MATHEMATICS

(SINGLE CORRECT ANSWER TYPE)

This section contains 20 multiple choice questions. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

1. Let $f:R-\left\{\frac{-4}{3}\right\}\to R-\left\{\frac{4}{3}\right\}$ be a function defined as $f(x)=\frac{4x}{3x+4}$. The inverse of f is the map $g:R-\left\{\frac{4}{3}\right\}\to R-\left\{\frac{-4}{3}\right\}$ is given by:

1) $g(y)=\frac{3y}{3-4y}$ **2)** $g(y)=\frac{4y}{4-3y}$

3) $g(y)=\frac{4y}{3-4y}$ **4)** $g(y)=\frac{3y}{4-3y}$

2. For an infinite A.G.P, the first five terms are $a,-6,-8,6,b$. Then the set of values of $\{a,d,r\}$ in order is $\{d\ is\ common\ difference,\ r\ is\ common\ ratio\ of\ A.G.P\}$

1) $\left\{\frac{-28}{9},\frac{-10}{9},3\right\}$ **2)** $\left\{108,-90,\frac{-1}{3}\right\}$ **3)** $\left\{\frac{28}{9},\frac{10}{9},3\right\}$ **4)** $\left\{108,90,\frac{1}{3}\right\}$

3. A boy 1.5 m tall is standing at some distance a 30m tall building. The angle of elevation from his eyes to the top of the building increases from 30^0 *to* 60^0 as he walks towards the building. The distance he walked towards the building is

1) $30\sqrt{3}$ **2)** $19\sqrt{3}$ **3)** $\frac{30}{\sqrt{3}}$ **4)** 30

4. If $f(x)=\begin{cases}\frac{x\left(3e^{1/x}+4\right)}{2-e^{1/x}}, & x\neq 0\\ 0, & x=0\end{cases}$, then $f(x)$ is

1) Continuous aswell as differentiable at x=0

2) Continuous but not differentiable at x=0

3) Differentiable but not continuous at x=0

4) Discontinuous every where

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5. If the curve $x+y=x^2(x+1)$ has two distinct horizontal tangents, then the distance between them is

1) $\frac{32}{27}$ **2)** $\frac{27}{32}$ **3)** $\frac{4}{3}$ **4)** $\frac{22}{27}$

6. $\int \frac{1-7\cos^2 x}{\sin^7 x\cos^2 x}dx=\frac{f(x)}{(\sin x)^7}+C,$ then $f(x)$ is equal to

1) $\sin x$ **2)** $\cos x$ **3)** $\tan x$ **4)** $\cot x$

7. Let p be Question paper is tough' and q be 'Rekha will fail in the examination'. Then the following statements in symbolic form are represented by:

i) The question paper is not tough and Rekha will fail in the examination

ii) If Rekha will not fail in the examination then question paper is not tough

1) $(i)\,p\Rightarrow q(ii)\sim q\Rightarrow\sim p$ **2)** $(i)\sim q\Rightarrow\sim p(ii)\sim p\wedge q$

3) $(i)\sim p\vee q(ii)\sim q\Rightarrow\sim p$ **4)** $(i)\sim p\wedge q(ii)\sim q\Rightarrow\sim p$

8. If $\sqrt{a}+\sqrt{d}=\sqrt{c}+\sqrt{b}$ and $ad=bc,$ where $a,b,c,d\in R^+$ then the family of lines $(a^2x+b^2y+c^2)+d^2x=0$ passes through a fixed point $M(x_0,y_0)$. Then the value of $(x_0^{-1}+y_0^{-1})$

1) 2 **2)** 0 **3)** 5 **4)** 1

9. PN is an ordinate of the parabola $y^2=4ax$ (P on $y^2=4ax$ and N on $x-$axis). A straight line is drawn parallel to the axis to bisect NP and meets the curve in Q. NQ meets the tangent at the vertex A in a point T such that $AT=kNP$, then the value of k is (where A is the vertex)

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

10. If circle whose diameter is major axis of ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1(a>b>0)$ meets minor axis at point P and orthocentre of ΔPF_1F_2 lies on ellipse where F_1 and F_2 are foci of ellipse, then square of eccentricity of ellipse, is

1) $2\sin\frac{\pi}{10}$ **2)** $2\sin\frac{\pi}{12}$ **3)** $\sin\frac{\pi}{4}$ **4)** $\sin\frac{\pi}{3}$

11. If $(1+x-3x^2)^{2145}=a_0+a_1x+a_2x^2+.....,$ then $a_0-a_1+a_2-a_3+.....$ ends with:

1) 1 **2)** 3 **3)** 7 **4)** 9

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12. The smallest value of k, for which both the roots of the equation $x^2-8kx+16\left(k^2-k+1\right)=0$ are real, distinct and have values at least 4, is

1) 3 **2)** 2 **3)** 0 **4)** 1

13. A man walks a distance of 3 units from the origin towards the north – east $\left(N\ 45^0\ E\right)$ direction. From there, he walks a distance of 4 units towards the north – west $\left(N\ 45^0\ W\right)$ direction to reach a point P. Then the position of P in the Argand plane is

1) $3e^{i\pi/4}+4i$ **2)** $\left(3-4i\right)e^{i\pi/4}$ **3)** $\left(4+3i\right)e^{i\pi/4}$ **4)** $\left(3+4i\right)e^{i\pi/4}$

14. The mean deviation about the mean of the numbers $1,2,3.....,n$ (if n is odd) is

1) $\frac{n^2-1}{4n}$ **2)** $\frac{n^2+1}{4n}$ **3)** $\frac{n^2-1}{12n}$ **4)** $\frac{n^2+1}{12n}$

15. Consider the following 3 lines in space

$L_1:\vec{r}=3i-\hat{j}+2\hat{k}+\lambda\left(2\hat{i}+4\hat{j}-\hat{k}\right)$

$L_2:\vec{r}=\hat{i}+\hat{j}-3\hat{k}+\mu\left(4\hat{i}+2\hat{j}+4\hat{k}\right)$

$L_3:\vec{r}=3\hat{i}+2\hat{j}-2\hat{k}+t\left(2\hat{i}+\hat{j}+2\hat{k}\right)$

Then which one of the following pair(s) are in the same plane.

1) only L_1L_2 **2)** only L_2L_3 **3)** only L_3L_1 **4)** L_1L_2 *and* L_2L_3

16. Let $ABCD$ be a parallelogram such that $\overrightarrow{AB}=\vec{q},\overrightarrow{AD}=\vec{p}$ and $\angle BAD$ be an acute angle. If $\vec{r}$ is the vector that coincides with the altitude directed from the vertex B to the side AD, then $\vec{r}$ is given by

1) $\vec{r}=3\vec{q}-\frac{\left(\vec{p}.\vec{q}\right)}{\left(\vec{p}.\vec{p}\right)}\vec{p}$ **2)** $\vec{r}=-\vec{q}+\frac{\left(\vec{p}.\vec{q}\right)}{\left(\vec{p}.\vec{p}\right)}\vec{p}$

3) $\vec{r}=\vec{q}-\frac{\left(\vec{p}.\vec{q}\right)}{\left(\vec{p}.\vec{p}\right)}\vec{p}$ **4)** $\vec{r}=-3\vec{q}+\frac{3\left(\vec{p}.\vec{q}\right)}{\left(\vec{p}.\vec{p}\right)}\vec{p}$

17. If the equation $x^2+2|a|x+4=0$ has integral roots then the minimum value of a is

1) $-\frac{5}{2}$ **2)** -1 **3)** 0 **4)** 1

18. If A, B are two square matrices of same order such that $A+B=AB$ and I is identity matrix of order same as that of A,B then

1) $AB\neq BA$ **2)** $|A-I|=0$ **3)** $|B-I|\neq 0$ **4)** $|A-B|=0$

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19. The set of homogeneous equations

$tx+(t+1)y+(t-1)z=0$

$(t+1)x+ty+(t+2)z=0$

$(t-1)x+(t+2)y+tz=0$

Has non – trivial solutions for :

