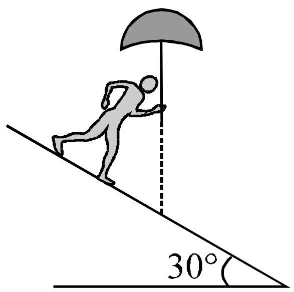
1) After time t, all the particles lie in a circle whose centre C is vertically below O, and as t increases C falls with acceleration g.

2) After time t, all the particles lie in a circle whose centre C is vertically below O, and as t increases C falls with constant velocity.

3) Products of the times for which any particular particle at the height h above the horizontal surface is $\frac{3h}{g}$.

4) Products of the times for which any particular particle at the height h above the horizontal surface is $\frac{h}{g}$.

58. A man is coming down an incline of angle 30°. When he walks with speed $2\sqrt{3}$ m/s he has to keep his umbrella vertical to protect himself from rain. The actual speed of rain is 5 m/s. At what angle with vertical should he keep his umbrella when he is at rest so that he does not get drenched?



1) 30º　　2) 60º

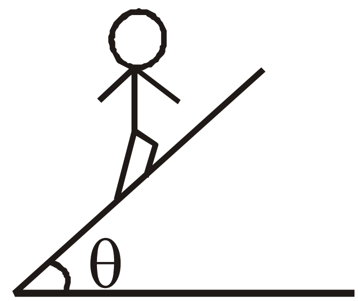
3) 53º　　4) 37º

59. If $\vec{r}$ is the position vector of a particle and $\vec{v}$ its velocity then

1) $\hat{v}\cdot\vec{r}=\frac{dr}{dt}$　　2) $\vec{v}\cdot\hat{r}=\frac{dr}{dt}$

3) $\vec{v}\cdot\vec{r}=0$　　4) $\vec{v}\cdot\vec{r}=vr$

60. A man is standing on incline which makes θ with horizontal and rain is falling vertically with respect to man. Now man starts walking along the incline. Mark the correct option.



1) If man walks up the incline, rain may appear to come horizontally

2) If man walks down the incline, rain may appear to come horizontally

3) No matter whether man walks up or down, rain can never appear to come horizontally.

4) If man walks (up or down) along incline rain may appear to come along the incline.

space for rough work

CHEMISTRY

61. In the reaction $CS_2\,(l) + 3O_2\,(g) \rightarrow CO_2\,(g) + 2SO_2\,(g)$ ΔH = -275 kcal The enthalpies of formation of SO_2 and CS_2 are –75 and +25kcal/mol respectively. Calculate the enthalpy of formation of CO_2.

1) – 75 kcal/mol 2) – 50 kcal/mol
3) – 100 kcal/mol 4) – 150 kcal/mol

62. For the reaction $Br_2(g) \rightarrow 2Br(g)$, ΔH = 'a' KJ the correct statement (s) is/are

1) Enthalpy of formation of Br(g) is 'a' KJ
2) Enthalpy of atomisation of Br(g) is 'a' KJ
3) Bond enthalpy of Br–Br bond is 'a' KJ
4) Bond enthalpy of Br–Br bond is 'a' KJ but enthalpy of atomisation of $Br_2(g)$ is not equal to 'a' KJ

63. The following equilibria are given :

$N_2 + 3H_2 \rightleftharpoons 2NH_3$ ------------ K_1
$N_2 + O_2 \rightleftharpoons 2NO$ ----------- K_2

The equilibrium constant of the reaction $NH_3 + \frac{1}{2}O_2 \rightleftharpoons NO + \frac{3}{2}H_2$ in terms of K_1, K_2 is:

1) $\frac{1}{K_1K_2}$ 2) $\frac{\sqrt{K_2}}{K_1}$
3) $\sqrt{\frac{1}{K_1.K_2}}$ 4) $\sqrt{\frac{K_2}{K_1}}$

64. Certain amount of PCl_5 is taken in a closed container to establish the equilibrium $PCl_5 \rightleftharpoons PCl_3 + Cl_2$, 25% of PCl_5 is found to be dissociated at equillibrium. If total pressure at equilibrium is 30 atm then find k_p for the reaction

1) 4 2) 1/2
3) 2 4) 1/4

65. For the reaction $CaCO_3(S) \rightleftharpoons CaO(s) + CO_2(g)$, the pressure of $CO_2(g)$ depends on

1) The mass of $CaCO_3(s)$
2) The mass of CaO(s)
3) The masses of both $CaCO_3(s)$ and CaO(s)
4) Temperature of the system

66. Which of the reaction defines ΔH^o_f

1) $C_{(diamond)} + O_2(g) \rightarrow CO_2(g)$

2) $\frac{1}{2}H_2(g) + \frac{1}{2}F_2(g) \rightarrow HF(g)$

3) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

4) $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

67. In Haber's process of ammonia manufacture :

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$;

