SAMPLE CONTENT

MHT-CET

22 MODEL QUESTION PAPERS

WITH SOLUTIONS

+3 Previous Years' Original Exam Papers

PHYSICS | CHEMISTRY | MATHEMATICS



Target Publications® Pvt. Ltd.

Written in accordance with the latest MHT-CET Paper Pattern prescribed by
State Common Entrance Test Cell, Maharashtra State

MHT-CET 22 MODEL QUESTION PAPERS WITH SOLUTIONS

and

Three Original Question Papers of MHT-CET Examination

PHYSICS | CHEMISTRY | MATHEMATICS

Salient Features

- Set of 22 Model Question Papers (with answers and solutions) for Physics, Chemistry and Mathematics
- Prepared as per the latest paper pattern of MHT-CET examination
- Detailed Solutions provided to difficult MCQs for easy comprehension
- 21 Model Question Papers with answers and solutions are provided in book while 1 Model Question Paper with its solution is provided through Q.R. code.
- Includes Multiple **Smart Keys** to enhance understanding of concepts and problem solving skills:
  - ***Smart Code*** - ***Caution*** - ***Thinking Hatke***
- Three Original MHT-CET Question Papers with Answer Keys *(Solutions through Q.R. codes):*
  - 20^{th} September 2021, Shift-I
  - 6^{th} August 2022, Shift-I
  - 9^{th} May 2023, Shift-I

Printed at: **Print to Print,** Mumbai

Balbharati Registration No.: 2018MH0022

P.O. No. 11897

TEID: 3494

PREFACE

In the enchanting world of education, where curiosity ignites minds and knowledge illuminates paths, we proudly present a compendium of intellectual challenges, **'MHT-CET: 22 Model Question Papers with Solutions (PCM)'.** It is a meticulously designed book to assess the threshold of knowledge imbibed by the students over a period of two years in the junior college. 21 Model Question Papers with answers and solutions are provided in book while 1 Model Question Paper with its solution is provided through Q.R. code.

The book charts out a compilation of Model Question Papers for the students appearing for the MHT-CET examination. Every question paper in this book has been created in line with the examination pattern and touches upon all the conceptual nodes of Physics, Chemistry and Mathematics. The core objective of this book is to gauge the student's preparedness to appear for the examination.

To aid students, detailed solutions are provided to difficult MCQs. **Smart Keys** (Shortcut, Caution and Thinking Hatke) are provided, which offer supplemental explanations for the tricky questions and are intended to help students approaching problems in novel ways in the shortest possible time with accuracy.

Smart Keys

- **Shortcut** incorporates important theoretical or formula based short tricks, beneficial in solving MCQs.
- **Caution** apprises students about mistakes often made while solving MCQs.
- **Thinking Hatke** reveals quick witted approach to crack the specific question.

Previous years' examination papers have been provided to offer students a glimpse of the complexity of the questions asked in the examination.

MHT-CET Question Papers and Answer Keys

- 20^{th} September, 2021 (Shift I), 6^{th} August, 2022 (Shift I) and 9^{th} May, 2023 (Shift I)
- Solutions provided through Q.R. codes

We hope that this book will enable students to optimize their time-management abilities to achieve high scores in the examination.

They say, *'With the right tools, even ordinary men achieve extraordinary results'*. We aspire this book to be the perfect tool that would help students to take off their career in the most extraordinary way possible.

Publisher
Edition: Fourth

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

Please write to us on: mail@targetpublications.org

MHT-CET PAPER PATTERN

- There will be three papers of Multiple Choice Questions (MCQs) in 'Mathematics', 'Physics and Chemistry' and 'Biology' of 100 marks each.
- Duration of each paper will be 90 minutes.
- Questions will be based on the syllabus prescribed by Maharashtra State Board of Secondary and Higher Secondary Education with approximately 20% weightage given to Std. XI and 80% weightage will be given to Std. XII curriculum.
- Difficulty level of questions will be at par with JEE (Main) for Mathematics, Physics, Chemistry and at par with NEET for Biology.
- There will be no negative marking.
- Questions will be mainly application based.
- Details of the papers are as given below:

Paper	Subject(s)	No. of MCQs based on		Mark(s) Per Question	Total Marks	Duration in Minutes
		Std XI	Std XII			
Paper I	Mathematics	10	40	2	100	90
Paper II	Physics	10	40	1	100	90
	Chemistry	10	40			
Paper III	Biology	20	80	1	100	90

- Questions will be set on
  i. the entire syllabus of Std. XII of Physics, Chemistry, Mathematics and Biology subjects prescribed by Maharashtra Bureau of Textbook Production and curriculum Research, Pune, and
  ii. chapters / units from Std. XI curriculum as mentioned below:

Sr.no	Subject	Chapters/Units of Std. XI
1	Physics	Motion in a Plane, Laws of Motion, Gravitation, Thermal Properties of Matter, Sound, Optics, Electrostatics, Semiconductors
2	Chemistry	Some Basic Concepts of Chemistry, Structure of Atom, Chemical Bonding, Redox Reactions, Elements of Group 1 and Group 2, States of Matter (Gaseous and Liquid States), Adsorption and Colloids (Surface Chemistry), Hydrocarbons, Basic Principles of Organic Chemistry
3	Mathematics	Trigonometry II, Straight Line, Circle, Measures of Dispersion, Probability, Complex Numbers, Permutations and Combinations, Functions, Limits, Continuity
4	Biology	Biomolecules, Respiration and Energy Transfer, Human Nutrition, Excretion and Osmoregulation

- **Language of Question Paper:**
  The medium for examination shall be English / Marathi / Urdu for Physics, Chemistry and Biology. Mathematics paper shall be in English only.

- **Duration of Online Computer Based Test (CBT):**
  The duration of the examination for PCB is 180 minutes and PCM is 180 minutes.
  a. **For PCM** - This paper is having 2 Groups of Physics-Chemistry and Mathematics with total 180 Minutes Duration, first 90 minutes Physics and Chemistry will be enabled and only after completion of first 90 minutes' time Physics-Chemistry group will be auto submitted and Mathematics group will be enabled with 90 minutes' duration.
  b. **For PCB** - This paper is having 2 Groups of Physics-Chemistry and Biology with total 180 Minutes Duration, first 90 minutes Physics and Chemistry will be enabled and only after completion of time response for Physics-Chemistry group will be auto submitted and Biology group will be enabled with 90 minutes' duration.

[Note : Candidate should note that if he/she appearing for both the groups i.e. PCM and PCB, the Percentile / Percentage score of Physics or Chemistry will not be interchanged among the groups.**]**

INDEX

MODEL QUESTION PAPER

01

Time: 180 Minutes | Physics, Chemistry and Mathematics | Total Marks: 200

Physics and Chemistry

Time: 90 Minutes | Total Marks: 100

PHYSICS

1. In a diffraction pattern, width of a fringe
(A) does not depend on slit width.
(B) varies directly as slit width.
(C) varies inversely as slit width.
(D) is directly proportional to the square of slit width.

2. The average translational kinetic energy of a molecule in a gas becomes equal to 0.49 eV at a temperature about (Boltzmann constant $= 1.38 \times 10^{-23}$ JK^{-1})
(A) 4370 °C (B) 3514 °C
(C) 5333 °C (D) 5060 °C

3. The maximum average velocity of water in a tube of diameter 4 cm so that the flow becomes laminar is [Viscosity of water is 10^{-3} N m^{-2} s^{-1}, take $R_n = 200$]
(A) 1 m s^{-1} (B) 5×10^{-2} m s^{-1}
(C) 10 m s^{-1} (D) 5×10^{-3} m s^{-1}

4. An arc lamp requires a direct current of 10 A at 50 V to function. If it is connected to a 220 V (rms), 50 Hz AC supply, the series inductor needed for it to work is close to
(A) 0.08 H (B) 0.068 H
(C) 0.045 H (D) 60 H

5. In a transistor in CE configuration, the ratio of power gain to voltage gain is
(A) α (B) β / α
(C) $\beta\alpha$ (D) β

6. A particle is given an initial speed u inside a smooth spherical shell of radius R = 1 m so that it is just able to complete the circle. Acceleration of the particle when it is in vertical circle is
(A) $g\sqrt{10}$ m/s^2 (B) 3 g m/s^2
(C) $g\sqrt{2}$ m/s^2 (D) g m/s^2

7. The displacement of a particle performing S.H.M. is given by $x = 10 \sin(\omega t + \alpha)$ metre. If the displacement of the particle is 5 m, then the phase of S.H.M. is
(A) $\frac{\pi}{6}$ radian (B) $\frac{\pi}{4}$ radian
(C) $\frac{\pi}{3}$ radian (D) $\frac{\pi}{2}$ radian

8. Two strings have same radii and densities in the ratio 8 : 7. They are under the same tension. Ratio of their lengths, so as to have same fundamental frequencies is
(A) $\sqrt{8} : \sqrt{7}$ (B) 7 : 8
(C) 8 : 7 (D) $\sqrt{7} : \sqrt{8}$

9. Identify the mismatched pair from the given options
(A) Photoelectric Effect - Emission of electrons from a material when illuminated by light.
(B) Compton Effect - Scattering of X-rays by electrons, leading to a shift in wavelength.
(C) Wave-Particle Duality - Particles such as electrons exhibit both wave-like and particle-like behaviour
(D) Stefan-Boltzmann Law - Relates the energy radiated by any body to its temperature.

10. A metal surface is illuminated by photons of energy 5 eV and 2.5 eV respectively. The ratio of their wavelengths is
(A) 1 : 3 (B) 1 : 4 (C) 2 : 1 (D) 1 : 2

11. Choose the CORRECT statement.
(A) The viscosity of liquid decreases with temperature while that of gas increases with temperature.
(B) The viscosity of liquid and gases decreases with temperature.
(C) The viscosity of liquid and gases increases with temperature.
(D) The viscosity of liquid increases with temperature while that of gas decreases with temperature.

12. In a given process for an ideal gas, dW = 0 and dQ < 0. Then for the gas
(A) The temperature will decrease.
(B) The volume will increase.
(C) The pressure will remain constant.
(D) The temperature will increase.

13. If the current flowing in a circular loop is in clockwise direction, then the magnetic induction will be
(A) along the direction of current.
(B) perpendicular to plane of coil.
(C) directed inwards.
(D) both (B) and (C).

14. A magnet of magnetic moment 6 Am^2 weighs 65 g. The density of the material of the magnet is 6500 kg/m^3. What is the magnetization?
(A) 4×10^5 A/m (B) 3×10^5 A/m
(C) 6×10^5 A/m (D) 2.5×10^5 A/m

15. A 600 turn coil of effective area 0.05 m^2 is kept perpendicular to a magnetic field 4×10^{-5} T. When the plane of the coil is rotated by 90° around any of its coplanar axis in 0.1 s, the e.m.f. induced in the coil will be:
(A) 12×10^{-3} V (B) 12×10^{-4} V
(C) 12×10^{-2} V (D) 12×10^{-5} V

16. Generally, the number of electrons in the valence shell of good conductors is
(A) 6 or more than 6 (B) 5
(C) 4 (D) 3 or less than 3

17. Equation of a plane progressive wave is given by $y = 0.6\sin 2\pi\left(t - \frac{x}{2}\right)$. On reflection from denser medium its amplitude become $\frac{2}{3}$ of the amplitude of the incident wave. The equation of the reflected wave is
(A) $y = 0.6\sin 2\pi\left(t + \frac{x}{2}\right)$
(B) $y = -0.4\sin 2\pi\left(t + \frac{x}{2}\right)$
(C) $y = 0.4\sin 2\pi\left(t + \frac{x}{2}\right)$
(D) $y = -0.4\sin 2\pi\left(t - \frac{x}{2}\right)$

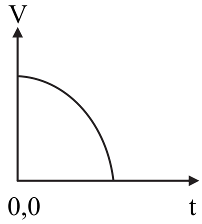
18. Let I_1 and I_2 be the moments of inertia of two bodies of identical geometrical shape. If the first body is made of aluminium and the second of iron, then
(A) $I_1 < I_2$ (B) $I_1 = I_2$
(C) $I_1 > I_2$ (D) $I_1 = \frac{I_2}{2}$

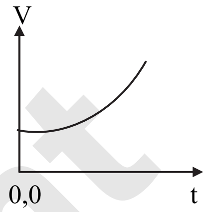
19. An electron is moving towards X-axis. An electric field is along Y-direction then path of electron is
(A) circular (B) elliptical
(C) parabola (D) linear

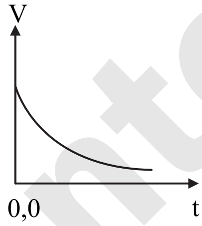
20. Which of the following transition will have highest emission wavelength?
(A) n = 2 to n = 1 (B) n = 1 to n = 2
(C) n = 2 to n = 5 (D) n = 5 to n = 2

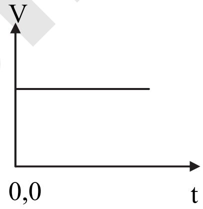
21. Two waves, $y_1 = A \sin [k (x - ct)]$ and $y_2 = A \sin [k (x + ct)]$ are superposed on a string. The distance between adjacent nodes is
(A) $\frac{ct}{\pi}$ (B) $\frac{ct}{2\pi}$ (C) $\frac{\pi}{2k}$ (D) $\frac{\pi}{k}$

22. The insulated plates of a charged parallel plate capacitor (with small separation between the plates) are approaching each other due to electrostatic attraction. Assuming no other force to be operative and no radiation taking place, which of the following graphs approximately shows the variation with time (t) of the potential difference (V) between the plates?

(A)


(B)


(C)


(D)


23. A parallel beam of light is incident normally on a perfectly absorbing surface. If the force exerted by the light beam on the surface is 2×10^{-7} N in 10 nanoseconds, the energy of photons hitting the surface is
(A) 600 nJ (B) 500 nJ
(C) 400 nJ (D) 700 nJ

24. A voltmeter of range 3 V and resistance 200 Ω cannot be converted into an ammeter of range
(A) 10 mA (B) 100 mA
(C) 1 A (D) 10 A

25. Rutherford's atom model cannot explain
(A) presence of nucleus at the centre of atom.
(B) total negative and positive changes are equal.
(C) distribution of electrons outside the nucleus.
(D) revolution of electrons in circular orbits.

