CAREER POINT
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AIEEE EXAMINATION PAPER 2008
Code-A6

CHEMISTRY , PHYSICS, MATHEMATICS

Time : - 3 Hours **Max. Marks:- 315** **Date : 27/04/08**

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 **105** questions of **3 marks each.** The maximum marks are **315.**

5. There are **three** parts in the question paper.
The distribution of marks subjectwise in each part is as under for each correct response.
Part A – Chemistry (105 Marks) – 35 Questions
Part B – Physics (105 Marks) – 35 Questions
Part C – Mathematics (105 Marks) – 35 Questions

6. Candidates will be awarded **three** marks each for indicated **correct** response of each question. **One** mark will be deducted for indicated **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. Use **Blue/Black Ball Point Pen only** for writing particulars/marking responses on **Side-I** and **Side-2** of the Answer Sheet **Use of pencil is strictly prohibited**.

8. 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 hall/room.

9. 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 2 pages (Pages 38 – 39) at the end of the booklet.

10. 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.

11. The **CODE** for this Booklet is **A6.** Make sure that the **CODE** printed on Side-2 of the Answer Sheet is 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

12. Do not fold or make any stray marks on the Answer Sheet.

PART A – CHEMISTRY

1. The ionization enthalpy of hydrogen atom is 1.312×10^6 J mol^{-1}. The energy required to excite the electron in the atom from n = 1 to n = 2 is

(1) 6.56×10^5 J mol^{-1} (2) 7.56×10^5 J mol^{-1}

(3) 9.84×10^5 J mol^{-1} (4) 8.51×10^5 J mol^{-1}

Ans. [3]

2. Which one of the following pairs of species have the same bond order?

(1) CN^- and CN^+ (2) O_2^- and CN^-

(3) NO^+ and CN^+ (4) CN^- and NO^+

Ans. [4]

3. Which one of the following constitutes a group of the isoelectronic species?

(1) NO^+, C_2^{2-}, CN^-, N_2 (2) CN^-, N_2, O_2^{2-}, C_2^{2-}

(3) N_2, O_2^-. NO^+, CO (4) C_2^{2-}, O_2^-, CO, NO

Ans. [1]

4. Four species are listed below:

i. HCO_3^- ii. H_3O^+

iii. HSO_4^- iv. HSO_3F

Which one of the following is the correct sequence of their acid strength?

(1) ii < iii < i < iv (2) i < iii < ii< iv

(3) iii < i < iv < ii (4) iv < ii < iii < i

Ans. [2]

5. The pK_a of a weak acid, HA, is 4.80. The pK_b of a weak base, BOH, is 4.78. The pH of an aqueous solution of the corresponding salt, BA, will be

(1) 4.79 (2) 7.01

(3) 9.22 (4) 9.58

Ans. [2]

6. The correct decreasing order of priority for the functional groups of organic compounds in the IUPAC system of nomenclature is

(1) $-SO_3H$, $-COOH$, $-CONH_2$, $-CHO$ (2) $-CHO$, $-COOH$, $-SO_3H$, $-CONH_2$

(3) $-CONH_2$, $-CHO$, $-SO_3H$, $-COOH$ (4) $-COOH$, $-SO_3H$, $-CONH_2$, $-CHO$

Ans. [4]

7. The treatment of CH_3MgX with $CH_3C \equiv C - H$ produces

(1) $CH_3C \equiv C - CH_3$

(2) $CH_3 - \overset{\displaystyle H}{\overset{|}{C}} = \overset{\displaystyle H}{\overset{|}{C}} - CH_3$

(3) CH_4

(4) $CH_3–CH = CH_2$

Ans. [3]

8. The hydrocarbon which can react with sodium in liquid ammonia is

(1) $CH_3CH_2\, C\equiv CH$

(2) $CH_3CH = CHCH_3$

(3) $CH_3CH_2C \equiv CCH_2CH_3$

(4) $CH_3CH_2CH_2C \equiv CCH_2CH_2CH_3$

Ans. [1]

9. The vapour pressure of water at 20º C is 17.5 mm Hg. If 18g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water at 20° C, the vapour pressure of the resulting solution will be

(1) 15.750 mm Hg

(2) 16.500 mm Hg

(3) 17.325 mm Hg

(4) 17.675 mm Hg

Ans. [3]

10. Gold numbers of protective colloids A, B, C and D are 0.50, 0.01, 0.10 and 0.005, respectively. The correct order of their protective powers is

(1) C < B < D < A

(2) A < C < B < D

(3) B < D < A < C

(4) D < A < C < B

Ans. [2]

11. In a compound, atoms of element Y form ccp lattice and those of element X occupy $2/3^{rd}$ of tetrahedral voids. The formula of the compound will be

(1) X_2Y_3

(2) X_2Y

(3) X_3Y_4

(4) X_4Y_3

Ans. [4]

12. In context with the industrial preparation of hydrogen from water gas ($CO + H_2$), which of the following is the correct statement?

(1) CO is removed by absorption in aqueous Cu_2Cl_2 Solution

(2) H_2 is removed through occlusion with Pd

(3) CO is oxidized to CO_2 with steam in the presence of a catalyst followed by absorption of CO_2 in alkali

(4) CO and H_2 are fractionally separated using differences in their densities

Ans. [3]

13. Among the following substituted silanes the one which will give rise to cross linked silicone polymer on hydrolysis is

(1) $RSiCl_3$

(2) R_2SiCl_2

(3) R_3SiCl_2

(4) R_4Si

Ans. [1]

14. Amount of oxalic acid present in a solution can be determined by its titration with $KMnO_4$ solution in the presence of H_2SO_4. The titration gives unsatisfactory result when carried out in the presence of HCl, because HCl

(1) furnishes H^+ ions in addition to those from oxalic acid

(2) reduces permanganate to Mn^{2+}

(3) oxidises oxalic acid to carbon dioxide and water

(4) gets oxidised by oxalic acid to chlorine

Ans. [2]

15. Given $E^0_{Cr^{3+}/Cr} = -0.72$ V, $E^0_{Fe^{2+}/Fe} = -0.42$ V.

The potential for the cell Cr $|Cr^{3+}$ (0.1 M) $|| Fe^{2+}$ (0.01 M) | Fe is

(1) 0.339 V

(2) – 0.339 V

(3) – 0.26 V

(4) 0.26 V

Ans. [4]

16. Which one of the following is the correct statement ?

(1) Beryllium exhibits coordination number of six

(2) Chlorides of both beryllium and aluminium have bridged chloride structures in solid phase

(3) $B_2H_6.2NH_3$ is known as 'inorganic benzene'

(4) Boric acid is a protonic acid

Ans. [2]

