JEE MAIN - PAPER I

Held on 04-04-15

LMN

No.: 150609933

This booklet contains **24** printed pages.

PAPER - 1 : PHYSICS, CHEMISTRY & MATHEMATICS

Test Booklet Code

A

Do not open this Test Booklet until you are asked to do so.

Read carefully the Instructions on the Back Cover of this Test Booklet.

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 Answer Sheet is kept inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully.
3. The test is of **3 hours** duration.
4. The Test Booklet consists of **90** questions**.** The maximum marks are **360.**
5. There are ***three*** parts in the question paper A, B, C consisting of **Physics, Chemistry** and **Mathematics** having 30 questions in each part of equal weightage. Each question is allotted **4 (four)** marks for each correct response.
6. *Candidates will be awarded marks as stated above in instruction No. 5 for correct response of each question. ¼ (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.*
7. There is only one correct response for each question. Filling up more than one response in each question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 6 above.
8. Use ***Blue/Black Ball Point Pen only*** for writing particulars/marking responses on ***Side-1*** and ***Side-2*** of the Answer Sheet. ***Use of pencil is strictly prohibited.***
9. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. except the Admit Card inside the examination room/hall.
10. Rough work is to be done on the space provided for this purpose in the Test Booklet only. This space is given at the bottom of each page and in **three** pages (Pages **21 - 23**) at the end of the booklet.
11. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. ***However, the candidates are allowed to take away this Test Booklet with them.***
12. The CODE for this Booklet is **A**. Make sure that the CODE printed on **Side-2** of the Answer Sheet and also tally the serial number of the Test Booklet and Answer Sheet are the same as that on this booklet. In case of discrepancy, the candidate should immediately report the matter to the Invigilator for replacement of both the Test Booklet and the Answer Sheet.
13. **Do not fold or make any stray mark on the Answer Sheet.**

Name of the Candidate (in Capital letters) : _____

Roll Number : in figures | | | | | | | | |

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Candidate's Signature : _____ 1. Invigilator's Signature : _____

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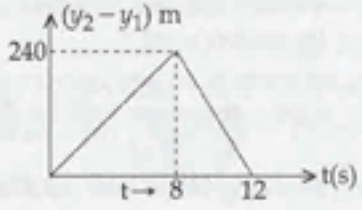
PART A – PHYSICS

1. Two stones are thrown up simultaneously from the edge of a cliff 240 m high with initial speed of 10 m/s and 40 m/s respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first ?

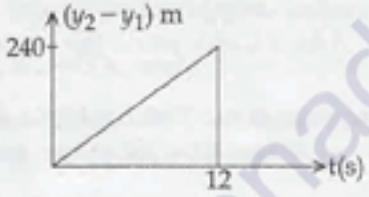
(Assume stones do not rebound after hitting the ground and neglect air resistance, take $g = 10\ m/s^2$)

(The figures are schematic and not drawn to scale)

(1)



(2)



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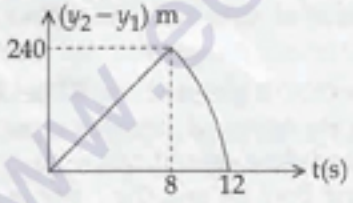
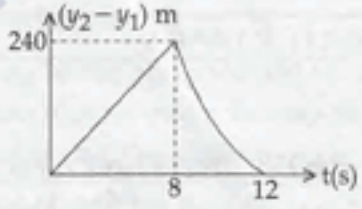


(4)



2. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 20.0 cm known to 1 mm accuracy and time for 100 oscillations of the pendulum is found to be 90 s using a wrist watch of 1s resolution. The accuracy in the determination of g is :

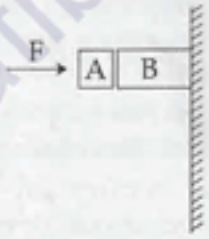
(1) 2%

(2) 3%

(3) 1%

(4) 5%

3.



Given in the figure are two blocks A and B of weight 20 N and 100 N, respectively. These are being pressed against a wall by a force F as shown. If the coefficient of friction between the blocks is 0.1 and between block B and the wall is 0.15, the frictional force applied by the wall on block B is :

(1) 100 N

(2) 80 N

(3) 120 N

(4) 150 N

SPACE FOR ROUGH WORK

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

(1) 44%

(2) 50%

(3) 56%

(4) 62%

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

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

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

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

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

6. From a solid sphere of mass M and radius R a cube of maximum possible volume is cut. Moment of inertia of cube about an axis passing through its center and perpendicular to one of its faces is :

(1) $\frac{MR^2}{32\sqrt{2}\pi}$

(2) $\frac{MR^2}{16\sqrt{2}\pi}$

(3) $\frac{4MR^2}{9\sqrt{3}\pi}$

(4) $\frac{4MR^2}{3\sqrt{3}\pi}$

7. From a solid sphere of mass M and radius R, a spherical portion of radius $\frac{R}{2}$ is removed, as shown in the figure. Taking gravitational potential $V=0$ at $r=\infty$, the potential at the centre of the cavity thus formed is :
(G = gravitational constant)

(1) $\frac{-GM}{2R}$

(2) $\frac{-GM}{R}$

(3) $\frac{-2GM}{3R}$

(4) $\frac{-2GM}{R}$

SPACE FOR ROUGH WORK

8. A pendulum made of a uniform wire of cross sectional area *A* has time period *T*. When an additional mass M is added to its bob, the time period changes to T_M. If the Young's modulus of the material of the wire is Y then $\frac{1}{Y}$ is equal to :
(g =gravitational acceleration)

(1) $\left[\left(\frac{T_M}{T}\right)^2 - 1\right]\frac{A}{Mg}$

(2) $\left[\left(\frac{T_M}{T}\right)^2 - 1\right]\frac{Mg}{A}$

(3) $\left[1 - \left(\frac{T_M}{T}\right)^2\right]\frac{A}{Mg}$

(4) $\left[1 - \left(\frac{T}{T_M}\right)^2\right]\frac{A}{Mg}$

9. Consider a spherical shell of radius R at temperature T. The black body radiation inside it can be considered as an ideal gas of photons with internal energy per unit volume $u = \frac{U}{V} \propto T^4$ and pressure $p = \frac{1}{3}\left(\frac{U}{V}\right)$. If the shell now undergoes an adiabatic expansion the relation between T and R is :

(1) $T \propto e^{-R}$

(2) $T \propto e^{-3R}$

(3) $T \propto \frac{1}{R}$

(4) $T \propto \frac{1}{R^3}$

10. A solid body of constant heat capacity *1 J/°C is being heated by keeping it in* contact with reservoirs in two ways :

(i) Sequentially keeping in contact with 2 reservoirs such that each reservoir supplies same amount of heat.

(ii) Sequentially keeping in contact with 8 reservoirs such that each reservoir supplies same amount of heat.

In both the cases body is brought from initial temperature 100°C to final temperature 200°C. Entropy change of the body in the two cases respectively is :

(1) *ln*2, 4*ln*2

(2) *ln*2, *ln*2

(3) *ln*2, 2*ln*2

(4) 2*ln*2, 8*ln*2

SPACE FOR ROUGH WORK

11. Consider an ideal gas confined in an isolated closed chamber. As the gas undergoes an adiabatic expansion, the average time of collision between molecules increases as V^q, where V is the volume of the gas. The value of q is :

$\left(\gamma = \frac{C_p}{C_v}\right)$

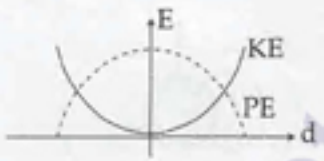
(1) $\frac{3\gamma + 5}{6}$

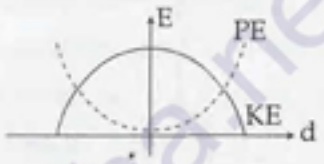
(2) $\frac{3\gamma - 5}{6}$

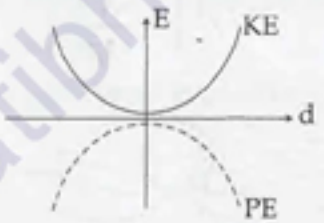
(3) $\frac{\gamma + 1}{2}$

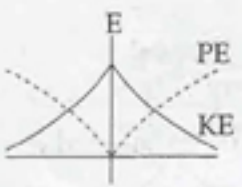
(4) $\frac{\gamma - 1}{2}$

12. For a simple pendulum, a graph is plotted between its kinetic energy (KE) and potential energy (PE) against its displacement d. Which one of the following represents these correctly ? *(graphs are schematic and not drawn to scale)*

(1) 

(2) 

(3) 

(4) 

13. A train is moving on a straight track with speed 20 ms^{-1}. It is blowing its whistle at the frequency of 1000 Hz. The percentage change in the frequency heard by a person standing near the track as the train passes him is (speed of sound = 320 ms^{-1}) close to :

(1) 6%

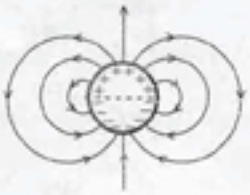
(2) 12%

(3) 18%

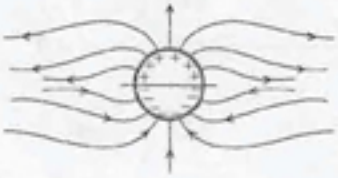
(4) 24%

SPACE FOR ROUGH WORK

14. A long cylindrical shell carries positive surface charge σ in the upper half and negative surface charge $-\sigma$ in the lower half. The electric field lines around the cylinder will look like figure given in : *(figures are schematic and not drawn to scale)*

(1) 

(2) 

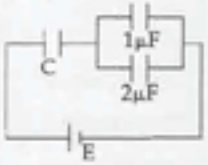
(3) 

(4) 

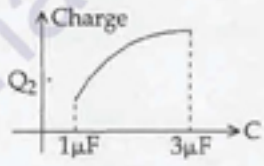
15. A uniformly charged solid sphere of radius R has potential V_0 (measured with respect to ∞) on its surface. For this sphere the equipotential surfaces with potentials $\frac{3V_0}{2}$, $\frac{5V_0}{4}$, $\frac{3V_0}{4}$ and $\frac{V_0}{4}$ have radius R_1, R_2, R_3 and R_4 respectively. Then

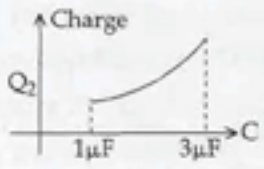
(1) $R_1 = 0$ and $R_2 > (R_4 - R_3)$
(2) $R_1 \neq 0$ and $(R_2 - R_1) > (R_4 - R_3)$
(3) $R_1 = 0$ and $R_2 < (R_4 - R_3)$
(4) $2R < R_4$

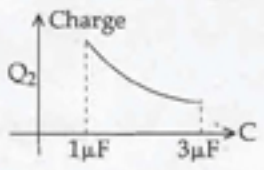
16. In the given circuit, charge Q_2 on the $2\mu F$ capacitor changes as C is varied from $1\mu F$ to $3\mu F$. Q_2 as a function of 'C' is given properly by : *(figures are drawn schematically and are not to scale)*



(1) 

(2) 

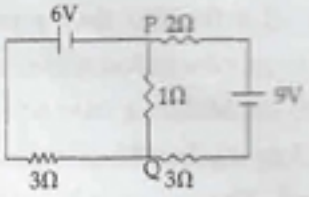
(3) 

(4) 

17. When 5V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is 2.5×10^{-4} ms^{-1}. If the electron density in the wire is 8×10^{28} m^{-3}, the resistivity of the material is close to :

(1) 1.6×10^{-8} Ωm
(2) 1.6×10^{-7} Ωm
(3) 1.6×10^{-6} Ωm
(4) 1.6×10^{-5} Ωm

SPACE FOR ROUGH WORK

18. 

In the circuit shown, the current in the 1Ω resistor is :

(1) 1.3 A, from P to Q

(2) 0A

(3) 0.13 A, from Q to P

(4) 0.13 A, from P to Q

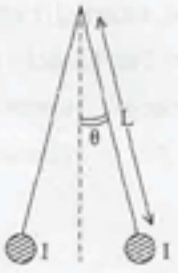
19. Two coaxial solenoids of different radii carry current I in the same direction. Let $\vec{F_1}$ be the magnetic force on the inner solenoid due to the outer one and $\vec{F_2}$ be the magnetic force on the outer solenoid due to the inner one. Then :

(1) $\vec{F_1} = \vec{F_2} = 0$

(2) $\vec{F_1}$ is radially inwards and $\vec{F_2}$ is radially outwards

(3) $\vec{F_1}$ is radially inwards and $\vec{F_2} = 0$

(4) $\vec{F_1}$ is radially outwards and $\vec{F_2} = 0$

20. 

Two long current carrying thin wires, both with current I, are held by insulating threads of length L and are in equilibrium as shown in the figure, with threads making an angle 'θ' with the vertical. If wires have mass λ per unit length then the value of I is :
(g = gravitational acceleration)

(1) $\sin\theta \sqrt{\frac{\pi\lambda g L}{\mu_0 \cos\theta}}$

(2) $2\sin\theta \sqrt{\frac{\pi\lambda g L}{\mu_0 \cos\theta}}$

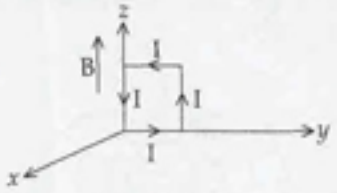
(3) $2\sqrt{\frac{\pi g L}{\mu_0}\tan\theta}$

(4) $\sqrt{\frac{\pi\lambda g L}{\mu_0}\tan\theta}$

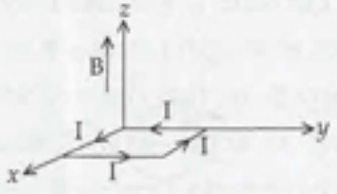
SPACE FOR ROUGH WORK

21. A rectangular loop of sides 10 cm and 5 cm carrying a current I of 12 A is placed in different orientations as shown in the figures below :

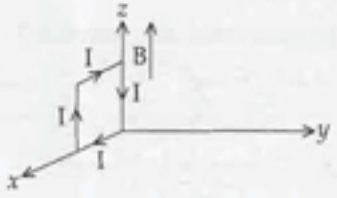
(a)



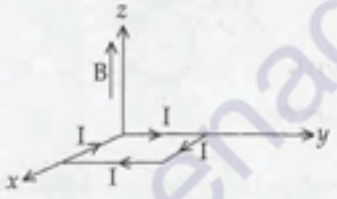
(b)



(c)



(d)



If there is a uniform magnetic field of 0.3 T in the positive z direction, in which orientations the loop would be in (i) stable equilibrium and (ii) unstable equilibrium ?