26. Moment of inertia of earth about its axis of rotation is
(A) $\frac{2}{3}\pi R^5\rho$ (B) $\frac{2}{5}\pi R^5\rho$
(C) $\frac{8}{15}\pi R^5\rho$ (D) $\frac{4}{15}\pi R^5\rho$

27. Two cells when connected in series are balanced on 8 m on a potentiometer. If the cells are connected with polarities of one of the cell reversed, they balance on 2 m. The ratio of e.m.f's of the two cells is
(A) 3 : 5 (B) 5 : 3
(C) 3 : 4 (D) 4 : 3

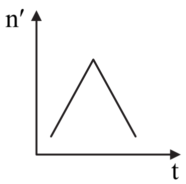
28. If a million tiny droplets of water of the same radius coalesce into one larger drop, then the ratio of the surface energy of the large drop to the total surface energy of all the droplets will be

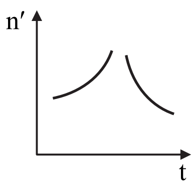
(A) 1 : 10 (B) $1 : 10^2$
(C) $1 : 10^4$ (D) $1 : 10^6$

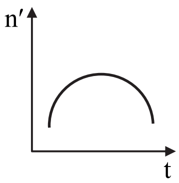
29. An object is thrown vertically upward with a speed of 15 m/s. The velocity of the object 2s before it reaches the maximum height is

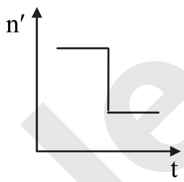
(A) 4.9 m/s (B) 9.8 m/s
(C) 19.6 m/s (D) 25.1 m/s

30. A railway engine whistling at a constant frequency moves with a constant speed and it goes past a stationary observer standing beside the railway track. Then the frequency of (n′) of the sound heard by the observer with respect to time (t) can be best represented by which of the following curve?

(A)


(B)


(C)


(D)


31. The centre of mass of a right circular cone of height h, radius R and constant density σ is at

(A) $\left(0,0,\frac{h}{4}\right)$ (B) $\left(\frac{h}{4},0,0\right)$
(C) $\left(\frac{h}{3},0,0\right)$ (D) $\left(0,0,\frac{h}{3}\right)$

32. If a lens is cut into two pieces perpendicular to the principal axis and only one part is used, the intensity of the image will be

(A) same (B) $\frac{1}{2}$ times
(C) 2 times (D) infinite

33. Why is a conical projection in front of the hole in Ferry's blackbody?

(A) To avoid absorption of radiations.
(B) To avoid return of the radiations by reflection.
(C) To avoid emission of radiations.
(D) For some reason other than those mentioned above.

34. A uniform bar RS weighs 100 g and is 80 cm long. From the end R, two masses 50 g and 100 g are hung from the bar at a distance of 10 cm and 60 cm respectively. If the bar is to remain horizontal when balanced on a knife-edge, its position is

(A) 42 cm from S (B) 38 cm from R
(C) 38 cm from G (D) 42 cm from R

35. In Young's double slit experiment, the two slits act as coherent sources of equal amplitude A and wavelength λ. In another experiment with the same set up the two slits are of equal amplitude A and wavelength λ but are incoherent. The ratio of the intensity of light at the mid-point of the screen in the first case to that in the second case is

(A) 1 : 2 (B) 2 : 1
(C) 4 : 1 (D) 1 : 1

36. A conducting circular loop is placed in a uniform magnetic field 0.02 T with its plane perpendicular to the magnetic field. The radius of the loop starts shrinking at 2 mm/s. The induced e.m.f. in the loop when the radius is 2 cm will be

(A) 3.2 π μV (B) 4.8 π μv
(C) 0.8 π μV (D) 1.6 π μV

37. One mole of an ideal gas with $\gamma = 1.4$ is adiabatically compressed so that its temperature rises from 27 °C to 47 °C. The change in the internal energy of the gas is
(R = 8.3 J/mol.K)

(A) –415 J (B) 415 J
(C) –168 J (D) 168 J

38. Two long conductors, separated by a distance 80 cm carry current I_1 and I_2 in the same direction. They exert a force F on each other. Now the current in one of them is increased to two times and its direction is reversed. The distance is also increased to 1.8 m. The new value of the force between them is

(A) –8 F (B) F/3
(C) –8 F/9 (D) –F/9

39. A coil has inductance 2 H. The ratio of its reactance, when it is connected first to an a.c. source and then to d.c. source, is

(A) zero (B) infinity
(C) 1 (D) less than 1

40. In switching circuit, transistor is in ON state and values of I_C and I_B are 4.2 mA and 5 μA respectively and R_c = 1 kΩ and R_B = 300 kΩ. If V_{BE} = 0.5 V, find the value of V_{BB}.

(A) 2.5 V (B) 2 V
(C) 5 V (D) 5.5 V

41. If the distance between any two bodies in the universe is reduced to $\frac{3}{4}^{\text{th}}$ of the present distance between them, then attraction between them will
(A) increase 1.78 times.
(B) increase 0.56 times.
(C) remain constant.
(D) decrease by 3/4.

42. The equiconvex lens has focal length 'f'. If it is cut perpendicular to the principal axis passing through optical centre, then focal length of each half will be
(A) half of initial.
(B) $3/4^{\text{th}}$ of initial.
(C) same as that of initial.
(D) twice that of initial.

43. Wavefront is the locus of all points, where the particles of the medium vibrate with the same
(A) phase (B) amplitude
(C) frequency (D) period

44. What is the r.m.s. value of an alternating current which when passed through a resistor produces heat which is four times of that produced by a direct current of 3 ampere in the same resistor?
(A) 6 A (B) 2 A
(C) 3 A (D) 18 A

45. Two simple pendulums A and B are made to oscillate simultaneously and it is found that A completes 10 oscillations in 20 sec and B completes 8 oscillations in 10 sec. The ratio of the lengths of A and B is
(A) $\frac{25}{64}$ (B) $\frac{64}{25}$
(C) $\frac{8}{5}$ (D) $\frac{5}{4}$

46. The unit of intensity of polarization is _______.
(A) $\frac{m^2}{C}$ (B) $\frac{C^2}{m}$
(C) $\frac{C^2}{m^2}$ (D) $\frac{C}{m^2}$

47. Liquid is filled in a vessel which is kept in a room with temperature 20 °C. When the temperature of the liquid is 80 °C, then it loses heat at the rate of 90 cal/s. What will be the rate of loss of heat when the temperature of the liquid is 40 °C?
(A) 180 cal/s (B) 40 cal/s
(C) 30 cal/s (D) 20 cal/s

48. Two waves of wavelength 2 m and 2.02 m, with the same speed superimpose to produce 2 beats per second. The speed of each wave is
(A) 400 ms^{-1} (B) 402 ms^{-1}
(C) 404 ms^{-1} (D) 406 ms^{-1}

49. Two toroids 1 and 2 have total number of turns 400 and 200 respectively with average radii 40 cm and 20 cm respectively. If they carry same current I, the ratio of the magnetic fields along the two loops is,
(A) 1 : 2 (B) 1 : 1
(C) 4 : 1 (D) 2 : 1

50. A spherical conductor of radius 10 cm has a charge of 3.2×10^{-7} C distributed uniformly. What is the magnitude of electric field at a point 15 cm from the centre of the sphere?
$\left(\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \text{ Nm}^2/\text{C}^2\right)$
(A) 1.28×10^5 N/C (B) 1.28×10^6 N/C
(C) 1.28×10^7 N/C (D) 1.28×10^4 N/C

CHEMISTRY

1. Which of the following is INCORRECT?
(A) Metal deficiency defect is possible only in compounds of metals that show variable oxidation states.
(B) In substitutional impurity defect, the impurity atoms occupy interstitial spaces of lattice structure.
(C) $Zn_{1+x}O_{1.0}$ is an example of metal excess defect.
(D) NaCl shows yellow colour due to the formation of F-centre.

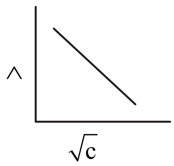
2. Dihydrogen with high purity (>99.5%) is obtained by________.
(A) electrolysis of brine solution
(B) electrolysis of warm barium hydroxide solution
(C) electrolysis of dilute sulphuric acid
(D) action of dilute hydrochloric acid on zinc granules

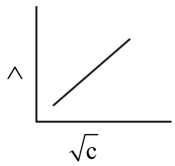
3. Select the INCORRECT match.
(A) SO_2 : Angular
(B) SF_6 : Octahedral
(C) BrF_5 : Square pyramidal
(D) ClF_3 : Trigonal planar

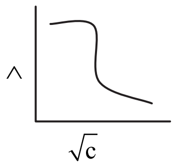
4. Alkyl chloride containing 4° carbon atom(s) would be _______.
(A) tert-butyl chloride
(B) neopentyl chloride
(C) sec-butyl chloride
(D) n-propyl chloride

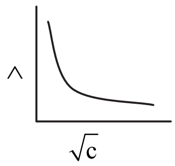
5. The number of moles of hydrogen gas formed when 2 moles of 2-methylpropan-2-ol reacts with aluminium is _______.
(A) 1 (B) 2
(C) 3 (D) 6

6. Which of the following graph represents the variation of $\wedge$ with $\sqrt{c}$ for acetic acid solution?

(A) 

(B) 

(C) 

(D) 

7. Which of the following is CORRECT for an aqueous solution of NH_4CN?
[K_a of HCN = 4.0×10^{-10}, K_b for NH_4OH = 1.8×10^{-5}]
(A) The solution turns blue litmus red.
(B) The solution is neutral.
(C) The solution contains equal concentration of H_3O^+ and OH^- ions.
(D) The solution is basic.

8. Which of the following ions has d^6 outer electronic configuration?
(A) Cr^{2+} (B) Co^{3+}
(C) Mn^{3+} (D) Fe^{3+}

9. **Assertion (A):** p-Nitrochlorobenzene is more reactive towards nucleophilic substitution reactions as compared to chlorobenzene.
Reason (R): Electron withdrawing group at meta position has practically no effect on reactivity.
In the light of the above statements, choose the most appropriate answer from the options given below.
(A) Assertion is True, Reason is True; Reason is a correct explanation for Assertion
(B) Assertion is True, Reason is True; Reason is not a correct explanation for Assertion
(C) Assertion is True, Reason is False
(D) Assertion is False, Reason is True.

10. The volume of hydrogen gas liberated at STP when 23 g of sodium is reacted with ethanol is _______.
(A) 22.4 dm^3 (B) 0.5 dm^3
(C) 11.2 dm^3 (D) 1.12 dm^3

11. Which of the following is INCORRECTLY matched?
(A) H_2S – polar molecule with polar bonds
(B) CO_2 – non-polar molecule with polar bonds
(C) $CHCl_3$ – polar molecule with polar bonds
(D) CCl_4 – non-polar molecule with non-polar bonds

12. Calculate the time required (in hours) to decrease the concentration of reactant of first order reaction from 1.2 M to 0.3 M if rate constant is 0.1155 $hour^{-1}$.
(A) 6 (B) 12
(C) 18 (D) 24

13. The electronic configuration of thorium (Z = 90) is _______.
(A) [Rn] $5f^0\ 6d^1\ 7s^2$
(B) [Rn] $5f^0\ 6d^2\ 7s^2$
(C) [Rn] $5f^1\ 6d^0\ 7s^2$
(D) [Rn] $5f^0\ 6d^0\ 7s^2$

14. Which one of the following methods is NOT used for the synthesis of amines?
(A) Hofmann bromamide degradation
(B) Mendius reduction
(C) Gabriel phthalimide synthesis
(D) Carbylamine reaction

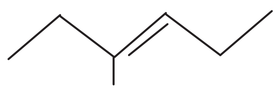
15. When ethyl methyl ether is treated with cold concentrated HI, it gives two products. Products formed are _______.
(A) $CH_3I + C_2H_5OH$
(B) $CH_3CH_2OH + CH_3OH + CH_3I$
(C) $CH_3OH + C_2H_5I$
(D) $CH_3CH_2I + CH_3I + H_2O$

16. Isopropyl alcohol + acidic $K_2Cr_2O_7 \longrightarrow X$
Identify product 'X' in the above reactions.
(A) acetone (B) acetaldehyde
(C) ether (D) ethylene

17. Which of the following amino acids has $-CH_2OH$ group in its side chain?
(A) Arginine (B) Serine
(C) Proline (D) Tyrosine

18. 3.795 g of sulphur is dissolved in 100 g of CS_2. This solution boils at 319.81 K. The boiling point of CS_2 is 319.45 K. The molecular formula of sulphur in solution is ______. (Given that K_b for CS_2 = 2.42 K kg mol^{-1} and atomic mass of S = 32 u)
(A) S_4 (B) S_6
(C) S_8 (D) S_{10}

19. The IUPAC name of the following compound is _______.



(A) hept-3-ene
(B) 2-ethylpent-2-ene
(C) hex-3-ene
(D) 3-methylhex-3-ene

20. Combustion of glucose takes place as

$C_6H_{12}O_{6(s)} + 6O_{2(g)} \longrightarrow 6CO_{2(g)} + 6H_2O_{(g)}$; $\Delta H = -72 \text{ kcal mol}^{-1}$

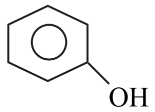
The energy needed for the production of 1.8 g of glucose by photosynthesis will be _______.

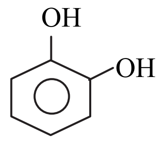
(A) 0.82 kcal (B) 0.72 kcal
(C) 8.2 kcal (D) 7.2 kcal

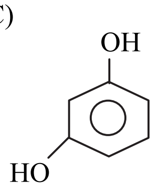
21. When chlorine reacts with excess of ammonia, X and nitrogen are formed. When excess of chlorine reacts with ammonia, Y and hydrogen chloride are formed. Identify X and Y.