17. Identify the wrong statement in the following :

(1) Greenhouse effect is responsible for global warming

(2) Ozone layer does not permit infrared ratiation from the sun to reach the earth

(3) Acid rain is mostly because of oxides of nitrogen and sulphur

(4) Chlorofluorocarbons are responsible for ozone layer depliction

Ans. [2]

18. The coordination number and the oxidation state of the element 'E' in the complex $[E(en)_2(C_2O_4)]\ NO_2$ (when (en) is ethylene diamine) are, respectively,

(1) 4 and 2

(2) 4 and 3

(3) 6 and 3

(4) 6 and 2

Ans. [3]

19. In which of the following octahedral complexes of Co (at no. 27), will the magnitude of Δ_0 be the highest?

(1) $[Co(C_2O_4)_3]^{3-}$ (2) $[Co(H_2O)_6]^{3+}$

(3) $[Co(NH_3)_6]^{3+}$ (4) $[Co(CN)_6]^{3-}$

Ans. [4]

20. Larger number of oxidation states are exhibited by the actinoids than those by the lanthanoids, the main reason being

(1) lesser energy difference between 5f and 6d than between 4f and 5d orbitals

(2) more energy difference between 5f and 6d than between 4f and 5d orbitals

(3) more reactive nature of the actinoids than the lanthanoids

(4) 4f orbitals more diffused than the 5f orbitals

Ans. [1]

21. Which of the following factors is of no significance for roasting sulphide ores to the oxides and not subjecting the sulphide ores to carbon reduction directly ?

(1) CO_2 is thermodynamically more stable than CS_2

(2) Metal sulphides are less stable than the corresponding oxides

(3) CO_2 is more volatile than CS_2

(4) Metal sulphides are thermodynamically more stable than CS_2

Ans. [3]

22. Oxidising power of chlorine in aqueous solution can be determined by the parameters indicated below :

$$\frac{1}{2}Cl_2(g) \xrightarrow{\frac{1}{2}\Delta_{diss}H^\Theta} Cl(g) \xrightarrow{\Delta_{eg}H^\Theta} Cl^-(g) \xrightarrow{\Delta_{hyd}H^\Theta} Cl^-(aq)$$

The energy involved in the conversion of $\frac{1}{2}Cl_2(g)$ to $Cl^-(aq)$

(using the data, $\Delta_{diss}\ H^\Theta_{Cl_2} = 240$ kJ mol^{-1}, $\Delta_{eg}\ H^\Theta_{Cl} = -349$ kJ mol^{-1}, $\Delta_{hyd}\ H^\Theta_{Cl^-} = -381$ kJ mol^{-1}) will be

(1) – 610 kJ mol^{-1} (2) – 850 kJ mol^{-1}

(3) + 120 kJ mol^{-1} (4) + 152 kJ mol^{-1}

Ans. [1]

23. In the following sequence of reactions, the alkene affords the compound 'B'

$CH_3CH = CHCH_3 \xrightarrow{O_3} A \xrightarrow[Zn]{H_2O} B$, The compound B is

(1) CH_3COCH_3 (2) $CH_3CH_2COCH_3$

(3) CH_3CHO (4) CH_3CH_2CHO

Ans. [3]

24. Phenol, when it first reacts with concentrated sulphuric acid and then with concentrated nitric acid, gives

(1) o-nitrophenol (2) p-nitrophenol

(3) nitrobenzene (4) 2,4,6-trinitrobenzene

Ans. [1]

25. Toluene is nitrated and the resulting product is reduced with tin and hydrochloric acid. The product so obtained is diazotised and then heated with cuprous bromide. The reaction mixture so formed contains

(1) mixture of o– and p-dibromobenzenes (2) mixture of o- and p-bromoanilines

(3) mixture of o- and m-bromotoluenes (4) mixture of o- and p-bromotoluenes

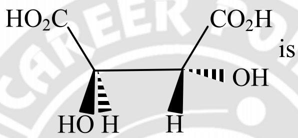
Ans. [4]

26. The organic chloro compound, which shows complete stereochemical inversion during a S_N2 reaction , is

(1) $(CH_3)_3CCl$ (2) $(CH_3)_2CHCl$

(3) CH_3Cl (4) $(C_2H_5)_2CHCl$

Ans. [3]

27. The absolute configuration of  is

(1) R, R (2) R, S (3) S, R (4) S, S

Ans. [1]

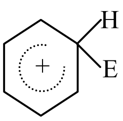
28. α-D-(+)-glucose and β-D-(+)-glucose are

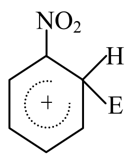
(1) epimers (2) anomers

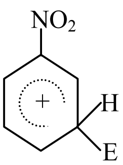
(3) enantiomers (4) conformers

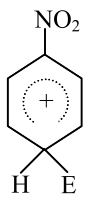
Ans. [2]

29. The electrophile, $E^{\oplus}$ attacks the benzene ring to generate the intermediate σ-complex. Of the following, which σ-complex is of lowest energy ?

(1) 

(2) 

(3) 

(4) 

Ans. [1]

30. Standard entropy of X_2, Y_2 and XY_3 are 60, 40 and 50 J K^{-1} mol^{-1}, respectively. For the reaction,

$\frac{1}{2}X_2 + \frac{3}{2}Y_2 \rightarrow XY_3$ $\Delta H = -30$ kJ, to be at equilibrium, the temperature will be

(1) 500 K (2) 750 K

(3) 1000 K (4) 1250 K

Ans. [2]

31. For the following three reactions a, b and c, equilibrium constants are given:

(1) $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g); K_1$ (2) $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g); K_2$

(3) $CH_4(g) + 2H_2O(g) \rightleftharpoons CO_2(g) + 4H_2(g); K_3$

Which of the following relations is correct ?