$\Delta H^0_{25\,^0C} = -92.2kJ$

Molecule	$N_2(g)$	$H_2(g)$	$NH_3(g)$
$C_P JK^{-1}mol^{-1}$	29.1	28.8	35.1

If C_P is independent of temperature, then reaction at 100°C as compared to that of 25°C will be :

1) More endothermic

2) Less endothermic

3) More exothermic

4) Less exothermic

68. Predict which of the following reaction (s) has a negative entropy change?

i) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

ii) $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$

iii) $2KClO_4(s) \rightarrow 2KClO_3(s) + O_2(s)$

1) iii   2) ii

3) i and ii   4) i

69. For the reaction

$X_2O_4(l) \longrightarrow 2XO_2(g)$

$\Delta E = 2.1\,kcal.\ \Delta S = 20\,cal/K$ at 300 K

Hence ΔG is

1) 2.7 kcal   2) –2.7 kcal

3) 9.3 kcal   4) –9.3 kcal

70. If ΔG= -177 K cal for

(1) $2Fe(s) + \frac{3}{2}O_2(g) \rightarrow Fe_2O_3(s)$

and ΔG=19 K cal for

(2) $4Fe_2O_3(s) + Fe(s) \rightarrow 3Fe_3O_4(s)$

What is the Gibbs free energy of formation of Fe_3O_4?

1) $+229.6\frac{kcal}{mol}$ 2) $-242.3\frac{kcal}{mol}$

3) $-727\frac{kcal}{mol}$ 4) $-229.6\frac{kcal}{mol}$

71. When a certain amount of ethylene was combusted, 6226 kj heat was evolved. If heat of combustion of ethylene is 1411 kJ, the volume of O_2 (at NTP) that entered into the reaction is -

1) 296.5ml

2) 296.5 liters

3) 6226 × 22.4 liters

4) 22.4 liters

72. 1 mole of an ideal gas at 25°C is subjected to expand reversibly ten times of its initial volume. The change in entropy due to expansion is :

1) 19.15 JK^{-1} $mole^{-1}$

2) 16.15 JK^{-1} $mole^{-1}$

3) 22.15 JK^{-1} $mole^{-1}$

4) None

73. Following reaction occurs at 25°C :

2NO (g, 1×10^{-5} atm) + Cl_2 (g, 1×10^{-2} atm) $\rightleftharpoons$ 2NOCl (g, 1×10^{-2} atm) ΔG^O is-

1) -45.65 KJ   2) -28.53 KJ

3) -22.82 KJ   4) -57.06 KJ

74. For the reaction $N_2O + O_2 \rightleftharpoons 2NO$ equilibrium constant $K_c = 2$. Degrees of dissociation of N_2 and O_2 are

1) $\frac{1}{1+\sqrt{2}}, \frac{1}{1-\sqrt{2}}$

2) $\frac{1}{1-\sqrt{2}}, \frac{1}{1+\sqrt{2}}$

3) Both are $\frac{1}{1+\sqrt{2}}$

4) $\frac{2}{1+\sqrt{2}}, \frac{2}{1-\sqrt{2}}$

75. consider the reaction equilibrium,

$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}, \Delta H^0 = -198kJ$.

On the basis of Le chatelier's principle, the condition favourable for the forward reaction is

1) Lowering of temperature as well as pressure

2) Increasing temperature as well as pressure

3) Lowering the temperature and increasing the pressure

4) Any value of temperature and pressure

76. For an equilibrium

$H_2O(s) \rightleftharpoons H_2O(l)$ which of the following statements is true.

1) The pressure changes do not affect the equilibrium

2) More of ice melts if pressure on the system is increased

3) More of liquid freezes if pressure on the system is increased

4) The pressure changes may increase or decrease the degree of advancement of the reaction depending upon the temperature of the system

77. A 10 litre box contains O_3 and O_2 at equilibrium at 2000 K. $K_p = 4\times10^{14}$ atm for $2O_3(g) \rightleftharpoons 3O_2(g)$ Assume that $P_{O_2} >> P_{O_3}$ and if total pressure is 8 atm, then partial pressure of O_3 will be

1) 8×10^{-5} atm 2) 11.3×10^{-7} atm

3) 9.71×10^{-6} atm 4) 9.71×10^{-2} atm

78. The degree of dissociation of SO_3 is α at equilibrium pressure P_0

K_p for $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ is

1) $\left[\left(P_0\alpha^3\right)/2(1-\alpha)^3\right]$

2) $\left[\left(P_0\alpha^3\right)/(2+\alpha)(1-\alpha)^2\right]$

3) $\left[\left(P_0\alpha^2\right)/2(1-\alpha)^2\right]$

4) None of these

79. When 3 moles of ethyl alcohol are mixed with 3 moles of acetic acid, 2 moles of ester are formed at equilibrium according to the equation

$CH_3COOH(l) + C_2H_5OH(l)$
$\rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$ The value of the equilibrium constant for the reaction is

1) 4 2) 2/9

3) 2 4) 4/9

80. $X_2(g) + Y_2(g) \rightleftharpoons 2XY(g)$ reaction was studied at a certain temperature. In the beginning 1 mole of X_2 was taken in a one liter flask and 2 moles of Y_2 was taken in another 2 liter flask and both these containers are connected so equilibrium can be established. What is

the equilibrium concentration of X_2 and Y_2? Given Equilibrium concentration of $[XY] = 0.6$ moles/liter.