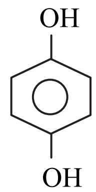
(A) NH_4Cl, NCl_3 (B) NCl_3, NH_4Cl
(C) HCl, NCl_3 (D) HCl, N_2

22. Which of the following is catechol?

(A)


(B)


(C)


(D)


23. The product of the reaction between dimethylcadmium and acetyl chloride is _______.

(A) CH_3COCH_3 (B) $C_2H_5COC_2H_5$
(C) CH_3CHO (D) $CH_3COC_2H_5$

24. Which of the following are CORRECT regarding nylon 2-nylon 6 and PHBV?

(I) Both are condensation polymers.
(II) Both are copolymers.
(III) Both are aliphatic polyesters.
(IV) Both are non-biodegradable.

(A) I, II (B) I, II, IV
(C) II, III (D) III, IV

25. Consider the following elementary reaction;

$2AB_{(g)} \longrightarrow A_{2(g)} + B_{2(g)}$

The molecularity of the reaction is _______.

(A) 1 (B) 2
(C) 3 (D) 4

26. Find the vapour pressure of a solution containing 4.0 g urea in 15 g of water.

(P_1^0 = 32 mm Hg and molar mass of urea = 60 g mol^{-1})

(A) 6.40 mm Hg (B) 37.12 mm Hg
(C) 34.56 mm Hg (D) 29.44 mm Hg

27. The cracking of propane yields ______.

(A) ethene and ethane
(B) ethane and methane
(C) propene and H_2
(D) ethene and methane

28. 3 moles of an ideal gas is compressed from 50 dm^3 to 30 dm^3 against a constant external pressure of 3.039×10^5 N m^{-2}. The work done in calories is _______. (1 J = 0.239 cal)

(A) +30.39 cal (B) +72.63 cal
(C) +1452.6 cal (D) +2905.2 cal

29. Which of the following is obtained by doping pure silicon with an impurity of group 15 element?

(A) n-Type semiconductor
(B) p-Type semiconductor
(C) Intrinsic semiconductor
(D) Insulator

30. $Cl_2 + H_2S \rightarrow 2HCl + S$

In the above reaction, oxidation state of sulphur changes from _________.

(A) zero to –2 (B) –2 to zero
(C) zero to +2 (D) +2 to zero

31. Which of the following is a mineral of zinc?

(A) Limonite (B) Siderite
(C) Cuprite (D) Calamine

32. Dimethylamine + Benzoyl chloride $\xrightarrow{\text{Pyridine}}$?

Product formed is _______.

(A) N,N-dimethylbenzamide
(B) N,N-dimethylacetamide
(C) N-phenylbenzamide
(D) N-methylbenzamide

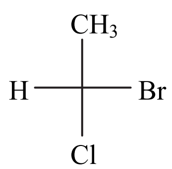
33. The formula of two complexes X and Y of chromium are given below:

$[Cr(H_2O)_6]Cl_3$ (X) and $[Cr(H_2O)_5Cl]Cl_2.H_2O$ (Y)

X and Y are examples of _______ isomers.

(A) coordination (B) linkage
(C) ionization (D) solvate

34. Fischer projection formula of a molecule is given below.



According to the representation, which bonds lie below the plane of the paper?

(A) C – Cl and C – H
(B) C – Cl and C – CH_3
(C) C – Br and C – CH_3
(D) C – Br and C – H

35. What is the pH of 0.01 M solution of ammonium hydroxide which is 10% dissociated?
(A) 3.00 (B) 8.00
(C) 10.00 (D) 11.00

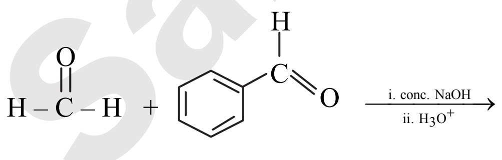
36. Which of the following substances is expected to have the highest van't Hoff factor when dissolved in water?
(A) Potassium chloride
(B) Magnesium chloride
(C) Sodium nitrate
(D) Sucrose

37. **Statement (I):** Finely divided substances, rough surfaces and colloidal substances are good adsorbents.
Statement (II): The extent of adsorption increases with decrease in surface area of adsorbent.
Choose the most appropriate answer from the options given below.
(A) Both the statements are correct.
(B) Both the statements are incorrect.
(C) Only statement I is correct.
(D) Only statement II is correct.

38. For a zero order reaction, the plot of $[A]_t$ vs t is linear. The slope of the line is equal to ________.
(A) $[A]_0$ (B) $-k$
(C) k (D) $2.303 \times k$

39. The IUPAC name of the complex $[Pt(en)_2(SCN)_2]^{2+}$ is _______.
(A) di(ethylenediamine)dithiocyanatoplatinum(IV)
(B) bis(ethylenediamine)dithiocyanatoplatinum(IV)
(C) dithiocyanatobis(ethylenediamine)platinate(IV)
(D) bis(ethylenediamine)dithiocyanatoplatinum(II)

40. Identify the products formed in the following reaction.



(A) Phenylmethanol and benzoic acid
(B) Phenylmethanol and formic acid
(C) Methanol and benzoic acid
(D) Formic acid and benzoic acid

41. $Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}\uparrow$
Calculate the mass of Mg required to liberate 6.72 dm^3 of H_2 at STP.
(Molar mass of Mg = 24 g mol^{-1})
(A) 3.2 g (B) 4.8 g
(C) 7.2 g (D) 14.4 g

42. Which of the following pair represents one-dimensional nanomaterials?
(A) Nanowires, nanotubes
(B) Nanotubes, microcapsules
(C) Nanowires, thin films
(D) Quantum dots, nanoshells

43. XeF_6 on complete hydrolysis forms:
(A) Xe (B) $XeOF_2$
(C) XeO_3 (D) XeO_2F_2

44. Calculate the number of atoms present in unit cell of an element having molar mass 63.5 g mol^{-1} and density 8.9 g cm^{-3}.
[$a^3.N_A$ = 28.5 cm^3 mol^{-1}]
(A) 1 (B) 2
(C) 4 (D) 6

45. At 25 °C, the emf of the following electrochemical cell
$Ag_{(s)} \mid Ag^+$ (0.01 M) | | Zn^{2+}(0.1 M) | $Zn_{(s)}$ will be _______ V.
(Given $E^{\circ}_{cell} = -1.562$ V)
(A) – 1.432 V (B) – 1.4732 V
(C) + 1.432 V (D) – 1.4436 V

46. The density of an ideal gas can be expressed as d = _______.
(A) $\frac{RT}{PM}$ (B) $\frac{RP}{TM}$
(C) $\frac{RM}{TP}$ (D) $\frac{PM}{RT}$

47. What is angular momentum of an electron in second orbit of hydrogen atom?
(A) $\frac{h}{2\pi}$ (B) $\frac{h}{\pi}$
(C) $\frac{2h}{\pi}$ (D) $\frac{4h}{\pi}$

48. Consider the coordination compound, $K_2[Cu(CN)_4]$. A coordinate covalent bond exists between:
(A) K^+ and CN^-
(B) Cu^{2+} and CN^-
(C) K^+ and $[Cu(CN)_4]^{2-}$
(D) Cu^{2+} and K^+

49. Calculate the enthalpy of hydrogenation of $C_2H_{4(g)}$, given that the enthalpy of formation of ethane and ethylene are –30.2 kcal and +12.5 kcal respectively.
(A) –4.8 kcal (B) +7.7 kcal
(C) –42.7 kcal (D) –7.7 kcal

50. The overlap of $\sigma - p$ orbitals is called ______.
(A) inductive effect
(B) electronic effect
(C) hyperconjugation
(D) resonance

Mathematics

Time: 90 Minutes

Total Marks: 100

1. If the direction cosines of the two lines satisfy the equations $l - \text{m} + \text{n} = 0$ and $l^2 - \text{m}^2 + \text{n}^2 = 0$, then the angle between the lines is

(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{2}$ (C) $\frac{\pi}{3}$ (D) $\frac{\pi}{4}$

2. The differential equation whose solution is $y = \text{A}e^{x} + \text{B}e^{-x}$, is

(A) $\frac{d^2y}{dx^2} + y = 0$ (B) $\frac{d^2y}{dx^2} - y = 0$

(C) $\frac{dy}{dx} + y = 0$ (D) $\frac{dy}{dx} - y = 0$

3. If $y = (\sin x)^{\sin x}$, then $\frac{dy}{dx} =$

(A) $(\sin x)^{\cos x}\left\{\sin\log\left[\sin\left(\frac{\pi}{4} - \frac{x}{2}\right)\right]\right\}$

(B) $(\sin x)^{\cos x}\left\{\sin\log\left[\cos\left(\frac{\pi}{4} + \frac{x}{2}\right)\right]\right\}$

(C) $(\sin x)^{\sin x}[\cos x.\log(\sin x) - \cos x]$

(D) $(\sin x)^{\sin x}[\cos x.\log(\sin x) + \cos x]$

4. A survey of people in a given region showed that 20% were smokers. The probability of death due to lung cancer, given that a person smoked, was 10 times the probability of death due to lung cancer, given that a person did not smoke. If the probability of death due to lung cancer in the region is 0.006, what is the probability of death due to lung cancer given that a person is a smoker?

(A) $\frac{1}{140}$ (B) $\frac{1}{70}$ (C) $\frac{3}{140}$ (D) $\frac{1}{10}$

5. The solution of the differential equation $1 + \frac{dy}{dx} = \frac{\sin^2(x+y)}{\cos(x+y)}$ is

(A) $\text{cosec}(x+y) + \tan(x+y) = x + c$

(B) $x + \text{cosec}(x+y) = c$

(C) $x + \tan(x+y) = c$

(D) $x + \sec(x+y) = c$

6. If z_1 and z_2 are z co-ordinates of the points of trisection of the segment joining the points A (2, 1, 4), B (–1, 3, 6) then $z_1 + z_2 =$

(A) 1 (B) 4

(C) 5 (D) 10

7. The vector equation of line $2x - 2 = 3y + 1 = 6z - 2$ is

(A) $\bar{r} = \left(\hat{i} - \frac{2}{3}\hat{j} + 2\hat{k}\right) + \lambda(\hat{i} + 2\hat{j} + 6\hat{k})$

(B) $\bar{r} = \left(\hat{i} - \frac{2}{3}\hat{j} + \frac{2}{3}\hat{k}\right) + \lambda(3\hat{i} + 2\hat{j} + \hat{k})$

(C) $\bar{r} = \left(\hat{i} - \frac{1}{3}\hat{j} + \frac{1}{3}\hat{k}\right) + \lambda(3\hat{i} + 2\hat{j} + \hat{k})$

(D) $\bar{r} = \left(\hat{i} - \frac{1}{3}\hat{j} - \frac{1}{3}\hat{k}\right) + \lambda(3\hat{i} + 2\hat{j} + 6\hat{k})$

8. $\frac{\cos 25^\circ + \sin 25^\circ}{\cos 25^\circ - \sin 25^\circ} =$

(A) $\tan 25^\circ$ (B) $\cot 20^\circ$

(C) $\tan 65^\circ$ (D) $\cot 35^\circ$

9. $\int\left(\frac{3e^{2x} + 5}{4e^{2x} - 5}\right)dx = \text{A}x + \text{B}\log\left|4e^{2x} - 5\right| + c$, then

(A) $\text{A} = -1, \text{B} = \frac{7}{8}$ (B) $\text{A} = 1, \text{B} = -\frac{7}{8}$

(C) $\text{A} = -5, \text{B} = -\frac{7}{8}$ (D) $\text{A} = -5, \text{B} = \frac{7}{8}$

10. Given $0 \le x \le \frac{1}{2}$, then the value of

$\tan\left[\sin^{-1}\left\{\frac{x}{\sqrt{2}} + \frac{\sqrt{1-x^2}}{\sqrt{2}}\right\} - \sin^{-1}x\right]$ is

(A) 1 (B) $\sqrt{3}$ (C) –1 (D) $\frac{1}{\sqrt{3}}$

11. The general solution of $\sec\theta = \sqrt{2}$ is

(A) $2n\pi \pm \frac{\pi}{3}, n \in Z$ (B) $2n\pi \pm \frac{\pi}{6}, n \in Z$

(C) $n\pi \pm \frac{\pi}{2}, n \in Z$ (D) $2n\pi \pm \frac{\pi}{4}, n \in Z$

12. $\int \frac{(x-1)e^x}{(x+1)^3}\,dx$ is equal to

(A) $\frac{1}{(x+1)^2} + c$ (B) $\frac{e^x}{(x+1)^2} + c$

(C) $\frac{e^x}{x+1} + c$ (D) $\frac{e^x}{(x+1)^3} + c$

13. If the lines given by $ax^2 + 2hxy + by^2 = 0(h^2 > ab)$ form an equilateral triangle with the line $lx + my = 1$, then

(A) $(2a + b)(a + 2b) = 4h^2$

(B) $(2a - b)(a - 2b) = 8h^2$

(C) $(3a + b)(a + 3b) = 4h^2$

(D) $(3a - b)(a - 3b) = 8h^2$

14. If the volume of the tetrahedron formed by the coterminous edges $\bar{a}$, $\bar{b}$ and $\bar{c}$ is 5, then the volume of the parallelopiped formed by the coterminous edges $\bar{a} \times \bar{b}$, $\bar{b} \times \bar{c}$ and $\bar{c} \times \bar{a}$ is

(A) 400 (B) 576

(C) 900 (D) 1296

15. $\int e^{2x}\cos 3x\, dx =$

(A) $\dfrac{e^{2x}(2\cos 3x + 3\sin 3x)}{13} + c$

(B) $\dfrac{e^{2x}(2\cos 3x - 3\sin 3x)}{13} + c$

(C) $\dfrac{e^{2x}(3\cos 3x + 2\sin 3x)}{13} + c$

(D) $\dfrac{e^{2x}(3\cos 3x - 2\sin 3x)}{13} + c$

16. The equation of the plane passing through (3, 1, 2) and making equal intercepts on the coordinate axes is

(A) $x + y + z = 4$ (B) $x + y + z = 5$

(C) $x + y + z = 6$ (D) $x + y + z = 7$

17. If $|\bar{a}| = |\bar{b}| = |\bar{a} + \bar{b}| = 1$, then $|\bar{a} - \bar{b}|$ is equal to

(A) 1 (B) $\sqrt{3}$

(C) 0 (D) $\sqrt{2}$

18. The matrix M = $\begin{bmatrix} 0 & 1 & 2 \\ 1 & 2 & 3 \\ 3 & 1 & 1 \end{bmatrix}$ and its inverse is N = $[n_{ij}]$. What is the element n_{23} of matrix N?