(1) $K_2 K_3 = K_1$ (2) $K_3 = K_1K_2$

(3) $K_3 K_2^3 = K_1^2$ (4) $K_1\sqrt{K_2} = K_3$

Ans. [2]

32. Bakelite is obtained from phenol by reacting with

(1) CH_3CHO (2) CH_3COCH_3

(3) HCHO (4) $(CH_2OH)_2$

Ans. [3]

33. The equilibrium constants Kp_1 and Kp_2 for the reactions $X \rightleftharpoons 2Y$ and $Z \rightleftharpoons P + Q$, respectively are in the ratio of 1 : 9. If the degree of dissociation of X and Z be equal then the ratio of total pressures at these equilibria is

(1) 1 : 1 (2) 1 : 3

(3) 1 : 9 (4) 1 : 36

Ans. [4]

34. For a reaction $\frac{1}{2}A \rightarrow 2B$, rate of disappearance of 'A' related to the rate of appearance of 'B' by the expression

(1) $-\frac{d[A]}{dt} = \frac{1}{4}\frac{d[B]}{dt}$ (2) $-\frac{d[A]}{dt} = \frac{d[B]}{dt}$

(3) $-\frac{d[A]}{dt} = 4\frac{d[B]}{dt}$ (4) $-\frac{d[A]}{dt} = \frac{1}{2}\frac{d[B]}{dt}$

Ans. [1]

35. At 80º C , the vapour pressure of pure liquid 'A' is 520 mm Hg and that of pure liquid 'B' is 1000 mm Hg. If a mixture solution of 'A' and 'B' boils at 80º C and 1 atm pressure, the amount of 'A' in the mixture is (1 atm = 760 mm Hg)

(1) 34 mol percent (2) 48 mol percent

(3) 50 mol percent (4) 52 mol percent

Ans. [3]

PART B – PHYSICS

36. A body of mass m = 3.513 kg is moving along the x- axis with a speed of 5.00 ms^{-1}. The magnitude of its momentum is recorded as

(1) 17.565 kg ms^{-1} (2) 17.56 kg ms^{-1}

(3) 17.57 kg ms^{-1} (4) 17.6 kg ms^{-1}

Ans. [4]

37. Consider a uniform square plate of side 'a' and mass 'm'. The moment of inertia of this plate about an axis perpendicular to its plane and passing through one of its corners is

(1) $\frac{1}{12}ma^2$ (2) $\frac{7}{12}ma^2$

(3) $\frac{2}{3}ma^2$ (4) $\frac{5}{6}ma^2$

Ans. [3]

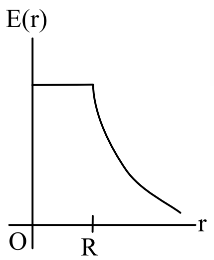
38. The speed of sound in oxygen (O_2) at a certain temperature is 460 ms^{-1}. The speed of sound in helium (He) at the same temperature will be (assume both gases to be ideal)

(1) 500 ms^{-1} (2) 650 ms^{-1}

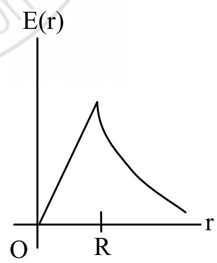
(3) 330 ms^{-1} (4) 460 ms^{-1}

Ans. [BONUS]

39. A thin spherical shell of radius R has charge Q spread uniformly over its surface. Which of the following graphs most closely represents the electric field E (r) produced by the shell in the range $0 \le r < \infty$, where r is the distance from the centre of the shell?



(1)



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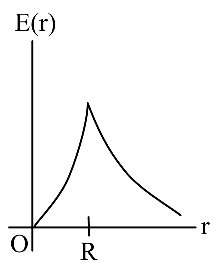

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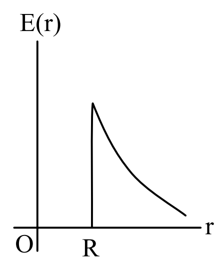


(4)

Ans. [4]

40. Relative permittivity and permeability of a material are ε_r and μ_r, respectively. Which of the following values of these quantities are allowed for a diamagnetic material?

(1) $\varepsilon_r = 1.5$, $\mu_r = 0.5$
(2) $\varepsilon_r = 0.5$, $\mu_r = 0.5$
(3) $\varepsilon_r = 1.5$, $\mu_r = 1.5$
(4) $\varepsilon_r = 0.5$, $\mu_r = 1.5$

Ans. [1]

41. Suppose an electron is attracted towards the origin by a force $\frac{k}{r}$ where 'k' is a constant and 'r' is the distance of the electron from the origin. By applying Bohr model to this system, the radius of the n^{th} orbital of the electron is found to be 'r_n' and the kinetic energy of the electron to be 'T_n'. Then which of the following is true?

(1) T_n independent of n, $r_n \propto n$
(2) $T_n \propto \frac{1}{n}$, $r_n \propto n$
(3) $T_n \propto \frac{1}{n}$, $r_n \propto n^2$
(4) $T_n \propto \frac{1}{n^2}$, $r_n \propto n^2$

Ans. [1]

42. A block of mass 0.50 kg is moving with a speed of 2.00 ms^{-1} on a smooth surface. It strikes another mass of 1.00 kg and then they move together as a single body. The energy loss during the collision is

(1) 1.00 J
(2) 0.67 J
(3) 0.34 J
(4) 0.16 J

Ans. [2]

43. A wave travelling along the x- axis is described by the equation $y(x,t) = 0.005 \cos (\alpha x - \beta t)$. If the wavelength and the time period of the wave are 0.08 m and 2.0 s, respectively, then α and β in appropriate units are

(1) $\alpha = \frac{0.08}{\pi}$, $\beta = \frac{2.0}{\pi}$
(2) $\alpha = \frac{0.04}{\pi}$, $\beta = \frac{1.0}{\pi}$
(3) $\alpha = 12.50\,\pi$, $\beta = \frac{\pi}{2.0}$
(4) $\alpha = 25.00\pi$, $\beta = \pi$

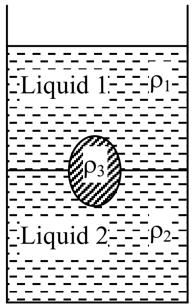
Ans. [4]

44. A working transistor with its three legs marked P, Q and R is tested using a multimeter. No conduction is found between P and Q. By connecting the common (negative) terminal of the multimeter to R and the other (positive) terminal to P or Q, some resistance is seen on the multimeter. Which of following is true for the transistor ?

(1) It is a pnp transistor with R as collector
(2) It is a pnp transistor with R as emitter
(3) It is an npn transistor with R as collector
(4) It is an npn transistor with R as base

Ans. [4]

45. A jar is filled with two non-mixing liquids 1 and 2 having densities ρ_1 and ρ_2, respectively. A solid ball, made of a material of density ρ_3, is dropped in the jar. It comes to equilibrium in the position shown in the figure.



Which of the following is true for ρ_1, ρ_2 and ρ_3 ?