1) three values of t **2)** two values of t

3) one value of t **4)** no value of t

20. Solution of the equation $3\sqrt{3}\sin^3 x+\cos^3 x+3\sqrt{3}\sin x\cos x=1$

1) $x=\left(n\pi+(-1)^n\dfrac{\pi}{6}\right)-\dfrac{\pi}{6}, n\in I$ **2)** $x=(2n+1)\dfrac{\pi}{6}, n\in I$

3) $x=2n\pi+\dfrac{\pi}{3}, n\in I$ **4)** $x=n\pi+(-1)^n\dfrac{\pi}{3}, n\in I$

(NUMERICAL VALUE TYPE)

This section contains 5 questions. Each question is numerical value. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to second decimal place. (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).
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21. If $g(x)$ is the inverse of $f(x)$ and $f(x)$ has domain $x\in[1,5]$. Where $f(1)=2$ and $f(5)=10$ then the value of $\int_1^5 f(x)\,dx+\int_2^{10} g(y)\,dy$ is

22. The area bounded by the curve $y=\sin^2 x-2\sin x$ and the $x-$axis, where $x\in[0,2\pi]$, in sq. units

23. A circle is drawn to pass through the extremities of the latus rectum of the parabola $y^2=20x$. It is given that this circle also touches the directrix of the parabola. Then the radius of this circle is equal to

24. Number of ways in which 7 green bottles and 8 blue bottles can be arranged in a row if exactly 1 pair of green bottles is side by side, is (Assume all bottles to be alike except for the colour):

25. If the distance from the point $P(1,1,1)$ to the line passing through the points $Q(0,6,8)$ and $R(-1,4,7)$ is expressed in the form $\sqrt{\dfrac{p}{q}}$ where p and q are coprime, then the value of $\dfrac{(p+q)(p+q-1)}{2}$ equals:

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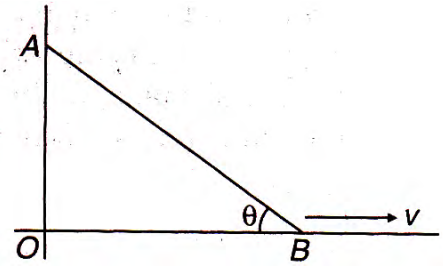
PHYSICS

(SINGLE CORRECT ANSWER TYPE)

This section contains 20 multiple choice questions. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

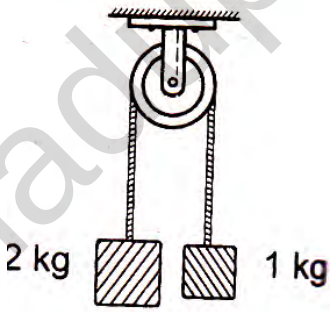
Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

26. The lower end of a 4 m long uniform rod AB is pulled with constant speed $\upsilon = 4\ m/s$. The speed of centre of mass of the rod at $\theta = 60^0$ will be



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

27. Two blocks of masses 2 kg and 1 kg respectively are tied to the ends of a string which passes over a light frictionless pulley. The masses are held at rest at the same horizontal level and then released. The distance traversed by centre of mass in 2s is $\left(g = 10\ m/s^2\right)$



1) $1.42m$ **2)** $2.22m$ **3)** $3.12\ m$ **4)** $3.33m$

28. A small heavy block is attached to the lower end of a light rod of length l which can be rotated about its clamped upper end. What minimum horizontal velocity should the block be given so that it moves in a complete vertical circle?

1) $7\sqrt{gl}$ **2)** $9\sqrt{gl}$ **3)** $2\sqrt{gl}$ **4)** $3\sqrt{gl}$

29. A satellite is orbiting the earth close to its surface. A particle is to be projected from the satellite to just escape from the earth. The escape speed from the earth is υ_e. Its speed with respect to the satellite

1) will be less than υ_e **2)** will be more than υ_e

3) will be equal to υ_e **4)** will depend on direction of projection

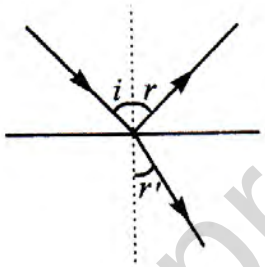
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30. A small spherical ball is released from a point at a height h on a rough track shown in figure. Assuming that it does not slip anywhere, find its linear speed when it rolls on the horizontal part of the track.



1) $V=\sqrt{\frac{12gh}{5}}$ **2)** $V=\sqrt{\frac{10gh}{5}}$ **3)** $V=\sqrt{\frac{10gh}{3}}$ **4)** $V=\sqrt{\frac{10gh}{7}}$

31. A ray of light is incident at an angle i from denser to rare medium. The reflected and the refracted rays are mutually perpendicular. The angle of reflection and the angle of refraction are respectively r and r', then the critical angle will be



1) $\sin^{-1}(\sin r)$ **2)** $\sin^{-1}(\tan r')$ **3)** $\sin^{-1}(\tan i)$ **4)** $\tan^{-1}(\sin i)$

32. A microscope has objective of aperture 8mm and focal length 2.5 cm. It's resolving limit is nearly $(Given\ \lambda=5500A^0, \mu=1)$

1) $2\times10^{-6}m$ **2)** $4\times10^{-6}m$ **3)** $6\times10^{-6}m$ **4)** $8\times10^{-6}m$

33. A hydrogen like atom of atomic number Z is in an excited state of quantum number $2n$. It can emit a maximum energy photon of $204eV$. If it makes transition to quantum state n, a photon of energy $40.8eV$ is emitted. The value of n will be

1) 1 **2)** 2 **3)** 3 **4)** 4

34. The compound unstable nucleus ${}^{236}_{92}U$ often decays in accordance with the following reaction ${}^{236}_{92}U \rightarrow {}^{140}_{54}Xe + {}^{94}_{38}Sr +$ other particles. In the nuclear reaction presented above, the "other particle" might be

1) an alpha particle, which consists of two protons and two neutrons

2) two protons

3) one proton and one neutron

4) two neutrons

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35. Consider telecommunication through optical fibres. Which of the following statements is not true

1) Optical fibres may have homogeneous core with a suitable cladding

2) Optical fibres can be of graded refractive index

3) Optical fibres are subject to electromagnetic interference from outside

4) Optical fibres have extremely low transmission loss

36. Two points charges q and $-q$ are at positions $(0,0,d)$ and $(0,0,-d)$ respectively. What is the electric field at $(\alpha,0,0)$?

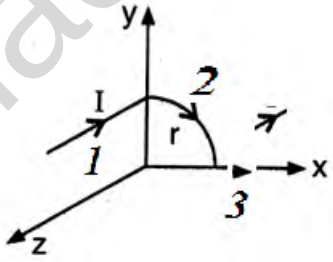
1) $\frac{2qd}{4\pi\varepsilon_0\left(d^2+a^2\right)^{3/2}}\hat{k}$ **2)** $\frac{qd}{4\pi\varepsilon_0\left(d^2+a^2\right)^{3/2}}\hat{k}$

3) $\frac{-2qd}{4\pi\varepsilon_0\left(d^2+a^2\right)^{3/2}}\hat{k}$ **4)** $\frac{-qd}{4\pi\varepsilon_0\left(d^2+a^2\right)^{3/2}}\hat{k}$

37. Two identical sheets of a metallic foil are separated by d and capacitance of the system is C and charged to a potential difference E. Keeping the charge constant, the separation is increased by l. Then the capacitance and potential difference will be:

1) $\frac{\in_0 A}{d}, E$ **2)** $\frac{\in_0 A}{d+l}, E$ **3)** $\frac{\in_0 A}{d+l}, \left(1+\frac{l}{d}\right)E$ **4)** $\frac{\in_0 A}{d}, \left(1+\frac{l}{d}\right)E$