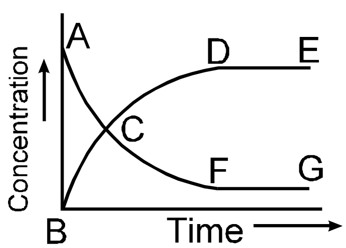
1) $\left(\frac{1}{3}-0.3\right),\left(\frac{2}{3}-0.3\right)$

2) $\left(\frac{1}{3}-0.6\right),\left(\frac{2}{3}-0.6\right)$

3) $(1-0.3),(2-0.3)$

4) $(1-0.6),(2-0.6)$

81. $N_2O_4(g) \rightleftharpoons 2NO_2(g), K_C = 4$. This reversible reaction is studied graphically as shown in figure. Select the correct statements out of I, II and III



I : Reaction quotient has maximum value at point A

II : Reaction proceeds left to right at a point when $[N_2O_4] = [NO_2] = 0.1M$

III : K_c = Q when point D or F is reached

1) I, II
2) II, III
3) I, III
4) I, II, III

82. The reaction $A(g)+B(g) \rightleftharpoons C(g)+D(g)$ is studied in a one litre vessel at 250^0C. The initial concentration of A was 3n and that of B was n. when equilibrium was attained, equilibrium concentration of C was found to the equal to the equilibrium concentration of B. What is the concentration of D at equilibrium?

1) n/2
2) (3n – 1/2)
3) (n – n/3)
4) n

83. For the equilibrium $CuSO_4.5H_2O(s) \rightleftharpoons CuSO_4.3H_2O(s)+2H_2O(g)$ $K_p = 2.25\times10^{-4}$ atm^2 and vapour pressure of water is 22.8 Torr at 298 K. $CuSO_4 5H_2O(s)$ is efflorescent (i.e. loses water) when relative humidity is

1) Less than 33.3%

2) Less than 50%

3) Less than 66.6%

4) above 66.6%

84. An equilibrium mixture in a vessel of capacity 100 litre contain 1 mol N_2, 2 mol O_2 and 3 mol NO. number of moles of O_2 to be added so that at new equilibrium the conc. Of NO is found to be 0.04 mol/lit.

1) (101/18) 2) (101/9)

3) (202/9) 4) None of these

85. Equilibrium constants are given (in atm) for the following reactions 0^0C

$SrCl_2.6H_2O(s) \rightleftharpoons SrCl_2.2H_2O(s) + 4H_2O(g)$ $K_p = 5\times10^{-12}$

$Na_2HPO_4.12H_2O(s) \rightleftharpoons Na_2HPO_4 7H_2O\ (s) + 5H_2O(g)$ $K_p = 2.43\times10^{-13}$

$Na_2SO_{4.}10H_2O(s) \rightleftharpoons Na_2SO_4(s) + 10H_2O(g)$ $K_p = 1.024\times10^{-27}$

The vaopur pressure of water at 0^0C is 4.56 torr. Which is the most effective drying agent at 0^0C

1) $SrCl_2$. $2H_2O$

2) $Na_2HPO_4.7H_2O$

3) Na_2SO_4

4) all equally

86. Ammonia dissociates into N_2 and H_2 such that degree of dissociation α is very less than 1 and equilibrium pressure is P_0 then the value of α is [if K_p for $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$ is $27 \times 10^{-8} P_0^2$

1) 10^{-4}

2) 4×10^{-4}

3) 0.02

4) Can't be calculated

87. For a reaction: $A \rightleftharpoons B,$ carried out at 27^0C, the ratio of equilibrium concentrations of product to reactant changes by a factor of e^4 for every

1) 1.2 kcal rise in ΔG^0

2) 1.2 kcal fall in ΔG^0

3) 2.4 kcal rise in ΔG^0

4) 2.4 kcal fall in ΔG^0

88. When a mixture of N_2 and H_2 in the volume ratio of 1 : 5 is allowed to react at 700 K and 10^3 atm pressure, 0.4 mole fraction of NH_3 is formed at equilibrium. The K_p for the reaction