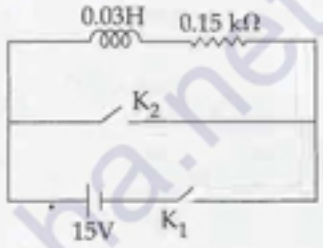
(1) (a) and (b), respectively

(2) (a) and (c), respectively

(3) (b) and (d), respectively

(4) (b) and (c), respectively

22. An inductor (L = 0.03H) and a resistor (R = 0.15 kΩ) are connected in series to a battery of 15V EMF in a circuit shown below. The key K_1 has been kept closed for a long time. Then at t = 0, K_1 is opened and key K_2 is closed simultaneously. At t = 1ms, the current in the circuit will be : ($e^5 \cong 150$)



(1) 100 mA

(2) 67 mA

(3) 6.7 mA

(4) 0.67 mA

23. A red LED emits light at 0.1 watt uniformly around it. The amplitude of the electric field of the light at a distance of 1 m from the diode is :

(1) 1.73 V/m

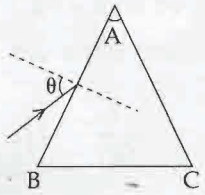
(2) 2.45 V/m

(3) 5.48 V/m

(4) 7.75 V/m

SPACE FOR ROUGH WORK

24. Monochromatic light is incident on a glass prism of angle A. If the refractive index of the material of the prism is μ, a ray, incident at an angle θ, on the face AB would get transmitted through the face AC of the prism provided :



(1) $\theta > \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(2) $\theta < \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(3) $\theta > \cos^{-1}\left[\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(4) $\theta < \cos^{-1}\left[\mu \sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

25. On a hot summer night, the refractive index of air is smallest near the ground and increases with height from the ground. When a light beam is directed horizontally, the Huygens' principle leads us to conclude that as it travels, the light beam :

(1) becomes narrower

(2) goes horizontally without any deflection

(3) bends downwards

(4) bends upwards

26. Assuming human pupil to have a radius of 0.25 cm and a comfortable viewing distance of 25 cm, the minimum separation between two objects that human eye can resolve at 500 nm wavelength is :

(1) 1 μm

(2) 30 μm

(3) 100 μm

(4) 300 μm

27. As an electron makes a transition from an excited state to the ground state of a hydrogen - like atom/ion :

(1) its kinetic energy increases but potential energy and total energy decrease

(2) kinetic energy, potential energy and total energy decrease

(3) kinetic energy decreases, potential energy increases but total energy remains same

(4) kinetic energy and total energy decrease but potential energy increases

SPACE FOR ROUGH WORK

28. Match List - I (Fundamental Experiment) with List - II (its conclusion) and select the correct option from the choices given below the list :

	List - I		List - II
(A)	Franck-Hertz Experiment.	(i)	Particle nature of light
(B)	Photo-electric experiment.	(ii)	Discrete energy levels of atom
(C)	Davison - Germer Experiment.	(iii)	Wave nature of electron
		(iv)	Structure of atom

(1) (A) - (i) (B) - (iv) (C) - (iii)

(2) (A) - (ii) (B) - (iv) (C) - (iii)

(3) (A) - (ii) (B) - (i) (C) - (iii)

(4) (A) -(iv) (B) - (iii) (C) - (ii)

29. A signal of 5 kHz frequency is amplitude modulated on a carrier wave of frequency 2 MHz. The frequencies of the resultant signal is/are :

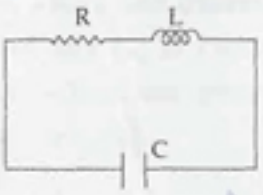
(1) 2 MHz only

(2) 2005 kHz, and 1995 kHz

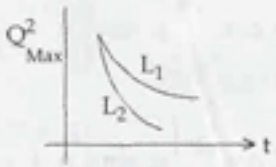
(3) 2005 kHz, 2000 kHz and 1995 kHz

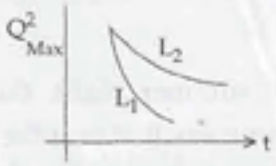
(4) 2000 kHz and 1995 kHz

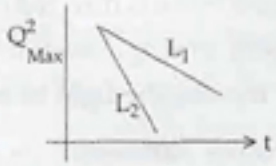
30. An LCR circuit is equivalent to a damped pendulum. In an LCR circuit the capacitor is charged to Q_0 and then connected to the L and R as shown below :

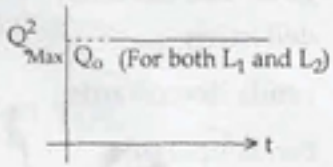


If a student plots graphs of the square of maximum charge (Q^2_{Max}) on the capacitor with time(t) for two different values L_1 and L_2 ($L_1 > L_2$) of L then which of the following represents this graph correctly ? *(plots are schematic and not drawn to scale)*

(1) 

(2) 

(3) 

(4) 

SPACE FOR ROUGH WORK

PART B – CHEMISTRY

31. The molecular formula of a commercial resin used for exchanging ions in water softening is $C_8H_7SO_3Na$ (Mol. wt. 206). What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin ?

(1) $\frac{1}{103}$

(2) $\frac{1}{206}$

(3) $\frac{2}{309}$

(4) $\frac{1}{412}$

32. Sodium metal crystallizes in a body centred cubic lattice with a unit cell edge of 4.29Å. The radius of sodium atom is approximately :

(1) 1.86Å

(2) 3.22Å

(3) 5.72Å

(4) 0.93Å

33. Which of the following is the energy of a possible excited state of hydrogen ?

(1) +13.6 eV

(2) −6.8 eV

(3) −3.4 eV

(4) +6.8 eV

34. The intermolecular interaction that is dependent on the inverse cube of distance between the molecules is :

(1) ion - ion interaction

(2) ion - dipole interaction

(3) London force

(4) hydrogen bond

35. The following reaction is performed at 298 K.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$$

The standard free energy of formation of NO(g) is 86.6 kJ/mol at 298 K. What is the standard free energy of formation of $NO_2(g)$ at 298 K? $(K_p = 1.6 \times 10^{12})$

(1) $R(298)\ ln(1.6 \times 10^{12}) - 86600$

(2) $86600 + R(298)\ ln(1.6 \times 10^{12})$

(3) $86600 - \frac{ln\,(1.6 \times 10^{12})}{R\,(298)}$

(4) $0.5[2 \times 86{,}600 - R(298)\ ln(1.6 \times 10^{12})]$

36. The vapour pressure of acetone at 20°C is 185 torr. When 1.2 g of a non-volatile substance was dissolved in 100 g of acetone at 20°C, its vapour pressure was 183 torr. The molar mass ($g\ mol^{-1}$) of the substance is :

(1) 32

(2) 64

(3) 128

(4) 488

SPACE FOR ROUGH WORK

37. The standard Gibbs energy change at 300 K for the reaction $2A \rightleftharpoons B + C$ is 2494.2 J. At a given time, the composition of the reaction mixture is $[A] = \frac{1}{2}$, $[B] = 2$ and $[C] = \frac{1}{2}$. The reaction proceeds in the : $[R = 8.314\ J/K/mol,\ e = 2.718]$

(1) forward direction because $Q > K_c$

(2) reverse direction because $Q > K_c$

(3) forward direction because $Q < K_c$

(4) reverse direction because $Q < K_c$

38. Two Faraday of electricity is passed through a solution of $CuSO_4$. The mass of copper deposited at the cathode is : *(at. mass of Cu =63.5 amu)*

(1) 0 g

(2) 63.5 g

(3) 2 g

(4) 127 g

39. Higher order (>3) reactions are rare due to :

(1) low probability of simultaneous collision of all the reacting species

(2) increase in entropy and activation energy as more molecules are involved

(3) shifting of equilibrium towards reactants due to elastic collisions

(4) loss of active species on collision

40. 3 g of activated charcoal was added to 50 mL of acetic acid solution (0.06N) in a flask. After an hour it was filtered and the strength of the filtrate was found to be 0.042 N. The amount of acetic acid adsorbed (per gram of charcoal) is :

(1) 18 mg

(2) 36 mg

(3) 42 mg

(4) 54 mg

41. The ionic radii (in Å) of N^{3-}, O^{2-} and F^- are respectively :

(1) 1.36, 1.40 and 1.71

(2) 1.36, 1.71 and 1.40

(3) 1.71, 1.40 and 1.36

(4) 1.71, 1.36 and 1.40

42. In the context of the Hall - Heroult process for the extraction of Al, which of the following statements is **false** ?

(1) CO and CO_2 are produced in this process

(2) Al_2O_3 is mixed with CaF_2 which lowers the melting point of the mixture and brings conductivity

(3) Al^{3+} is reduced at the cathode to form Al

(4) Na_3AlF_6 serves as the electrolyte

SPACE FOR ROUGH WORK

43. From the following statements regarding H_2O_2, choose the **incorrect** statement :

(1) It can act only as an oxidizing agent

(2) It decomposes on exposure to light

(3) It has to be stored in plastic or wax lined glass bottles in dark

(4) It has to be kept away from dust

44. Which one of the following alkaline earth metal sulphates has its hydration enthalpy greater than its lattice enthalpy ?

(1) $CaSO_4$

(2) $BeSO_4$

(3) $BaSO_4$

(4) $SrSO_4$

45. Which among the following is the most reactive ?

(1) Cl_2

(2) Br_2

(3) I_2

(4) ICl

46. Match the catalysts to the correct processes :

	Catalyst		Process
(A)	$TiCl_3$	(i)	Wacker process
(B)	$PdCl_2$	(ii)	Ziegler - Natta polymerization
(C)	$CuCl_2$	(iii)	Contact process
(D)	V_2O_5	(iv)	Deacon's process

(1) (A) - (iii), (B) - (ii), (C) - (iv), (D) - (i)

(2) (A) - (ii), (B) - (i), (C) - (iv), (D) - (iii)

(3) (A) - (ii), (B) - (iii), (C) - (iv), (D) - (i)

(4) (A) - (iii), (B) - (i), (C) - (ii), (D) - (iv)

47. Which one has the highest boiling point ?

(1) He

(2) Ne

(3) Kr

(4) Xe

48. The number of geometric isomers that can exist for square planar [Pt (Cl) (py) (NH_3) (NH_2OH)]$^+$ is (py = pyridine) :

(1) 2

(2) 3

(3) 4

(4) 6

49. The color of $KMnO_4$ is due to :

(1) M $\rightarrow$ L charge transfer transition

(2) d $-$ d transition

(3) L $\rightarrow$ M charge transfer transition

(4) $\sigma - \sigma^*$ transition

SPACE FOR ROUGH WORK

50. **Assertion :** Nitrogen and Oxygen are the main components in the atmosphere but these do not react to form oxides of nitrogen.

Reason : The reaction between nitrogen and oxygen requires high temperature.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion

(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion

(3) The assertion is incorrect, but the reason is correct

(4) Both the assertion and reason are incorrect

51. In Carius method of estimation of halogens, 250 mg of an organic compound gave 141 mg of AgBr. The percentage of bromine in the compound is :
(at. mass Ag =108; Br =80)

(1) 24

(2) 36

(3) 48

(4) 60

52. Which of the following compounds will exhibit geometrical isomerism ?

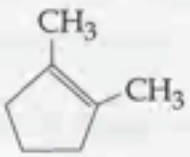
(1) 1 - Phenyl - 2 - butene

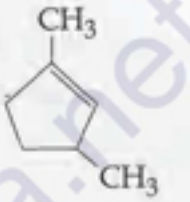
(2) 3 - Phenyl - 1 - butene

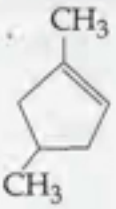
(3) 2 - Phenyl - 1 - butene

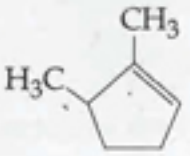
(4) 1, 1 - Diphenyl - 1 - propane

53. Which compound would giv 5 - keto - 2 - methyl hexanal upo ozonolysis ?

(1) 

(2) 

(3) 

(4) 

54. The synthesis of alkyl fluorides is bes accomplished by :

(1) Free radical fluorination

(2) Sandmeyer's reaction

(3) Finkelstein reaction

(4) Swarts reaction

SPACE FOR ROUGH WORK

55. In the following sequence of reactions :

$$\text{Toluene} \xrightarrow{KMnO_4} A \xrightarrow{SOCl_2} B \xrightarrow[BaSO_4]{H_2/Pd} C,$$

the product C is :

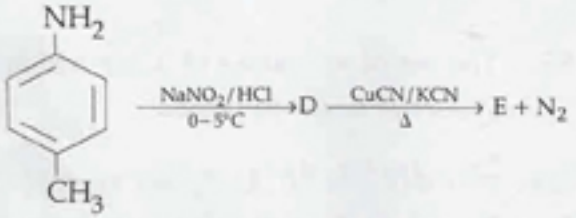
(1) C_6H_5COOH

(2) $C_6H_5CH_3$

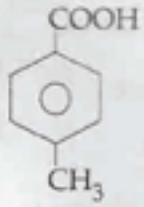
(3) $C_6H_5CH_2OH$

(4) C_6H_5CHO

56. In the reaction



the product E is :

(1) 

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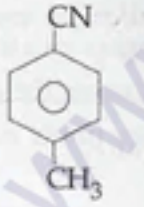
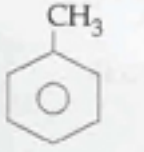
(3) 

(4) 

57. Which polymer is used in the manufacture of paints and lacquers ?

(1) Bakelite

(2) Glyptal

(3) Polypropene

(4) Poly vinyl chloride

58. Which of the vitamins given below is water soluble ?

(1) Vitamin C

(2) Vitamin D

(3) Vitamin E

(4) Vitamin K

59. Which of the following compounds is **not** an antacid ?

(1) Aluminium hydroxide

(2) Cimetidine

(3) Phenelzine

(4) Ranitidine

60. Which of the following compounds is **not** colored yellow ?

(1) $Zn_2[Fe(CN)_6]$

(2) $K_3[Co(NO_2)_6]$

(3) $(NH_4)_3[As(Mo_3O_{10})_4]$

(4) $BaCrO_4$

SPACE FOR ROUGH WORK

PART C – MATHEMATICS

61. Let A and B be two sets containing four and two elements respectively. Then the number of subsets of the set $A \times B$, each having at least three elements is :

(1) 219

(2) 256

(3) 275

(4) 510

62. A complex number z is said to be unimodular if $|z| = 1$. Suppose z_1 and z_2 are complex numbers such that $\frac{z_1 - 2z_2}{2 - z_1\bar{z}_2}$ is unimodular and z_2 is not unimodular. Then the point z_1 lies on a :

(1) straight line parallel to x-axis.

(2) straight line parallel to y-axis.

(3) circle of radius 2.

(4) circle of radius $\sqrt{2}$.

63. Let α and β be the roots of equation $x^2 - 6x - 2 = 0$. If $a_n = \alpha^n - \beta^n$, for $n \geq 1$, then the value of $\frac{a_{10} - 2a_8}{2a_9}$ is equal to :

(1) 6

(2) -6

(3) 3

(4) -3

64. If $A = \begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ a & 2 & b \end{bmatrix}$ is a matrix satisfyi

the equation $AA^T = 9I$, where I is 3 × identity matrix, then the ordered pa (a, b) is equal to :

(1) (2, −1)

(2) (−2, 1)

(3) (2, 1)

(4) (−2, −1)

65. The set of all values of λ for which t system of linear equations :

$2x_1 - 2x_2 + x_3 = \lambda x_1$

$2x_1 - 3x_2 + 2x_3 = \lambda x_2$

$-x_1 + 2x_2 \quad = \lambda x_3$

has a non-trivial solution,

(1) is an empty set.

(2) is a singleton.

(3) contains two elements.