(1) $\rho_1 > \rho_3 > \rho_2$ (2) $\rho_1 < \rho_2 < \rho_3$

(3) $\rho_1 < \rho_3 < \rho_2$ (4) $\rho_3 < \rho_1 < \rho_2$

Ans. [3]

46. An athlete in the olympic games covers a distance of 100 m in 10 s. His kinetic energy can be estimated to be in the range

(1) 2×10^5 J – 3×10^5 J (2) 20,000 J – 50,000 J

(3) 2,000 J – 5,000 J (4) 200 J – 500 J

Ans. [3]

47. A parallel plate capacitor with air between the plates has a capacitance of 9 pF. The separation between its plates is 'd'. The space between the plates is now filled with two dielectrics. One of the dielectrics has dielectric constant $k_1 = 3$ and thickness $\frac{d}{3}$ while the other one has dielectric constant $k_2 = 6$ and thickness $\frac{2d}{3}$. Capacitance of the capacitor is now

(1) 45 pF (2) 40.5 pF

(3) 20.25 pF (4) 1.8 pF

Ans. [2]

48. The dimension of magnetic field in M, L, T and C (Coulomb) is given as

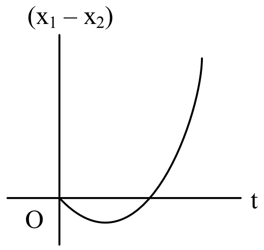
(1) MT^2C^{-2} (2) $MT^{-1}C^{-1}$

(3) $MT^{-2}C^{-1}$ (4) $MLT^{-1}C^{-1}$

Ans. [2]

49. A body is at rest at x = 0. At t = 0, it starts moving in the positive x-direction with a constant acceleration. At the same instant another body passes through x = 0 moving in the positive x-direction with a constant speed. The position of the first body is given by $x_1(t)$ after time 't' and that of second body by $x_2(t)$ after the same time interval. Which of the following graphs correctly describes $(x_1 - x_2)$ as a function of time 't' ?

(1)



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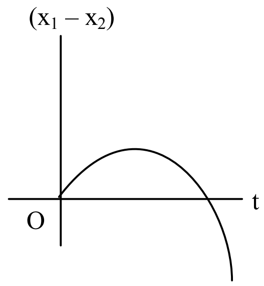

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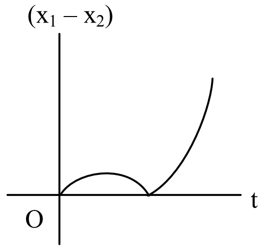

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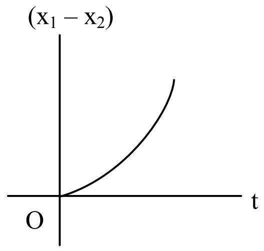
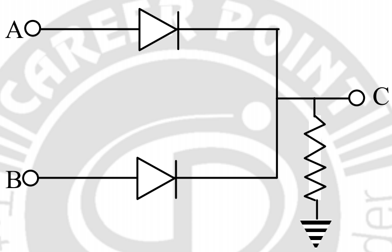


Ans. [1]

50. In the circuit below, A and B represent two inputs and C represents the output.



The circuit represents

(1) AND gate (2) NAND gate

(3) OR gate (4) NOR gate

Ans. [3]

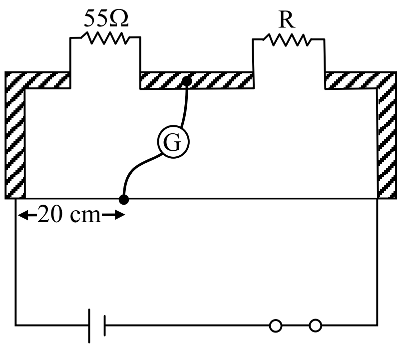
51. While measuring the speed of sound by performing a resonance column experiment, a student gets the first resonance condition at a column length of 18 cm during winter. Repeating the same experiment during summer, she measures the column length to be x cm for the second resonance. Then

(1) $x > 54$ (2) $54 > x > 36$

(3) $36 > x > 18$ (4) $18 > x$

Ans. [1]

52. Shown in the figure below is a meter-bridge set up with null deflection in the galvanometer.



The value of the unknown resistor R is

(1) 220 Ω (2) 110 Ω

(3) 55 Ω (4) 13.75 Ω

Ans. [1]

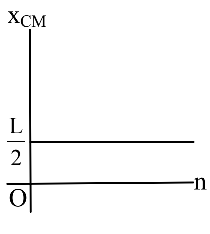
53. A spherical solid ball of volume V is made of a material of density ρ_1. It is falling through a liquid of density ρ_2 ($\rho_2 < \rho_1$). Assume that the liquid applies a viscous force on the ball that is proportional to the square of its speed υ, i.e., $F_{viscous} = -k\upsilon^2$ ($k > 0$). The terminal speed of the ball is

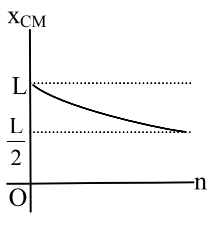
(1) $\frac{Vg\rho_1}{k}$ (2) $\sqrt{\frac{Vg\rho_1}{k}}$

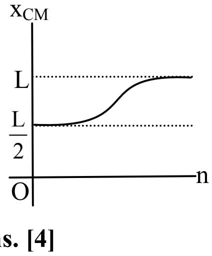
(3) $\frac{Vg(\rho_1 - \rho_2)}{k}$ (4) $\sqrt{\frac{Vg(\rho_1 - \rho_2)}{k}}$

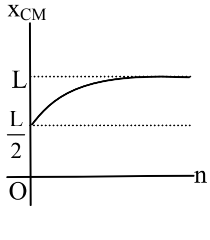
Ans. [4]

54. A thin rod of length 'L' is lying along the x-axis with its ends at x = 0 and x = L. Its linear density (mass/length) varies with x as $k\left(\frac{x}{L}\right)^n$, where n can be zero or any positive number. If the position x_{CM} of the centre of mass of the rod is plotted against 'n', which of the following graphs best approximates the dependence of x_{CM} on n ?

(1) 

(2) 

(3) 

(4) 

Ans. [4]

55. A planet in a distant solar system is 10 times more massive than the earth and its radius is 10 times smaller. Given that the escape velocity from the earth is 11 km s^{-1}, the escape velocity from the surface of the planet would be

(1) 11 km s^{-1} (2) 110 km s^{-1}

(3) 0.11 km s^{-1} (4) 1.1 km s^{-1}

Ans. [2]

56. An insulated container of gas has two chambers separated by an insulating partition. One of the chambers has volume V_1 and contains ideal gas at pressure P_1 and temperature T_1. The other chamber has volume V_2 and contains ideal gas at pressure P_2 and temperature T_2. If the partition is removed without doing any work on the gas, the final equilibrium temperature of the gas in the container will be -

(1) $\frac{P_1V_1T_1 + P_2V_2T_2}{P_1V_1 + P_2V_2}$ (2) $\frac{P_1V_1T_2 + P_2V_2T_1}{P_1V_1 + P_2V_2}$

(3) $\frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_1 + P_2V_2T_2}$ (4) $\frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_2 + P_2V_2T_1}$

Ans.[4]