(A) 2 (B) –2 (C) 1 (D) –1

19. $\int \dfrac{\sin(\log x)^2}{x} \log x\, dx =$

(A) $\sin(\log x)^2 + c$

(B) $\cos(\log x)^2 + c$

(C) $-\dfrac{1}{2}\cos(\log x)^2 + c$

(D) $-\dfrac{1}{2}\sin(\log x)^2 + c$

20. In a ΔABC, $c^2\sin 2B + b^2\sin 2C =$

(A) Δ (B) 2Δ

(C) 3Δ (D) 4Δ

(where Δ is the area of triangle ABC)

21. $\bar{a} \times (\bar{b} \times \bar{c}) + \bar{b} \times (\bar{c} \times \bar{a}) + \bar{c} \times (\bar{a} \times \bar{b}) =$

(A) 0 (B) 1 (C) 2 (D) 3

22. The shortest distance between the lines

$\bar{r} = (\hat{i} + 2\hat{j} + \hat{k}) + \lambda(\hat{i} - \hat{j} + \hat{k})$ and

$\bar{r} = (2\hat{i} - \hat{j} - \hat{k}) + \mu(2\hat{i} + \hat{j} + 2\hat{k})$ is

(A) $3\sqrt{2}$ (B) $\dfrac{3}{\sqrt{2}}$ (C) $\dfrac{5}{\sqrt{2}}$ (D) $5\sqrt{2}$

23. The angle between the tangents to the circle $x^2 + y^2 = 25$ from the point (7, –1) is

(A) $\dfrac{\pi}{3}$ (B) $\dfrac{\pi}{6}$ (C) $\dfrac{\pi}{4}$ (D) $\dfrac{\pi}{2}$

24. If $\tan^{-1}x + 2\cot^{-1}x = \dfrac{5\pi}{6}$, then x is

(A) $\dfrac{1}{\sqrt{3}}$ (B) $\sqrt{3}$ (C) 3 (D) $\dfrac{\sqrt{3}-1}{\sqrt{3}+1}$

25. $\displaystyle\int_0^{\frac{\pi}{2}} \frac{\cos x}{(4+\sin x)(3+\sin x)}\, dx =$

(A) $\log\left(\dfrac{4}{3}\right)$ (B) $\log\left(\dfrac{16}{15}\right)$

(C) $\log\left(\dfrac{4}{5}\right)$ (D) $\log\left(\dfrac{11}{15}\right)$

26. The range of 7, 11, 16, 27, 31, 33, 42, 49 is

(A) 42 (B) 41 (C) 7 (D) 31

27. The derivative of $\sqrt{x^2+1}$ is

(A) $\dfrac{x}{\sqrt{x^2-1}}$ (B) $\dfrac{x}{2\sqrt{x^2+1}}$

(C) $\dfrac{2x}{\sqrt{x^2+1}}$ (D) $\dfrac{x}{\sqrt{x^2+1}}$

28. A coin is tossed 10 times. The probability of getting exactly six heads is

(A) $\dfrac{512}{513}$ (B) $\dfrac{105}{512}$

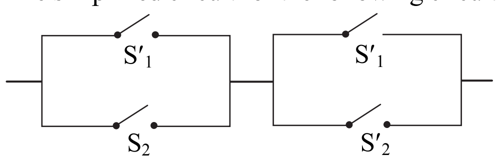
(C) $\dfrac{100}{153}$ (D) ${}^{10}C_6$

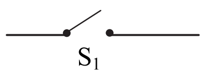
29. The function $f(x) = 9 - x^5 - x^7$ is decreasing for

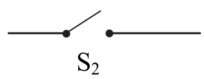
(A) $5 \le x \le 7$ (B) $x \le 1$

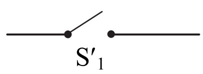
(C) $x \ge 1$ (D) All values of x

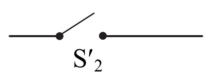
30. The simplified circuit for the following circuit is



(A) 

(B) 

(C) 

(D) 

31. The locus of the mid-point of the portion intercepted between the axes of the variable line $x\cos\alpha + y\sin\alpha = p$, where p is a constant, is

(A) $x^2 + y^2 = 4p^2$ (B) $\dfrac{1}{x^2} + \dfrac{1}{y^2} = \dfrac{4}{p^2}$

(C) $x^2 + y^2 = \dfrac{4}{p^2}$ (D) $\dfrac{1}{x^2} + \dfrac{1}{y^2} = \dfrac{2}{p^2}$

32. If $x = e^{2y}$, then $\dfrac{d^2y}{dx^2} \cdot \dfrac{d^2x}{dy^2}$ is equal to

(A) e^{-2y} (B) $-2e^{-2y}$

(C) $2e^{-2y}$ (D) 1

33. X is a continuous random variable with probability density function

$f(x) = \dfrac{x^3}{16}, 0 \le x \le 1$

$= 0,$ otherwise

Then, the value of $P(0.2 \le X \le 0.3)$ is

(A) $\dfrac{0.65}{64}$ (B) $\dfrac{0.0065}{64}$

(C) $\dfrac{0.065}{64}$ (D) $\dfrac{0.0064}{65}$

34. If $|z_1|=1, |z_2|=2, |z_3|=3$ and $|9z_1z_2+4z_1z_3+z_2z_3|=12$, then the value of $|z_1+z_2+z_3|$ is

(A) 3 (B) 4
(C) 8 (D) 2

35. If $(p \wedge \sim r) \rightarrow (\sim p \vee q)$ is a false statement, then respective truth values of p, q and r are

(A) T, F, F (B) F, T, T
(C) T, T, T (D) F, F, F

36. Maximum value of $4x + 13y$ subject to constraints $x \ge 0, y \ge 0, x + y \le 5$ and $3x + y \le 9$ is

(A) 47 (B) 65
(C) 56 (D) 12

37. $\lim\limits_{x\to 3} \dfrac{x^5 - 243}{x^3 - 27} =$

(A) $\dfrac{17}{3}$ (B) $\dfrac{5}{2}$ (C) 15 (D) 1

38. The domain of the function $\cos^{-1}(\log_2(x^2 + 5x + 8))$ is

(A) [2, 3] (B) [−2, 2]
(C) [3, 1] (D) [−3, −2]

39. A square plate is contracting at the uniform rate of 3cm^2/sec. The rate at which the perimeter is decreasing when the side of the square is 12 cm long is

(A) $\dfrac{1}{2}$ cm/sec (B) $\dfrac{1}{3}$ cm/sec

(C) $\dfrac{1}{4}$ cm/sec (D) none of these

40. Equation of angle bisector of the two planes $x + 2y + 3z = 1$ and $3x + y + 2z = 2$ is

(A) $4x - 3y - 5z = 3$ (B) $2x + y + z = 1$
(C) $2x - y - z = 1$ (D) None of These

41. The degree of the differential equation $\dfrac{d^4y}{dx^4} + \sqrt{1+\left(\dfrac{dy}{dx}\right)^4} = 0$ is

(A) 1 (B) 2 (C) 3 (D) 4

42. The number of arrangements of the letters of the word BANANA in which two N's do not appear adjacently is

(A) 40 (B) 60 (C) 80 (D) 100

43. If the tangent to the curve $y = 3x^2 - 2x + 1$ at a point P is parallel to $y = 4x + 3$, the co-ordinates of P are

(A) (2, 1) (B) (1, 2)
(C) (– 1, 2) (D) (2, – 1)

44. A random variable X has the following probability distribution:

$X = x$	0	1	2	3
$P(X = x)$	$\frac{1}{10}$	$\frac{1}{2}$	$\frac{1}{5}$	k

Then the value of k is

(A) $\dfrac{1}{4}$ (B) $\dfrac{1}{5}$ (C) $\dfrac{2}{5}$ (D) $\dfrac{1}{2}$

45. The value of p and q for which the function

$$f(x) = \begin{cases} \dfrac{\sin(p+1)x + \sin x}{x}, & x < 0 \\ q, & x = 0 \\ \dfrac{\sqrt{x+x^2} - \sqrt{x}}{x^{3/2}}, & x > 0 \end{cases}$$

is continuous for all x in R, are

(A) $p = \dfrac{1}{2}, q = -\dfrac{3}{2}$ (B) $p = \dfrac{5}{2}, q = \dfrac{1}{2}$

(C) $p = -\dfrac{3}{2}, q = \dfrac{1}{2}$ (D) $p = \dfrac{1}{2}, q = \dfrac{3}{2}$

46. If $f(x) = x^2$ and $g(x) = \sin x$, then $\int f(x).g(x)dx =$

(A) $x \cos x + \sin x + c$
(B) $-x \cos x + \sin x + c$
(C) $2x \sin x - 2\cos x - x^2 \cos x + c$
(D) $2x \sin x + 2\cos x - x^2 \cos x + c$

47. In a ΔABC, $\cot\left(\dfrac{A-B}{2}\right).\tan\left(\dfrac{A+B}{2}\right)$ is equal to

(A) $\dfrac{a-b}{a+b}$ (B) $\dfrac{a+b}{a-b}$

(C) $\dfrac{a(a-b)}{b(a+b)}$ (D) $\dfrac{b-a}{b+a}$

48. For any two vectors $\bar{a}$ and $\bar{b}$, $(\bar{a} \times \bar{b})^2$ is equal to

(A) $\bar{a}^2 - \bar{b}^2$ (B) $\bar{a}^2 + \bar{b}^2$
(C) $\bar{a}^2\,\bar{b}^2 - (\bar{a}\cdot\bar{b})^2$ (D) None of these

49. The approximate value of sin (31°), given that $1° = 0.0175^c$, cos 30° = 0.8660, is

(A) 0.5100 (B) 0.5152
(C) 0.5295 (D) 0.5175

50. Area bounded by the curve $y = x^4$, X-axis and ordinates $x = 1$ and $x = 3$ is

(A) 64 sq. units (B) 27 sq. units

(C) $\dfrac{127}{5}$ sq. units (D) $\dfrac{242}{5}$ sq. units

Page no. **11** to **230** are purposely left blank.

To see complete chapter buy **Target Notes** or **Target E-Notes**

ANSWERS AND SOLUTIONS

Model Question Paper 01

PHYSICS

1. **(C)**

For a diffraction pattern, $W = \dfrac{\lambda D}{a}$

$\therefore$ $W \propto \dfrac{1}{a}$, where a is slit width.

2. **(B)**

$K.E._{avg} = \dfrac{3}{2}k_BT$

$\therefore$ $T = \dfrac{2}{3} \times \dfrac{0.49 \times 1.6 \times 10^{-19}}{1.38 \times 10^{-23}} = 3787.44\ K$

$= 3514\ °C$

3. **(D)**

$v_C = R_n \dfrac{\eta}{\rho D}$

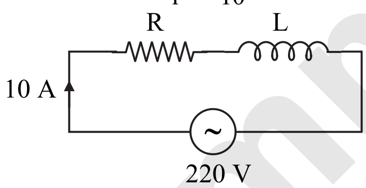
For laminar flow, Reynold's number $R_n = 200$

$\therefore$ $v_C = \dfrac{200 \times 10^{-3}}{10^3 \times 4 \times 10^{-2}}$

$= 5 \times 10^{-3}\ m\ s^{-1}$

4. **(B)**

Resistance, $R = \dfrac{V}{i} = \dfrac{50}{10} = 5\ \Omega$



For a RL circuit;

$e = \sqrt{e_R^2 + e_L^2}$

$\therefore$ $e_L^2 = e^2 - e_R^2$

$i^2(2\pi fL)^2 = e^2 - (iR)^2$

$\therefore$ $L^2 = \dfrac{e^2 - (iR)^2}{i^2 4\pi^2 f^2}$

$= \dfrac{(220)^2 - (10 \times 5)^2}{10^2 \times 4 \times (3.14)^2 \times (50)^2}$

$L^2 = 0.466 \times 10^{-2}$

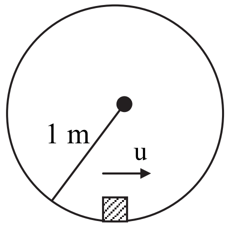
$\therefore$ $L = 0.068\ H$

5. **(D)**

For CE configuration, voltage gain = $\beta \times R_L/R_i$

Power gain = $\beta^2 \times R_L/R_i \Rightarrow \dfrac{\text{Power gain}}{\text{Voltage gain}} = \beta$

6. **(A)**



Vertical velocity at bottom,
$u^2 = 5gR$

$\therefore$ $v^2 = u^2 - 2gR = 5gR - 2gR = 3gR$

Tangential acceleration at bottom is
$a_t = g$ (downwards)

Centripetal acceleration at bottom is

$a_c = \dfrac{v^2}{R} = 3g$

$\therefore$ Total acceleration will be

$a = \sqrt{a_c^2 + a_t^2} = g\sqrt{10}\ m/s^2$

7. **(A)**

$x = 5 = 10 \sin(\omega t + \alpha)$

$\Rightarrow \dfrac{1}{2} = \sin(\omega t + \alpha)$

$\therefore$ $\sin(\omega t + \alpha) = \sin \dfrac{\pi}{6}$

$\Rightarrow \omega t + \alpha = \dfrac{\pi}{6}$ radian

8. **(D)**

$n = \dfrac{1}{2l}\sqrt{\dfrac{T}{\rho\pi r^2}}$

For $n_1 = n_2$, when T is same,

$\dfrac{1}{l_1\sqrt{\rho_1 r_1^2}} = \dfrac{1}{l_2\sqrt{\rho_2 r_2^2}}$

$\dfrac{l_1}{l_2} = \dfrac{\sqrt{\rho_2}}{\sqrt{\rho_1}} = \dfrac{\sqrt{7}}{\sqrt{8}}$ ....[$\because r_1 = r_2$]

9. **(D)**

Stefan-Boltzmann Law - Relates the energy radiated by a black body to its temperature. Hence, this is the wrong pairing.