$N_2(g)+3H_2(g) \rightleftharpoons 2NH_3(g)$

1) $2.6\times10^{-5} atm^{-2}$ 2) $2.6\times10^{-4} atm^{-2}$

3) $2.6\times10^{3} atm^{-2}$ 4) $5.1\times10^{-3} atm^{-2}$

89. In the system, $LaCl_3(s)+H_2O(g)+$ heat $\rightleftharpoons LaClO(s) + 2HCl(g)$, equilibrium is established. More water vapour is added to disturb the equilibrium. If the pressure of water vapour at new equilibrium is double of that at initial equilibrium, the factor to which pressure of HCl is changed is

1) 2 times 2) $\sqrt{2}$ times

3) $\frac{1}{\sqrt{2}}$ times 4) 4 times

90. PCl_5 (molecular mass = M) dissociates into PCl_3 and Cl_2 as: $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$. If the total pressure of the system at equilibrium is P and the density is 'd' at temperature, T K. The degree of dissociation of PCl_5 may be represented as

1) $\frac{PM}{dRT}$ 2) $\frac{PM}{dRT}-1$

3) $\frac{dRT}{PM}-1$ 4) $\frac{dRT}{PM}$

space for rough work

Master JEE CLASSES
Kukatpally, Hyderabad.

IIT-JEE-MAINS PAPER-6
Max. Marks: 360

KEY SHEET

MATHS

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

PHYSICS

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

CHEMISTRY

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

SOLUTIONS:

MATHS

1. $$\begin{vmatrix} \sin\theta & \cos\theta & \sin 2\theta \\ \sin\left(\theta+\frac{2\pi}{3}\right) & \cos\left(\theta+\frac{2\pi}{3}\right) & \sin\left(2\theta+\frac{4\pi}{3}\right) \\ \sin\left(\theta-\frac{2\pi}{3}\right) & \cos\left(\theta-\frac{2\pi}{3}\right) & \sin\left(2\theta-\frac{4\pi}{3}\right) \end{vmatrix} = 0\left[R_1 \to R_1+R_2+R_3\right]$$

2. $$\begin{vmatrix} p & b & c \\ a & q & c \\ a & b & r \end{vmatrix} = 0$$

$$\Rightarrow (p-q)(q-b)(r-c)\begin{vmatrix} p-a & b-q & 0 \\ 0 & q-b & c-r \\ a & b & r \end{vmatrix} = 0$$

$$\frac{p}{p-a}+\frac{q}{q-b}+\frac{r}{r-c} = 2$$

3. $$\begin{vmatrix} 1-\sin^2 x & \cos^2 x & 4\sin 2x \\ \sin^2 x & 1+\cos^2 x & 4\sin 2x \\ \sin^2 x & \cos^2 x & 1+4\sin 2x \end{vmatrix} = 2+4\sin 2x$$

Maxm value of $(2+4\sin 2x) = 6$

4. $R_2 \to R_2 - R_1$, $R_3 \to R_3 - R_1$ and expand

5. Take x, y, z from C_1, C_2, C_3 respectively and multiply R_1, R_2, R_3 with x, y, z

6. $$\begin{vmatrix} a^2 & a & 1 \\ \cos nx & \cos(n+1)x & \cos(n+2)x \\ \sin nx & \sin(n+1)x & \sin(n+2)x \end{vmatrix} = a^2 \sin x - a\sin 2x + \sin x \quad (\text{independent of } n)$$

7. $$\begin{vmatrix} a-b & b-c & c-a \\ x-y & y-z & z-x \\ p-q & q-r & r-p \end{vmatrix} = \begin{vmatrix} 0 & b-c & c-a \\ 0 & y-z & z-x \\ 0 & q-r & r-p \end{vmatrix} = 0$$

8. $C_1 \to C_1 + C_2 + C_3$

$\Rightarrow (x+9)$ would be a factor in each determinant

$\Rightarrow X = -9$

9. $$P(x) = \begin{vmatrix} x^3+4x & x+3 & x-2 \\ x-2 & 5x & x-1 \\ x-3 & x+2 & 4x \end{vmatrix}$$

$$P(0) = f = \begin{vmatrix} 0 & 3 & -2 \\ -2 & 0 & -1 \\ -3 & 2 & 0 \end{vmatrix} = -3(-3) - 2(-4) = 17$$

10. $C_1 \to C_1 + C_2 + C_3$

$$\begin{vmatrix} b-c & c-a & a-b \\ b^1 - c^1 & c^1 - a^1 & a^1 - b^1 \\ b^{11} - c^{11} & c^{11} - a^{11} & a^{11} - b^{11} \end{vmatrix} = O = m$$