57. Two full turns of the circular scale of a screw gauge cover a distance of 1 mm on its main scale. The total number of divisions on the circular scale is 50. Further, it is found that the screw gauge has a zero error of – 0.03 mm. While measuring the diameter of a thin wire, a student notes the main scale reading of 3 mm and the number of circular scale divisions in line with the main scale as 35. The diameter of the wire is -

(1) 3.73 mm (2) 3.67 mm

(3) 3.38 mm (4) 3.32 mm

Ans.[3]

58. A horizontal overhead powerline is at a height of 4 m from the ground and carries a current of 100 A from east to west. The magnetic field directly below it on the ground is ($\mu_0 = 4\pi \times 10^{-7}$ T mA^{-1})

(1) 5×10^{-6} T northward (2) 5×10^{-6} T southward

(3) 2.5×10^{-7} T northward (4) 2.5×10^{-7} T southward

Ans.[2]

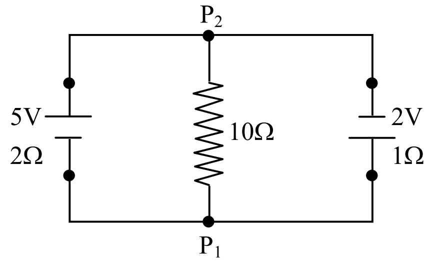
59. An experiment is performed to find the refractive index of glass using a travelling microscope. In this experiment distances are measured by -

(1) a standard laboratory scale (2) a meter scale provided on the microscope

(3) a screw gauge provided on the microscope (4) a vernier scale provided on the microscope

Ans.[4]

60. A 5 V battery with internal resistance 2 Ω and a 2V battery with internal resistance 1Ω are connected to a 10Ω resistor as shown in the figure.



The current in the 10 Ω resistor is -

(1) 0.03 A P_1 to P_2

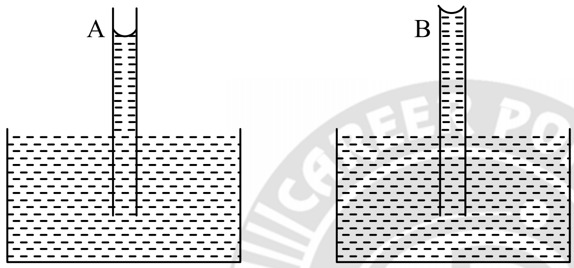
(2) 0.03 A P_2 to P_1

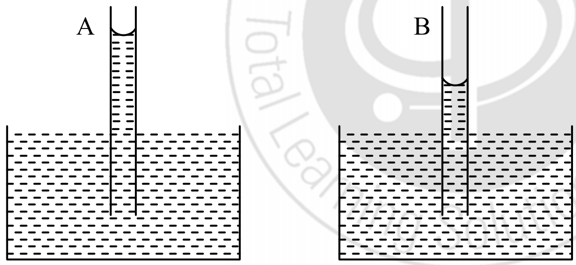
(3) 0.27 A P_1 to P_2

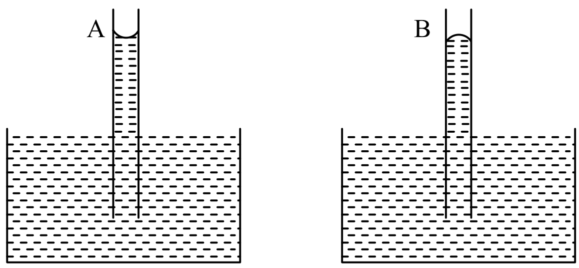
(4) 0.27 A P_2 to P_1

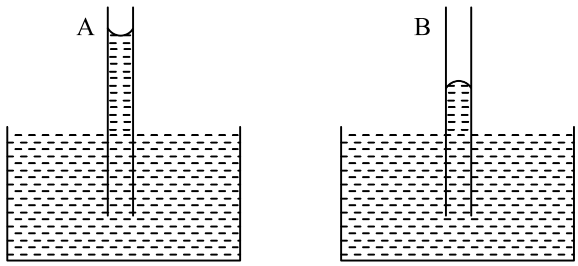
Ans.[2]

61. A capillary tube (A) is dipped in water. Another identical tube (B) is dipped in a soap-water solution. Which of the following shows the relative nature of the liquid columns in the two tubes ?

(1) 

(2) 

(3) 

(4) 

Ans.[2]

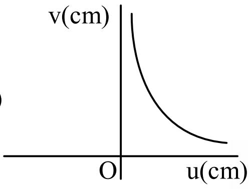
62. Two coaxial solenoids are made by winding thin insulated wire over a pipe of cross-sectional area $A = 10\ cm^2$ and length = 20 cm. If one of the solenoids has 300 turns and the other 400 turns, their mutual inductance is ($\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1})

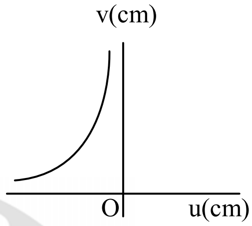
(1) $4.8\ \pi \times 10^{-4}$ H (2) $4.8\ \pi \times 10^{-5}$ H

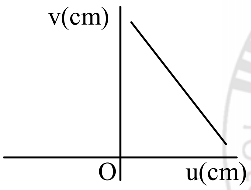
(3) $2.4\ \pi \times 10^{-4}$ H (4) $2.4\ \pi \times 10^{-5}$ H

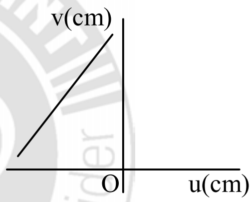
Ans.[3]

63. A student measures the focal length of a convex lens by putting an object pin at a distance 'u' from the lens and measuring the distance 'v' of the image pin. The graph between 'u' and 'v' plotted by the student should look like -

(1)


(2)


(3)


(4)


Ans.[2]

64. This question contains Statement-1 and Statement-2. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement-1 :

For a mass M kept at the centre of a cube of side 'a', the flux of gravitational field passing through its sides is $4\ \pi GM$.

and

Statement-2 :

If the direction of a field due to a point source is radial and its dependence on the distance 'r' from the source is given as $\frac{1}{r^2}$, its flux through a closed surface depends only on the strength of the source enclosed by the surface and not on the size or shape of the surface.

(1) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1

(2) Statement-1 is true. Statement-2 is true; Statement-2 is not a correct explanation for Statement-1

(3) Statement-1 is true, Statement-2 is false.

(4) Statement-1 is false, Statement-2 is true.

Ans.[1]

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65. This question contains Statement-1 and Statement-2. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement-1 :

Energy is released when heavy nuclei undergo fission or light nuclei undergo fusion.

and

Statement-2 :

For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei it decreases with increasing Z.