38. Adjoining figure shows a conductor carrying a current i. The magnitude of magnetic field at the origin is:



1) $-\frac{\mu_0 i}{4r}\left(\frac{\hat{i}}{\pi}+\frac{\hat{j}}{2}\right)$ **2)** $\frac{\mu_0 i}{4r}\left(\frac{\hat{i}}{\pi}-\frac{\hat{j}}{2}\right)$ **3)** $\frac{\mu_0 i}{4r}\left(\frac{\hat{i}}{2}-\frac{\hat{j}}{\pi}\right)$ **4)** $\frac{-\mu_0 i}{4r}\left(\frac{\hat{i}}{\pi}+\frac{\hat{k}}{2}\right)$

39. A tank is filled with two immiscible liquids of densities 2ρ and ρ each of height h. Two holes are made to the side wall at $\frac{h}{2}$ and $\frac{3h}{2}$ from upper surface of the liquid, then the ratio of velocity of efflux of the liquids through the holes is

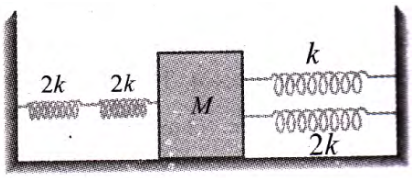
1) $\frac{1}{\sqrt{2}}$ **2)** $\frac{\sqrt{3}}{2}$ **3)** $\frac{2}{\sqrt{3}}$ **4)** $\sqrt{\frac{2}{3}}$

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40. A water drop of diameter 2mm is split up into 10^9 identical water drops. Then the work done in this process is (The surface tension of water is $7.3\times10^{-2}\,Nm^{-1}$).

1) $8.5\times10^{-5}\,J$ **2)** $9.1\times10^{-4}\,J$ **3)** $5.14\times10^{-6}\,J$ **4)** $9.1\times10^{-7}\,J$

41. Four massless springs whose force constants are $2k, 2k, k$ *and* $2k$ respectively are attached to a mass M kept on a frictionless plane (as shown in figure). If the mass M is displaced in the horizontal direction, then the frequency of the system

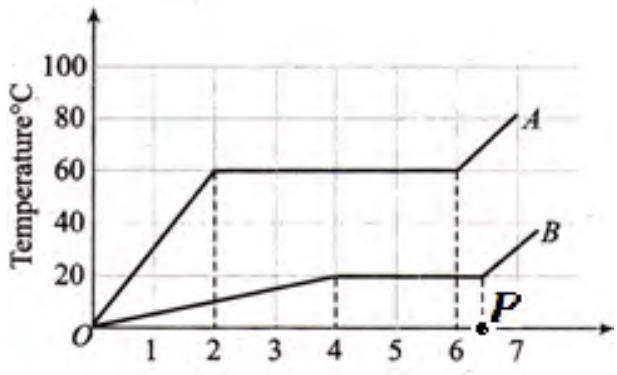


1) $\frac{1}{2\pi}\sqrt{\frac{k}{4M}}$ **2)** $\frac{1}{\pi}\sqrt{\frac{k}{M}}$ **3)** $\frac{1}{2\pi}\sqrt{\frac{k}{7M}}$ **4)** $\frac{1}{2\pi}\sqrt{\frac{7k}{M}}$

42. An ideal gas is taken through a process in which the pressure(P) and the volume(V) are changed according to the equation P=kV . Where 'k' is constant. If the molar heat capacity of the gas at constant volume is C_V and universal gas constant is 'R', then molar heat capacity of the gas in the above process is

1) $\frac{C_V}{2}+R$ **2)** C_V+R **3)** $C_V+\frac{R}{3}$ **4)** $C_V+\frac{R}{2}$

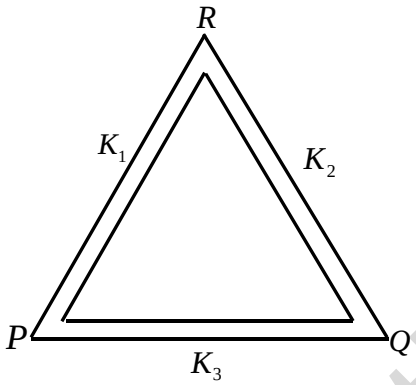
43. Two substances A and B of equal mass 'm' are heated at uniform rate of $6cal\ s^{-1}$ under similar conditions. A graph between temperature and time is shown in figure. Ratio of heats absorbed (H_A/H_B) by them for complete fusion of them is ('P' is the midpoint between 6 th and 7 th division of time axis.)



1) $\frac{9}{4}$ **2)** $\frac{4}{9}$ **3)** $\frac{8}{5}$ **4)** $\frac{5}{8}$

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44. Three rods of same dimensions are arranged in the form of a triangle PQR as shown in figure. They have coefficient of thermal conductivities K_1, K_2 and K_3 as shown in figure. Points P and Q are maintained at different temperatures for the heat to flow at the same rate along PRQ and PQ.



Then the following correct option is:

1) $K_3 = \frac{1}{2}(K_1 + K_2)$ **2)** $K_3 = K_1 + K_2$

3) $K_3 = \frac{K_1 K_2}{K_1 + K_2}$ **4)** $K_3 = 2(K_1 + K_2)$

45. The total number of degrees of freedom of all molecules of hydrogen in $1cc$ volume of hydrogen gas at NTP is nearly

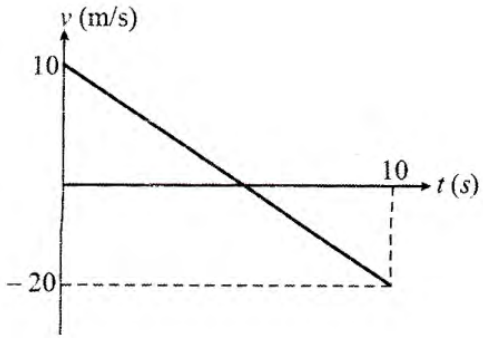
1) 2.3×10^{15} **2)** 1.344×10^{20} **3)** 5 **4)** 5×10^{10}

(NUMERICAL VALUE TYPE)

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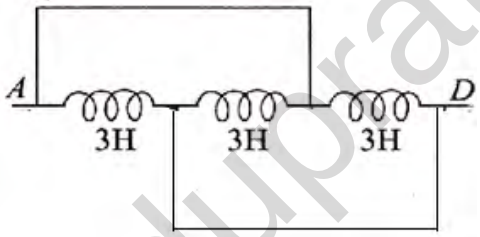
46. velocity – time graph of a particle moving in a straight line is as shown in figure. Mass of the particle is 2 kg. Work done by all the forces acting on the particle in time interval between $t = 0$ *to* $t = 10s$ is --- in Joul

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47. A hunter has a machine gun that can fire 50 g bullets with a velocity of $150 ms^{-1}$. A 60 kg tiger springs at him with a velocity of $10 ms^{-1}$. Then number of bullets must the hunter fire into the tiger in order to stop him in track are (in henrys)

48. The inductance between A and D is



49. In a common – emitter amplifier, using output resistance of 5000 ohm and input resistance of 2000 ohm, if the peak value of input signal voltage is 10mV and $\beta = 50$, then the peak value of output voltage is --- in volts

50. Consider that 10 identical sitars are playing a note, each at 70 dB. If they all are in chorus, what will be the sound level (in dB)

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CHEMISTRY

(SINGLE CORRECT ANSWER TYPE)

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51. The wave length associated with a ball weighing 100gm and moving at a speed of 5m/min is of the order

1) $10^{-10}m$ **2)** $10^{-20}m$ **3)** $10^{-32}m$ **4)** $10^{-40}m$

52. The values of a Vanderwalls' constant 'a' for the gases O_2, N_2, NH_3 *and* CH_4 are 1.360, 1.390, 4.170 and 2.253 L^2 atm mol^{-2} respectively. The gas which can most easily be liquified is:

1) O_2 **2)** N_2 **3)** NH_3 **4)** CH_4

53. Which of the following systems is not correctly matched

1) Monoclinic, $a \neq b \neq c, \alpha = \gamma = 90^0, \beta \neq 90^0$

2) Tetragonal $a = b \neq c, \alpha = \beta = \gamma = 90^0$

3) Hexagonal $a = b = c, \alpha = \beta = 90^0, \gamma = 120^0$

4) Triclinic $a \neq b \neq c, \alpha \neq \beta \neq \gamma \neq 90^0$

54. $2NO_{(g)} + 2H_{2(g)} \rightarrow N_{2(g)} + 2H_2O_{(g)}$

Mechanism:

Step1: $2NO \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} N_2O_2$ (fast, equilibrium)

Step2: $N_2O_2 + H_2 \xrightarrow{K_2} N_2O + H_2O$ (slow)

Step3: $N_2O + H_2 \xrightarrow{K_3} N_2 + H_2O$ (fast)

Regarding above reaction, the incorrect statement (s) is/are

1) The intermediates formed in the above reaction are N_2O_2 & N_2O

2) Rate = $\frac{K_2.K_1}{K_{-1}}[NO]^2[H_2]$

3) It follows overall third order kinetics

4) Its molecularity is 4

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55. First electron affinity is endothermic for

1) Nitrogen **2)** oxygen **3)** sulphur **4)** carbon

56. Which of the following species have shortest N – O bond length

1) NO **2)** NO^+ **3)** NO_2 **4)** NO^-

57. Among the following which one is more soluble in water

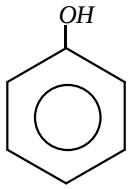
1) LiF **2)** NaF **3)** RbF **4)** CsF

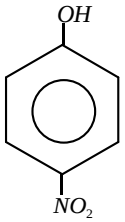
58. Anhydrous $AlCl_3$ is covalent however, when it is dissolved in water hydrated ionic species are formed. This transformation is owing to:

1) The trivalent state of Al **2)** The large hydration energy of Al^{3+}

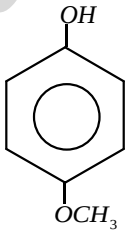
3) The low hydration energy of Al^{3+} **4)** The polar nature of water

59. Which of the following is most acidic?

1) 

2) 

3) 

4) 

60. Which of the following is a reducing sugar?

1) Fructose **2)** Maltose **3)** Lactose **4)** All of these

61. Which of the following is a polyamide?

1) Buna – N **2)** *PHBV* **3)** Nylon 2 – nylon 6 **4)** Glyptal

62. Which of the following is incorrect?

1) Zantac - Antacid **2)** Heroin – Narcotic analgesics

3) Penicillin - Antibiotic **4)** Ethynylestradiol – Antiseptic

63. $CH_3CHO + CH_3MgCl \rightarrow \xrightarrow{H_2O} X$ product 'X' is

1) $CH_3 - CH_2OH$ **2)** $CH_3 - CO - CH_3$

3) $CH_3 - CH(CH_3)OH$ **4)** $CH_3 - CH_2 - CH_2 - OH$

64. $S - S$ bond is present in

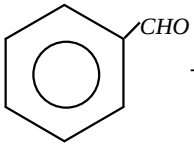
1) $H_2S_2O_7$ **2)** $H_2S_2O_8$ **3)** $H_2S_2O_6$ **4)** all of these

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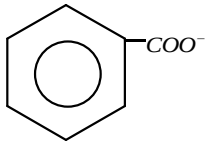
65. The products obtained when chlorine gas reacts with cold and dil aqueous $NaOH$ are:

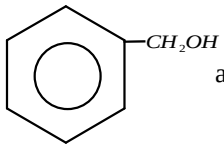
1) ClO_2^- *and* ClO_3^- **2)** Cl^- *and* ClO^- **3)** Cl^- *and* ClO_2^- **4)** ClO^- *and* ClO_3^-

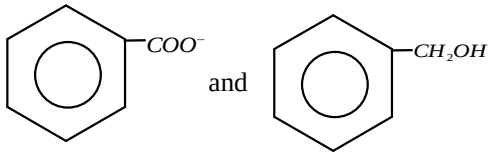
66. The major products obtained in the following reaction is:



$$+HCHO \xrightarrow{Con\ NaOH} A + B$$

1)  and CH_3OH

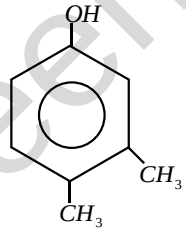
2)  and $HCOO^-$

3) 

4) $HCOO^-$ *and* CH_3OH

67. Which of the following is a coloured, paramagnetic acidic oxide?

1) N_2O **2)** N_2O_3 **3)** NO **4)** NO_2



68. The IUPAC name of is

1) 1, 2 – dimethyl phenol **2)** Dimethyl phenol

3) 3 – hydroxyl – 3 – methyl toluene **4)** 3, 4 – dimethyl phenol

69. Calamine is____

1) $ZnCO_3$ **2)** ZnS **3)** ZnO **4)** $Zn(OH)_2$

70. Hybridisation of Ni in the complex $\left[Ni(CO)_4\right]$ is

1) SP^3 **2)** dSP^2 **3)** SP^2 **4)** SP^3d

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(NUMERICAL VALUE TYPE)

This section contains 5 questions. Each question is numerical value. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to second decimal place. (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).
Marking scheme: +4 for correct answer , 0 if not attempted and 0 in all other cases.

71. The number of significant figures in 0.0256 is

72. ΔG^0 for the reaction X + Y $\rightleftharpoons$ Z is -4.6 kcal. The value of equilibrium constant for the reaction at 227°C is

73. A fuel cell develops an electrical potential from the combustion of butane at 1 bar and 298 K

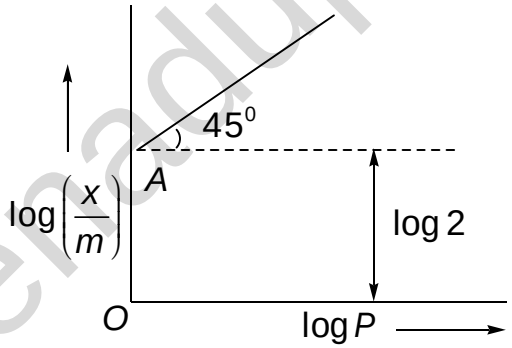
$C_4H_{10}(g) + 6.5\,O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l);\ \Delta_r G^0 = -2746 kJ/mol$

What is E^0 of a cell (in volts)

74. A solution of 0.640 g of azulene in 100.0 g of benzene boils at $80.23^o C$. The boiling point of benzene is $80.10^o C$; the K_b is $2.53^o K/molal$. What is the molecular weight of azulene?

75. Graph between $\log\left(\frac{x}{m}\right)$ and $\log P$ is a straight line at 45^0 with intercept OA as shown.

Hence, $\left(\frac{x}{m}\right)$ at a pressure of 2 atm is:



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KEY SHEET

MATHEMATICS

1) 2	**2)** 2	**3)** 2	**4)** 2	**5)** 1	**6)** 3	**7)** 4	**8)** 2	**9)** 2	**10)** 1
11) 2	**12)** 2	**13)** 4	**14)** 1	**15)** 4	**16)** 2	**17)** 1	**18)** 3	**19)** 3	**20)** 1
21) 48	**22)** 8	**23)** 10	**24)** 504	**25)** 4950					

PHYSICS

26) 1	**27)** 2	**28)** 3	**29)** 4	**30)** 4	**31)** 3	**32)** 1	**33)** 2	**34)** 4	**35)** 3
36) 3	**37)** 3	**38)** 4	**39)** 1	**40)** 2	**41)** 2	**42)** 4	**43)** 3	**44)** 3	**45)** 2
46) 300	**47)** 80	**48)** 1	**49)** 1.25	**50)** 80					