(4) contains more than two elements

66. The number of integers greater than 6,0 that can be formed, using the digits 3, 5, 7 and 8, without repetition, is :

(1) 216

(2) 192

(3) 120

(4) 72

SPACE FOR ROUGH WORK

67. The sum of coefficients of integral powers of x in the binomial expansion of $\left(1 - 2\sqrt{x}\right)^{50}$ is :

(1) $\frac{1}{2}\left(3^{50} + 1\right)$

(2) $\frac{1}{2}\left(3^{50}\right)$

(3) $\frac{1}{2}\left(3^{50} - 1\right)$

(4) $\frac{1}{2}\left(2^{50} + 1\right)$

68. If m is the A.M. of two distinct real numbers l and n (l, $n > 1$) and G_1, G_2 and G_3 are three geometric means between l and n, then $G_1^4 + 2G_2^4 + G_3^4$ equals.

(1) $4\, l^2mn$

(2) $4\, lm^2n$

(3) $4\, lmn^2$

(4) $4\, l^2m^2n^2$

69. The sum of first 9 terms of the series $\frac{1^3}{1} + \frac{1^3 + 2^3}{1+3} + \frac{1^3 + 2^3 + 3^3}{1 + 3 + 5} + \ldots$ is :

(1) 71

(2) 96

(3) 142

(4) 192

70. $\lim\limits_{x \to 0} \frac{(1 - \cos 2x)(3 + \cos x)}{x \tan 4x}$ is equal to :

(1) 4

(2) 3

(3) 2

(4) $\frac{1}{2}$

71. If the function.

$$g(x) = \begin{cases} k\sqrt{x+1}, & 0 \le x \le 3 \\ mx + 2, & 3 < x \le 5 \end{cases}$$

is differentiable, then the value of $k + m$ is :

(1) 2

(2) $\frac{16}{5}$

(3) $\frac{10}{3}$

(4) 4

72. The normal to the curve, $x^2 + 2xy - 3y^2 = 0$, at (1, 1) :

(1) does not meet the curve again.

(2) meets the curve again in the second quadrant.

(3) meets the curve again in the third quadrant.

(4) meets the curve again in the fourth quadrant.

SPACE FOR ROUGH WORK

73. Let $f(x)$ be a polynomial of degree four having extreme values at $x=1$ and $x=2$.

If $\lim\limits_{x\to 0}\left[1+\frac{f(x)}{x^2}\right]=3$, then $f(2)$ is equal to :

(1) -8

(2) -4

(3) 0

(4) 4

74. The integral $\int\frac{dx}{x^2(x^4+1)^{3/4}}$ equals :

(1) $\left(\frac{x^4+1}{x^4}\right)^{\frac{1}{4}}+c$

(2) $(x^4+1)^{\frac{1}{4}}+c$

(3) $-(x^4+1)^{\frac{1}{4}}+c$

(4) $-\left(\frac{x^4+1}{x^4}\right)^{\frac{1}{4}}+c$

75. The integral

$$\int_2^4\frac{\log x^2}{\log x^2+\log(36-12x+x^2)}dx$$

is equal to :

(1) 2

(2) 4

(3) 1

(4) 6

76. The area (in sq. units) of the reg described by

$\{(x, y) : y^2 \le 2x$ and $y \ge 4x-1\}$ is :

(1) $\frac{7}{32}$

(2) $\frac{5}{64}$

(3) $\frac{15}{64}$

(4) $\frac{9}{32}$

77. Let $y(x)$ be the solution of the differe equation

$(x\log x)\frac{dy}{dx}+y=2x\log x, (x\ge 1$

Then $y(e)$ is equal to :

(1) e

(2) 0

(3) 2

(4) 2e

78. The number of points, having b co-ordinates as integers, that lie in interior of the triangle with vertices ((0, 41) and (41, 0), is :

(1) 901

(2) 861

(3) 820

(4) 780

SPACE FOR ROUGH WORK

79. Locus of the image of the point (2, 3) in the line $(2x-3y+4)+k\,(x-2y+3)=0$, $k \in \mathbf{R}$, is a :

(1) straight line parallel to x-axis.

(2) straight line parallel to y-axis.

(3) circle of radius $\sqrt{2}$.

(4) circle of radius $\sqrt{3}$.

80. The number of common tangents to the circles $x^2+y^2-4x-6y-12=0$ and $x^2+y^2+6x+18y+26=0$, is :

(1) 1

(2) 2

(3) 3

(4) 4

81. The area (in sq. units) of the quadrilateral formed by the tangents at the end points of the latera recta to the ellipse $\frac{x^2}{9}+\frac{y^2}{5}=1$, is :

(1) $\frac{27}{4}$

(2) 18

(3) $\frac{27}{2}$

(4) 27

82. Let O be the vertex and Q be any point on the parabola, $x^2=8y$. If the point P divides the line segment OQ internally in the ratio 1 : 3, then the locus of P is :

(1) $x^2=y$

(2) $y^2=x$

(3) $y^2=2x$

(4) $x^2=2y$

83. The distance of the point (1, 0, 2) from the point of intersection of the line $\frac{x-2}{3}=\frac{y+1}{4}=\frac{z-2}{12}$ and the plane $x-y+z=16$, is :

(1) $2\sqrt{14}$

(2) 8

(3) $3\sqrt{21}$

(4) 13

84. The equation of the plane containing the line $2x-5y+z=3$; $x+y+4z=5$, and parallel to the plane, $x+3y+6z=1$, is :

(1) $2x+6y+12z=13$

(2) $x+3y+6z=-7$

(3) $x+3y+6z=7$

(4) $2x+6y+12z=-13$

85. Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three non-zero vectors such that no two of them are collinear and $(\vec{a}\times\vec{b})\times\vec{c}=\frac{1}{3}|\vec{b}||\vec{c}|\vec{a}$. If θ is the angle between vectors $\vec{b}$ and $\vec{c}$, then a value of $\sin\theta$ is :

(1) $\frac{2\sqrt{2}}{3}$

(2) $\frac{-\sqrt{2}}{3}$

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

(4) $\frac{-2\sqrt{3}}{3}$

SPACE FOR ROUGH WORK

86. If 12 identical balls are to be placed in 3 identical boxes, then the probability that one of the boxes contains exactly 3 balls is :

(1) $\frac{55}{3}\left(\frac{2}{3}\right)^{11}$

(2) $55\left(\frac{2}{3}\right)^{10}$

(3) $220\left(\frac{1}{3}\right)^{12}$

(4) $22\left(\frac{1}{3}\right)^{11}$

87. The mean of the data set comprising of 16 observations is 16. If one of the observation valued 16 is deleted and three new observations valued 3, 4 and 5 are added to the data, then the mean of the resultant data, is :

(1) 16.8

(2) 16.0

(3) 15.8

(4) 14.0

88. If the angles of elevation of the top of a tower from three collinear points A, B and C, on a line leading to the foot of the tower, are 30°, 45° and 60° respectively, then the ratio, AB : BC, is :

(1) $\sqrt{3} : 1$

(2) $\sqrt{3} : \sqrt{2}$

(3) $1 : \sqrt{3}$

(4) 2 : 3

89. Let

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

where $|x| < \frac{1}{\sqrt{3}}$. Then a value of y is :

(1) $\frac{3x - x^3}{1 - 3x^2}$

(2) $\frac{3x + x^3}{1 - 3x^2}$

(3) $\frac{3x - x^3}{1 + 3x^2}$

(4) $\frac{3x + x^3}{1 + 3x^2}$

90. The negation of $\sim s \vee (\sim r \wedge s)$ is equivalent to :

(1) $s \wedge \sim r$

(2) $s \wedge (r \wedge \sim s)$

(3) $s \vee (r \vee \sim s)$

(4) $s \wedge r$

- o 0 o -

SPACE FOR ROUGH WORK

Read the following instructions carefully :

1. The candidates should fill in the required particulars on the Test Booklet and Answer Sheet (*Side-1*) with ***Blue/Black Ball Point Pen.***
2. For writing/marking particulars on ***Side-2*** of the Answer Sheet, use ***Blue/Black Ball Point Pen only.***
3. The candidates should not write their Roll Numbers anywhere else (except in the specified space) on the Test Booklet/Answer Sheet.
4. Out of the four options given for each question, only one option is the correct answer.
5. For each ***incorrect response, one-fourth*** (¼) of the total marks allotted to the question would be deducted from the total score. ***No deduction*** from the total score, however, will be made ***if no response*** is indicated for an item in the Answer Sheet.
6. Handle the Test Booklet and Answer Sheet with care, *as under no circumstances (except for discrepancy in Test Booklet Code and Answer Sheet Code), another set will be provided.*
7. The candidates are not allowed to do any rough work or writing work on the Answer Sheet. All calculations/writing work are to be done in the space provided for this purpose in the Test Booklet itself, marked 'Space for Rough Work'. This space is given at the bottom of each page and in **three** pages (Pages 21 – 23) at the end of the booklet.
8. On completion of the test, the candidates must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. **However, the candidates are allowed to take away this Test Booklet with them.**
9. Each candidate must show on demand his/her Admit Card to the Invigilator.
10. No candidate, without special permission of the Superintendent or Invigilator, should leave his/her seat.
11. The candidates should not leave the Examination Hall without handing over their Answer Sheet to the Invigilator on duty and sign the Attendance Sheet again. Cases where a candidate has not signed the Attendance Sheet a second time will be deemed not to have handed over the Answer Sheet and dealt with as an unfair means case. **The candidates are also required to put their left hand THUMB impression in the space provided in the Attendance Sheet.**
12. Use of Electronic/Manual Calculator and any Electronic device like mobile phone, pager etc. is prohibited.
13. The candidates are governed by all Rules and Regulations of the JAB/Board with regard to their conduct in the Examination Hall. All cases of unfair means will be dealt with as per Rules and Regulations of the JAB/Board.
14. No part of the Test Booklet and Answer Sheet shall be detached under any circumstances.
15. **Candidates are not allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, electronic device or any other material except the Admit Card inside the examination room/hall.**

JEE (MAINS)-2015 'PAPER-1' KEY

Q.No.	CODE-A	CODE-B	CODE-C	CODE-D
1	3	2	4	4
2	2	3	1	4
3	3	1	3	3
4	3	2	4	4
5	2	2	1	4
6	3	4	1	2
7	2	2	1	4
8	1	3	3	1
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32	1	2	3	2
33	3	3	4	3
34	2	1	3	2
35	4	3	3	1
36	2	2	3,4	3
37	2	No Answer	3	1
38	2	2	4	1
39	1	3	4	2
40	1	3	4	3
41	3	3	4	4
42	4	2	4	2
43	1	3	2	1
44	2	1	1	1
45	4	2	3	1
46	2	3	2	4
47	4	1	4	1
48	2	4	3	2
49	3	4	3	4
50	1	2	2	2
51	1	3	2	2
52	1	4	1	2
53	2	2	1,4	3
54	4	4	2	3
55	4	3	3	2
56	3	4	4	1
57	2	2	1,4	1
58	1	3	2	1
59	3	2	4	2
60	1	2	1	No Answer
61	1	4	3	4
62	3	1	2	3
63	3	4	4	4
64	4	2	1	1
65	3	2	3	3
66	2	2	1	3
67	1	4	2	1
68	2	1	2	1
69	2	3,4	1	1
70	3	2	3	2
71	1	4	3	2
72	4	1	1	3
73	3	1	3	3
74	4	2	1	4
75	3	1	2	4
76	4	2	4	2
77	3	2	2	4
78	4	2,3	2	4
79	3	1	3	3
80	3	2	1	1
81	4	4	4	2
82	4	2	2	3
83	4	2	2	4
84	3	3	3	2
85	1	1	3	4
86	No Answer	2	4	3
87	4	2	1	2
88	1	1	2	4
89	1	1	4	2
90	4	3	3	3

JEE MAINS 2015

PAPER - I

CODE-A

PAPER - 1 : PHYSICS ; CHEMISTRY & MATHEMATICS

Do not open this Test Booklet until you are asked to do so.
Read carefully the Instructions on the Back Cover of this Test Booklet.

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 Answer Sheet is kept inside this Test Booklet. When You are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully,

3. The test is of 3 hours duration.

4. The Test Booklet consists of 90 questions. The maximum marks are 360.

5. There are three parts in the question paper A, B, C consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage. Each question is allotted 4 (four) marks for each correct response.

6. Candidates will be awarded marks as stated above in instruction No.5 of 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.

7. There is only one correct response for each question. Filling up more than one response in each question will be treated as wrong response will be deducted accordingly as per instruction 6 above.

8. Use Blue / Black Ball point pen only for writing particulars / marking responses on side-1 and side-2 of the Answer Sheet. Use of pencil is strictly prohibited.

9. No candidate is allowed to carry any textual material, printed or written, bits of parpers, pager, mobile phone, any electronic device, etc. except the Admit Card inside the examination hall/room.

10. Rough work is to be done on the space provided for this purpose in the Test Booklet only. This space is given at the bottom of each page and in 3 pages (Pages 21-23 at the end of the booklet.

11. On completion of the test, the candidate must hand over the Anser Sheet to the Invigilator on duty in the Room / Hall. However, the candidates are allowed to take away this Test Booklet with them.

12. Tthe CODE for this Booklet is E. Make sure that the CODE printed on Side-2 of the Answer Sheet and also tally the serial numbe rof the Test Booklet and Answer Sheet are the same as that on this booklet. In case of discrepancy, the candidate should immediately report the matter to the Invigilator for replacement of both the Test Booklet and the Answer Sheet.

13. Do not fold or make any stray mark on the Answer Sheet.

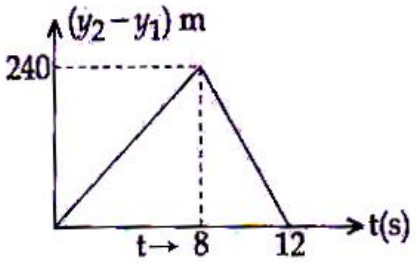
PHYSICS

1. Two stones are thrown up simultaneously from the edge of a diff 240 m high with initial speed of 10 m/s and 40 m/s respectively. Which of the following graph best represents the time variation of relative position of the secod stone with respect to the first ?

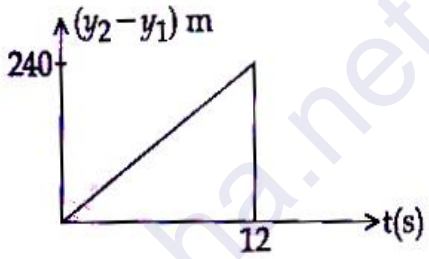
(Assume stones do not rebound after hitting the ground and neglect air resistance take $g = 10\,m/s^2$)

(The figures are schematic and not drawn to scale)

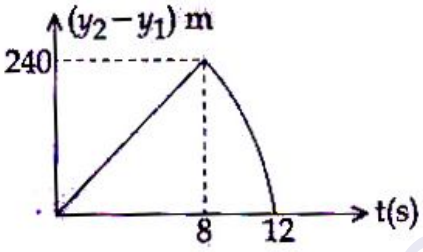
(1)



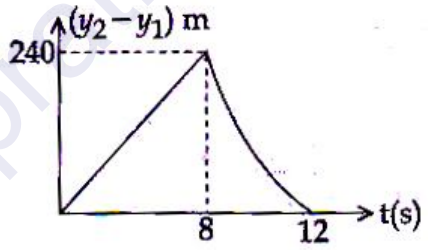
(2)



(3)



(4)



Ans : 3

Sol. : $V_{rel} = V_2 - V_1 = 30$

$\therefore (y_2 - y_1) = 30t$

until 1 collides with ground thereafter 2 w.r.t. 1 is like free fall.

2. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 20.0 cm known to 1 mm accuracy and time for 100 oscillations of the pendulum is found to be 90 s using a wrist watch of 1s resolution. The accuracy in the determination of g is.