11. $D_1 = \begin{vmatrix} 1 & 1 & 1 \\ x^2 & y^2 & z^2 \\ x & y & z \end{vmatrix} = \frac{1}{xyz} \begin{vmatrix} xyz & xyz & xyz \\ x^2 & y^2 & z^2 \\ x & y & z \end{vmatrix}$

$$= \begin{vmatrix} yz & xz & xy \\ x & y & z \\ 1 & 1 & 1 \end{vmatrix}$$

$$= \begin{vmatrix} 1 & 1 & 1 \\ yz & xz & xy \\ x & y & z \end{vmatrix} = D_2$$

12. $\begin{vmatrix} a+b+2c & a & b \\ c & b+c+2a & b \\ c & a & a+c+2b \end{vmatrix} = 2(a+b+c)^3 \left[C_1 \to C_1 + C_2 + C_3\right]$

13. $\begin{vmatrix} 0 & 0 & 1 \\ -1 & 1 & 1 \\ -1 & 0 & 2 \end{vmatrix} = 1 = [Z]$

14. $R_2 \to R_2 + R_1$

$R_3 \to R_3 + R_1$

4(Determinant) =4

15. $\Delta_1 = \begin{vmatrix} a_1 & 1 & 1 \\ 0 & b_2 & 1 \\ 0 & 0 & c_3 \end{vmatrix} \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$

16. $\Delta = \begin{vmatrix} \frac{\alpha}{1-\alpha} & \frac{\beta}{1-\beta} & \frac{\gamma}{1-\gamma} \\ \alpha & \beta & \gamma \\ \alpha^2 & \beta^2 & \gamma^2 \end{vmatrix}$

$$= \frac{\alpha\beta\gamma}{(1-\alpha)(1-\beta)(1-\gamma)} \begin{vmatrix} 1 & 1 & 1 \\ \alpha & \beta & \gamma \\ \alpha^2 & \beta^2 & \gamma^2 \end{vmatrix}$$

$$= \frac{\alpha\beta\gamma}{(1-\alpha)(1-\beta)(1-\gamma)} \left[(\beta-\gamma)(\gamma-\alpha)(\alpha-\beta)\right] = \frac{-25d}{2(a+b+c+d)}$$

17. $|A|^{2015} |A^2 - 5I|$

18. $R_1 \to R_1 - R_3$

First two rows would be identical

19. $R_3 \to R_3 - R_2$

$\Delta = 0$

20. directly evaluate

21. $(1+\cos x)(\sin^2 x) = x^2 + \frac{1}{x^2}$

This can't be equal anytime as $x^2 + \frac{1}{x^2} \geq 2$ occurs at $x = \pm 1$

And $1 + \cos x = 2, \sin^2 x = 1$ can't be true simultaneously

22. $\sin^{50} x = 1 + \cos^{50} x$

$\sin x = \pm 1; \cos x = 0$

$X = n\pi \pm \frac{\pi}{2} (n \in N)$

23. $\left(\frac{\sqrt{3}-1}{2\sqrt{2}}\right)\sin\theta + \left(\frac{\sqrt{3}+1}{2\sqrt{2}}\right)\cos\theta = \frac{1}{\sqrt{2}}$

$\Rightarrow \sin(\theta + 75°) = \sin 45°$

$\Rightarrow \cos(15° - \theta) = \cos 45°$

$\Rightarrow 15° - \theta = 2n\pi \pm \frac{\pi}{4}$

$\Rightarrow \theta = 2n\pi \pm \frac{\pi}{4} + \frac{\pi}{12}$

24. $\sin^8 x + \cos^8 x = \left(\sin^4 x + \cos^4 x\right)^2 - 2\sin^4 x \cos^4 x$

$\Rightarrow \frac{17}{32} = 1 - 4\sin^2 x \cos^2 x + 2\sin^4 x \cos^4 x$

$\Rightarrow \frac{17}{32} = 1 - \left(\sin 2x\right)^2 + \frac{\left(\sin 2x\right)^4}{8}$

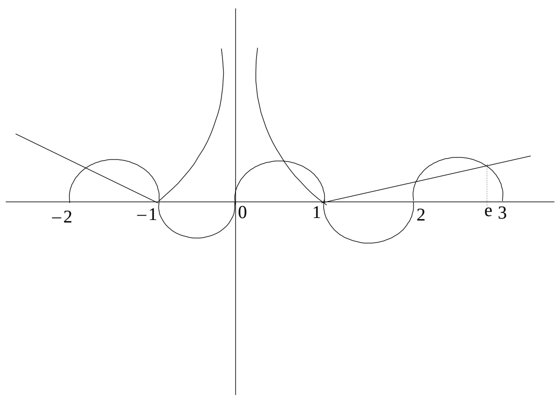
$$\Rightarrow 4(\sin 2x)^4 - 32(\sin 2x)^2 + 15 = 0$$

$$\Rightarrow (\sin 2x)^2 = \frac{1}{2}$$

$$\Rightarrow 2x = n\pi \pm \frac{\pi}{4}$$

$$\Rightarrow x = \frac{n\pi}{2} \pm \frac{\pi}{8}$$

25. Use Graph (Total 6 points)



26. $$\frac{1}{\sin\theta \sin\left(\theta + \frac{\pi}{4}\right)} = \sqrt{2}\left[\cot\theta - \cot\left(\theta + \frac{\pi}{4}\right)\right]$$

$$\sum_{m=1}^{6} \operatorname{cosec}\left(\frac{\theta + (m-1)\pi}{4}\right)\operatorname{cosec}\left(\frac{\theta + m\pi}{4}\right) = \sqrt{2}\left[\cot\theta - \cot\left(\theta + \frac{3\pi}{2}\right)\right] = 4\sqrt{2}$$

$$\Rightarrow \cot\theta + \tan\theta = 4(2 \text{ solutions in } \left(0, \frac{\pi}{2}\right))$$