(1) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1

(2) Statment-1 is true, Statement-2 is true; Statement-2 is not a correct explanation for Statement-1

(3) Statement-1 is true, Statement-2 is false

(4) Statement-1 is false, Statement-2 is true

Ans.[3]

Directions : Questions No. 66 and 67 are based on the following paragraph.

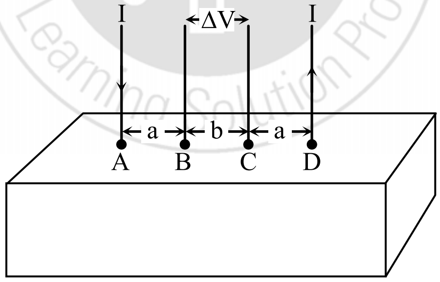
Consider a block of conducting material of resistivity 'ρ' shown in the figure. Current 'I' enters at 'A' and leaves from 'D'. We apply superposition principle to find voltage 'ΔV' developed between 'B' and 'C'. The calculation is done in the following steps :

(i) Take current 'I' entering from 'A' and assume it to spread over a hemispherical surface in the block.

(ii) Calculate field E(r) at distance 'r' from A by using Ohm's law E = ρj, where j is the current per unit area at 'r'.

(iii) From the 'r' dependence of E(r), obtain the potential V(r) at r.

(iv) Repeat (i), (ii) and (iii) for current 'I' leaving 'D' and superpose results for 'A' and 'D'.



66. For current entering at A, the electric field at a distance 'r' from A is -

(1) $\frac{\rho I}{r^2}$ (2) $\frac{\rho I}{2\pi r^2}$ (3) $\frac{\rho I}{4\pi r^2}$ (4) $\frac{\rho I}{8\pi r^2}$

Ans.[2]

67. ΔV measured between B and C is -

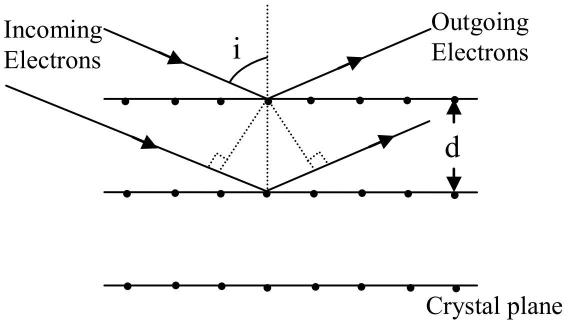
(1) $\frac{\rho I}{a} - \frac{\rho I}{(a+b)}$ (2) $\frac{\rho I}{2\pi a} - \frac{\rho I}{2\pi(a+b)}$

(3) $\frac{\rho I}{2\pi(a-b)}$ (4) $\frac{\rho I}{\pi a} - \frac{\rho I}{\pi(a+b)}$

Ans.[2]

Directions : Questions No.68, 69 and 70 are based on the following paragraph.

Wave property of electrons implies that they will show diffraction effects. Davisson and Germer demonstrated this by diffracting electrons from crystals. The law governing the diffraction from a crystal is obtained by requiring that electron waves reflected from the planes of atoms in a crystal interfere constructively (see figure),



68. If a strong diffraction peak is observed when electrons are incident at an angle 'i' from the normal to the crystal planes with distance 'd' between them (see figure) de Broglie wavelength λ_{dB} of electrons can be calculated by the relationship (n is an integer).

(1) $2d \cos i = n \lambda_{dB}$
(2) $2d \sin i = n \lambda_{dB}$
(3) $d \cos i = n \lambda_{dB}$
(4) $d \sin i = n \lambda_{dB}$

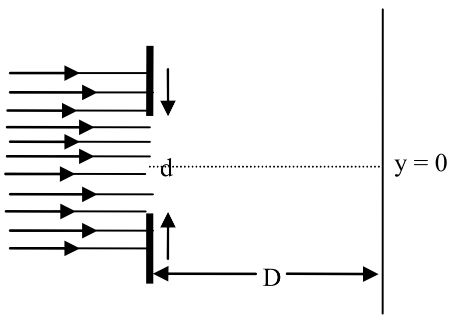
Ans. [1]

69. Electrons accelerated by potential V are diffracted from a crystal. If d = 1Å and i = 30°, V should be about ($h = 6.6 \times 10^{-34}$Js, $m_e = 9.1 \times 10^{-31}$ kg., $e = 1.6 \times 10^{-19}$ C)

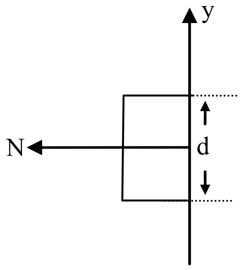
(1) 50 V
(2) 500 V
(3) 1000 V
(4) 2000V

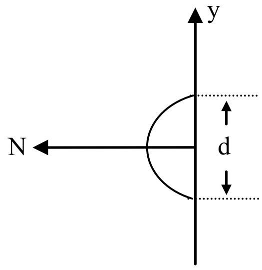
Ans. [1]

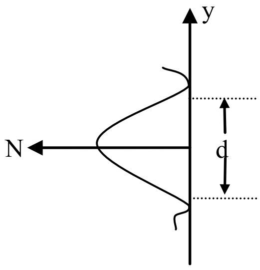
70. In an experiment, electrons are made to pass through a narrow slit of width 'd' comparable to their de Broglie wavelength. They are detected on a screen at a distance 'D' from the slit (see figure).

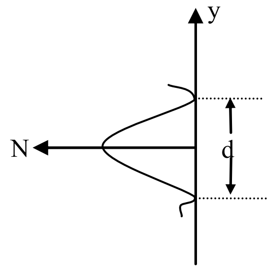


Which of the following graphs can be expected to represent the number of electrons 'N' detected as a function of the detector position 'y' (y = 0 corresponds to the middle of the slit)?

(1) 

(2) 

(3) 

(4) 

Ans. [3]

PART C – MATHEMATICS

71. Let $f : N \rightarrow Y$ be a function defined as $f(x) = 4x + 3$ where

$Y = |y \in N : y = 4x + 3$ for some $x \in N|$. Show that f is invertible and its inverse is

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

(2) $g(y) = \frac{y+3}{4}$

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

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

Ans.[3]

72. Let R be the real line. Consider the following subsets of the plane R × R :

$S = \{(x, y): y = x + 1 \text{ and } 0 < x < 2\}$

$T = \{(x, y) : x - y \text{ is an integer}\}$.

Which one of the following is true ?