(1) 2% **(2) 3%** **(3) 1%** **(4) 5%**

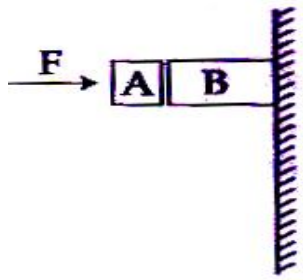
Ans : 2

Sol. : $g = 4\pi^2 \frac{l}{T^2}$

$\frac{\Delta g}{g} = \frac{\Delta l}{l} + 2\frac{\Delta T}{T}$

$= \frac{0.1}{20} + 2 \times \frac{1}{90} = 0.03$

3.

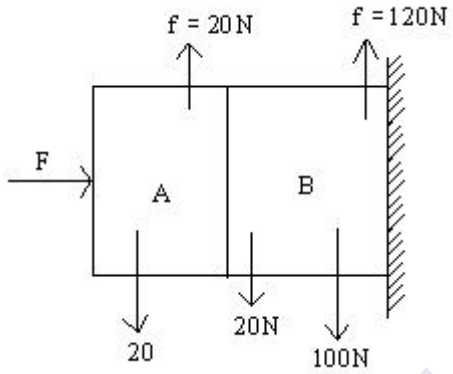


Given in the figure are two blocks A and B of weight 20 N and 100 N, respectively. These are being pressed against a wall by a force F as shown. If the coefficient of friction between the blocks is 0.1 and between block B and the wall is 0.15, the frictional force applied by the wall on block B is.

(1) 100 N **(2) 80 N** **(3) 120 N** **(4) 150 N**

Ans : 3

Sol. :



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

(1) 44% **(2) 50%** **(3) 56%** **(4) 62%**

Ans : 3

Sol. : $m\times 2V\hat{i}+2mV\hat{j}=3mV'$

$$V'=\frac{2}{3}V\hat{i}+\frac{2}{3}V\hat{j}$$

$$V'=\sqrt{\frac{4}{9}V^2+\frac{4}{9}V^2}=\sqrt{2}\times\frac{2}{3}V$$

$$=\frac{2\sqrt{2}}{3}V$$

$$\frac{\Delta E}{E}\times 100=\frac{\left(\frac{1}{2}m\times 4V^2+\frac{1}{2}\times 2m\times V^2-\frac{1}{2}\times 3m\times\frac{4\times 2}{9}.V^2\right)}{\left(\frac{1}{2}m\times 4V^2+\frac{1}{2}\times 2m\times V^2\right)}\times 100$$

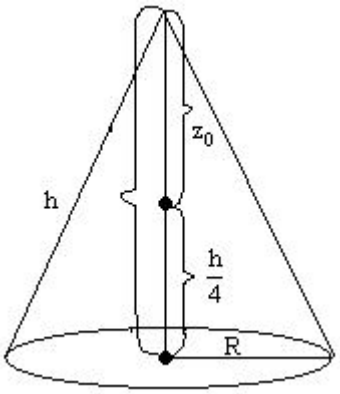
$$=\frac{\left(\frac{5mV^2}{3}\right)}{3mV^2}\times 100=\frac{5}{9}\times 100\approx 56\%$$

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

(1) $\frac{h^2}{4R}$ **(2)** $\frac{3h}{4}$ **(3)** $\frac{5h}{8}$ **(4)** $\frac{3h^2}{8R}$

Ans : 2

Sol. :



height of c.o.m from the base of the cone is $\frac{h}{4}$

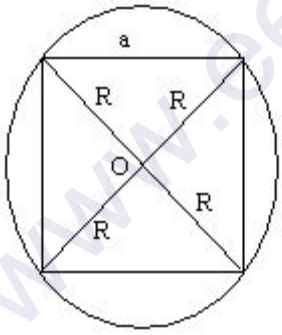
$\therefore$ **from vertex** $Z_0 = h - \frac{h}{4} = \frac{3h}{4}$

6. From a solid sphere of mass M and radius R a cube of maximum possible volume is cut. Moment of inertia of cube about an axis passing through its center and perpendicular to one of its faces is.

(1) $\frac{MR^2}{32\sqrt{2}\pi}$ **(2)** $\frac{MR^2}{16\sqrt{2}\pi}$ **(3)** $\frac{4MR^2}{9\sqrt{3}\pi}$ **(4)** $\frac{4MR^2}{3\sqrt{3}\pi}$

Ans : 3

Sol. :



Here $2R = \sqrt{3}a$

side of the cube $a = \frac{2R}{\sqrt{3}}$

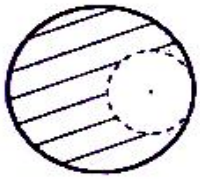
Mass of the cube $M' = \frac{2M}{\sqrt{3}\pi}$

M.I. of the cube about the given axis $I = \frac{M'a^2}{6}$

$$I = \frac{\frac{2M}{\sqrt{3}\pi} \times \frac{4R^2}{3}}{6} = \frac{4MR^2}{9\sqrt{3}\pi}$$

7. From a solid sphere of mass M and radius R, a spherical portion of radius $\frac{R}{2}$ is removed, as shown in the figure. Taking gravitational potential $V = 0$ at $r = \infty$, the potential at the centre of the cavity thus formed is.

(G = gravitational constant)



(1) $\frac{-GM}{2R}$ **(2)** $\frac{-GM}{R}$ **(3)** $\frac{-2GM}{3R}$ **(4)** $\frac{-2GM}{R}$

Ans : 2

Sol. : $V = \frac{2GM}{2R^3}\left(3R^2 - r^2\right)$

$\therefore V = V_{full} - V_{cavity}$

$$= \frac{-GM}{2R^3}\left(3R^2 - \frac{R^2}{4}\right) - \left(-\frac{3}{2}\frac{GM/8}{R/2}\right)$$

$$= \frac{-GM}{R}$$

8. A pendulum made of a uniform wire of cross sectional area A has time period T. When an additional mass M is added to its bob, the time period changes to T_M. If the Young's modulus of the meterial of the wire is Y then $\frac{1}{Y}$ is equal to.

(g = gravitational acceleration)

(1) $\left[\left(\frac{T_M}{T}\right)^2 - 1\right]\frac{A}{Mg}$ **(2)** $\left[\left(\frac{T_M}{T}\right)^2 - 1\right]\frac{Mg}{A}$ **(3)** $\left[1 - \left(\frac{T_M}{T}\right)^2\right]\frac{A}{Mg}$ **(4)** $\left[1 - \left(\frac{T}{T_M}\right)^2\right]\frac{A}{Mg}$

Ans : 1

Sol. : $T = 2\pi\sqrt{\frac{mL}{AY}}$ **m = initial mass**

$$T_M = 2\pi\sqrt{\frac{(M+m)L}{AY}}$$

$$\therefore \frac{T_M^2 - T^2}{4\pi^2} = \frac{ML}{AY}$$

or $\frac{1}{Y}=\left[\frac{T_M^2-T^2}{4\pi^2}\right]\frac{A}{ML}$

But $T=2\pi\sqrt{\frac{L}{g}}$

or $L=\frac{T_g^2}{4\pi^2}$

$\therefore \frac{1}{Y}=\left[\frac{T_M^2-T^2}{4\pi^2}\right]\left[\frac{A}{M}\right]\left[\frac{4\pi^2}{T^2g}\right]$

or $\frac{1}{Y}=\left[\left(\frac{T_M}{T}\right)^2-1\right]\frac{A}{Mg}$

9. Consider a spherical shell of radius R at temperature T. The black body radiation inside it can be considered as an ideal gas of photons with internal energy per unit volume $u=\frac{U}{V}\propto T^4$ **and pressure** $P=\frac{1}{3}\left(\frac{U}{V}\right)$**. If the shell now undergoes an adiabatic expansion the relation between T and R is.**

(1) $T\propto e^{-R}$ **(2)** $T\propto e^{-3R}$ **(3)** $T\propto\frac{1}{R}$ **(4)** $T\propto\frac{1}{R^3}$

Ans : 3

Sol. : $PV=nRT$

$P=\frac{nRT}{\frac{4}{3}\pi R^3}$

$P\propto\frac{T}{R^3}$

$\frac{T}{R^3}\propto T^4$

$\frac{1}{R^3}\propto T^3$

$T\propto\frac{1}{R}$

10. **A solid body of constant heat capacity $1\,J/^{o}C$ is being heated by keeping it in contact with reservoirs in two ways.**

(i) Sequentially keeping in constant with 2 reservoirs such that each reservoir supplies same amount of heat.

(ii) Sequentially keeing in contact with 8 reservoirs such that each reservoir supplies same amount of heat.

In both the cases body is brought from initial temperature $100\,^{o}C$ to final temperature $200\,^{o}C$. Entropy change of the body in the two cases respectively is.

(1) $\ln 2, 4\ln 2$ **(2)** $\ln 2, \ln 2$ **(3)** $\ln 2, 2\ln 2$ **(4)** $2\ln 2, 8\ln 2$

Ans : 2

11. **Consider an ideal gas confined in an isolated closed chamber. As the gas undergoes an adiabatic expansion, the average time of collision between molecules increases as V^{q}, where V is the volume of the gas. The value of q is :** $\left(\gamma = \frac{C_p}{C_v}\right)$

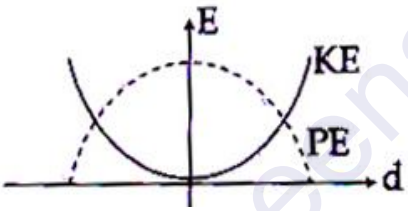
(1) $\frac{3\gamma+5}{6}$ **(2)** $\frac{3\gamma-5}{6}$ **(3)** $\frac{\gamma+1}{2}$ **(4)** $\frac{\gamma-1}{2}$

Ans : 3

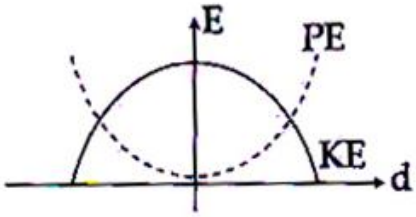
Sol. : Conceptual

12. **For a simple pendulum, a graph is plotted between its kenetic energy (KE) and potential energy (PE) against its displacement d. Which one of the following represents these correctly ? (graphs are schematic and not drawn to scale)**

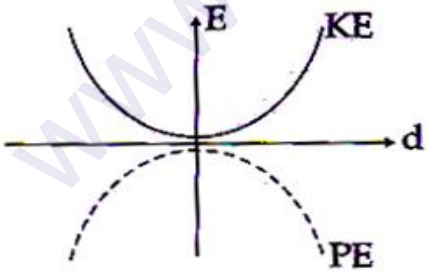
(1)



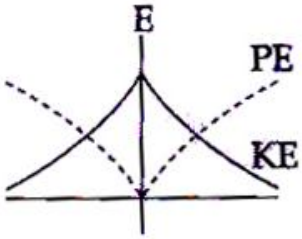
(2)



(3)



(4)



Ans : 2

Sol. : Conceptual

13. **A train is moving on a straight track with speed $20\,ms^{-1}$. It is blowing its whistle at the frequency of 1000 Hz. The ercentage change in the frequency heard by a person standing near the track as the train passes him is (speed of sound $= 320 ms^{-1}$) close to.**

(1) 6% **(2) 12%** **(3) 18%** **(4) 24%**

Ans : 2

Sol. : $V_s = 20ms^{-1}$; $n = 1000Hz$

while approching the person apparent frequency and is n'.

$$n' = n\left(\frac{V}{V - V_s}\right)$$

while receding from the person apparent frequency and is n''

$$n'' = n\left(\frac{V}{V + V_s}\right)$$

percentage change in frequency $= \frac{\Delta n}{n} \times 100$

$$= \frac{n' - n''}{n'} \times 100$$

$$\Delta n = n' - n'' = n\left(\frac{V}{V - V_s}\right) - n\left(\frac{V}{V + V_s}\right)$$

$$\Delta n = nV\frac{2V_s}{V^2 - V_s^2} \text{ as } V^2 >> V_s^2$$

$$\Delta n = \frac{2nV_s}{V}$$

% change in frequency $= \frac{\Delta n}{n'} \times 100$

$$= \frac{2nV_s}{Vn\left(\frac{V}{V - V_s}\right)} \times 100$$

$$= \frac{2V_s(V - V_s) \times 100}{V^2}$$

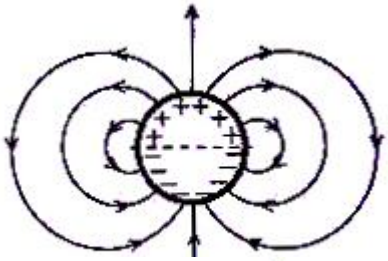
$$= \frac{2 \times 20(320 - 20) \times 100}{320 \times 320}$$

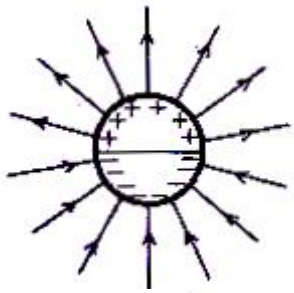
$$= \frac{40 \times 300 \times 100}{320 \times 320} = \frac{12000}{32 \times 32}$$

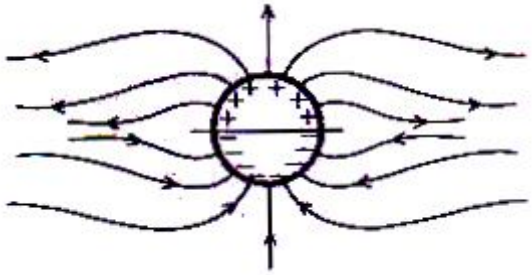
$$= 11.7\%$$

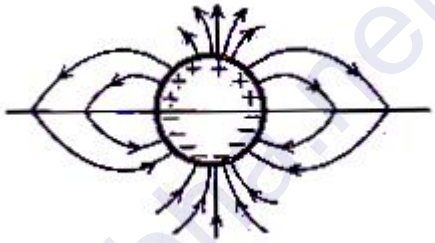
% change in frequency $\simeq 12\%$

14. A long cylindrical shell carries positive surface charge σ in the upper half and negative surface charge $-\sigma$ in the lower half. The electric field lines around the cylinder will look like figure given in.
(figures are schematic and not drawn to scale)

(1) 

(2) 

(3) 

(4) 

Ans : 1
Sol. : Conceptual

15. A uniformly charged solid sphere of radius R has potential V_0 (measured with respect to ∞) on its surface. For this sphere the equipotential surfaces with potentials $\frac{3V_0}{2}, \frac{5V_0}{4}, \frac{3V_0}{4}$ and $\frac{V_0}{4}$ have radius R_1, R_2, R_3 and R_4 respectively. Then