10. **(D)**

$E = \dfrac{hc}{\lambda}$

i.e. $E \propto \dfrac{1}{\lambda}$

$\therefore$ $\dfrac{\lambda_1}{\lambda_2} = \dfrac{E_2}{E_1} = \dfrac{2.5}{5} = \dfrac{1}{2}$

$\therefore$ $\lambda_1 : \lambda_2 = 1 : 2$

11. (A)

12. (A)

From 1st law of thermodynamics,
$dU = dQ - dW$
$\Rightarrow dU = dQ(< 0)$ $(\because dW = 0)$
$\Rightarrow dU < 0$
So temperature will decrease.

13. (D)

14. (C)

Volume of the magnet,
$V = \frac{\text{mass}}{\text{density}} = \frac{65\times10^{-3}}{65\times10^{2}} = 10^{-5}\ m^3$

$\therefore$ Magnetization, $M_z = \frac{M_{net}}{V} = \frac{6}{10^{-5}}$

$\therefore$ $M_z = 6\times10^5$ A/m

15. (A)

Given that, coil is kept perpendicular to magnetic field $B = 5\times10^{-5}$ T.
Thus, angle between area vector A and magnetic field B is, $\theta = 0°$

$\therefore$ e.m.f. induced,

$$e = N\frac{d\phi}{dt}$$
$$= N\frac{BA\cos\theta}{dt}$$
$$= \frac{600\times4\times10^{-5}\times0.05}{0.1}$$
$$= 12\times10^{-3}V$$

16. (D)

17. (B)

On reflection from denser medium, there is a phase reversal of 180°

Now, new amplitude = $\frac{2}{3}\times0.6 = 0.4$

After reflection, wave will travel along negative x - direction

$\therefore$ Equation of reflected wave is

$$y = 0.4\sin2\pi\left[t+\frac{x}{2}+\pi\right]$$
$$= -0.4\sin2\pi\left(t+\frac{x}{2}\right) \quad ....[\because \sin(\pi+\theta) = -\sin\theta]$$

18. (A)

I is always proportional to mass and radius of the body. Here, two bodies having same shape and same radius are given.

$\therefore$ I is directly proportional to mass of the body.

$I \propto M$ and $I \propto \rho V$
But V = constant

$\therefore$ $I \propto \rho$

$\therefore$ $\frac{I_1}{I_2} = \frac{\rho_1}{\rho_2} = \frac{\rho_{Al}}{\rho_{iron}}$

But $\rho_{Al} < \rho_{iron}$

$\therefore$ $I_1 < I_2$

19. (C)

When charge enters perpendicular to electric field, it describes parabolic path.

20. (D)

To obtain an emission wavelength electron must transit from higher energy state to lower.

$\therefore$ For transition from n = 2 to n = 1,

$$\frac{1}{\lambda_{21}} = R\left[\frac{1}{1^2}-\frac{1}{2^2}\right] = \frac{3R}{4}$$

For transition from n = 5 to n = 2,

$$\frac{1}{\lambda_{52}} = R\left[\frac{1}{2^2}-\frac{1}{5^2}\right] = \frac{21R}{100}$$

$\therefore$ $\frac{1}{\lambda_{52}} < \frac{1}{\lambda_{21}}$

$\therefore$ $\lambda_{52} > \lambda_{21}$

21. (D)

Distance between adjacent nodes = $\lambda/2$

Also, $\frac{2\pi}{\lambda}$ = coefficient of x in the argument of the sine function = k or, $\lambda = \frac{2\pi}{k}$

$\therefore$ The distance between adjacent nodes = $\frac{\pi}{k}$.

22. (A)

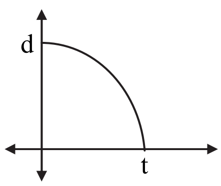
Separation between the plates is decreasing as they approach each other.
$V = Ed$
Electric field remains constant between the plates, so $V \propto d$

Now, force on each plate = $\frac{q^2}{2A\varepsilon_0}$

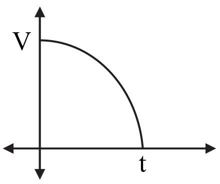
But, F = ma

$\therefore$ Acceleration (a) = $\frac{F}{m} = \frac{q^2}{2A\varepsilon_0(m)}$

$\Rightarrow$ a = constant
As, acceleration is constant and distance is decreasing, the distance – time graph will be a parabola with decreasing value of d.



Similarly, V-t curve will be,



23. (A)

Power of the incident photons is,

$P = \frac{E}{t}$

But, P = Fc

$\therefore$ E = Fct

$= 2 \times 10^{-7} \times 3 \times 10^{8} \times 10 \times 10^{-9}$

$= 600 \times 10^{-9}$ J

= 600 nJ

24. (A)

Let $I = \frac{V}{R} = \frac{3}{200} = 0.015\text{ A} = 15 \times 10^{-3}\text{ A}$

= 15 mA

Range of ammeter is 15 mA.

The range of ammeter can be increased but cannot be decreased. Hence, the ammeter cannot be converted into range of 10 mA.

25. (C)

26. (C)

Earth is solid sphere, so M.I. = $\frac{2}{5}MR^2$

where, $M = \frac{4}{3}\pi R^3 \rho$

$\therefore$ M.I. = $\frac{2}{5}\left[\frac{4}{3}\pi R^3 \rho\right] R^2$

$= \frac{8}{15}\pi R^5 \rho$

27. (B)

$$\frac{E_1}{E_2} = \frac{l_1 + l_2}{l_1 - l_2} = \frac{(8+2)}{(8-2)} = \frac{5}{3}$$

28. (B)

Let r be the radius of each droplet and R be the radius of the big drop.

Since the total volume is the same, we have

$10^6 \times \frac{4\pi r^3}{3} = \frac{4\pi R^3}{3}$

$R^3 = 10^6 r^3 \Rightarrow R = 100$ r.

The surface energy of one million drops,

$E_1 = 4\pi r^2 T \times 10^6$

The surface energy of one big drop,

$E_2 = 4\pi R^2 T$

$\therefore \frac{E_2}{E_1} = \left(\frac{R}{r}\right)^2 \times \frac{1}{10^6} = \left(\frac{100r}{r}\right)^2 \times \frac{1}{10^6} = \frac{1}{10^2}$

29. (C)

For an object thrown upward,

Velocity 2s before maximum height

= Velocity 2s after maximum height

$\therefore$ v = u + at = 0 + 9.8 × 2 = 19.6 m/s

30. (D)

For an observer at rest and source velocity constant, apparent frequency heard,

$n' = n\left(\frac{v}{v \pm v_s}\right)$

When source approaches,

$n' = n\left(\frac{v}{v - v_s}\right)$ = constant × n

Here, constant >1, hence apparent frequency heard is constant and higher than n.

When source moves away,

$n' = n\left(\frac{v}{v + v_s}\right)$ = constant × n

Here, constant < 1, hence apparent frequency heard is constant and lesser than n.

The graph (D) represents the situation best.

31. (A)

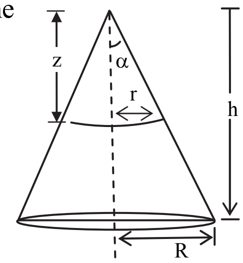
Mass = density × volume

$dm = \sigma\, \pi r^2 dz$

From the figure,

$\tan\alpha = \frac{r}{z} = \frac{R}{h}$

$\therefore r = \frac{R}{h} z$



Now,

$$z_{CM} = \frac{\int z\,dm}{\int dM} = \frac{\int_0^h \sigma\pi r^2 z\,dz}{\frac{1}{3}\pi R^2 h\sigma}$$

where, dM = mass element of entire cone.

$$\therefore z_{CM} = \frac{3}{R^2 h}\int_0^h \left(\frac{R}{h}z\right)^2 z\,dz$$

$$= \frac{3}{hR^2}\left(\frac{R^2}{h^2}\right)\int_0^h z^3\,dz$$

$$= \frac{3}{h^3}\left[\frac{z^4}{4}\right]_0^h$$

$$= \frac{3h}{4}$$

$\therefore$ distance of centre of mass from base is

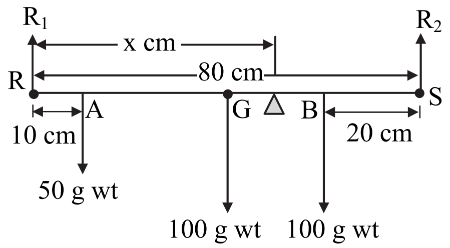
$h - \frac{3h}{4} = \frac{h}{4}$

$\therefore$ centre of mass has co-ordinates $\left(0, 0, \frac{h}{4}\right)$

32. (A)
Since light transmitting area is same, there is no effect on intensity.

33. (B)

34. (D)



Let the knife – edge be balanced at x cm from point R. For equilibrium, considering moments about point R,

$W_1 \times RA + W \times RG + W_2 \times RB$
$= (W_1 + W + W_2) \times x$

$50 \times 10 + 100 \times 40 + 100 \times 60$
$= (50 + 100 + 100)\ x$

$\Rightarrow x = \dfrac{500+4000+6000}{250} = 42$ cm

35. (B)

Resultant intensity,
$I = I_1 + I_2 + 2\sqrt{I_1I_2}\cos\phi$

At central position with coherent source,
$I_{coh} = 4I_0$ $\quad(\because I_1 = I_2 = I_0)$ ….(i)

In case of incoherent at a given point, ϕ varies randomly with time $\Rightarrow (\cos\phi)_{av} = 0$

$\therefore\quad I_{In\,coh} = I_1 + I_2 = 2I_0$ ….(ii)

$\therefore\quad \dfrac{I_{coh}}{I_{Incoh}} = \dfrac{2}{1}$ ….[from (i) and (ii)]

36. (D)

$|e| = \dfrac{d\phi}{dt} = B\dfrac{dA}{dt} = B\dfrac{d}{dt}(\pi r^2) = 2\pi Br\dfrac{dr}{dt}$

$\therefore\quad |e| = 2\pi \times 0.02 \times 2 \times 10^{-2} \times 2 \times 10^{-3}$
$= 1.6\ \pi\ \mu V$

37. (B)
Change in internal energy of the gas,

$\Delta U = -\ \Delta W = \dfrac{R(T_2 - T_1)}{\gamma - 1}$ ....($\because$ n = 1)

$= \dfrac{8.3}{(1.4-1)}(320 - 300) = 415$ J

38. (C)
Force between two long conductors carrying current,

$F = \dfrac{\mu_0}{2\pi}\dfrac{I_1I_2}{d}l$ ….(i)

After carrying out changes,

$F' = \dfrac{\mu_0}{2\pi}\dfrac{(-2\ I_1)(I_2)}{d'}l$

From (i) and (ii),

$\dfrac{F'}{F} = \dfrac{-2/d'}{1/d} = -2\left(\dfrac{d}{d'}\right) = -2\left(\dfrac{0.8}{1.8}\right) = \dfrac{-8}{9}$

$\Rightarrow F' = \dfrac{-8}{9}F$

39. (B)
For AC, $X_L = 2\pi fL$
For DC, f = zero

$\therefore\quad \dfrac{X_{L(AC)}}{X_{L(DC)}} =$ infinity

40. (B)
$I_B = 5\ \mu A$, $R_B = 300\ k\Omega$, $V_{BE} = 0.5V$
$V_{BB} = I_BR_B + V_{BE}$
$= 5 \times 10^{-6} \times 300 \times 10^3 + 0.5$
$= 5 \times 3 \times 10^{-1} + 0.5$
$= 1.5 + 0.5$
$= 2$ V

41. (A)

$F = \dfrac{Gm_1m_2}{r^2}$

$\therefore\quad F \propto \dfrac{1}{r^2}$

$\therefore\quad \dfrac{F'}{F} = \left(\dfrac{r}{r'}\right)^2$

$= \left(\dfrac{r}{3r/4}\right)^2 = \dfrac{16}{9}$

$\therefore\quad F' = 1.78F$

42. (D)

For bifocal convex lens:

$\dfrac{1}{f} = (\mu - 1)\left[\dfrac{1}{R_1} + \dfrac{1}{R_2}\right]$

$= \dfrac{(\mu-1)\times 2}{R}$ ….($R_1 = R_2 = R$)

For half plane-convex lens:
For plane surface: $R_2 = \infty$

$\therefore\quad \dfrac{1}{f'} = (\mu - 1)\dfrac{1}{R}$

$\therefore\quad \dfrac{1/f}{1/f'} = \dfrac{(\mu-1)}{R} \times 2 \times \dfrac{R}{\mu - 1} = 2$

$\therefore\quad \dfrac{f'}{f} = 2$

$\Rightarrow f' = 2f$

43. (A)

On a wavefront, all the points are in same phase.