27. θ must lie in 4th quadrant $\Rightarrow 2n\pi + \frac{7\pi}{4}$

28. $\cos\theta \cos 2\theta \cos 3\theta = \frac{1}{4}$ $\cos 4\theta = 0$ or $\cos 2\theta = \frac{-1}{2}$

$$\theta = \frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}, \frac{2\pi}{3}, \frac{\pi}{3}$$

29. $b^2 - 4ac \geq 0$

$$\cos^2 p - 4(\cos p - 1)\sin p \geq 0$$

$$p \in (0, \pi)$$

30. $1 + \sin\theta\cos\theta - \cos\theta|\sin\theta| - 2 = -1$

$$\sin\theta\cos\theta - \cos\theta|\sin\theta| = 0$$

$\Rightarrow \theta \in \left(\frac{3\pi}{2}, \pi\right)$ as $\sin\theta - \cos\theta \neq 0$ & all terms should be finite.

PHYSICS

31. $A=\int_0^R y\,dx=\frac{2v^4}{3g^2}\sin^3\theta\cos\theta$

32. $v=\sqrt{2g\left(h-y\right)}$

$x=vt=2\sqrt{y\left(h-y\right)}$

33. $\int_0^\tau\left(v-u\cos\alpha\right)dt=l,\int_0^\tau v\cos\alpha\,dt=u\tau$

34. $\sin\theta=\frac{1}{\sqrt{2+2gh/v^2}}$

35. $\overrightarrow{V_A}=10\hat{i}$

$\overrightarrow{V_B}-\overrightarrow{V_A}=6\cos\theta\hat{i}+6\sin\theta\hat{j}$

$\overrightarrow{V_C}-\overrightarrow{V_B}=-12\hat{i}$

36. Plot ($V_A - V_B$)- t graph

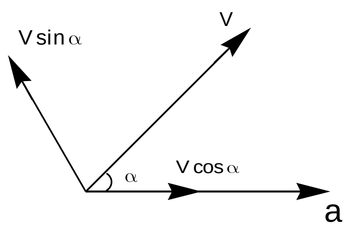
Find time till area is positive.

37. $V_{avg}=\frac{\text{displacement}}{\text{time}}$

Time is same for all the particles.

Displacement is distance between vertex and incentre.

38.



For minimum relative velocity, $v\cos\alpha=at$

39 Solve the problem by taking OB as X-axis and OA as Y-axis

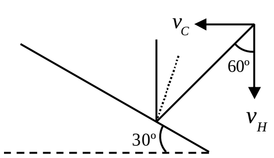
Along OB, $a=-g\sin\beta$

Perpendicular to OB, $a=-g\cos\beta$

40. Conceptual

41. $\tan 60^o=\frac{v_C}{v_H}$

$\therefore \quad v_C=v_H\tan 60^o=15m/s$



42. Let the height of point P above the ground be h.

$u\cos 53^{o}t + h = \frac{1}{2}at^{2}$

$\frac{u\ \sin 53^{o} - gt}{u\ \cos 53^{o}} = 1$

$h = u\ \sin 53^{o}t - \frac{1}{2}gt^{2}$

43. $T_1 = \frac{2u\sin(\alpha+\beta)}{g\cos\alpha}$

$T_2 = \frac{2u\sin(\beta-\alpha)}{g\cos\alpha}$

$\frac{T_1}{T_2} = \frac{\sin(\beta+\alpha)}{\sin(\beta-\alpha)}$

$\beta - \alpha = \theta$

$\sin(\alpha+\beta) = \cos\theta$

$\alpha + \beta = 90^{o} - \theta$ but

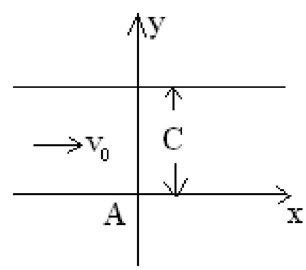
$\beta - \alpha = \theta$

$\therefore \beta = 45^{o}$

44. Relative velocity of balls must be along their line joining
i.e. $v\sin 53^{\circ} = 24\sin 37^{\circ}$

45. $t = \frac{C}{\mu}$; $v = \frac{2v_0}{c}y$

Where y is the distance from bank from A, and upto middle. It follow from this relation that boat moves parallel to banks with constant acceleration.