(1) $R_1 = 0$ **and** $R_2 > (R_4 - R_3)$

(2) $R_1 \neq 0$ **and** $(R_2 - R_1) > (R_4 - R_3)$

(3) $R_1 = 0$ **and** $R_2 > (R_4 - R_3)$

(4) $2R < R_4$

Ans : 3 & 4
Sol. : Inside the sphere

$$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{2R}\left[3 - \frac{r^2}{R^2}\right]$$

on the surface potential is V_0

$$V_0 = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$$

But center $V = \frac{3}{2}V_0 \qquad \therefore R_1 = 0$

$$\frac{5V_0}{4} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{2R}\left[3 - \frac{R_2^2}{R^2}\right]$$

$$\frac{5V_0}{4} = \frac{V_0}{2}\left[3 - \frac{R_2^2}{R^2}\right]$$

$$R_2^2 = \frac{1}{2}R^2 \Rightarrow \qquad R_2 = \frac{R}{\sqrt{2}} = 0.702R$$

$\frac{3V_0}{4}$ **and** $\frac{V_0}{4}$ **are outside the sphere**

$$\frac{3V_0}{4}=\frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{R_3}.$$

$$\frac{3}{4}\cdot\frac{1}{4\pi\varepsilon_0}\frac{Q}{R}=\frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{R_3}\Rightarrow R_3=\frac{4R}{3}$$

$$R_3=1.33R$$

$$\frac{V_0}{4}=\frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{R_4}$$

$$\frac{1}{4}\cdot\frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{R}=\frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{R_4}\Rightarrow R_4=4R$$

$$R_4-R_3=4R-\frac{4}{3}R=\frac{8R}{3}=2.66R$$

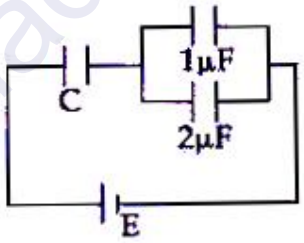
$$R_2=0.762R$$

$$R_2<(R_4-R_3)$$

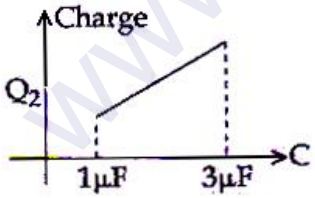
$2R<4R$

$\therefore 2R<4R$

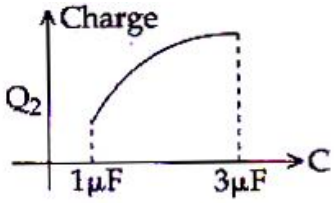
16. In the given circuit, charge Q_2 on the $2\mu F$ capacitor changes as C is varied from $1\mu F$ to $3\mu F$. Q_2 as a function of $'C'$ is given properly by:
(figures are drawn schematically and are not to scale)



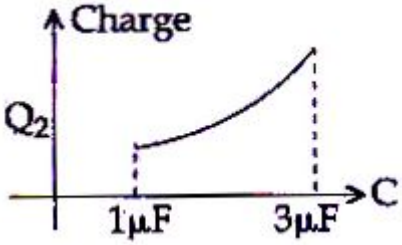
(1)



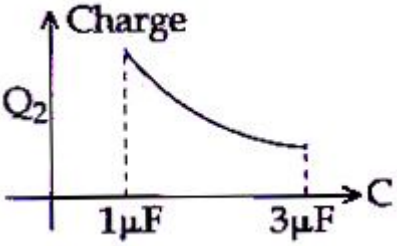
(2)



(3)



(4)



Ans : 2

Sol. : $Q = \frac{3CE}{3+C}$

$\frac{Q_1}{Q_2} = \frac{1}{2}$

$Q_2 = \frac{2CE}{3+C}$

$Q_2 = \frac{2E}{\frac{3}{C}+1}$

$\frac{dQ_2}{dC} > 0$ **and** $\frac{d^2Q_2}{dC^2} < 0$

Correct graph is (2).

17. When 5V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is $2.5\times10^{-4}ms^{-1}$. If the electon density in the wire is $8\times10^{28}m^{-3}$, the resistivity of the material is close to.

(1) $1.6\times10^{-8}\Omega m$ **(2)** $1.6\times10^{-7}\Omega m$ **(3)** $1.6\times10^{-6}\Omega m$ **(4)** $1.6\times10^{-5}\Omega m$

Ans : 4

Sol. : $i = nA\,e\,V_d$

$\frac{V}{R} = nA\,e\,V_d$

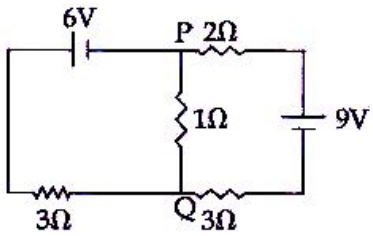
$\frac{V}{\frac{\rho l}{A}} = nA\,e\,V_d$

or $\rho = \frac{V}{n\,l\,e\,V_d}$

substitutig given values

$\rho = 1.6\times10^{-5}\Omega m$

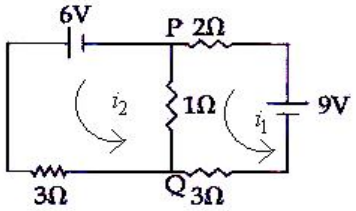
18. In the circuit shown, the current in the 1Ω resistoris



1)1.3A,from P and Q 2)0A 3)0.13 A, from Q to P 4) 0.13A, from P to Q

Ans : 3

Sol. :



$9 = 6i_1 - i_2$

& $6 = -i_1 + 4i_2$

Solving $i_1 = 1.83\,\text{A}$

$i_2 = 1.96\,\text{A}$

$\therefore i_2 - i_1 = 0.13A$

19. Two coaxial solenoids of different radii carry current I in the same direction. Let $\vec{F}_1$ be the magnetic force on the inner solenoid due to the outer one and $\vec{F}_2$ be the magnetic force on the outer solenoid due to the inner one. Then

1) $\vec{F}_1 = \vec{F}_2 = 0$

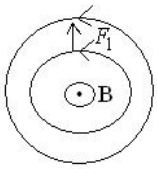
2) $\vec{F}_1$ is radially inwards and $\vec{F}_2$ is radially outwards

3) $\vec{F}_1$ is radially inwards and $\vec{F}_2 = 0$

4) $\vec{F}_1$ is radially outwards and $\vec{F}_2 = 0$

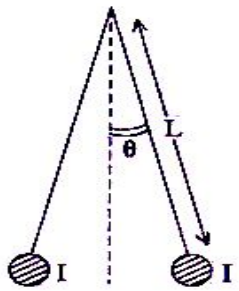
Ans : 1 & 4

Sol. : $\vec{F}_2 = 0$ as B=0



$\therefore F_1$ is radially outward & net $\vec{F}_1$ is zero

20. Two long current carrying thin wires, both with current I, are held by insulating threads of length L and are in equilibrium as shown in the figure, with threads making an angle 'θ' with the vertical. If wires have mass λ per unit length then the value of I is (g= gravitational acceleration)



1) $\sin\theta\sqrt{\dfrac{\pi\lambda gL}{\mu_0\cos\theta}}$

2) $2\sin\theta\sqrt{\dfrac{\pi\lambda gL}{\mu_0\cos\theta}}$

3) $2\sqrt{\dfrac{\pi gL}{\mu_0}\tan\theta}$

4) $\sqrt{\dfrac{\pi\lambda gL}{\mu_0}\tan\theta}$

Ans : 2

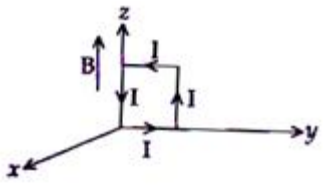
Sol. : $\frac{\mu_0 I^2}{4\pi L \sin\theta} = \lambda g \tan\theta$

$$I = \sqrt{\frac{4\pi L \lambda g \sin\theta \tan\theta}{\mu_0}}$$

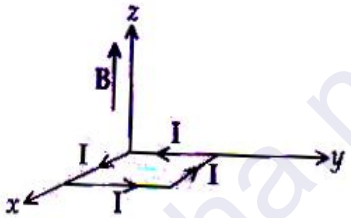
$$= 2\sin\theta \sqrt{\frac{\pi L \lambda g}{\mu_0 \cos\theta}}$$

21. A rectangular loop of sides 10 cm and 5 cm carrying a current I of 12 A is placed in differnt orientations as shown in the figures below

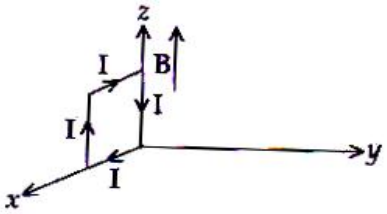
a)



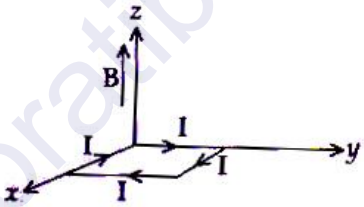
b)



c)



d)



If there is a uniform magnetic field of 0.3 T in the positive z direction, in which orientations the loop would be in (i) stable equilibrium and (ii) unstable equilibrium?

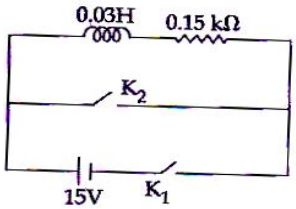
1) (a) and (b), respectively
2) (a) and (c), respectively
3) (b) and (d), respectively
4) (b) and (c), respectively

Ans : 3

Sol. : $\vec{\tau} = \vec{M} \times \vec{B}$

$\theta = 0$ stable : $\theta = 180$ unstable

22. An inductor (L= 0.03H) and a resistor (R=0.15 $k\Omega$) are connected in series to battery of 15 EMF in circuit shown below. The key K_1 has been kept close for a long time. Then at t=0, K_1 is opened and key K_2 is closed simultaneously. At t=1 ms, the current in the circuit will be ($e^5 \cong 150$)



1) 100 mA
2) 67 mA
3) 6.7 mA
4) 0.67 mA

Ans : 4

Sol. : $I_0 = \frac{E}{R} = 0.1A$

$\tau = \frac{L}{R} = 2\times10^{-4}$

$\therefore \text{decay } I = I_0 e^{-t/\tau}$

$= 0.1e^{\frac{-10^{-3}}{2\times10^{-4}}}$

$= \frac{0.1}{e^5} = 0.67\,\text{mA}$

23. A red LED emits light at 0.1 watt uniformly around it. The amplitude of the electric field of the light at a distance of 1 m from the diode is

1) 1.73 V/m 2) 2.45 V/m 3) 5.48 V/m 4) .75 V/m

Ans : 2

Sol. : $\vec{S} = \frac{P}{4\pi r^2} = \frac{1}{\mu_0}\vec{E}\times\vec{B} = \frac{E_0 B_0}{2\mu_0}$

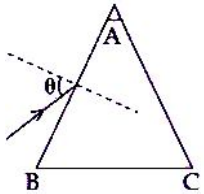
$\frac{P}{4\pi r^2} = \frac{E_0}{2c\mu_0}$

$E_0 = \sqrt{\frac{Pc\mu_0}{2\pi r^2}}$

$= \sqrt{0.1\times3\times10^8\times2\times10^{-7}}$

$= \sqrt{6}$

24. Monochromatic light is incident on a glass prism of angle A. If the refractive index of the material of the peism is μ, a ray, incident at an angle θ, on the face AB would get transmitted through the face AC of the prism provided

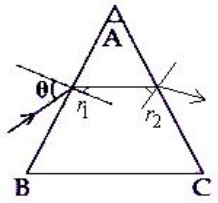


1) $\theta > \sin^{-1}\left[\mu\sin\left(A-\sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$ 2) $\theta < \sin^{-1}\left[\mu\sin\left(A-\sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

3) $\theta > \cos^{-1}\left[\mu\sin\left(A+\sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$ 4) $\theta < \cos^{-1}\left[\mu\sin\left(A+\sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

Ans : 1

Sol. :



$r_2 < c$

$\sin\theta = \mu \sin r_1$

$r_1 + r_{2=A}$

$r_2 = A - r_1$

$A - r_1 < C$

$r_1 > A - C$

$\sin\theta = \mu \sin r_1$

$\sin r_1 = \dfrac{\sin\theta}{\mu}$

$\sin r_1 > \sin(A - C)$

$\dfrac{\sin\theta}{\mu} > \sin(A - C)$

$\sin\theta > \mu \sin(A - C)$

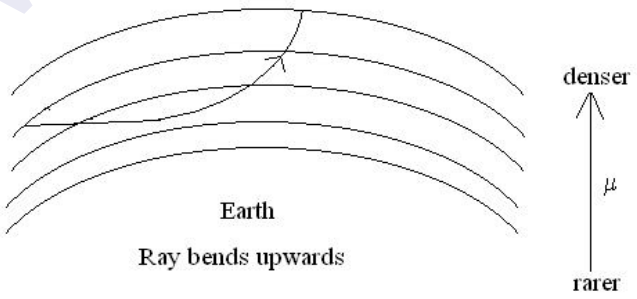
$\theta > \sin^{-1}\left[\mu \sin\left[A - \sin^{1}\left(\dfrac{1}{\mu}\right)\right]\right]$

25. On a hot summer night, the refractive index of air is smallest near the ground and increses with height from the ground. When a light beam is directed horizontally, the Hugens' principle leads us to condlude that as it travels, the light beam

1) becomes narrower
2) goes horizontally without any deflection
3) bends downwards
4) bends upwards

Ans : 4

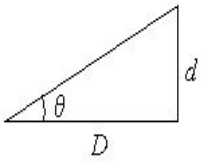
Sol. :



26. Assuming human pupil to have a radius of 0.25 cm and a comfortable viewing distance of 25 cm, the minimum separation between two objects that human eye can resolove at 500 nm wavelength is

1) 1 μm 2) 30 μm 3) 100 μm 4) 300 μm

Ans : 2

Sol. : 

$r = 0.25cm$

D=25 cm

$\lambda = 500\mu m$

$$\theta = \frac{1.22\lambda}{a} = \frac{1.22\lambda}{2r}$$

$$D\theta = d$$

$$\theta = \frac{d}{D}$$

$$\frac{d}{D} = \frac{1.22\lambda}{2r}$$

$$d = D \times \frac{1.22\lambda}{2r}$$

$$= \frac{25 \times 1.22 \times 500 \times 10^{-9}}{0.5}$$

$$= 50 \times 1.22 \times 500 \times 10^{-9}\mu m$$

$$= 50 \times 122 \times 5 \times 10^{-9} \times \frac{2}{2}$$

$$= 100 \times 122 \times 2.5 \times 10^{-9}$$

$$= 25 \times 122 \times 10^{-8}$$

$$= 3050 \times 10^{-8}$$

$$= 30.5 \times 10^{-6} = 30\mu m$$

27. As an electron makes a transition from an excited state to the ground state of a hydrogen - like atom/ion.

1) its kinetic energy increases but potential energy and total energy decrease

2) kinetic energy, potenital energy and total energy decreases

3) kinetic energy decreases, potential energy increases but total energy remains same

4) kinetic energy and total energy decrease but potential energy increases

Ans : 1

Sol. : $PE = \frac{-Ze^2}{4\pi \in_0 r}$

$$KE = \frac{Ze^2}{4\pi \in_0 (2r)}$$

$$TE = \frac{-Ze^2}{4\pi \in_0 (2r)}$$

$\therefore \quad r \downarrow \quad PE \downarrow \quad KE \uparrow \quad TE \downarrow$

28. Match List-I (Fundamental Experiment) with List-II(its conclusion) and select the correct option from the choices given below the list.