CHEMISTRY

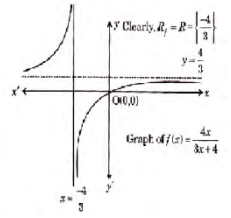
51) 3	**52)** 3	**53)** 3	**54)** 4	**55)** 1	**56)** 2	**57)** 4	**58)** 2	**59)** 2	**60)** 4
61) 3	**62)** 4	**63)** 3	**64)** 3	**65)** 2	**66)** 2	**67)** 4	**68)** 4	**69)** 1	**70)** 1
71) 3	**72)** 100	**73)** 1.09	**74)** 125	**75)** 4					

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SOLUTIONS
MATHEMATICS

1. As f is one – one and onto, so f is invertible.

$$f(x)=\frac{4x}{(3x+4)}, x\in R-\left\{\frac{-4}{3}\right\}$$



Now $y=\dfrac{4x}{3x+4} \quad \Rightarrow 3xy+4y=4x \quad \Rightarrow (4-3y)x=4y \;\therefore g(y)=\dfrac{4y}{4-3y}$

2. $a, r(a+d), r^2(a+2d), r^3(a+3d), ...$

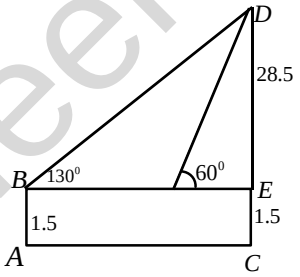
$$r(a+d)=-6, r^2(a+2d)=-8, r^3(a+3d)=6 \Rightarrow a+d=\frac{-6}{r}, a+2d=\frac{-8}{r^2},\ a+3d=\frac{6}{r^3}$$

Subtracting $d=\dfrac{-8}{r^2}+\dfrac{6}{r}=\dfrac{6}{r^3}+\dfrac{8}{r^2} \Rightarrow r=\dfrac{-1}{3}, 3$

3. From $\Delta BFE, \cot 60^0=\dfrac{EF}{28.5}, EF=\dfrac{28.5}{\sqrt{3}}$

From $\Delta BDE, \cot 30^0=\dfrac{BE}{28.5}, BE=28.\sqrt{3}$

$$BF=BE-EF \quad =28.5\sqrt{3}-\frac{28.5}{\sqrt{3}} \quad =28.5\left(\sqrt{3}-\frac{1}{\sqrt{3}}\right) \quad =28.5\left(\frac{2}{\sqrt{3}}\right)=\frac{57}{\sqrt{3}}=19\sqrt{3}$$



4. $$f^1(0)=\lim_{h\to 0}\frac{f(0-h)-f(0)}{-h} \quad =\lim_{n\to 0}\left(\frac{-h\left(3e^{-1/h}+4\right)}{2-e^{-1/h}}-0\right)\left(\frac{-1}{h}\right)=2$$

$$Rf^1(0)=\lim_{h\to 0}\frac{f(0+h)-f(0)}{h}=\lim_{h\to 0}\left(\frac{h\left(3e^{1/h}+4\right)}{2-e^{1/h}}-0\right)\left(\frac{1}{h}\right)$$

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$= \lim_{h\to 0}\left(\frac{3+4e^{-1/h}}{2e^{-1/h}-1}\right) = -3$ Since $Lf^1(0) \neq Rf^1(0)$

$\therefore f(x)$ is differentiable at x=0. But $f(x)$ is continuous at $x=0$

5. $\frac{dy}{dx} = 0 \Rightarrow x = -1, \frac{1}{3} \Rightarrow y = 1, -\frac{5}{27}$

6. $\int \frac{1-7\cos^2 x}{\sin^7 x \cos^2 x}dx = \int \left(\frac{\sec^2 x}{\sin^7 x} - \frac{7}{\sin^7 x}\right)dx = \int \frac{\sec^2 x}{\sin^7 x}dx - \int \frac{7}{\sin^7 x}dx = I_1 + I_2$

$I_1 = \int \frac{\sec^2 x}{\sin^7 x}dx\left(Integration\ by\ parts\right) = \frac{\tan x}{\sin^7 x} + 7\int \frac{\tan x \cos x}{\sin^8 x}dx$

$= \frac{\tan x}{\sin^7 x} - I_2 \qquad \therefore I_1 + I_2 = \frac{\tan x}{\sin^7 x} + C \qquad \Rightarrow f(x) = \tan x$

7. Conceptual

8. We have $a + d + 2\sqrt{ad} = c + b + 2\sqrt{bc} \qquad \Rightarrow a + d = c + b\left(As\ ad = bc\right)$

$\therefore a^2 + d^2 + 2ad = c^2 + b^2 + 2bc \Rightarrow a^2 + d^2 = c^2 + b^2 \qquad \therefore \left(a^2 + d^2\right)x + b^2 y + c^2 = 0$

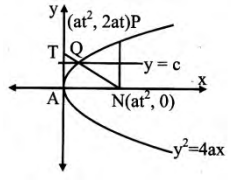
$\Rightarrow \left(b^2 + c^2\right)x + b^2 y + c^2 = 0 \qquad \Rightarrow b^2\left(y + x\right) + c^2\left(x + 1\right) = 0$

$\Rightarrow \left(y + x\right) + \frac{c^2}{b^2}\left(x + 1\right) = 0$

Which is of the form $L_1 + \lambda L_2 = 0$

So, fixed point is $(-1,1) = (x_0, y_0)(Given)$ Hence, $\left(x_0^{-1} + y_0^{-1}\right) = -1 + 1 = 0$

9. Equation of PN: $x = at^2 \qquad y = c\ bisects\ PN$



$\therefore c = at$

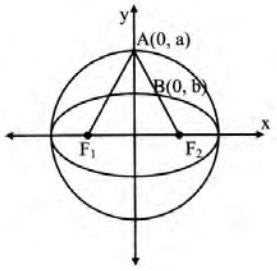
Which cuts the parabola at $Q \Rightarrow c^2 = 4ax \qquad \therefore x = \frac{c^2}{4a} \qquad \therefore Q\left(\frac{c^2}{4a}, c\right) = Q\left(\frac{at^2}{4}, at\right)$

$\therefore$ Equation of $NQ: y - 0 = \frac{at - 0}{\frac{at^2}{4} - at^2}\left(x - at^2\right); \quad y = \frac{-4}{3t}\left(x - at^2\right)$

Which cuts $x = 0\, at\left(0, \frac{4at}{3}\right) \therefore T = \frac{4at}{3}\ and\ Np = 2at; \qquad \therefore \frac{AT}{NP} = \frac{4at/3}{2at} = \frac{2}{3}$

10. $m_{F_1B}.m_{AF_2} = -1 \Rightarrow e^4 + e^2 - 1 = 0$

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$$\therefore e^2 = 2\left(\frac{\sqrt{5}-1}{4}\right) = 2\sin\frac{\pi}{10}$$

11. Put $x=-1; (-3)^{2145} = a_0 - a_1 + a_2 - a_3 + ...; -(3)^{2145} = -\left(3^4\right)^{536}.3 \Rightarrow$ *Ends in* 3.