$a = \frac{2v_0\mu}{C}$ ($v_0 = at$; $= a\frac{C}{2\mu}$ up to middle of the bank)

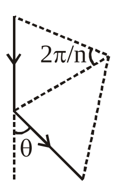
$\therefore$ The boat will reach the middle of the river in time $T = \frac{C}{2\mu}$

and will be carried down stream by $S = \frac{1}{2}aT^2 = \frac{V_0C}{4\mu}$ when moving from the middle of the river to the opposite bank, the boat will again be carried away by a distance of $\frac{v_0C}{4\mu}$.

Total dirft = $\frac{v_0C}{2\mu}$

46. Conceptual

47. Sides are shown



$$\theta = \pi - 2\left(\frac{\pi - \frac{2\pi}{n}}{2}\right)$$

$$= \frac{2\pi}{n}$$

Here n = 12

$\Rightarrow \theta = \frac{2\pi}{12} = \frac{\pi}{6}$

Velocity of approach = V – V cos $\frac{\pi}{6} = V - \frac{\sqrt{3}}{2}V$

Time of approach $= \frac{a}{V\left(1 - \frac{\sqrt{3}}{2}\right)}$

Distance travelled $= \left(\frac{2a}{2-\sqrt{3}}\right)$.

48. $\vec{v}_{Bg} = \vec{v}_{BR} + \vec{v}_{Rg} = 4\hat{i} + 2\hat{j}$

$\vec{v}_{wg} = 6\hat{i}$

$\vec{v}_{wB} = \vec{v}_w - \vec{v}_B = 6\hat{i} - 4\hat{i} - 2\hat{j} = 2\hat{i} - 2\hat{j}$

Direction will be north-west

49. Vp/w = 500 kmph $\hat{j}$

Vw/g = $v_x\hat{i} + v_y\hat{j}$

Vp/g = $v_x\hat{i} + (v_y + 500)\hat{j}$ kmph

In two hours Sp/g = $150\sqrt{2}\,\hat{i} + 1150\sqrt{2}\,\hat{j}$ km = $2v_x\,\hat{i} + (2v_y + 1000)\,\hat{j}$

$\Rightarrow$ vx= $75\sqrt{2}$ vy= $75\sqrt{2}$

Vw/g = $75\sqrt{2}\,\hat{i} + 75\sqrt{2}\,\hat{j}$ = 150 kmph at 45° N of E

50. Net velocity of boat in river = $\sqrt{5^2 - u^2}$

$t = \frac{\text{Distance}}{\text{Velocity}} \Rightarrow \frac{1}{4} = \frac{1}{\sqrt{5^2 - u^2}} \Rightarrow u = 3kmh^{-1}$

51. For the minimum time man should swim perpendicular to the direction of flow of stream.

52. Velocity of boat w.r.t. ground is $\vec{v} = (u - v\sin\theta)\hat{i} + v\cos\theta\hat{j}$

For the required condition $v_0 = u - v\sin\theta$

53. $y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$

Let $m = \tan\theta$

$\left(\frac{gx^2}{2u^2}\right)m^2 - xm + \left(\frac{gx^2}{2u^2} + y\right) = 0$

Two roots m_1 & m should be same

$\therefore discrimant = 0$

$$x^2 - u\left(\frac{gx^2}{2u^2}\right)\left(\frac{gx^2}{2u^2} + y\right) = 0$$

54. Conceptual

55. $\sin\theta = \frac{5}{10}$

So $\theta = 30^\circ$

Speed relative to shore = $10\cos 30^\circ = 5\sqrt{3}$

56. $10\sin 37^\circ = v\sin 30^\circ$

57. $x = (u\cos\theta)t$

$$y + \frac{1}{2}gt^2 = (u\sin\theta)t$$

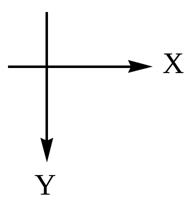
$$\Rightarrow x^2 + \left(y + \frac{1}{2}gt^2\right)^2 = u^2t^2$$

Circle with centre

$$\left(0, -\frac{1}{2}gt^2\right)$$

And radius = ut

58.