44. (A)

Heat produced by A.C. = 4 × Heat produced by D.C

$\therefore$ $i_{rms}^2 Rt = 4 \times I^2 Rt$

$i_{rms}^2 = 4 \times 3^2$

$\therefore$ $i_{rms} = 2 \times 3 = 6$ A

45. (B)

$T_A = \dfrac{20}{10} = 2$ s

$T_B = \dfrac{10}{8} = 1.25$ s

But $T \propto \sqrt{l}$

$\therefore$ $\dfrac{T_A}{T_B} = \sqrt{\dfrac{l_A}{l_B}}$

$\therefore$ $\dfrac{l_A}{l_B} = \dfrac{T_A^2}{T_B^2} = \dfrac{2^2}{1.25^2}$

$\dfrac{l_A}{l_B} = \dfrac{64}{25}$

46. (D)

47. (C)

$\left(\dfrac{\Delta Q}{t}\right) \propto \Delta\theta$

$\dfrac{\left(\dfrac{\Delta Q}{t}\right)_1}{\left(\dfrac{\Delta Q}{t}\right)_2} = \dfrac{\Delta\theta_1}{\Delta\theta_2}$

$\dfrac{90}{\left(\dfrac{\Delta Q}{t}\right)_2} = \dfrac{80-20}{40-20}$

$\left(\dfrac{\Delta Q}{t}\right)_2 = 30$ cal/s

48. (C)

$n_1 = \dfrac{v}{\lambda_1}$ and $n_2 = \dfrac{v}{\lambda_2}$

$\lambda_1 = 2$ m, $\lambda_2 = 2.02$ m

Since $\lambda_1 < \lambda_2$, so $n_1 > n_2$

$\therefore$ $n_1 - n_2 = 2$

$\therefore$ $\dfrac{v}{\lambda_1} - \dfrac{v}{\lambda_2} = 2$

$\therefore$ $v\left(\dfrac{\lambda_2 - \lambda_1}{\lambda_1\lambda_2}\right) = 2$

$\therefore$ $v = \dfrac{2 \times \lambda_1\lambda_2}{\lambda_2 - \lambda_1}$

$= \dfrac{2 \times 2 \times 2.02}{2.02 - 2} = 404$ m/s

49. (B)

Magnetic field inside a toroid is given by,

$B = \mu_0 nI = \dfrac{\mu_0 NI}{2\pi R}$

$\therefore$ For first toroid, $B_1 = \dfrac{\mu_0 N_1 I}{2\pi R_1}$

For second toroid, $B_2 = \dfrac{\mu_0 N_2 I}{2\pi R_2}$

$\therefore$ $\dfrac{B_1}{B_2} = \dfrac{N_1}{R_1} \times \dfrac{R_2}{N_2} = \dfrac{400}{0.4} \times \dfrac{0.2}{200} = 1:1$

50. (A)

If R is radius of sphere and r is distance of point from centre of sphere then, for r > R,

$E = \dfrac{q}{4\pi\varepsilon_0 r^2}$

$= \dfrac{1}{4\pi\varepsilon_0} \times \dfrac{3.2 \times 10^{-7}}{\left(15 \times 10^{-2}\right)^2}$

$= 9 \times 10^9 \times \dfrac{3.2 \times 10^{-7}}{225 \times 10^{-4}} = 1.28 \times 10^5$ N/C

CHEMISTRY

1. (B)

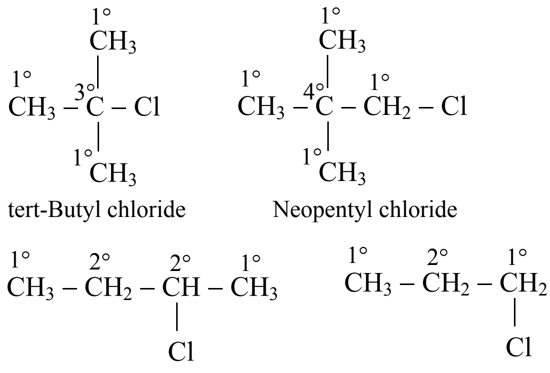
In substitutional impurity defect, the foreign (impurity) atoms are found at the lattice sites in place of host atoms.

2. (B)

Electrolysis of warm aqueous solution of barium hydroxide using nickel electrodes gives dihydrogen of high purity (>99.5%).

3. (D)

4. (B)



tert-Butyl chloride — Neopentyl chloride — sec-Butyl chloride — n-Propyl chloride

5. (A)

Alcohols react with active metals to form hydrogen gas.

$$\underset{\text{Alcohol}}{6(CH_3)_3C\text{–}OH} + \underset{\text{Active metal}}{2Al} \longrightarrow \underset{\text{Alkoxide}}{2\,[(CH_3)_3C-O]_3Al} + 3H_2\uparrow$$

$\therefore$ 2 moles of 2-methylpropan-2-ol will give one mole of hydrogen gas.

6. **(D)**

7. **(D)**
Since $K_a < K_b$, the solution will be basic.

8. **(B)**
Cr^{2+} : $[Ar]\ 3d^4$
Co^{3+} : $[Ar]\ 3d^6$
Mn^{3+} : $[Ar]\ 3d^4$
Fe^{3+} : $[Ar]\ 3d^5$

9. **(B)**
The presence of electron withdrawing group at ortho and/or para position greatly increases the reactivity of haloarenes towards nucleophilic substitution reactions.
Hence, p-Nitrochlorobenzene is more reactive towards nucleophilic substitution reactions as compared to chlorobenzene. The presence of electron withdrawing group at meta position has practically no effect on reactivity.

10. **(C)**
The reaction is
$2C_2H_5 - OH + 2Na \longrightarrow 2C_2H_5ONa + H_2\uparrow$
Now, 23 g sodium = 1 mol sodium
From reaction, 2 mol sodium liberate 1 mol H_2 = 22.4 dm^3 H_2
Hence, 1 mol sodium liberates 0.5 mol H_2 = 11.2 dm^3 H_2

11. **(D)**
CCl_4 – non-polar molecule with polar bonds

12. **(B)**
For a first order reaction,
$$k = \frac{2.303}{t}\log_{10}\frac{[A]_0}{[A]_t}$$
$$\therefore \quad t = \frac{2.303}{0.1155}\times\log_{10}\frac{1.2}{0.3}$$
$= 19.94 \times \log_{10}(4) = 19.94 \times \log_{10}(2^2)$
$= 19.94 \times 2\log_{10}(2) = 19.94 \times 2 \times 0.301$
$= 12.0$ hours

<u>Alternate method</u>:
$$t_{1/2} = \frac{0.693}{k} = \frac{0.693}{0.1155} = 6 \text{ hours}$$
$$\underset{[A]_t}{1.2\text{ M}} \xrightarrow{t_{1/2}} \underset{[A]_t}{0.6\text{ M}} \xrightarrow{t_{1/2}} \underset{[A]_t}{0.3\text{ M}}$$
No. of half-lives (n) = 2
Therefore, time (t) = 2 × 6 = 12 hours

13. **(B)**

14. **(D)**

15. **(A)**
$$\underset{\text{Ethyl methyl ether}}{CH_3OC_2H_5} + HI \xrightarrow{\text{Cold}} \underset{\text{Methyl iodide}}{CH_3I} + \underset{\text{Ethyl alcohol}}{C_2H_5OH}$$

16. **(A)**

17. **(B)**
```
HO – CH2
      |
H2N – CH – COOH
```
Serine

18. **(C)**
For solution of sulphur in CS_2 (solvent),
$\Delta T_b = T_b - T_b^0 = (319.81 - 319.45)\text{ K} = 0.36\text{ K}$
From formula,
$$M_2 = \frac{1000\,K_b W_2}{\Delta T_b W_1}$$
$$= \frac{1000\text{ g kg}^{-1} \times 2.42\text{ K kg mol}^{-1} \times 3.795\text{ g}}{0.36\text{ K} \times 100\text{ g}}$$
$= 255.1\text{ g mol}^{-1}$
Now, atomic mass of S = 32 u
$\therefore$ Number of Sulphur atoms in a molecule
$$= \frac{\text{Molar mass of sulphur}}{\text{Atomic mass of sulphur}}$$
$$= \frac{255.1}{32}$$
$= 7.97 \approx 8$
$\therefore$ Molecular formula of sulphur in $CS_2 = S_8$

19. **(D)**

20. **(B)**
The equation for photosynthesis is the reverse of combustion of glucose.
$\therefore \quad 6CO_{2(g)} + 6H_2O_{(g)} \longrightarrow C_6H_{12}O_{6(s)} + 6O_{2(g)}$;
$\Delta H = 72\text{ kcal mol}^{-1}$
Molecular mass of glucose = 180 g mol^{-1}
180 g mol^{-1} ≡ 72 kcal mol^{-1}
$$\therefore \quad 1.8\text{ g} \equiv \frac{72\text{ kcal mol}^{-1}\times 1.8\text{ g}}{180\text{ g mol}^{-1}} = 0.72\text{ kcal}$$

21. **(A)**
$$8NH_3 + \underset{\text{(Excess)}}{} 3Cl_2 \longrightarrow 6NH_4Cl + N_2$$
(Excess)
$$NH_3 + 3Cl_2 \longrightarrow NCl_3 + 3HCl$$
(Excess)

22. **(B)**

23. **(A)**
$$\underset{\text{Dimethylcadmium}}{(CH_3)_2Cd} + \underset{\text{Acetyl chloride}}{2CH_3COCl} \longrightarrow \underset{\text{Acetone}}{2CH_3COCH_3} + \underset{\text{Cadmium chloride}}{CdCl_2}$$

24. **(A)** 25. **(B)**

26. (D)

$$\frac{P_1^0 - P_1}{P_1^0} = \frac{W_2 M_1}{M_2 W_1}$$

$$\frac{32\,\text{mm Hg} - P_1}{32\text{ mm Hg}} = \frac{4\text{ g} \times 18\text{ g mol}^{-1}}{60\text{ g mol}^{-1} \times 10.5\text{ g}}$$

$\therefore \quad \dfrac{32\,\text{mm Hg} - P_1}{32\text{ mm Hg}} = 0.08$

$\therefore \quad 32\text{ mm Hg} - P_1 = 0.08 \times 32\text{ mm Hg}$

$\therefore \quad 32\text{ mm Hg} - P_1 = 2.56\text{ mm Hg}$

$\therefore \quad P_1 = 32\text{ mm Hg} - 2.56\text{ mm Hg} = 29.44\text{ mm Hg}$

27. (D)

$$\underset{\text{Propane}}{CH_3{-}CH_2{-}CH_3} \xrightarrow[\text{Cracking}]{\Delta} \underset{\text{Ethene}}{CH_2 = CH_2} + \underset{\text{Methane}}{CH_4}$$

28. (C)

$W = P_{ext}.\Delta V$ (as work is done on the system)

$= (3.039 \times 10^5\text{ N m}^{-2})\ (50 - 30)\text{ dm}^3$

$= 3.039 \times 10^5\text{ N m}^{-2} \times 20 \times 10^{-3}\text{ m}^3$

$= 6078\text{ N m} = 6078\text{ J}$

$= (6078 \times 0.239)\text{ cal}$

$= +1452.6\text{ cal}$

29. (A)

30. (B)

$$Cl_2 + H_2\overset{-2}{S} \rightarrow 2HCl + \overset{0}{S}$$

31. (D)

32. (A)

$$\underset{\text{Dimethylamine}}{(CH_3)_2{-}NH} + \underset{\text{Benzoyl chloride}}{C_6H_5 - \overset{\overset{\displaystyle O}{\|}}{C} - Cl} \xrightarrow[\Delta]{\text{Pyridine}} \underset{\text{N,N-Dimethylbenzamide}}{(CH_3)_2 - N - \overset{\overset{\displaystyle O}{\|}}{C} - C_6H_5} + HCl$$

33. (D) **34. (B)**

35. (D)

$c = 10^{-2}$ M

For a monoacid weak base,

$[OH^-] = c \times \alpha$

$[OH^-] = 10^{-2} \times \dfrac{10}{100}$

$[OH^-] = 1 \times 10^{-3}$ M

$pOH = -\log_{10}[OH^-] = -\log_{10}(1 \times 10^{-3})$

$pOH = 3.00$

$pH + pOH = 14$

$\therefore \quad pH = 14 - pOH = 14 - 3.00$

$pH = 11.00$

36. (B)

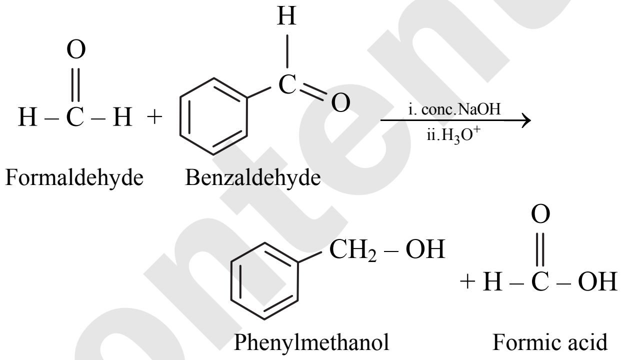
37. (C)

Finely divided substances, rough surfaces, and colloidal substances have higher surface areas making them more effective at adsorbing molecules or ions from the surrounding medium. The large surface area provides more sites for interaction, enhancing the adsorption process. Hence, statement I is correct but statement II is incorrect.

38. (B) **39. (B)**

40. (B)

The given reaction is Cross Cannizzaro reaction.