12. $x^2 - 8kx + 16\left(k^2 - k + 1\right) = 0$

Since roots are real and distinct, D>0

$\Rightarrow 64k^2 - 64\left(k^2 - k + 1\right) > 0$ .....(1)

$\Rightarrow k > 1$

Also, from the figure, we have

$\frac{-b}{2a} > 4 \Rightarrow \frac{8k}{2} > 4$

$\Rightarrow k > 1$ .....(2)

Further

$f(4) \geq 0$

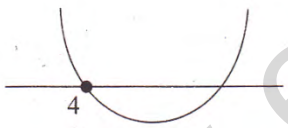
$\Rightarrow 16 - 32k + 16\left(k^2 - k + 1\right) \geq 0$

$\Rightarrow k^2 - 3k + 2 \geq 0$

$\Rightarrow k \leq 1 \; or \; k \geq 2$ .....(3)

From (1), (2) and (3)

K min = 2



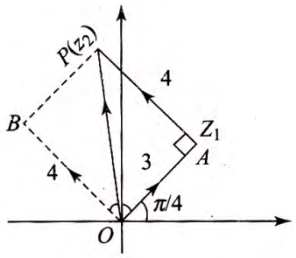
13. $\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{Ap}$

Rotating OA by an angle 45^0 in Anticlockwise direction to get OP, we have

$\frac{z_2 - 0}{z_1 - 0} = \frac{|z_2|}{|z_1|e^{i\theta}}$ (where $\tan\theta = 4/3$)

$\Rightarrow \frac{z_2 - 0}{3e^{i\pi/4}} = \frac{5}{3}(\cos\theta + i\sin\theta) \Rightarrow \frac{z_2 - 0}{e^{i\pi/4}} = 5\left(\frac{3}{5} + i\frac{4}{5}\right) \Rightarrow z_2 = (3+4i)e^{i\pi/4}$

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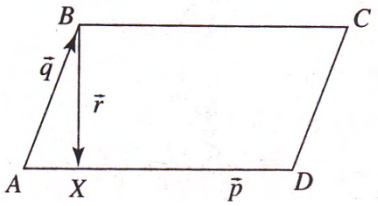
14. mean $(\bar{x}) = \dfrac{1+2+3+.....+n}{n} = \dfrac{n+1}{2}$

$$\text{M.D}(\bar{x}) = \frac{1}{n}\Sigma|xu-\bar{x}| = \frac{1}{n}\left[\left(1-\frac{n+1}{2}\right)+\left(2-\frac{n+1}{2}\right)+.....+\left(n-\frac{n+1}{2}\right)\right]$$

$$= \frac{1}{n}.2\left(\Sigma\left(\frac{n-1}{2}\right)\right) \quad = \frac{2}{n}.\frac{\left(\frac{n-1}{2}\right)\left(\frac{n+1}{2}\right)}{2} = \frac{n^2-1}{4n}$$

15. L_1L_2 intersecting; L_2L_3 parallel; L_3L_1 skew

16.



$$\overrightarrow{AX} = \frac{\vec{p}.\vec{q}}{|\vec{p}|}\frac{\vec{p}}{|\vec{p}|} = \frac{\vec{p}.\vec{q}}{|\vec{p}|^2}\vec{p}$$

$$\overrightarrow{BX} = \overrightarrow{BA} + \overrightarrow{AX}$$

$$= -\vec{q} + \frac{\vec{p}.\vec{q}}{|\vec{p}|^2}\vec{p}$$

17. Here $\alpha+\beta = -2|a|$

$\alpha\beta = 4$ and $\alpha, \beta \in$ integer

$\alpha = 4, \beta = 1$ (or) $\alpha = 1, \beta = 4$

$\alpha = 2, \beta = 2$

$\therefore$ Minimum value of $a = -\dfrac{5}{2}$

18. $A+B = AB$, $A-(A+B-AB) = I$, $(I-A)(I-B) = I$

$|I-A||I-B| = |I|$ $|I-A|, |I-B|$ are non zero

Also $(I-B)(I-A) = I$ $I-A-B+BA = I$ $A+B = B+A$ $AA = BA$ $\therefore C$ is correct

19. D simplifies to $-4(2t+1) = 0$

20. It is in the form of $a^3+b^3+c^3-3abc = 0$

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$(a+b+c)(a^2+b^2+c^2-ab-bc-ca)=0, (\sqrt{3}\sin x)^3+(\cos x)^3+(-1)^3-3(\sqrt{3}\sin x)(\cos x)(-1)=0$

$\sqrt{3}\sin x+\cos x-1=0$

$\sqrt{3}\sin x+\cos x=1$, divided by 2

$\sin\left(x+\frac{\pi}{6}\right)=\sin\frac{\pi}{6}$ $\qquad x+\frac{\pi}{6}=n\pi(-1)^n\frac{\pi}{6}, n\in z$

21. $y=f(x)$

$\Rightarrow x=f^{-1}(y)=g(y)$

$dy=f'(x)dx$

Where y is 2 then $x=1$ and y is 10 then $x=5$

$\therefore I=\int_1^5 f(x)dx+\int_2^{10} g(y)dy$

$=\int_1^5 f(x)dx+\int_1^5 xf'(x)dx$

$=\int_1^5 (f(x)+xf'(x))dx=\left[xf(x)\right]_1^5$

$=5f(5)-f(1)$

$=5(10)-2$

$=48$

22. $y=\sin^2 x-2\sin x=\sin x(\sin x-2)$

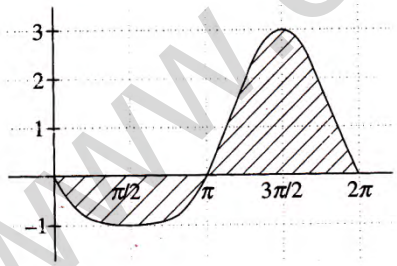
$y=0\therefore \sin x=0\therefore x=0,\pi,2\pi$

Also $\sin x-2<0$

$\therefore\ y>0 if\ \sin x<0$

And $y<0 if\ \sin x>0$

$\therefore$ Graph of the function is shown in the figure:



The required area = The shaded area

$=\left|\int_0^{\pi}(\sin^2 x-2\sin x)dx\right|+\int_{\pi}^{2\pi}(\sin^2 x-2\sin x)dx$

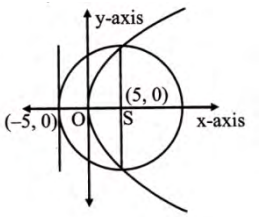
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$$= \left| \frac{1}{2}\int_0^{\pi} (1-\cos 2x)\,dx - 2\int_0^{\pi} \sin x\,dx \right| + \int_{\pi}^{2\pi} \left(\frac{1-\cos 2x}{2} - 2\sin x \right) dx$$

$$= \left| \frac{1}{2}\left(x - \frac{\sin 2x}{2} \right) + 2\cos x \right|_0^{\pi} + \left[\frac{1}{2}\left(x - \frac{\sin 2x}{2} \right) + 2\cos x \right]_{\pi}^{2\pi}$$

$$= \left| \frac{1}{2}\pi - 4 \right| + \frac{2\pi - \pi}{2} + 4 \qquad = \left(4 - \frac{\pi}{2} \right) + 4 + \frac{\pi}{2} = 8 sq.units$$

23. Extremities of the latus rectum are $(5,10)$ and $(5,-10)$. Since any circle drawn with any focal chord as its diameter touches the directirx, thus the equations of the required circle is $(x-5)^2 + (y-10)(y+10) = 0$



(circle touching the directrix at $(-5,0)$ which is the foot of the directrix)

$i.e., x^2 + y^2 - 10x - 75 = 0$

Its radius $= 10$

24. $GGGGGGG/BBBBBBBB$

One gap out of nine can be taken in ${}^9C_1$ ways and 2 green bottles can be placed.

Now, green remaining 5

Gaps remaining 8

5 gaps out of 8 gaps for remaining 5 green bottles can be selected in ${}^8C_5$.