List-I	**List-II**
A) Franck- Hertz Experiment	**I) Particle nature of light**
B) Photo - electric experiment	**II) Discrete energy levels of atom**
C) Davison- Germer Experiment	**III) Wave nature of electron**
	IV) Structure of atom

1) A-I, B- IV, C- III 2) A- II, B- IV, C- III 3) A- II, B- I, C- III 4) A- IV, B- III, C- II

Ans : 3

Sol. : Conceptual

29. A signal of 5 kHz frequency is amplitude modulated on a carrier wave of frequency 2 MHz. The frequencies of the resultant signal is /are

1) 2 MHz only 2) 2005 kHz, and 1995 kHz

3) 2005 kHz, 2000 kHz and 1995 kHz 4) 2000 kHz and 19958 kHz

Ans : 3

Sol. : $f_m = 5kHz$

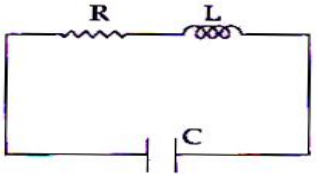
$f_c = 2MHz$

Max : $f_c + f_m = 2005kHz$

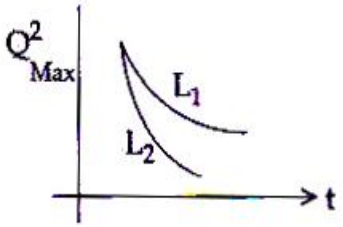
Min : $f_c - f_m = 1995kHz$

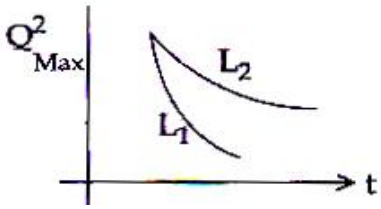
$f_c = 2000kHz$ **.**

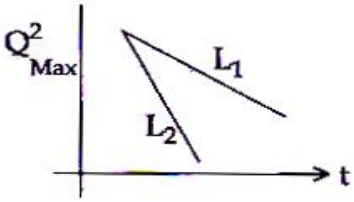
30. An LCR circuit is equivlent to a damped pendulum. In an LCR circuit the capacitor is charged to Q_0 and then connected to the L and R as shown below.

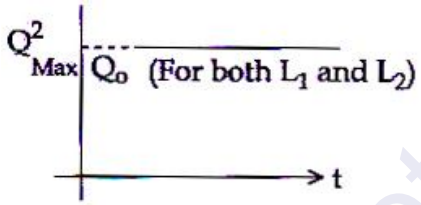


If a student plots graphs of the square of maximum charge $\left(Q_{Max}^2\right)$ on the capacitro with time (t) for two different values L_1 and $L_2 (L_1 > L_2)$ of L then which of the following represents this graph correctly? (plots are schematic and not drawn to scale)

1) 

2) 

3) 

4) 

Ans : 1

Sol. :damping constant

$$b = \frac{R^2}{4L^2} \qquad \therefore b \propto \frac{1}{L^2}$$

CHEMISTRY

31. The molecular formula of a commerical resin used for exchanging ions in water softening is $C_8H_7SO_3Na(Mol.wt.206)$ What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin?

1) $\frac{1}{103}$ 2) $\frac{1}{206}$ 3) $\frac{2}{309}$ 4) $\frac{1}{412}$

Ans : 4

Sol. : $2C_8H_7SO_3Na + Ca^{+2} \rightarrow (C_8H_7SO_3Na)_2 Ca$

$2mol \rightarrow 1mol$

$2 \times 206_g \rightarrow 1mol$

$1g = 1/412$

32. Sodium metal crystallizes in a body centred cubic lattice with a unit cell edge of 4.29A. The radius of sodium atom is approximately:

1) $1.86A^0$ 2) $3.22A^0$ 3) $5.72A^0$ 4) $0.93A^0$

Ans : 1

Sol. : $\sqrt{3}a = 4r$

$$r = \frac{\sqrt{3}}{4} = 4.29$$

$$\Rightarrow \frac{1.732}{4} \times 4.29$$

$$= 1.86A^0$$

33.. Which of the following is the energy of a possible excited state of hydrogen?.

1) +13.6eV 2) -6.8eV 3) -3.4eV 4) +6.8eV

Ans : 3

Sol. : $E_H = \frac{-13.6}{n^2} ev$

If $n=1 \Rightarrow E_1 = \frac{-13.6}{1^2} ev$

if $n=2 \Rightarrow E_2 = \frac{-13.6}{2^2} = -3.4$

34. The intermolecular interaction that is dependent on the inverse cube of distance between the molecules is :

1) ion-ion interaction 2) ion-dipole interaction

3) London force 4) hydrogen bond

Ans : 2

Sol. : Conceptual

35. The following reaction is performed at 298K. $2NO_{(g)} + O_2(g) \rightleftharpoons 2NO_2(g)$ **The standard free energy of formation of** $NO(g)$ **is 86.6kj/mol at 298 K. What is the standard free energy of formation of** $NO_2(g)$ **at 298K?** $\left(K_p = 1.6\times10^{12}\right)$

1) $R(298)\ln\left(1.6\times10^{12}\right) - 86600$ 2) $86600 + R(298)\ln\left(1.6\times10^{12}\right)$

3) $86600 - \frac{\ln\left(1.6\times10^{12}\right)}{R(298)}$ 4) $0.5\left[2\times86600 - R(298)\ln\left(1.6\times10^{12}\right)\right]$

Ans : 4

Sol. : $\Delta G_r = 2\times\Delta G_{f(NO_2)} - [2\times86.6+0]$

$= 2\times\Delta G_{(NO_2)} - 2\times86.6\times10^3$

$= 2\left[\Delta G_{f(NO_2)} - 86.6\times10^3\right]$

$-R\times298\times\ln\left(1.6\times10^{12}\right) = 2\left[\Delta G_{f(NO_2)} - 86600\right]$

$\Delta G_{f(NO_2)} = 0.5\left[2\times86600 - R(298)\ln\left(1.6\times10^{12}\right)\right]$

36. The vapour pressure of acetone at 20^0C **is 185 torr. when 1.2g of a non-volatile substance was dissolved in 100g of acetone at** 20^0C**, its vapour pressure was 183 torr. The molar mass** $\left(gmol^{-1}\right)$ **of the substance is**

1) 32 2) 64 3) 128 4) 488

Ans : 2

Sol. : $\frac{P^0 - P_s}{P^0} = X_{Solute}$

$$\frac{185-183}{185} = \frac{1.2/w}{100/58}$$

$$\Rightarrow 2/185 = 1.2/100 \times 58/w$$

$$= 64$$

37. The standard Gibbs energy change at 300 K for the reaction $2A \rightleftharpoons B + C$ is 2494.2J. At a given time, the composition of the reaction mixture is $[A] = \frac{1}{2}, [B] = 2$ and $[C] = \frac{1}{2}$. The reaction proceeds in the $[R = 8.314 J/K/mole = 2.718]$

1) Forward direction because $Q > K_C$ 2) reverse direction beacuse $Q > K_C$

3) forward direction because $Q < K_C$ 4) reverse direction because $Q < K_C$

Ans : 2

Sol. : $\because \Delta G_r^0 = -300 \times 8.314 . \ln K_C$

$$\frac{-2494.2}{300 \times 8.314} = \ln K_C$$

$$\ln K_C = -1$$

$$\Rightarrow K_C = e^{-1} \Rightarrow \frac{1}{e} \Rightarrow \frac{1}{2.718}$$

$$Q_C = \frac{[B][C]}{[A]^2} = \frac{\left[2 \times \frac{1}{2}\right]}{\left[\frac{1}{2}\right]^2}$$

$$= 4$$

$$Q > K_C$$

38. Two Faraday of electricity is passed through a solution of $CuSO_4$. The mass of copper deposited at the cathode is : $(at.mass\ of\ Cu = 63.5 amu)$

1) 0g 2) 63.5 g 3) 2 g 4) 127 g

Ans : 2

Sol. : $1F \rightarrow 1$ equalent wt $Cu^{+2} \rightarrow 31.73g$

$2F \rightarrow 2$ equalent wt 31.73×2

= 63.5

39. Higher order (>3) reaction are rare due to :

1) low probability of simultaneous collision of all the reacting species

2) increase in entropy and activation energy as more molecules are involved

3) shifting of equillibrium towards reactants due to elastic collisions

4) loss of active species on collision

Ans : 1

Sol. : Conceptual

40. 3g of activated charcol was added to 50mL. of acetic acid solution (0.06N) in a falsk. After an hour it was filtered was found to be 0.042 N. The amount of acetic acid absorbed (per gram of charcoal) is

1) 18 mg 2) 36 mg 3) 42 mg 4) 54 mg

Ans : 1

Sol. : no. of m.eq of HAc = 0.06×50

=3

no . of m.eq of HAc left = 50×0.042

=2.1

no. of m.eq HAc adsorbed 3-2.1 = 0.9 m.eq

wt of HAc adsorbed = 0.9×60

= 54 mg

wt of HAc per gram charcol

$=54/3=18mg$

41. The ionic radii (in A^0) of N^{3-}, O^{2-} and F^- are respectively:

1) 1.36 1.40 and 1.71 2) 1.36, 17.71 and 1.40

3) 1.71 , 1.40 and 1.36 4) 1.71 , 1.36 and 1.40

Ans : 3

Sol. : $N^{3-} > O^{2-} > F^-$

$\therefore 1.71 > 1.40 > 1.36$

42. In the context of the Hall-Heroult process for the extraction of Al, which of the following statement is false?

1) CO and CO_2 are produced in this process

2) Al_2O_3 is mixed with CaF_2 which lowers the melting point of the mixture and brings conductivity

3) Al^{3+} is reduced at the cathode to form Al

4) Na_3AlF_6 serves as the electrolyte

Ans : 4

Sol. : Conceptual

43. From the following statements regarding H_2O_2 choose the incoorrect statement:

1) It can act only as an oxidizing agent

2) It decomposes on exposure to light

3) It has to be stored in plastic or wax lined glass bottle in dark

4) It has to be kept away form dust

Ans : 1

Sol. : Also with as reducing and bleching agent

44. Which one of he following alkaline earth metal sulphates has its hydration enthalpy greater than its lattice enthalpy?

1) $CaSO_4$ 2) $BeSO_4$ 3) $BaSO_4$ 4) $SrSO_4$

Ans : 2

Sol. : Conceptual

45. Which among the following is the most reactive?

1) Cl_2 2) Br_2 3) I_2 4) ICI

Ans : 4

Sol. : Intra halogen compounds are more reactive than halogens

46. Match the cataiysts to the correct processes:

Catalyst	**Process**
(A) $TiCl_3$	**(i) Wacker process**
(B) $PdCl_2$	**(ii) Ziegler-Natta polymerization**
(C) $CuCl_2$	**(iii) Conatact process**
(D) V_2O_5	**(iv) Deacon's process**

1) (A) -(iii),(B) -(ii),(C)-(iv), (D)-(i) 2) (A) -(ii),(B) -(i),(C)-(iv), (D)-(iii)

3) (A) -(ii),(B) -(iii),(C)-(iv), (D)-(i) 4) (A) -(iii),(B) -(i),(C)-(ii), (D)-(iv)

Ans : 2

Sol. : Conceptual

47. Which one has the highest boiling point?

1) He 2) Ne 3) Kr 4) Xe

Ans : 4

Sol. : Conceptual

48. The number of geometric isomers that can exist for sqare planar [Pt(Cl)(py) (NH_3) $\left(NH_2OH\right)]^+$ is (py=pyridine):

1) 2 2) 3 3) 4 4)6

Ans : 2

Sol. : Mabcd

Square planer has three geometrical isomers.

49. The order of $KMnO_4$ is due to:

1) M $\rightarrow$ L charge transfer transsition 2) d-d transition

3) L $\rightarrow$ M charge transfer transition 4) $\sigma - \sigma^*$

Ans : 3

Sol. :

$$O^{2-} \rightarrow O^{-} + e^{-}$$
$$Mn^{+7} + e^{-} \rightarrow Mn^{+6}$$
$$Mn^{+7} + O^{2-} \rightarrow Mn^{+6} + O^{-}$$
$$\therefore \; L \rightarrow M \quad Charge\ transfer$$

50. Assertion:Nitrogen and Oxygen are the main components in the atmosphere but these do not react to form oxides of nitrogen

Reasom: The reaction between nitogen and oxygen required high temperature.

1) Both assertion and reason are correct, and the reason is the correct explaination for the assetion

2) Both assertion and reason are correct , but reason is not the correct exploination for the assertion

3) Assertion is incorrection, but the reason is correct

4) Bot the assertion and reason are incorrect.

Ans : 1

Sol. : $N_2 + O_2 \xrightarrow{3000^{o}C} 2NO$

i.e, it requires high temperature

51. In Carius method of estimated of halogens, 250mg of an orgonic compound gave 141mg of AgBr. The percentage of bromine in the compound is:

(at , mass Ag=108; Br=80)

1) 24 2) 36 3) 48 4) 60

Ans : 1

Sol. : $\%Br = \frac{80}{108+80} x \frac{141}{250} x100 = 24$

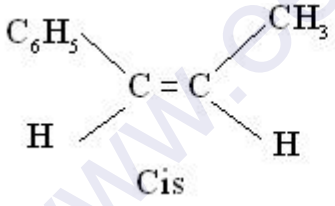
52. Which of the following compound will exbhit geometrical isomerism?

1) 1-Phenyl - 2- butene 2) 3Phenyl - 1- butene

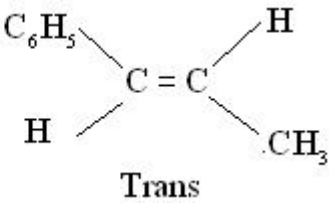
3) 2-Phenyl - 1- butene 4) 1,1-DiPhenyl - 1- propane

Ans : 1

Sol. :

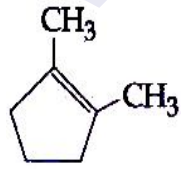


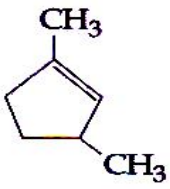
Cis

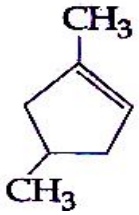


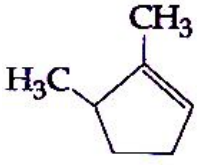
Trans

53. Which compound would give 5-keto -2-methyl hexanal upon ozonolysis?

1) 

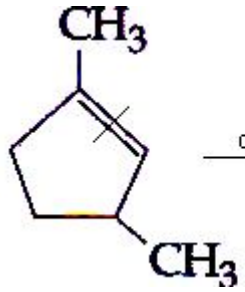
2) 

3) 

4) 

Ans : 2

Sol. :



$\xrightarrow{O_3}$ $CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-\underset{\underset{CH_3}{|}}{CH}-CHO$

54. The synthesis of alkyl fluroides is best accomplished by:

1) Free radical fluorination
2) Sandmeyer's reaction
3) Finkelstein reaction
4) Swarts reaction

Ans : 4

Sol. Alkyl Floride is best in Swarts reaction

55. In the following sequance of reactions: Toluene $\xrightarrow{KMnO_4} A \xrightarrow{SOCl_2} B \xrightarrow[BnSO_4]{H_2/Pd} C$ **the product C is:**

1) C_6H_5COOH 2) $C_6H_5CH_3$ 3) $C_6H_5CH_2OH$ 4) C_6H_5CHO

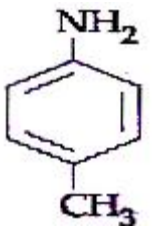
Ans : 4

Sol.