(1) Both S and T are equivalence relations on R

(2) S is an equivalence relation on R but T is not

(3) T is an equivalence relation on R but S is not

(4) Neither S nor T is an equivalence relation on R

Ans. [3]

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73. The conjugate of a complex number is $\frac{1}{i-1}$. Then that complex number is

(1) $\frac{1}{i+1}$ (2) $\frac{-1}{i+1}$

(3) $\frac{1}{i-1}$ (4) $\frac{-1}{i-1}$

Ans. [2]

74. The quadratic equations

$x^2 - 6x + a = 0$

and $x^2 - cx + 6 = 0$

have one root in common. The other roots of the first and second equations are integers in the ratio 4 : 3. Then the common root is

(1) 4 (2) 3

(3) 2 (4) 1

Ans. [3]

75. Let A be a square matrix all of whose entries are integers. Then which one of the following is true ?

(1) If det A $\neq \pm 1$, then A^{-1} exists and all its entries are non-integers

(2) If det A = $\pm$ 1, then A^{-1} exists and all its entries are integers

(3) If det A = $\pm$ 1, then A^{-1} need not exist

(4) If det A = $\pm$ 1, then A^{-1} exists but all its entries are not necessarily integers

Ans. [2]

76. Let a, b, c be any real numbers. Suppose that there are real numbers x, y, z not all zero such that $x = cy + bz$, $y = az + cx$, and $z = bx + ay$. Then $a^2 + b^2 + c^2 + 2abc$ is equal to

(1) –1 (2) 0

(3) 1 (4) 2

Ans. [3]

77. How many different words can be formed by jumbling the letters in the word MISSISSIPPI in which not two S are adjacent ?

(1) $6 . 7 . {}^8C_4$ (2) $6 . 8 . {}^7C_4$

(3) $7 . {}^6C_4 . {}^8C_4$ (4) $8 . {}^6C_4 . {}^7C_4$

Ans. [3]

78. The first two terms of a geometric progression add up to 12. The sum of the third and the fourth terms is 48. If the terms of the geometric progression are alternately positive and negative, then the first term is

(1) – 12 (2) 12

(3) 4 (4) – 4

Ans. [1]

79. Let $f(x) = \begin{cases} (x-1)\sin\dfrac{1}{x-1} & \text{if } x \neq 1 \\ 0 & \text{if } x = 1 \end{cases}$

Then which one of the following is true ?

(1) f is differentiable at x = 0 and at x = 1

(2) f is differentiable at x = 0 but not at x = 1

(3) f is differentiable at x = 1 but not at x = 0

(4) f is neither differentiable at x = 0 nor at x = 1

Ans. [2]

80. How many real solution does the equation $x^7 + 14x^5 + 16x^3 + 30x - 560 = 0$ have ?

(1) 1

(2) 3

(3) 5

(4) 7

Ans. [1]

81. Suppose the cubic $x^3 - px + q$ has three distinct real roots where p > 0 and q > 0. Then which one of the following holds ?

(1) The cubic has minima at $-\sqrt{\dfrac{p}{3}}$ and maxima at $\sqrt{\dfrac{p}{3}}$

(2) The cubic has manima at both $\sqrt{\dfrac{p}{3}}$ and $-\sqrt{\dfrac{p}{3}}$

(3) The cubic has maxima at both $\sqrt{\dfrac{p}{3}}$ and $-\sqrt{\dfrac{p}{3}}$

(4) The cubic has minima at $\sqrt{\dfrac{p}{3}}$ and maxima at $-\sqrt{\dfrac{p}{3}}$

Ans. [4]

82. The value of $\sqrt{2}\displaystyle\int \frac{\sin x\, dx}{\sin\left(x - \frac{\pi}{4}\right)}$ is -

(1) $x - \log|\sin(x - \frac{\pi}{4})| + c$

(2) $x + \log|\sin(x - \frac{\pi}{4})| + c$

(3) $x - \log|\cos(x - \frac{\pi}{4})| + c$

(4) $x + \log|\cos(x - \frac{\pi}{4})| + c$

Ans.[2]

83. The area of the plane region bounded by the curves $x + 2y^2 = 0$ and $x + 3y^2 = 1$ is equal to -

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

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

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

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

Ans.[3]

84. Let I = $\int_0^1 \frac{\sin x}{\sqrt{x}}dx$ and J = $\int_0^1 \frac{\cos x}{\sqrt{x}}$ dx. Then which one of the following is true ?

(1) I < $\frac{2}{3}$ and J < 2 (2) I < $\frac{2}{3}$ and J > 2

(3) I > $\frac{2}{3}$ and J < 2 (4) I > $\frac{2}{3}$ and J > 2

Ans.[1]

85. The differential equation of the family of circles with fixed radius 5 units and centre on the line y = 2 is -

(1) $(y - 2)\, y'^2 = 25 - (y - 2)^2$ (2) $(y - 2)^2\, y'^2 = 25 - (y - 2)^2$

(3) $(x - 2)^2\, y'^2 = 25 - (y - 2)^2$ (4) $(x - 2)\, y'^2 = 25 - (y - 2)^2$

Ans.[2]

86. The solution of the differential equation $\frac{dy}{dx} = \frac{x+y}{x}$ satisfying the condition y (1) = 1 is -

(1) $y = x\,\ell n\, x + x^2$ (2) $y = xe^{(x-1)}$

(3) $y = x\,\ell n\, x + x$ (4) $y = \ell n\, x + x$

Ans.[3]

87. The perpendicular bisector of the line segment joining P(1, 4) and Q(k, 3) has y-intercept -4. Then a possible value of k is -

(1) 2 (2) –2

(3) –4 (4) 1

Ans.[3]

88. The point diametrically opposite to the point P(1, 0) on the circle $x^2 + y^2 + 2x + 4y - 3 = 0$ is -

(1) (–3, 4) (2) (–3, –4)

(3) (3, 4) (4) (3, – 4)

Ans.[2]

89. A parabola has the origin as its focus and the line x =2 as the directrix. Then the vertex of the parabola is at -

(1) (1, 0) (1) (0, 1)

(3) (2, 0) (4) (0, 2)

Ans.[1]

90 A focus of an ellipse is at the origin. The directrix is the line x = 4 and the eccentricity is $\frac{1}{2}$. Then the length of the semi-major axis is -

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

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

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

(4) $\frac{8}{3}$

Ans.[4]

91. If the straight lines

$\frac{x-1}{k} = \frac{y-2}{2} = \frac{z-3}{3}$ and $\frac{x-2}{3} = \frac{y-3}{k} = \frac{z-1}{2}$ intersect at a point, then the integer k is equal to

(1) 5

(2) 2

(3) –2

(4) –5

Ans. [4]

92. The line passing through the points (5, 1, a) and (3, b, 1) crosses the yz-plane at the point $\left(0, \frac{17}{2}, \frac{-13}{2}\right)$. Then

(1) a = 4, b = 6

(2) a = 6, b = 4

(3) a = 8, b = 2

(4) a = 2, b = 8

Ans. [2]

93. The non-zero vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$ are related by $\vec{a} = 8\vec{b}$ and $\vec{c} = -7\vec{b}$. Then the angle between $\vec{a}$ and $\vec{c}$ is

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

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

(3) π

(4) 0

Ans. [3]

94. The vector $\vec{a} = \alpha\hat{i} + 2\hat{j} + \beta\hat{k}$ lies in the plane of the vectors $\vec{b} = \hat{i} + \hat{j}$ and $\vec{c} = \hat{j} + \hat{k}$ and bisects the angle between $\vec{b}$ and $\vec{c}$. Then which one of the following gives possible values of α and β ?