Hence, total ways $= {}^9C_1 . {}^8C_5 = 9.\frac{8.7.6}{1.2.3}$

$= 72.7 = 504$

25. $\vec{a} = -\hat{i} - 2\hat{j} - \hat{k} \qquad \vec{b} = \hat{i} - 5\hat{j} - 7\hat{k} \qquad \left|\vec{d}\right| = \dfrac{\left|\vec{a} \times \vec{b}\right|}{\left|\vec{a}\right|}$

$\left|\vec{a}\right| = \sqrt{6}$

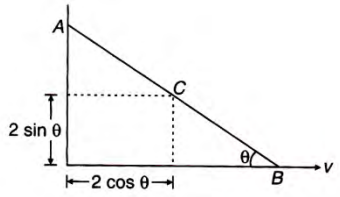
$\left|\vec{a} \times \vec{b}\right|^2 = \vec{a^2}\vec{b^2} - \left(\vec{a}.\vec{b}\right)^2 \qquad = (6)(75) - (-1+10+7)^2$

$= 450 - 256 = 194 \quad \left|\vec{a} \times \vec{b}\right| = \sqrt{194} \qquad \therefore d = \sqrt{\frac{194}{6}} = \sqrt{\frac{97}{3}}$

$\therefore p + q = 100 \qquad \Rightarrow \frac{(p+q)(p+q-1)}{2} = \frac{100 \times 99}{2} = 4950$

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26. $OB = x(say) = AB\cos\theta$ Or $x = 4\cos\theta$ $\therefore \frac{dx}{dt} = (-4\sin\theta)\frac{d\theta}{dt}$



But $\frac{dx}{dt} = 4m/s$ $\therefore \left(-\frac{d\theta}{dt}\right)_{at\,60^0} = \cos ec\ 60^0 = \frac{2}{\sqrt{3}} rad/s$

Further, $\vec{r}_c = (2\cos\theta)\hat{i} + (2\sin\theta)\hat{j}$

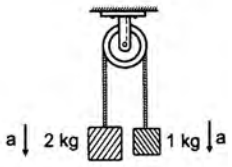
$\vec{r}_c = \frac{d\vec{r}}{dt} = \left(-2\sin\theta.\frac{d\theta}{dt}\right)\hat{i} + \left(2\cos\theta.\frac{d\theta}{dt}\right)\hat{j}$

At $\vec{v}_c = \left(2\times\frac{\sqrt{3}}{2}\times\frac{2}{\sqrt{3}}\right)\hat{i} + \left[(2)\left(\frac{1}{2}\right)\left(-\frac{2}{\sqrt{3}}\right)\right]\hat{j}$

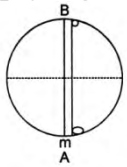
$= 2\hat{i} - \frac{2}{\sqrt{3}}\hat{j}$ $\therefore$ $v_c = \sqrt{4+\frac{4}{3}} = \frac{4}{\sqrt{3}} m/s$

27. $a = \frac{2g-1g}{2+1} = \frac{10}{3} m/s^2 \therefore a_{COM} = \frac{(2)(a)-(1)(a)}{2+1} = \frac{a}{3} = \frac{10}{9} m/s^2$

(downwards) $\therefore s_{COM} = \frac{1}{2}a_{COM}t^2 = \frac{1}{2}\left(\frac{10}{9}\right)(2)^2 = \frac{20}{9}M = 2.22M$



28. Let the velocity of the body at A is 'v' fro minimum velocity given at A velocity of the body at point B is zero. Applying law of conservation of energy at A and B.

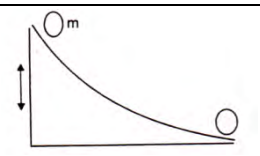


$\frac{1}{2}mv^2 = mgh$ $\frac{1}{2}mv^2 = mg(2L)$ $\Rightarrow v = \sqrt{(4gL)} = 2\sqrt{gL}$

29. Relative velocity of the particle depends on direction of projection.

30. A small spherical ball is released from a point at a height h on rough track and the sphere does not slip. Therefore, potential energy it has gained with respect to the surface will be converted to angular kinetic energy about the centre and linear kinetic energy.

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Therefore $mgh = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2$

$\Rightarrow mgh = \frac{1}{2} \times \frac{2}{5}mR^2\omega^2 + \frac{1}{2}mv^2 \qquad \Rightarrow gh = \frac{1}{5}v^2 + \frac{1}{2}v^2$

$\Rightarrow v^2 = \left(\frac{10}{7}\right)gh \qquad \Rightarrow v = \sqrt{\left(\frac{10gh}{7}\right)}$

31. We have, $r + r' = 90^0$

Or $r' = 90^0 - r = 90^0 - i$

Now $_d\mu_r = \frac{\sin i}{\sin r'} = \frac{\sin i}{\sin\left(90^0 - i\right)} = \tan i$

Critical angle, $\sin C = \frac{1}{_r\mu_d} = {}_d\mu_r = \tan i$

$\therefore \quad C = \sin^{-1}\left(\tan i\right) \quad \therefore \quad f = -60\ cm$

32. The given arrangement is a parallel combination of inductances. Therefore,

$\frac{1}{L} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3} = \frac{3}{3} = 1 \qquad \Rightarrow L = 1H$

33. Let ground state energy (in eV) be E_1

$E_{2n} - E_1 = 204eV \ or \frac{E_1}{4n^2} - E_1 = 204eV = E_1\left(\frac{1}{4n^2} - 1\right) = 204eV$

And $E_{2n} - E_n = 40.8eV$ (i)

$\Rightarrow \frac{E_1}{4n^2} - \frac{E_1}{n^2} = E_1\left(-\frac{3}{4n^2}\right) = 40.8eV$ (ii)

From equation (i) and (ii), $\frac{1 - \frac{1}{4n^2}}{\frac{3}{4n^2}} = 5 \Rightarrow n = 2$

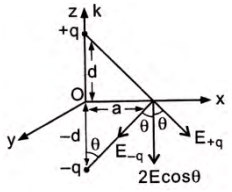
34. Nuclear reactions conserve total charge, and also conserve the total approximate mass. The other particles in the reaction will have mass $= 236 - 140 - 97 = 2$. The other particles are two neutrons. Hence, (a) is not correct. For nuclei, number of protons tells the charge. So, the other particles must have charge Z such that $92 = 54 + 38 + Z$

$\therefore Z = 0$, therefore, the other particles have a total atomic mass 2 and total charge 0. Hence, only (d) is correct.

35. Theory

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36. $E = \dfrac{1}{4\pi\varepsilon_0}\dfrac{q}{\left(a^2+d^2\right)}$



Resultant electric field $= 2E\cos\theta$

$= \dfrac{1}{4\pi\varepsilon_0}\dfrac{2q}{\left(a^2+d^2\right)}\dfrac{d}{\left(a^2+d^2\right)^{1/2}} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{2qd}{\left(a^2+d^2\right)^{3/2}} in-ve\,Z-direction$

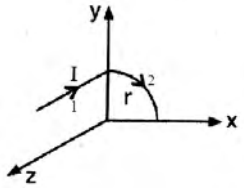
$\therefore E = \dfrac{1}{4\pi\varepsilon_0}\dfrac{2qd}{\left(a^2+d^2\right)^{3/2}}\left(-\hat{k}\right).$

37. $q = CV = C_1V_1$ where $C = \dfrac{\varepsilon_0 A}{d}$ And $q = \dfrac{\varepsilon_0 AE}{d} = \dfrac{\varepsilon_0 AE_1}{d+l}$

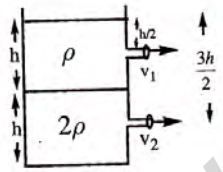
Or $\dfrac{\varepsilon_0 A}{d}E = \dfrac{\varepsilon_0 AE_1}{d+l}$ Or $E_1 = \dfrac{(d+1)}{d}E = \left(1+\dfrac{l}{d}\right)E$ And $C_1 = \dfrac{\varepsilon_0 A}{d+l}$

38. $\vec{B}_0 = \vec{B}_1 + \vec{B}_2 + \vec{B}_3$ Where, $\vec{B}_1 = \dfrac{\mu_0 i}{4\pi r}\left(-\hat{i}\right)$ $\vec{B}_2 = \dfrac{1}{2}\left(\dfrac{\mu_0 i}{4r}\right)\left(-\hat{j}\right)$ $\vec{B}_3 = 0$

(Since, wire 3 passes through origin)



39. According to Bernoulli's theorem, to find v_1



$P + \rho g\left(\dfrac{h}{2}\right) = P + \dfrac{1}{2}(\rho)\left(v_1^2\right) \Rightarrow v_1 = \sqrt{gh}$

To find $v_2, P + (\rho gh) + (2\rho)g\left(\dfrac{h}{2}\right) = \dfrac{1}{2}(2\rho)v_2^2 + P \Rightarrow v_2 = \sqrt{2gh}$ $\therefore \dfrac{v_1}{v_2} = \dfrac{1}{\sqrt{2}}$

40. Let a water drop of radius R be split up into 10^9 identical water drops each of radius r.

$R = \dfrac{D}{2} = \dfrac{2mm}{2} = 1mm = 1\times10^{-3}m$ Number of droplets $n = 10^9$

Surface tension $(T) = 7.3\times10^{-2}\,Nm^{-1}$ $W = 4\pi R^2T\left[n^{1/3}-1\right]$

$= 4\pi\left(10^{-3}\right)^2\times7.3\times10^{-2}\left[\left(10^9\right)^{1/3}-1\right] = 9.17\times10^{-7}\,J$

41. The equivalent system is shown in figure.

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The equivalent force constant of which

$k_e = k + 3k = 4k \quad \therefore \quad \omega = \sqrt{\frac{k_e}{m}} = \sqrt{\frac{4k}{m}} = 2\sqrt{\frac{k}{m}}$ And $f = \frac{\omega}{2\pi} = \frac{2}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{\pi}\sqrt{\frac{k}{m}}$.