Let $\overrightarrow{V_r} = a\hat{i} + b\hat{j}$

$\overrightarrow{V_M} = 3\hat{i} + \sqrt{3}\hat{j}$

$\overrightarrow{V_R} - \overrightarrow{V_m}$ is along vertical

$\therefore$ a = 3

$\sqrt{a^2 + b^2} = 5$

$b = 4$

59. Conceptual

60. Conceptual

CHEMISTRY

61. $\Delta Hr = 2(\Delta H_f)SO_2 + (\Delta H_f)CO_2 - (\Delta H_f)CS_2$

$-275 = 2 \times (-75) + x - 25, x = -100$

62. It $\Delta ng = 0$ then $K_P = K_C$

On increasing pressure reaction will proceed in the direction in which lesser number of gaseous moles are formed

In homogeneous equilibrium all the species are in single phase

63. Conceptual

64. $6PCl_5 \rightleftharpoons PCl_3 + Cl_2$

teq $1-\alpha \quad \alpha \quad \alpha$

$6Kp = \frac{\alpha^2}{1-\alpha^2} \times P$

$6 = \frac{\frac{1}{16}}{1-\frac{1}{16}} \times 30$

65. $K_p = P_{CO2}$

In hetrogeneous system equilibrium is unaffected by small amount addition of solid or liquid

66. Conceptual

67. Conceptual

68. Conceptual

69. $\Delta H = \Delta E + \Delta n_g RT = 2.1 + 2 \times 0.002 \times 300 = 3.03 kcal$

$\Delta G = DH - T\Delta S = 3.3 - 300 \times (0.02) = -2.7 kcal$

70. Conceptual

71. Conceptual

72. Conceptual

73. Conceptual

74. Conceptual

75. as $\Delta n_g <$ O and $\Delta H <$ O hence reaction is favourable at high pressure and low temperature.

76. As density of ice is less than density of water hence on increasing pressure some more ice will melt.

77. Conceptual

78. $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$

$1-\alpha \qquad \alpha \qquad \alpha/2$

$$K_P = \frac{\left(\frac{\alpha/2}{1+\alpha/2}.P_o\right)\left(\frac{\alpha}{1+\alpha/2}.p_o\right)^2}{\left(\frac{1-\alpha}{1+\alpha/2}.P_o\right)^2} = \frac{\alpha}{(2+\alpha)} \times \frac{P_o \times \alpha^2}{(1-\alpha)^2}$$

79. $CH_3COOH(\ell) + C_2H_5OH(\ell) \rightleftharpoons CH_3COOC_2H_5(\ell) + H_2O(\ell)$

$3 \qquad 3 \qquad 0 \qquad 0$

$3-2 \qquad 3-2 \qquad 2 \qquad 2$

$$K_C = \frac{2 \times 2}{1 \times 1} = 4$$

80. Conceptual

81. Conceptual

82. Conceptual

83. $K_p = \left(P_{H_2O}\right)^2$

$P_{H_2O} = \sqrt{K_p}$

$= \sqrt{2.25 \times 10^{-6}}$

$= \sqrt{225 \times 10^{-6}}$

$= 15 \times 10^{-3}$

R. H = $\frac{P_{H_2O}}{S.V.P} = \frac{15 \times 10^{-3}}{22.8/760}$

$= \frac{15 \times 10^{-3}}{3 \times 10^{-2}} = 0.5$

R.H = $0.5 \times 100 = 50\%$

84. Conceptual

85. $\left(P_{H_2O}\right)_1 = \left(5 \times 10^{-12}\right)^{\frac{1}{4}} = (5)^{1/4} \times 10^{-3}$

$\left(P_{H_2O}\right)_2 = \left(2.43 \times 10^{-13}\right)^{\frac{1}{5}} = 3 \times 10^{-3}$

$\left(P_{H_2O}\right)_3 = \left(1.204\times10^{-27}\right)^{\frac{1}{10}} = 2\times10^{-3}$

as (P_{H_2O})$_1$ is least hence $SrCl_2.2H_2O$ will act as good dehydrating agent

86.

$$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g) \quad K_p = 27\times10^{-8} P_0^2$$

$$1-\alpha \qquad \frac{\alpha}{2} \qquad \frac{3\alpha}{2} \qquad n_T = 1+\alpha$$

$$27\times10^{-8} P_0^2 = \frac{\left[\frac{\alpha}{2(1+\alpha)}P_0\right]\left[\frac{3\alpha}{2(1+\alpha)}P_0\right]^3}{\left[\frac{1-\alpha}{1+\alpha}P_0\right]^2}$$

$$27\times10^{-8} = \frac{3^3\alpha^4P_0^4P_0^2}{2\times2^3\times P_0^2}$$

$$2^4\times10^{-8} = \alpha^4$$

$$\alpha = 2\times10^{-2}$$

87. $\Delta G^o = -RT\ell nk$

$= -2\times300\times\ell ne^4$

$= -2\times300\times4\times10^{-3}$

$= -2.4kcal.$

88. Conceptual

89. Conceptual

90. $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

$$1-\alpha \qquad \alpha \qquad \alpha$$

$$M_{miX} = \frac{M}{1+\alpha}$$

$$d = \frac{PM_{mix}}{RT}$$

$$\Rightarrow d = \frac{PM}{(1+\alpha)RT}$$

$$\Rightarrow \alpha = \frac{PM}{dRT} - 1$$