(1) $\alpha = 1, \beta = 2$

(2) $\alpha = 2, \beta = 1$

(3) $\alpha = 1, \beta = 1$

(4) $\alpha = 2, \beta = 2$

Ans. [3]

95. The mean of the numbers a, b, 8, 5, 10 is 6 and the variance is 6.80. Then which one of the following gives possible values of a and b ?

(1) a = 5, b = 2

(2) a = 1, b = 6

(3) a = 3, b = 4

(4) a = 0, b = 7

Ans. [3]

96. A die is thrown. Let A be the event that the number obtained is greater than 3. Let B be the event that the number obtained is less than 5. Then P(A $\cup$ B) is

(1) 0 (2) 1

(3) $\frac{2}{5}$ (4) $\frac{3}{5}$

Ans. [2]

97. It is given that the events A and B are such that P(A) = $\frac{1}{4}$, P(A|B) = $\frac{1}{2}$ and P(B|A) = $\frac{2}{3}$. Then P(B) is

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

(3) $\frac{1}{2}$ (4) $\frac{1}{6}$

Ans. [1]

98. AB is a vertical pole with B at the ground level and A at the top. A man finds that the angle of elevation of the point A from a certain point C on the ground is 60º. He moves away from the pole along the line BC to a point D such that CD = 7 m. From D the angle of elevation of the points A is 45º. Then the height of the pole is

(1) $\frac{7\sqrt{3}}{2}(\sqrt{3}+1)\,\text{m}$ (2) $\frac{7\sqrt{3}}{2}(\sqrt{3}-1)\,\text{m}$

(3) $\frac{7\sqrt{3}}{2}\frac{1}{\sqrt{3}+1}\text{m}$ (4) $\frac{7\sqrt{3}}{2}\frac{1}{\sqrt{3}-1}\text{m}$

Ans. [1]

99. The value of cot $\left(\text{cosec}^{-1}\frac{5}{3}+\tan^{-1}\frac{2}{3}\right)$ is

(1) $\frac{3}{17}$ (2) $\frac{4}{17}$

(3) $\frac{5}{17}$ (4) $\frac{6}{17}$

Ans. [4]

100. The statement p $\rightarrow$ (q $\rightarrow$ p) is equivalent to

(1) p $\rightarrow$ (p $\vee$ q) (2) p $\rightarrow$ (p $\wedge$ q)

(3) p $\rightarrow$ (p $\leftrightarrow$ q) (4) p $\rightarrow$ (p $\rightarrow$ q)

Ans. [1]

Directions : Question number 101 to 105 are Assertion-Reason type questions. Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (reason). Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

101. Let A be a 2 × 2 matrix with real entries. Let I be the 2 × 2 identity matrix. Denote by tr (A), the sum of diagonal entries of A, Assume that $A^2 = I$.

Statement- 1:

If $A \neq I$ and $A \neq -I$, then det $A = -1$

Statement -2 :

If $A \neq I$ and $A \neq -I$, then tr $(A) \neq 0$

(1) Statement-1 is true, Statement -2 is true; Statement-2 is a correct explanation for Statement-1

(2) Statement-1 is true, Statement -2 is true; Statement-2 is not a correct explanation for Statement-1

(3) Statement-1 is true, Statement -2 is false

(4) Statement-1 is false, Statement-2 is true

Ans. [4]

102. **Statement-1:**

For every natural number $n \geq 2$.

$$\frac{1}{\sqrt{1}} + \frac{1}{\sqrt{2}} + \ldots\ldots.. + \frac{1}{\sqrt{n}} > \sqrt{n}$$

Statement -2:

For every natural number $n \geq 2$.

$$\sqrt{n(n+1)} < n + 1$$

(1) Statement-1 is true, Statement -2 is true; Statement-2 is a correct explanation for Statement-1

(2) Statement-1 is true, Statement -2 is true; Statement-2 is not a correct explanation for Statement-1

(3) Statement-1 is true, Statement -2 is false

(4) Statement-1 is false, Statement-2 is true

Ans. [2]

103. **Statement- 1:**

$$\sum_{r=0}^{n} (r+1)\, {}^nC_r = (n+2)\, 2^{n-1}$$

Statement -2:

$$\sum_{r=0}^{n} (r+1)\, {}^nC_r\, x^r = (1+x)^n + nx\,(1+x)^{n-1}$$

(1) Statement-1 is true, Statement -2 is true; Statement-2 is a correct explanation for Statement-1

(2) Statement-1 is true, Statement -2 is true; Statement-2 is not a correct explanation for Statement-1

(3) Statement-1 is true, Statement -2 is false

(4) Statement-1 is false, Statement-2 is true

Ans. [1]

104. In a shop there are five types of ice-creams available . A child buys six ice-creams.

Statement-1:

The number of different ways the child can buy the six ice-creams is ${}^{10}C_5$

Statement -2:

The number of different ways the child can buy the six ice-creams is equal to the number of different ways of arranging 6 A's and 4 B's in a row.

(1) Statement-1 is true, Statement -2 is true; Statement-2 is a correct explanation for Statement-1

(2) Statement-1 is true, Statement -2 is true; Statement-2 is not a correct explanation for Statement-1

(3) Statement-1 is true, Statement -2 is false

(4) Statement-1 is false, Statement-2 is true

Ans. [4]

105. Let p be the statement 'x is an irrational number", q be the statement 'y is a transcendental number", and r be the statement "x is a rational number iff y is a transcendental number.".

Statement-1 :

r is equivalent to either q or p.

Statement -2 :

r is equivalent ot $\sim(p \leftrightarrow \sim q)$

(1) Statement-1 is true, Statement -2 is true; Statement-2 is a correct explanation for Statement-1

(2) Statement-1 is true, Statement -2 is true; Statement-2 is not a correct explanation for Statement-1

(3) Statement-1 is true, Statement -2 is false

(4) Statement-1 is false, Statement-2 is true

Ans. [4]

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