42. $W = \int PdV = \int_{V_1}^{V_2} kVdV \quad \frac{kV_2^2 - kV_1^2}{2} = \frac{P_2V_2 - P_1V_1}{2} = \frac{nR\Delta T}{2}$

$\therefore nC\Delta T = nC_V\Delta T + \frac{nR\Delta T}{2} \Rightarrow C = C_V + \frac{R}{2}$

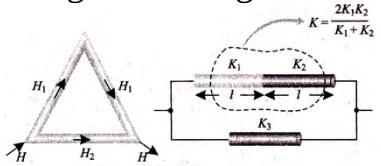
43. From given curve, Melting point for $A = 60^0 C$

And melting point for $B = 20^0 C$

Time taken by A for fusion $= (6-2) = 4$ minutes

Time taken by B for fusion $= (6.5-4) = 2.5$ minutes $\quad \therefore \frac{H_A}{H_B} = \frac{6\times 4\times 60}{6\times 2.5\times 60} = \frac{8}{5}$

44. The given arrangement of rods can be redrawn as follows:



It is given that $H_1 = H_2 \Rightarrow \frac{KA(\theta_1 - \theta_2)}{2l} = \frac{K_3A(\theta_1 - \theta_2)}{l} \Rightarrow K_3 = \frac{K}{2} = \frac{K_1K_2}{K_1 + K_2}$

45. Total number of degrees of freedom in a thermo dynamical system = Number of degrees of freedom associated per molecule × Number of molecules,

As given molecules are of hydrogen,

$\therefore$ Volume occupied by 1 mole = 1 mole of the gas at $NTP = 22400mL = 22400cc$

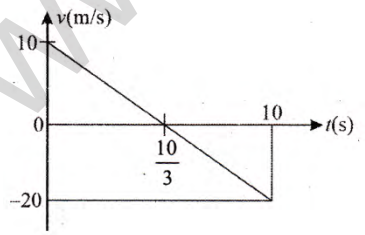
Any ideal gas has a molar volume of 22400 mL (cc) at NTP.

$\therefore$ Number of molecules in 1 cc of hydrogen $= \frac{6.023\times 10^{23}}{22400} = 2.688\times 10^{19}$

H_2 is diatomic gas, having a total of 5 degrees of freedom (3 translational + 2 rotational)

$\therefore$ Total degrees of freedom possessed by all the molecules $= 5\times 2.688\times 10^{19} = 1.344\times 10^{20}$

46.



$w = F.S \qquad w = m.a.s$

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$a = -\frac{30}{10} = -3m/s^2 \quad S = \left(\frac{1}{2} \times \frac{10}{3} \times 10\right) - \left(\frac{1}{2} \times \frac{20}{3} \times 20\right)$

$S = \frac{50}{3} - \frac{200}{3} = -\frac{150}{3} = -50m \qquad w = 2 \times (-3) \times (-50) = 300J$

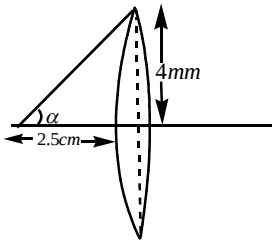
47. Mass of bullet, $m = 50g = 0.05kg$ Velocity of bullet, $\upsilon = 150ms^{-1}$

Mass of tiger, $M = 60kg$ Velocity of tiger, $V = 10ms^{-1}$

Let n be the number of bullets required to be pumped into the tiger to stop him in his track. According to the laws of conservation of momentum,

$n \times m\upsilon = MV \text{ or } n = \frac{MV}{m\upsilon} = \frac{60 \times 10}{0.05 \times 150} = 80$

48.



We assume that the object is placed a little beyond its focal distance, say 2.5 cm,

$\tan\alpha = \frac{4 \times 10^{-1}}{2.5} = \frac{4}{25}$ Since, α is small,

$\sin\alpha \approx \tan\alpha = \frac{4}{25}$ $\therefore$ Resolving limit of microscope,

$\Delta x = \frac{1.22\lambda}{2\mu\sin\alpha} = \frac{1.22 \times 5500 \times 10^{-10} \times 25}{2 \times 1 \times 4} = 2.0968 \times 10^{-6} cm \approx 2 \times 10^{-6} m$

49.

50. Let the intensity due to each sitar $= I$

Then, $10\log_{10}\frac{I}{I_0} = 70dB$ (given) .....(i)

Now, intensity due to 10 sitars is $I' = 10I$

Now, sound level $10\log_{10}\frac{I'}{I_0} = 10\log_{10}\frac{10I}{I_0} = 10\log_{10}10 + 10\log_{10}\frac{I}{I_0}$

$\therefore$ *Sound level* $= 10dB + 70dB$ (using Eq. (i)) $= 80\ dB$

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CHEMISTRY

51. $\lambda = \frac{h}{mv} = \frac{6.625\times10^{-34}\times60}{\left(100\times10^{-3}\right)\times5} = \frac{6.625\times10^{-34}\times60}{10^{-1}\times5} = 7.95\times10^{-32}$

52. Ease of liquificotion $\alpha\, a$

53. For hexagonal system $a = b \neq c$ *and* $\alpha = \beta = 90^0, = 120^0$

54. Molecularity of the reaction is not 4

55. N has stable electronic configuration $\left(2s^2 2p^3\right)$

56. NO^+ has highest bond order

57. Greater the difference in the size of cation and anion, greater the solubility in water

58. The large hydration energy of Al^{3+}

59. $2 > 1 > 3 > 4$ NCERT

60. NCERT – 409, 410

61. NCERT – 435, 436

62. NCERT – 447, 448 Ethynylestradiol – Antifertility drug

63. $CH_3 - \overset{OH}{\overset{|}{C}}H - CH_3$

64. $H_2S_2O_6\left(S-S\ bond\right);\ H_2S_2O_7\left(S-O-S\ bond\right)\ H_2S_2O_8\left(S-O-O-S\ bond\right)$

65. $Cl_2 + 2NaOH \rightarrow NaCl + NaOCl + H_2O$

66. Canizzaro's reaction

67. NO_2 – Brown gas, Paramagnetic, acidic oxide

68. NCERT – 339

69. NCERT – 163

70. NCERT – 249

71. In 0.0256 zeros are non significant figures.

72. $\Delta G^0 = -2.303\, RT\, \log K \quad -4.6\times10^3 = -2.303\times1.987\times500\times\log K\,.\log K = 2\ K = 10^2 = 100$

73. $C_4H_{10(g)} + 6.5O_{2(g)} \rightarrow 4CO_2 + 5H_2O$ n-factor $= 4(+4) + 10 = 26\ \Delta G = -nFE_0\ -nFE_o = -2746\ E_o = \frac{2746\times10^3}{26\times96500} = 1.09V$

74. $\triangle T_b = K_b \frac{w\times1000}{M\times W}$

75. $\log\frac{x}{m} = \log k + \frac{1}{n}\log P$

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