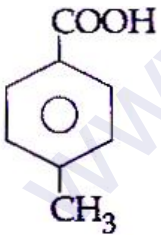
$$C_6H_5CH_3 \xrightarrow{KMnO_4} C_6H_5COOH \xrightarrow{SOCl_2} C_6H_5COCl \xrightarrow[BnSO_4]{H_2/Pd} C_6H_5CHO$$

Rosenmund reduction

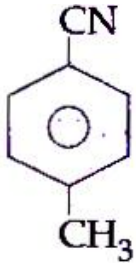
56. In the reaction

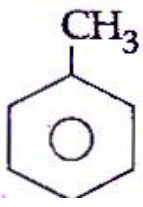


$\xrightarrow[0-5^oC]{NaNO_2/HCl} D \xrightarrow[\Delta]{CuCn/KCN} E + N_2$ **the product E is:**

1) 

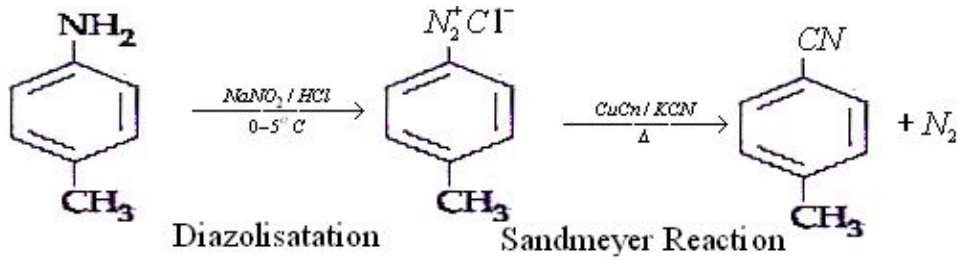
2) 

3) 

4) 

Ans : 3

Sol.



57. **Which polymer is used in the manufacture of paint and lacqures?**

1) Bakelite 2) Glyptal 3) Polpropene 4) Poly vinyl chloride

Ans : 2

Sol. Conceptual

58. Which of the vitamins given below is water soluble?

1) Vitamin C 2) Vitamin D 3) VitaminE 4) Vitamin K

Ans : 1

Sol. Only vitamin B and vitamin C soluable in water

59. Which of the following compounds is not an anthacid?

1) Aluminium hydroxide 2) Cimetidine

3) Phenezine 4) Ranitidine

Ans : 3

Sol. Phenezine **is a Tranquilizer**

60. Which of the following compounds is not colored yellow?

1) $Zn_2\left[Fe(CN)_6\right]$ **2)** $K_3\left[CO(NO_2)_6\right]$

3) $(NH_4)_3\left[As(Mo_3O_{10})_4\right]$ **4)** $BaCrO_4$

Ans : 1

Sol. : Conceptual

MATHS

61. Let A and B be two sets containing four and two elements respectively. Then the number of subsets of the set A×B, **each having at least three elements is.**

(1) 219 (2) 256 (3) 275 (4) 510

Ans : 1

Sol. : $A=\frac{\{a,b,c\}}{4}$ $B=\{1,2\}$

$A\times B=8$ elements

$A\times B=\{(a,1),(a,2),(b,1)(b,2)(c,1)(c,2)(d,1)(d,2)\}$

$2^8=32\times2\times2\times2$

$=64\times4$

$=256$

$^8C_3 + {}^8C_4 + ... + {}^8C_8$

$= 2^8 - {}^8C_0 - {}^8C_1 - {}^8C_2$

$= 256 - 1 - 8 - 28$

$= 219$

62. **A complex number z is said to be unimodular if $|z| = 1$. Suppose z_1 and z_2 are complex numbers such that $\frac{z_1 - 2z_2}{2 - z_1\bar{z}_2}$ is unimodular and z_2 is not unimocular. Then the point z_1 lies on a:**

(1) straight line parallel to $x-$axis **(2) straight line parallel to $y-$axis**

(3) circle of radius 2 **(4) circle of radius $\sqrt{2}$.**

Ans : 3

Sol. : $|z| = 1, \left|\frac{z_1 - 2z_2}{2 - z_1\bar{z}_2}\right| = 1 \quad |z_2| \neq 1$

$|z_1 - 2z_2|^2 = |2 - z_1\bar{z}_2|^2$

$|z_1|^2 + 4|z_2|^2 - 4\,\text{Re}(z_1\bar{z}_2) = 4 + |z_1\bar{z}_2|^2 - 4\,\text{Re}\, z_1\bar{z}_2$

$|z_1|^2 + 4|z_2|^2 = 4 + |\bar{z}_2|^2|z_1|^2$

$|z_1|^2 - |z_1|^2|z_2|^2 + 4|z_2|^2 = 4 \qquad |z_2| \neq 1$

$|z_1|^2\left(1 - |z_2|^2\right) = 4\left(1 - |z_2|^2\right) \qquad |z_1|^2 = 4$

63. **Let α and β be the roots of equation $x^2 - 6x - 2 = 0$. If $a_n = \alpha^n - \beta^n$, for $n \geq 1$, then the value of $\frac{a_{10} - 2a_8}{2a_9}$ is equal to.**

(1) 6 **(2) -6** **(3) 3** **(4) -3**

Ans : 3

Sol. : α, β root of $x^2 - 6x - 2 = 0$; $\quad a_n = \alpha^n - \beta^n \quad n \geq 1$

$a_{10} - 2a_8 = \alpha^{10} - \beta^{10} - 2\left(\alpha^8 - \beta^8\right) = \alpha^8\left(\alpha^2 - 2\right) - \beta^8\left(\beta^2 - 2\right)$

$= \alpha^8(6\alpha) - \beta^8(6\beta)$

$= 6(a_9) \qquad \therefore \frac{a_{10} - 2a_8}{2a_9} = \frac{6}{2} = 3$

64. **If** $A=\begin{bmatrix}1 & 2 & 2\\ 2 & 1 & -2\\ a & 2 & b\end{bmatrix}$ **is a matrix satisfying the equation** $AA^T=9I$, **where** I **is** 3×3 **identity matrix, then the ordered pair** (a,b) **is equal to.**

(1) $(2,-1)$ (2) $(-2,1)$ (3) $(2,1)$ (4) $(-2,-1)$

Ans : 4

Sol. : $A=\begin{bmatrix}1 & 2 & 2\\ 2 & 1 & -2\\ a & 2 & b\end{bmatrix}$ $\quad AA^T=9I$

$1(b+4)-2(2b+2a)+2(4-a)=2^7$ $\quad |AA^T|=9^3$

$b+4-4b-4a+8-2a=27$ $\quad |A|^2=9^3$

$-3b-6a+12=27$ $\quad |A|=3^3=27$

$-b-2a+4=9$

$-b-2a=5$

$a=-2,\ b-1$ $\quad (a,b)=(-2,-1)$

65. **The set of all values of** λ **for which the system of linear equations.**

$2x_1-2x_2+x_3=\lambda x_1, 2x_1-3x_2+2x_3=\lambda x_2, -x_1+2x_2=\lambda x_3$ **has a non-trivial solution,**

(1) is an empty set (2) is a singleton

(3) contains two elements (4) contains more than two elements

Ans : 3

Sol. : $\begin{vmatrix}2-\lambda & -2 & 1\\ 2 & -3-\lambda & 2\\ -1 & 2 & -\lambda\end{vmatrix}=0$

$(2-\lambda)(3\lambda+\lambda^2-4)+2(-2\lambda+2)+1(4-3-\lambda)=0$

$6\lambda+2\lambda^2-8-3\lambda^2-\lambda^3+4\lambda-4\lambda+4+1-\lambda=0$

$-\lambda^3-\lambda^2+5\lambda-3=0$

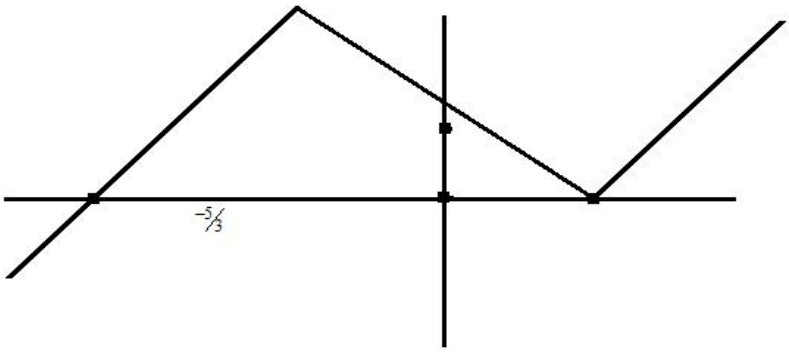
$\lambda^3+\lambda^2-5\lambda+3=0$

$f(x)=x^2+x^2-5x+3=0$ $\quad f'(x)=3x^2+2x-5$

$=3x^2+5x-3x-5$

$=3x(x-1)+5(x-1)$

$=3(x-1)(x+1)_3$



66. The number of integers greater than 6,000 that can be formed, using the digits $3,5,6,7$ and 8, without repetition, is.

(1) 216 (2) 192 (3) 120 (4) 72

Ans : 2

Sol. : Number of integers greater than 6,000

$3,5,6,7,8$ without repetition

$= 3\times {}^4P_3 = 3\times 4\times 3\times 2 = 72$

Another way is $\underline{|5} = 120$

Total number of ways = 120 + 72 = 192

67. The sum of coefficients of integral powers of x in the binomial expansion of $\left(1-2\sqrt{x}\right)^{50}$ is.

(1) $\frac{1}{2}\left(3^{50}+1\right)$ (2) $\frac{1}{2}\left(3^{50}\right)$ (3) $\frac{1}{2}\left(3^{50}-1\right)$ (4) $\frac{1}{2}\left(2^{50}+1\right)$

Ans : 1

Sol. : $\left(1-2\sqrt{x}\right)^{50}$

$=1-{}^{50}C_1 2\sqrt{x}+{}^{50}C_2\left(2\sqrt{x}\right)^2-{}^{50}C_3\left(2\sqrt{x}\right)^3+{}^{50}C_4\left(2\sqrt{x}\right)^4....$

$1+{}^{50}C_2(2)^2+{}^{50}C_4(2)^4+{}^{50}C_6(2)^6+.....+{}^{50}C_{50}(2)^{50}$

$(1+x)^{50}={}^{50}C_0+{}^{50}C_1x+{}^{50}C_2x^2+{}^{50}C_3x^3+{}^{50}C_4(x)^2+.....$

$(1+2)^{50}={}^{50}C_0+{}^{50}C_1(2)+{}^{50}C_2(2)^2+{}^{50}C_3(2)^3+{}^{50}C_4(2)^4+.....$

$={}^{50}C_0-{}^{50}C_1(2)+{}^{50}C_2(2)^2$

$\frac{3^{50}+1}{2}=1+{}^{50}C_2(2)^2+{}^{50}C_4(2)^4+.....$

68. If m is the A.M. of two distinct real numbers l and $n(l,n>1)$ and G_1,G_2 and G_3 are three geometric means between l and n, then $G_1^4+2G_2^4+G_3^4$ equals.

(1) $4l^2mn$ (2) $4lm^2n$ (3) $4lmn^2$ (4) $4l^2m^2n^2$

Ans : 2

Sol. : $m=\frac{l+n}{2}(l,n>1)$

$l \quad G_1 \quad G_2 \quad G_3 \quad n$

$lr \quad lr^2 \quad lr^3$

$n=lr^4$

$r^4=n/l$

$r=\left(n/l\right)^{\frac{1}{4}}$

$G_1=l.\left(n/l\right)^{\frac{1}{4}}$

$G_2=l.\left(n/l\right)^{-1/2}$

$G_3=l.\left(\frac{n}{l}\right)^{3/4}$

$4m^2=(l+n)^2 \quad =\ln\left(l^2+2nl+n^2\right)$

$=l^2+n^2+2nl \quad =\ln(l+n)^2$

$=\ln\left(4m^2\right)$

$=4m^2\ln$

$G_1^4+2G_2^4+G_3^4$

$=l^4\left(\frac{n}{l}+2\left(\frac{n}{l}\right)^2+\left(\frac{n}{l}\right)^3\right)$

$=\left(\frac{nl^2+2n^2l+n^3}{l^3}\right)l$

$=l\left(nl^2+2n^2l+n^3\right)$

69. The sum of first 9 terms of the series $\frac{1^3}{1}+\frac{1^3+2^3}{1+3}+\frac{1^3+2^3+3^3}{1+3+5}+....$ **is**

(1) 71 (2) 96 (3) 142 (4) 192

Ans : 2

Sol. : $\frac{1^3}{1}+\frac{1^3+2^3}{1+3}+\frac{1^3+2^3+3^3}{1+3+5}+.....$

$=\sum_{r=1}^{9}\frac{\frac{n^2(n+1)^2}{4}}{n^2}$

$=\frac{1}{4}\left[\sum_{r=1}^{9}\left(n^2+2n+1\right)\right]$

$$= \frac{1}{4}\left[\frac{n(n+1)(2n+1)}{6} + 2\left(\frac{n(n+1)}{2}\right) + n\right]$$

$$= \frac{1}{4}\left[\frac{9(10)(19)}{6} + 9\times 10 + 9\right]$$

$$= \frac{1}{4}[285 + 90 + 9]$$

$$= \frac{384}{4} = 96$$

70. $\lim\limits_{x\to 0} \dfrac{(1-\cos 2x)(3+\cos x)}{x\tan 4x}$ **is equal to.**

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

Ans : 3

Sol. : $\underset{x\to 0}{Lt} \dfrac{\left(\dfrac{1-\cos 2x}{x^2}\right)(3+\cos x)}{\dfrac{x\tan 4x}{4x^2}\times 4}$

$$= \frac{\frac{2^2}{2}(3+1)}{4} = 2$$

71. **If the function.** $g(x) = \begin{cases} k\sqrt{x+1}, & 0 \le x \le 3 \\ mx+2, & 3 < x \le 5 \end{cases}$ **is differentiable, then the value of** $k+m$ **is.**

(1) 2 (2) $\frac{16}{5}$ (3) $\frac{10}{3}$ (4) 4

Ans : 1

Sol. : $g(x) = k\sqrt{x+1}, 0 \le x \le 3$

$= mx+2, 3 < x \le 5$

$K + m = ?$

$g(x)$ is differentiable at $x = 3$ $g(x)$ is cantinuous at $x = 3$

$\dfrac{K}{2\sqrt{x+1}} = m$ $K.2 = 3m + 2$

$\dfrac{K}{4} = m$ $2K = 3m + 2$

$K = 4m$ $8m = 3m + 2$

$K = 8/5$ $5m = 2$

$\therefore K + m = \dfrac{10}{5} = 2$ $m = 2/5$

72. **The normal to the curve,** $x^2+2xy-3y^2=0,$ **at** $(1,1)$.