41. (C)

Number of moles of a gas (n)

$= \dfrac{\text{Volume of gas at STP}}{22.4\text{ dm}^3\text{ mol}^{-1}}$

$\therefore \quad n = \dfrac{6.72\text{ dm}^3}{22.4\text{ dm}^3\text{ mol}^{-1}} = 0.3\text{ mol}$

$Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_2 + H_{2(g)}\uparrow$

1 mol Mg $\equiv$ 1 mol H_2 gas

$\therefore$ Mg required to liberate 0.3 mol H_2 gas

$= 0.3\text{ mol} = 0.3 \times 24 = 7.2\text{ g}$

42. (A)

43. (C)

$XeF_6 + 3H_2O \rightarrow XeO_3 + 6\,HF$

44. (C)

Density $(\rho) = \dfrac{M\,n}{a^3\,N_A}$

$8.9 = \dfrac{63.5 \times n}{28.5}$

$n = \dfrac{8.9 \times 28.5}{63.5} = 4$

45. (B)

For the given electrochemical cell, the oxidation reaction at anode, reduction reaction at cathode and overall cell reaction are as follows:

$2Ag \longrightarrow 2Ag^+ + 2e^-$ (Oxidation at anode)

$Zn^{+2} + 2e^- \longrightarrow Zn$ (Reduction at cathode)

$2Ag + Zn^{+2} \longrightarrow 2Ag^+ + Zn$ (Overall cell reaction)

$\therefore$ The emf of the cell is given by

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0592}{n}\log_{10}\frac{[Ag^+]^2}{[Zn^{+2}]}$$

Substituting the values in above equation,

$$E_{cell} = -1.562 - \frac{0.0592}{2}\log_{10}\frac{(0.01)^2}{(0.1)}$$

$$= -1.562 - \frac{0.0592}{2}\log_{10}10^{-3}$$

$$= -1.562 - (-3)\frac{0.0592}{2}$$

$$= -1.562 + 0.0888 = -1.4732 \text{ V}$$

46. (D)

PV = nRT

$\therefore$ $PV = \frac{m}{M}RT$

$\therefore$ $P = \frac{m}{V}\cdot\frac{RT}{M}$

$\therefore$ $\frac{m}{V} = \frac{PM}{RT}$

$\therefore$ $d = \frac{PM}{RT}$ ($\because d = m/V$)

47. (B)

The angular momentum of an electron in a given stationary orbit of hydrogen atom

$= mvr = \frac{nh}{2\pi}$ (where n = 1, 2, 3)

Angular momentum of an electron in second orbit of hydrogen atom $= \frac{2h}{2\pi} = \frac{h}{\pi}$

48. (B)

49. (C)

Given that,

$2C_{(s)} + 3H_{2(g)} \longrightarrow C_2H_{6(g)}$; $\Delta H = -30.2$ kcal …(i)

$2C_{(s)} + 2H_{2(g)} \longrightarrow C_2H_{4(g)}$; $\Delta H = +12.5$ kcal …(ii)

Subtracting eq. (ii) from (i), we get

$C_2H_{4(g)} + H_{2(g)} \longrightarrow C_2H_{6(g)}$; $\Delta H = -42.7$ kcal

50. (C)

MATHEMATICS

1. (C)

Putting $m = l + n$ in $m^2 = l^2 + n^2$, we get

$(l + n)^2 = l^2 + n^2$

$\Rightarrow ln = 0 \Rightarrow l = 0$ or $n = 0$

If $l = 0$, then $m = n$

$\therefore$ $\frac{l}{0} = \frac{m}{1} = \frac{n}{1}$

If $n = 0$, then $m = l$

$\therefore$ $\frac{l}{1} = \frac{m}{1} = \frac{n}{0}$

$\therefore$ $a_1, b_1, c_1 = 0, 1, 1$ and

$a_2, b_2, c_2 = 1, 1, 0$

$\therefore$ The angle between the lines is given by

$$\cos\theta = \frac{0+1+0}{\sqrt{0+1+1}\cdot\sqrt{1+1+0}} = \frac{1}{2}$$

$\therefore$ $\theta = \frac{\pi}{3}$

2. (B)

$y = Ae^x + Be^{-x}$ …(i)

$\Rightarrow \frac{dy}{dx} = Ae^x - Be^{-x}$

$\Rightarrow \frac{d^2y}{dx^2} = Ae^x + Be^{-x}$

$= y$ …[From (i)]

$\therefore$ $\frac{d^2y}{dx^2} - y = 0$

3. (D)

$y = (\sin x)^{\sin x}$

Taking logarithm on both sides, we get

$\log y = \sin x \log(\sin x)$

Differentiating both sides w.r.t. x, we get

$\frac{1}{y}\cdot\frac{dy}{dx} = \sin x.\frac{1}{\sin x}.\cos x + \log(\sin x).\cos x$

$\Rightarrow \frac{1}{y}\cdot\frac{dy}{dx} = \cos x + \cos x\log(\sin x)$

$\Rightarrow \frac{dy}{dx} = (\sin x)^{\sin x}[\cos x + \cos x\log(\sin x)]$

4. (C)

Consider the following events:

S = person is smoker,

NS = person is non smoker,

D = death due to lung cancer

$$P(D) = P(S)\cdot P\left(\frac{D}{S}\right) + P(NS)\cdot P\left(\frac{D}{NS}\right)$$

$$\Rightarrow 0.006 = \frac{20}{100}\times P\left(\frac{D}{S}\right) + \frac{80}{100}\times\frac{1}{10}\times P\left(\frac{D}{S}\right)$$

$$\Rightarrow P\left(\frac{D}{S}\right) = \frac{1000\times 0.006}{280} = \frac{6}{280} = \frac{3}{140}$$

5. (B)

$1 + \frac{dy}{dx} = \frac{\sin^2(x+y)}{\cos(x+y)}$ …(i)

Put $x + y = v$ …(ii)

$\Rightarrow 1 + \frac{dy}{dx} = \frac{dv}{dx}$ …(iii)

Substituting (ii) and (iii) in (i), we get

$\Rightarrow \frac{dv}{dx} = \frac{\sin^2 v}{\cos v}$

Integrating on both sides, we get

$$\int dx - \int\frac{\cos v}{\sin^2 v}dv = c \Rightarrow x - \left(-\frac{1}{\sin v}\right) = c$$

…[Put $\sin v = t \Rightarrow \cos v\, dv = dt$]

$\Rightarrow x + \operatorname{cosec} v = c$

$\Rightarrow x + \operatorname{cosec}(x+y) = c$

6. **(D)**

$C(x_1, y_1, z_1)$ $D(x_2, y_2, z_2)$

A(2, 1, 4) B(−1, 3, 6)

C divides AB internally in the ratio 1 : 2 and
D divides AB internally in the ratio 2 : 1.

$\therefore$ $z_1 + z_2 = \dfrac{1(6)+2(4)}{1+2} + \dfrac{2(6)+1(4)}{2+1}$

$= \dfrac{14}{3} + \dfrac{16}{3}$

$= \dfrac{30}{3}$

$= 10$

7. **(C)**

Given cartesian equation of the line is

$2x - 2 = 3y + 1 = 6z - 2$

$\Rightarrow 2(x-1) = 3\left(y - \left(\dfrac{-1}{3}\right)\right) = 6\left(z - \dfrac{1}{3}\right)$

$\Rightarrow \dfrac{x-1}{\frac{1}{2}} = \dfrac{y - \left(\frac{-1}{3}\right)}{\frac{1}{3}} = \dfrac{\left(z - \frac{1}{3}\right)}{\frac{1}{6}}$

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

The given line passes through $\left(1, \dfrac{-1}{3}, \dfrac{1}{3}\right)$ and the direction ratios are proportional to 3, 2, 1

$\therefore$ The vector equation is

$\bar{r} = \left(\hat{i} - \dfrac{1}{3}\hat{j} + \dfrac{1}{3}\hat{k}\right) + \lambda(3\hat{i} + 2\hat{j} + \hat{k})$

8. **(B)**

$\dfrac{\cos 25^\circ + \sin 25^\circ}{\cos 25^\circ - \sin 25^\circ} = \dfrac{1 + \tan 25^\circ}{1 - \tan 25^\circ}$

$= \dfrac{\tan 45^\circ + \tan 25^\circ}{1 - \tan 45^\circ \tan 25^\circ}$

$= \tan(45^\circ + 25^\circ)$

$= \tan 70^\circ$

$= \tan(90^\circ - 20^\circ)$

$= \cot 20^\circ$

9. **(A)**

$\displaystyle\int \left(\dfrac{3e^{2x}+5}{4e^{2x}-5}\right) dx = \int \dfrac{-1\left(4e^{2x}-5\right) + \frac{7}{8}\left(8e^{2x}\right)}{4e^{2x}-5}\, dx$

$\displaystyle = -\int dx + \dfrac{7}{8}\int \dfrac{8e^{2x}}{4e^{2x}-5}\, dx$

$= -x + \dfrac{7}{8} \log\left|4e^{2x} - 5\right| + c$

$\therefore$ $A = -1$ and $B = \dfrac{7}{8}$

10. **(A)**

$\tan\left[\sin^{-1}\left\{\dfrac{x}{\sqrt{2}} + \dfrac{\sqrt{1-x^2}}{\sqrt{2}}\right\} - \sin^{-1} x\right]$

$= \tan\left[\sin^{-1}\left\{\dfrac{x + \sqrt{1-x^2}}{\sqrt{2}}\right\} - \sin^{-1} x\right]$

$= \tan\left[\sin^{-1}\left\{\dfrac{\sin\theta + \cos\theta}{\sqrt{2}}\right\} - \theta\right]$ $\quad \ldots\left[\begin{array}{l}\text{Put } \sin^{-1}x = \theta \\ \Rightarrow x = \sin\theta\end{array}\right]$

$= \tan\left[\sin^{-1}\left[\sin\left(\theta + \dfrac{\pi}{4}\right)\right] - \theta\right]$

$= \tan\left[\theta + \dfrac{\pi}{4} - \theta\right]$

$= \tan\dfrac{\pi}{4} = 1$

11. **(D)**

$\sec\theta = \sqrt{2}$

$\Rightarrow \cos\theta = \dfrac{1}{\sqrt{2}}$

$\Rightarrow \cos\theta = \cos\dfrac{\pi}{4}$

$\Rightarrow \theta = 2n\pi \pm \dfrac{\pi}{4}, n \in Z$

$\ldots[\because \cos\theta = \cos\alpha \Rightarrow \theta = 2n\pi \pm \alpha]$

12. **(B)**

$\displaystyle\int \dfrac{(x-1)e^x}{(x+1)^3}\, dx = \int \dfrac{(x+1-2)}{(x+1)^3} e^x\, dx$

$\displaystyle = \int e^x\left[\dfrac{1}{(x+1)^2} - \dfrac{2}{(x+1)^3}\right] dx$

$= \dfrac{e^x}{(x+1)^2} + c$

$\ldots\left[\because \int e^x\left[f(x) + f'(x)\right] dx = e^x f(x) + c\right]$

13. **(C)**

Since $ax^2 + 2hxy + by^2 = 0$ are pair of lines forming sides of an equilateral triangle.

$\therefore$ Angle between them is 60°.

$\therefore$ $\tan 60^\circ = \left|\dfrac{2\sqrt{h^2 - ab}}{a+b}\right|$

$\Rightarrow \sqrt{3} = \left|\dfrac{2\sqrt{h^2 - ab}}{a+b}\right|$

$\Rightarrow 3(a+b)^2 = 4(h^2 - ab)$

$\Rightarrow 3(a^2 + 2ab + b^2) = 4h^2 - 4ab$

$\Rightarrow 3a^2 + 10ab + 3b^2 = 4h^2$

$\Rightarrow 3a^2 + 9ab + ab + 3b^2 = 4h^2$

$\Rightarrow (a+3b)(3a+b) = 4h^2$

14. (C)

Volume of tetrahedron = $\frac{1}{6}\left[\bar{a}\ \bar{b}\ \bar{c}\right]$

$\Rightarrow 5 = \frac{1}{6}\left[\bar{a}\ \bar{b}\ \bar{c}\right] \Rightarrow \left[\bar{a}\ \bar{b}\ \bar{c}\right] = 30$

Edges of parallelopiped are $\bar{a}\times\bar{b}, \bar{b}\times\bar{c}, \bar{c}\times\bar{a}$

$\therefore$ Volume of parallelopiped $= [\bar{a}\times\bar{b}\quad \bar{b}\times\bar{c}\quad \bar{c}\times\bar{a}]$

$= \left[\bar{a}\ \bar{b}\ \bar{c}\right]^2$

$= 30^2 = 900$ sq. units

15. (A)

$\int e^{2x}\cos 3x\, dx = \frac{e^{2x}(2\cos 3x + 3\sin 3x)}{13} + c$

Shortcut - 15

$\int e^{ax}\cos bx\, dx = \frac{e^{ax}}{a^2+b^2}(a\cos bx + b\sin bx) + c$

16. (C)

Equation of a plane making equal intercepts on co-ordinate axes is $x + y + z = k$

Since this plane passes through (3, 1, 2),

$3 + 1 + 2 = k$

$\Rightarrow k = 6$

$\therefore$ Equation of the plane is $x + y + z = 6$

17. (B)

$|\bar{a}+\bar{b}|^2 + |\bar{a}-\bar{b}|^2 = 2|\bar{a}|^2 + 2|\bar{b}|^2$

$\Rightarrow 1 + |\bar{a}-\bar{b}|^2 = 2(1)^2 + 2(1)^2$

$\Rightarrow |\bar{a}-\bar{b}| = \sqrt{3}$

Shortcut - 17

$|\bar{a}+\bar{b}|^2 + |\bar{a}-\bar{b}|^2 = 2|\bar{a}|^2 + 2|\bar{b}|^2$

18. (D)

Since, $N = M^{-1}$

$$\therefore \quad N = \frac{\text{adj}M}{|M|} = \frac{\begin{bmatrix} * & * & * \\ * & * & 2 \\ * & * & * \end{bmatrix}}{-2} = \begin{bmatrix} * & * & * \\ * & * & -1 \\ * & * & * \end{bmatrix}$$

$\therefore$ $n_{23} = -1$

(Need not evaluate the remaining terms)

19. (C)

Put $(\log x)^2 = t \Rightarrow 2\log x . \frac{1}{x}\, dx = dt$

$\therefore \int \frac{\sin(\log x)^2}{x}\log x\, dx = \frac{1}{2}\int \sin t\, dt$

$= \frac{1}{2}(-\cos t) + c = -\frac{1}{2}\cos(\log x)^2 + c$

20. (D)

$c^2\sin 2B + b^2\sin 2C$

$= c^2(2\sin B\cos B) + b^2(2\sin C\cos C)$

Since $\Delta = \frac{1}{2}ac\sin B = \frac{1}{2}ab\sin C$

$\therefore \quad \sin B = \frac{2\Delta}{ac}, \sin C = \frac{2\Delta}{ab}$

$\therefore \quad c^2\sin 2B + b^2\sin 2C$

$= 2c^2\left(\frac{2\Delta}{ac}\cos B\right) + 2b^2\left(\frac{2\Delta}{ab}\cos C\right)$

$= 4\Delta\left(\frac{c\cos B + b\cos C}{a}\right)$

$= 4\Delta\left(\frac{a}{a}\right)$ ...[by projection rule]

$= 4\Delta$

21. (A)

$\bar{a}\times(\bar{b}\times\bar{c}) + \bar{b}\times(\bar{c}\times\bar{a}) + \bar{c}\times(\bar{a}\times\bar{b})$