(1) does not meet the curve again
(2) meets the curve again in the second quadrant
(3) meets the curve again in the third quadrant
(4) meets the curve again in the fourth quadrant

Ans : 4

Sol. : $x^2+2xy-3y^2=0,(1,1)$

$$\frac{dy}{dx}=-\left(\frac{2x+2y-0}{0+2x-6y}\right)$$

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

$$=-\left(\frac{2}{-2}\right)=1$$

$$m=\frac{-1}{1},(1,1)$$

$$x+y=2$$

$$y=2-x$$

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

$$x^2+4x-2x^2-3\left(4+x^2-4x\right)=0$$

$$-x^2+4x-12-3x^2+12x=0$$

$$-4x^2+16x-12=0$$

$$x^2-4x+3=0$$

$$x=1 \qquad \Rightarrow y=1$$

$$x=3 \qquad y=-1$$

$(3,-1)$ lies in fourth quadrant

73. Let $f(x)$ **be a polynomial of degree four having extreme values at** $x=1$ **and** $x=2.$ **If** $\lim\limits_{x\to 0}\left[1+\frac{f(x)}{x^2}\right]=3,$ **then** $f(2)$ **is equal to.**

(1) –8 (2) -4 (3) 0 (4) 4

Ans : 3

Sol. : $f(x)$ polynomial of degree $=4$ $x=1, x=2$

$$\underset{x\to 0}{Lt}\left[1+\frac{f(x)}{x^2}\right]=3$$

$$\underset{x\to 0}{Lt}\ 1+\frac{f'(x)}{2x}=3$$

$$f'(x)=a(x)(x-1)(x-2)$$

$$=ax\left(x^2-3x+2\right)=a\left(x^3-3x^2+2x\right)$$

$$f(x)=a\left(\frac{x^4}{4}-3.\frac{x^3}{3}+2.\frac{x^2}{2}\right)+c$$

$$f(0)=0,\ c=0$$

$$f'(1)=f'(2)=0$$

$$f(2)=8$$

$$f(0)=0$$

$$f'(0)=0$$

$$\underset{x\to 0}{Lt}\ 1+f''\frac{(x)}{2}=3$$

$f''(x) = a(3x^2 - 6x + 2)$ $\qquad 1 + \frac{f''(0)}{2} = 3$

$4 = 2a$ $\qquad f''(0) = 4$

$a = 2$

$f(x) = 2\left(\frac{x^4}{4} - x^3 + x^2\right)$

$f(2) = 2(4 - 8 + 4)$

$f(2) = 0$

74. **The integral $\int \frac{dx}{x^2\left(x^4+1\right)^{3/4}}$ equals.**

(1) $\left(\frac{x^4+1}{x^4}\right)^{\frac{1}{4}} + c$ (2) $\left(x^4+1\right)^{\frac{1}{4}} + c$ (3) $-\left(x^4+1\right)^{\frac{1}{4}} + c$ (4) $-\left(\frac{x^4+1}{x^4}\right)^{\frac{1}{4}} + c$

Ans : 4

Sol. : $\int \frac{dx}{x^2\, x^3\left(1+\frac{1}{x^4}\right)^{3/4}}$

$= -\frac{1}{4}\int \frac{1}{t^{3/4}}dt$ $\qquad 1 + \frac{1}{x^4} = t$

$= -\frac{1}{4}\int t^{-3/4}\,dt$ $\qquad \frac{-4}{x^5}dx = dt$

$= -\frac{1}{4}\frac{t^{-\frac{3}{4}+1}}{-\frac{3}{4}+1} + c$ $\qquad \frac{1}{x^5}dx = -\frac{1}{4}dt$

$= -t^{\frac{1}{4}} + c$

$= -\left(1+\frac{1}{x^4}\right)^{\frac{1}{4}} + c$

75. The integral $\int_2^4 \frac{\log x^2}{\log x^2 + \log\left(36 - 12x + x^2\right)}dx$ is equal to.

(1) 2 (2) 4 (3) 1 (4) 6

Ans : 3

Sol. : $I = \int_2^4 \frac{\log x^2}{\log x^2 + \log(6-x)^2}dx$

$$=\int_2^4 \frac{\log(6-x)^2}{\log(6-x)^2+\log\left[6-(6-x)\right]^2}dx$$

$$I=\int_2^4 \frac{\log(6-x)^2}{\log(6-x)^2+\log x^2}dx$$

$$2I=\int_2^4 1dx=2$$

$$I=1$$

76. The area (in sq. inits) of the region described by $\{(x,y): y^2 \le 2x \text{ and } y \ge 4x-1\}$ is:

1) $\frac{7}{32}$ 2) $\frac{5}{64}$ 3) $\frac{15}{64}$ 4) $\frac{9}{32}$

Ans : 4

Sol. : $f(y)=\frac{y^2}{2}-\frac{y}{4}-\frac{1}{4}$

$$\text{Area}=\frac{\Delta^{\frac{3}{2}}}{6a^2}$$

$$=\frac{\left(\frac{1}{16}+\frac{1}{2}\right)^{\frac{3}{2}}}{6\left(\frac{1}{4}\right)}$$

$$=\left(\frac{3}{4}\right)^3\times\frac{4}{6}$$

$$=\frac{9}{32}sq\,units$$

77. Let $y(x)$ be the solution of the differential equation

$(x\log x)\frac{dy}{dx}+y=2x\log x,(x\ge 1)$ **Then $y(e)$ is equal to**

1) e 2) 0 3) 2 4) 2e

Ans : 3

Sol. : $(x\log x)\frac{dy}{dx}+y=2x\log x$

$$\frac{dy}{dx}+\frac{y}{x\log x}=2$$

$e^{\int \frac{1}{x\log x}} = e^{\log_e(\log x)} = \log_e x$

$y \log x_e = \int 2\log_e x\, dx$

$y \log_e x = 2\left(\left(\log_e x\right)x - x\right) + c$

$x = 1 \quad c = 2$

$y \log_e x = 2x\left(\log_e x - 1\right) + 2$

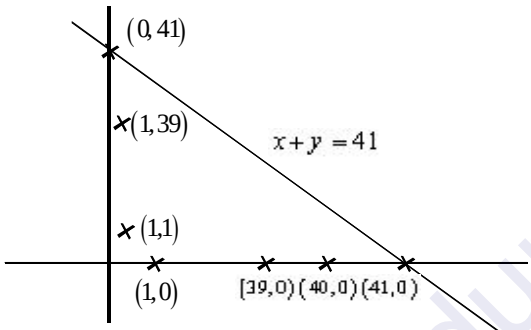
$y(e) = 2$

78. The number of points, having both co-ordinates as integers, that lie in the interior of the triangle with verices $(0,0)(0,41)$ and $(41,0)$, is :

1) 901 2) 861 3) 820 4) 780

Ans : 4

Sol. :



$39 + ... + 1$

$= 39 \times 20$

=780

79. Locus of the image of the point $(2,3)$ in the line $(2x-3y+4)+k(x-2y+3)=0, k \in R$, is a:

1) straight line parallel to x-axis 2) straight line parallel to y-axis

3) circle of radius $\sqrt{2}$ 4) circle of radius $\sqrt{3}$

Ans : 3

Sol. : $2x - 3y + 4 = 0$

$x - 2y + 3 = 0$

By solving above equations

$(x, y) = (1, 2)$, locus is a circle, centre 1, 2

radius $= \sqrt{(2-1)^2 (3-2)^2} = \sqrt{2}$

80. The number of common tangents to the circles $x^2+y^2-4x-6y-12=0$ and $x^2+y^2+6x+18y+26=0$, is:

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

Ans : 3

Sol. : $C_1=(2,3), r_1\sqrt{25}=5$

$C_2=(-3,-9), r_2=\sqrt{9+81-26}=8$

$C_1C_2=\sqrt{25+144}=13$

$r_1+r_2=13$

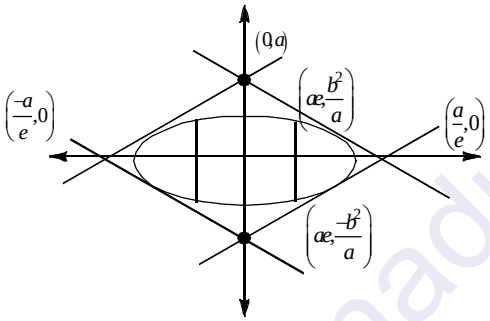
No. of Common tangents = 3

81. The area (in sq. units) of th quadrilateral formed by the tangents at the end points of the latera recta to the ellipse $\frac{x^2}{9}+\frac{y^2}{5}=1$, is

1) $\frac{27}{4}$ 2) 18 3) $\frac{27}{2}$ 4) 27

Ans : 4

Sol. :



$\frac{x(ae)}{a^2}+\frac{y\left(\frac{b^2}{a}\right)}{b^2}=1$

$\frac{ex}{a}+\frac{y}{a}=1$

$ex+y=a$ put $y=0\Rightarrow x=\frac{a}{e}$

put $x=0 \Rightarrow y=a$

Area $=\frac{1}{2}\times\frac{2a}{e}\times 2a$

$=\frac{2a^2}{e}$ $e=\sqrt{\frac{9-5}{9}}=\frac{2}{3}$

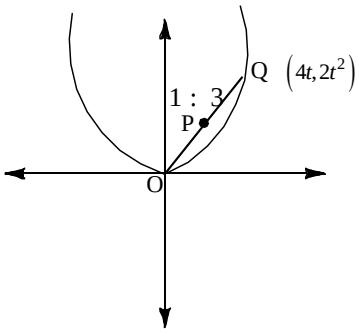
$=\frac{2(a)}{\left(\frac{2}{3}\right)}=27$ sq units

82. Let O be the vertex and Q be any point on the parabola, $x^2 = 8y$. If the point P divides the line segment OQ internally in the ratio $1:3$, then the locus of P is :

1) $x^2 = y$ 2) $y^2 = x$ 3) $y^2 = 2x$ 40 $x^2 = 2y$

Ans : 4

Sol. :



$$(x_1, y_1) = \frac{(4t, 2t^2) + 3(0,0)}{4}$$

$$(x_1, y_1) = \left(t, \frac{t^2}{2}\right)$$

$t = x_1,\ t^2 = 2y_1$

$x_1^2 = 2y_1$ $x^2 = 2y$

83. The distance of the point (1,0,2) from the point of intersection of the line $\frac{x-2}{3} = \frac{y+1}{4} = \frac{z-2}{12}$ and the plane $x - y + z = 16$, is

1) $2\sqrt{14}$ 2) 8 3) $3\sqrt{21}$ 4) 13

Ans : 4

Sol. : $(2+3r, -1+4r, 2+12r)$ lies on $x - y + z = 16$

$2 + 3r + 1 - 4r + 2 + 12r = 16$

$5r + 11r = 16$

$r = 1$

$A(5,3,14),\ B(1,0,2)$

$AB = \sqrt{16 + 9 + 144} = 13$

84. The equation of the plane containing the line $2x - 5y + z = 3; x + y + 4z = 5$, and parallel to the plane, $x + 3y + 6z = 1$, is:

1) $2x + 6y + 12z = 13$ 2) $x + 3y + 6z = -7$ 3) $x + 3y + 6z = 7$ 4) $2x + 6y + 12z = -13$

Ans : 3

Sol. : $(2x-5y+z-3)+\lambda(x+y+4z-5)=0$

$$\frac{2+\lambda}{1}=\frac{-5+\lambda}{3}=\frac{1+4\lambda}{6}$$

$$6+3\lambda=-5+\lambda$$

$$2\lambda=-11$$

$$\lambda=-\frac{11}{2}$$

$$(4x-10y+2z-6)-11(x+y+4z-5)=0$$

$$-7x-21y-42z+49=0$$

$$x+3y+6z=7$$

85. Let $\vec{a},\vec{b}$ and $\vec{c}$ be three non-zero vectors such that no two of them are collinear and $(\vec{a}\times\vec{b})\times\vec{c}=\frac{1}{3}|\vec{b}||\vec{c}|\vec{a}$. If θ is the angle between vectors $\vec{b}$ and $\vec{c}$, then a value of $\sin\theta$ is:

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

Ans : 1

Sol. : $(\vec{a}.\vec{c})\vec{b}-(\vec{b}.\vec{c})\vec{a}=\frac{1}{3}|\vec{b}||\vec{c}|\vec{a}$

$$(\vec{a},\vec{c})=\frac{\pi}{2},\qquad -\vec{b}.\vec{c}=\frac{1}{3}|\vec{b}||\vec{c}|$$

$$\cos(\vec{b},\vec{c})=-\frac{1}{3}$$

$$\sin\theta=\frac{2\sqrt{2}}{3}$$

86. If 12 identical balls are to be placed in 3 identical boxes, then the probability that one of the boxes contains exactly 3 balls is:

1) $\frac{55}{3}\left(\frac{2}{3}\right)^{11}$ 2) $55\left(\frac{2}{3}\right)^{10}$ 3) $220\left(\frac{1}{3}\right)^{12}$ 4) $22\left(\frac{1}{3}\right)^{11}$

Ans : No Key

Sol. : Favourble Cases = 5

Exhaustive cases = 19

probability = $\frac{5}{19}$

87. The mean of the data set comprising of 16 observations is 16. If one of the observation valued 16 is deleted and three new observations valued 3,4 and 5 are added to the data, then the mean of the resultant data, is

1) 16.8 2) 16.0 3) 15.8 4) 14.0

Ans : 4

Sol. : $\sum_{i=1}^{16} xi = (16)(16) = 256$

$\sum_{i=1}^{15} xi = 240$

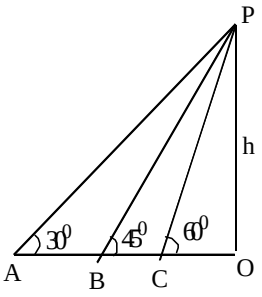
$\text{Mean} = \frac{1}{18}(252) = 14$

88. If the angles of elevation of the top of a tower from three collinear points A,B and C on a line leadingto the foot of the tower, are $30^0, 45^0$ and 60^0 respectively, then the ratio, AB : BC, is :

1) $\sqrt{3}:1$ 2) $\sqrt{3}:\sqrt{2}$ 3) $1:\sqrt{3}$ 4) $2:3$

Ans : 1

Sol. :



$OA = h\sqrt{3}$

$OB = h$

$OC = \frac{h}{\sqrt{3}}$

$AB = OA - OB = \left(\sqrt{3} - 1\right)h$

$BC = OB - OC = \left(1 - \frac{1}{\sqrt{3}}\right)h$

$AB : BC = 1 : \frac{1}{\sqrt{3}}$

$= \sqrt{3} : 1$

89. **Let** $\tan^{-1} y = \tan^{-1} x + \tan^{-1}\left(\frac{2x}{1-x^2}\right)$, **where** $|x| < \frac{1}{\sqrt{3}}$. **The a value of y is:**

1) $\frac{3x-x^3}{1-3x^2}$ 2) $\frac{3x+x^3}{1-3x^2}$ 3) $\frac{3x-x^3}{1+3x^2}$ 4) $\frac{3x+x^3}{1+3x^2}$

Ans : 1

Sol. : $|x| < \frac{1}{\sqrt{3}}$

$-\frac{1}{\sqrt{3}} < x < \frac{1}{\sqrt{3}}$ $\qquad -\frac{\pi}{6} < \theta < \frac{\pi}{6}$

$x = \tan\theta$

$\tan^{-1}(\tan 2\theta) = 2\theta$ $\qquad -\frac{\pi}{3} < 2\theta < \frac{\pi}{3}$

$\tan^{-1}(y) = 3\theta$ $\qquad -\frac{\pi}{2} < 3\theta < \frac{\pi}{2}$

$y = \tan 3\theta$

$= \frac{3x-x^3}{1-3x^2}$

90. **The negation of** $\sim sv(\sim r \wedge s)$ **is equivalent to :**

1) $s \wedge \sim r$ 2) $s \wedge (r \wedge \sim s)$ 3) $s \vee (r \vee \sim s)$ 4) $s \wedge r$

Ans : 4

Sol. : $\sim(\sim s \vee (\sim r \wedge s))$

$= s \wedge \sim(\sim r \wedge s)$

$= s \wedge (r \vee \sim s)$

$= (s \wedge r) \vee (s \wedge \sim s)$

$= (s \wedge r) \vee (\text{Contradiction})$

$= (s \wedge r)$

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