$= \left[(\bar{a}\cdot\bar{c})\bar{b} - (\bar{a}\cdot\bar{b})\bar{c}\right] + \left[(\bar{b}\cdot\bar{a})\bar{c} - (\bar{b}\cdot\bar{c})\bar{a}\right]$
$+ \left[(\bar{c}\cdot\bar{b})\bar{a} - (\bar{c}\cdot\bar{a})\bar{b}\right]$

$= (\bar{a}\cdot\bar{c})\bar{b} - (\bar{a}\cdot\bar{b})\bar{c} + (\bar{a}\cdot\bar{b})\bar{c} - (\bar{b}\cdot\bar{c})\bar{a}$
$+ (\bar{b}\cdot\bar{c})\bar{a} - (\bar{a}\cdot\bar{c})\bar{b}$

$= 0$

22. (B)

$\bar{r} = (\hat{i} + 2\hat{j} + \hat{k}) + \lambda(\hat{i} - \hat{j} + \hat{k})$

and $\bar{r} = (2\hat{i} - \hat{j} - \hat{k}) + \mu(2\hat{i} + \hat{j} + 2\hat{k})$

Here, $\bar{a_1} = \hat{i} + 2\hat{j} + \hat{k}$, $\quad \bar{b_1} = \hat{i} - \hat{j} + \hat{k}$,

$\bar{a_2} = 2\hat{i} - \hat{j} - \hat{k}$, $\quad \bar{b_2} = 2\hat{i} + \hat{j} + 2\hat{k}$

Now, $\bar{a_2} - \bar{a_1} = \hat{i} - 3\hat{j} - 2\hat{k}$

and $\bar{b_1}\times\bar{b_2} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -1 & 1 \\ 2 & 1 & 2 \end{vmatrix}$

$= \hat{i}(-2-1) - \hat{j}(2-2) + \hat{k}(1+2)$

$= -3\hat{i} + 3\hat{k}$

$\therefore \quad (\bar{a_2} - \bar{a_1})\cdot(\bar{b_1}\times\bar{b_2}) = (\hat{i} - 3\hat{j} - 2\hat{k})\cdot(-3\hat{i} + 3\hat{k})$

$= 1(-3) - 3(0) - 2(3) = -9$

$|\bar{b_1}\times\bar{b_2}| = \sqrt{(-3)^2 + 0^2 + 3^2}$

$= \sqrt{18}$

$= 3\sqrt{2}$

$\therefore$ Shortest distance $= \left|\frac{(\bar{a_2} - \bar{a_1})\cdot(\bar{b_1}\times\bar{b_2})}{|\bar{b_1}\times\bar{b_2}|}\right|$

$= \left|\frac{-9}{3\sqrt{2}}\right| = \frac{3}{\sqrt{2}}$ units

23. **(D)**

The equation of the circle is $x^2 + y^2 = 25$

$\therefore$ radius a = 5

Let P ≡ (7, –1)

Let the equation of a tangent to the given circle from P be

$y = mx \pm a\sqrt{1+m^2}$

$\therefore$ $y = mx \pm 5\sqrt{1+m^2}$

As P(7, –1) lies on tangent, we have

$-1 = 7m \pm 5\sqrt{1+m^2}$

$\Rightarrow (7m + 1)^2 = 25(1 + m^2)$

$\Rightarrow 49m^2 + 1 + 14m = 25 + 25m^2$

$\Rightarrow 24m^2 + 14m - 24 = 0$

$\Rightarrow 12m^2 + 7m - 12 = 0$

$\Rightarrow m = \frac{3}{4}, -\frac{4}{3}$

Let $m_1 = \frac{3}{4}$ and $m_2 = -\frac{4}{3}$

Then, $m_1m_2 = -1$

Hence, the angle between the tangents is $\frac{\pi}{2}$.

24. **(A)**

Given, $\tan^{-1}x + 2\cot^{-1}x = \frac{5\pi}{6}$

$\Rightarrow \tan^{-1}x + \cot^{-1}x + \cot^{-1}x = \frac{5\pi}{6}$

$\Rightarrow \cot^{-1}x = \frac{5\pi}{6} - \frac{\pi}{2}$ $\quad \ldots\left[\because \tan^{-1}x + \cot^{-1}x = \frac{\pi}{2}\right]$

$\Rightarrow \cot^{-1}x = \frac{\pi}{3}$

$\Rightarrow x = \cot\frac{\pi}{3}$

$\Rightarrow x = \frac{1}{\sqrt{3}}$

25. **(B)**

Let $I = \int_0^{\frac{\pi}{2}} \frac{\cos x}{(4+\sin x)(3+\sin x)}dx$

Put $\sin x = t \Rightarrow \cos x\, dx = dt$

$\therefore$ $I = \int_0^1 \frac{dt}{(4+t)(3+t)}$

$= -\int_0^1 \frac{1}{4+t}dt + \int_0^1 \frac{1}{3+t}dt$

$= -\left[\log|4+t|\right]_0^1 + \left[\log|3+t|\right]_0^1$

$= -(\log 5 - \log 4) + (\log 4 - \log 3)$

$= -\log\frac{5}{4} + \log\frac{4}{3}$

$\therefore$ $I = \log\left(\frac{16}{15}\right)$

26. **(A)**

Range = L – S = 49 – 7 = 42

27. **(D)**

Let $y = \sqrt{x^2+1}$

$\therefore$ $\frac{dy}{dx} = \frac{1}{2\sqrt{x^2+1}}.\frac{d}{dx}\left(x^2+1\right)$

$= \frac{2x}{2\sqrt{x^2+1}}$

$= \frac{x}{\sqrt{x^2+1}}$

28. **(B)**

Probability of getting head is $p = \frac{1}{2}$

$\therefore$ $q = 1 - p = 1 - \frac{1}{2} = \frac{1}{2}$

Also, n = 10

$\therefore$ Required probability = P (X = 6)

$= {}^{10}C_6\left(\frac{1}{2}\right)^6\left(\frac{1}{2}\right)^4$

$= \frac{105}{512}$

29. **(D)**

$f(x) = 9 - x^5 - x^7 \Rightarrow f'(x) = -5x^4 - 7x^6$

$\Rightarrow$ $f'(x) < 0$ for all values of x.

30. **(C)**

The symbolic form of circuit is

$(\sim p \vee q) \wedge (\sim p \vee \sim q)$

$\equiv \sim p \vee (q \wedge \sim q)$ …[De Morgan's law]

$\equiv \sim p \vee F$ …[Complement law]

$\equiv \sim p$ …[Identity law]

31. **(B)**

The straight line $x\cos\alpha + y\sin\alpha = p$ meets the X-axis at the point $A\left(\frac{p}{\cos\alpha}, 0\right)$ and the Y-axis at the point $B\left(0, \frac{p}{\sin\alpha}\right)$.

Let (h, k) be the co-ordinates of the middle point of the line segment AB.

Then, $h = \frac{p}{2\cos\alpha}$ and $k = \frac{p}{2\sin\alpha}$

$\Rightarrow \cos\alpha = \frac{p}{2h}$ and $\sin\alpha = \frac{p}{2k}$

$\cos^2\alpha + \sin^2\alpha = \frac{p^2}{4h^2} + \frac{p^2}{4k^2}$

$\Rightarrow 1 = \frac{p^2}{4}\left(\frac{1}{h^2} + \frac{1}{k^2}\right)$

$\Rightarrow \frac{1}{h^2} + \frac{1}{k^2} = \frac{4}{p^2}$

Hence, locus of the point (h, k) is

$\frac{1}{x^2} + \frac{1}{y^2} = \frac{4}{p^2}$.

32. **(B)**

$x = e^{2y}$

$\therefore \quad \dfrac{dx}{dy} = 2e^{2y}$

$\therefore \quad \dfrac{d^2x}{dy^2} = 4e^{2y}$

Now, $x = e^{2y}$

$\therefore \quad \log x = 2y$

$\therefore \quad y = \dfrac{1}{2}\log x$

$\therefore \quad \dfrac{dy}{dx} = \dfrac{1}{2x}$

$\therefore \quad \dfrac{d^2x}{dy^2} = \dfrac{-1}{2x^2} = \dfrac{-1}{2\left(e^{2y}\right)^2}$

$\therefore \quad \dfrac{d^2y}{dx^2} \times \dfrac{d^2x}{dy^2} = \dfrac{-2}{e^{2y}} = -2e^{-2y}$

33. **(B)**

$$P(0.2 \le X \le 0.3) = \int_{0.2}^{0.3} \frac{x^3}{16}\, dx = \left[\frac{x^4}{64}\right]_{0.2}^{0.3}$$

$$= \frac{1}{64}\left[(0.3)^4 - (0.2)^4\right]$$

$$= \frac{0.0081 - 0.0016}{64}$$

$$= \frac{0.0065}{64}$$

34. **(D)**

$|z_1| = 1, |z_2| = 2, |z_3| = 3$

$\Rightarrow z_1\overline{z_1} = 1,\ z_2\overline{z_2} = 4,\ z_3\overline{z_3} = 9$

$|9z_1z_2 + 4z_1z_3 + z_2z_3| = 12$

$\Rightarrow |z_3\overline{z_3}\,z_1z_2 + z_2\overline{z_2}\,z_1z_3 + z_1\overline{z_1}\,z_2z_3| = 12$

$\Rightarrow |z_1z_2z_3|\,|\overline{z_3} + \overline{z_2} + \overline{z_1}| = 12$

$\Rightarrow |z_1 + z_2 + z_3| = 2$

35. **(A)**

Since $(p \wedge \sim r) \rightarrow (\sim p \vee q) \equiv F$

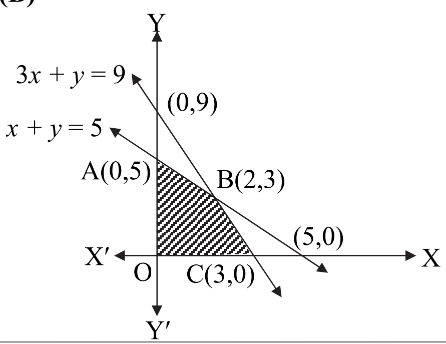
$\Rightarrow (p \wedge \sim r) \equiv T$ and $(\sim p \vee q) \equiv F$

$\Rightarrow p \equiv T, \sim r \equiv T$ and $\sim p \equiv F, q \equiv F$

$\Rightarrow p \equiv T,\ q \equiv F, r \equiv F$

$\therefore$ The truth values of p, q and r are T, F, F respectively.

36. **(B)**



The feasible region lies on origin side of lines $x + y = 5$ and $3x + y = 9$, in first quadrant.

$\therefore$ The corner points of feasible region are O (0, 0), A (0, 5), B (2, 3) and C (3, 0)

$\therefore$ Maximum value of objective function $z = 4x + 13y$ is at A (0, 5)

$\therefore \quad z = 4(0) + 13(5) = 65$

37. **(C)**

$$\lim_{x\to 3} \frac{x^5 - 243}{x^3 - 27} = \lim_{x\to 3} \frac{x^5 - 3^5}{x^3 - 3^3}$$

$$= \frac{5}{3}(3)^{5-3}$$

$$= 15 \qquad \ldots\left[\because \lim_{x\to a}\frac{x^m - a^m}{x^n - a^n} = \frac{m}{n}a^{m-n}\right]$$

38. **(D)**

$-1 \le \log_2(x^2 + 5x + 8) \le 1$

$\Rightarrow \dfrac{1}{2} \le (x^2 + 5x + 8) \le 2$

$\Rightarrow x^2 + 5x + \dfrac{15}{2} \ge 0$

$\Rightarrow x^2 + 2\left(\dfrac{5}{2}\right)x + \left(\dfrac{5}{2}\right)^2 - \left(\dfrac{5}{2}\right)^2 + \dfrac{15}{2} \ge 0$

$\Rightarrow \left(x + \dfrac{5}{2}\right)^2 + \dfrac{5}{4} \ge 0$ and $x^2 + 5x + 6 \le 0$

$\Rightarrow (x + 3)(x + 2) \le 0 \Rightarrow x \in [-3, -2]$

39. **(A)**

Let A, P and x be the area, perimeter and length of the side of the square respectively at time t seconds. Then, $A = x^2$ and $P = 4x$

$\therefore \quad P = 4\sqrt{A}$

$\therefore \quad \dfrac{dP}{dt} = 4.\dfrac{1}{2\sqrt{A}}.\dfrac{dA}{dt}$

$\qquad = \dfrac{2}{x}.\dfrac{dA}{dt} = \dfrac{2}{12}.3 = \dfrac{1}{2}\text{cm / sec}$

40. **(C)**

Equation of the required angle bisector is

$$\frac{x + 2y + 3z - 1}{\sqrt{1+4+9}} = \pm\frac{3x + y + 2z - 2}{\sqrt{9+1+4}}$$

$\Rightarrow x + 2y + 3z - 1 = 3x + y + 2z - 2$

OR

$x + 2y + 3z - 1 = -3x - y - 2z + 2$

$\Rightarrow 2x - y - z = 1 \qquad$ OR $\qquad 4x + 3y + 5z = 3$

Shortcut - 40

Equation of angle bisector of the two planes $a_1x + b_1y + c_1z + d_1 = 0$ and $a_2x + b_2y + c_2z + d_2 = 0$ is

$$\frac{a_1x + b_1y + c_1z + d_1}{\sqrt{a_1^2 + b_1^2 + c_1^2}} = \pm\frac{a_2x + b_2y + c_2z + d_2}{\sqrt{a_2^2 + b_2^2 + c_2^2}}$$

41. (B)

$$\frac{d^4y}{dx^4} + \sqrt{1+\left(\frac{dy}{dx}\right)^4} = 0$$

$$\Rightarrow \left(\frac{d^4y}{dx^4}\right)^2 = \left[-\sqrt{1+\left(\frac{dy}{dx}\right)^4}\right]^2$$

$$\Rightarrow \left(\frac{d^4y}{dx^4}\right)^2 = 1+\left(\frac{dy}{dx}\right)^4$$

Here, the highest order derivative is $\frac{d^4y}{dx^4}$ with power 2.

$\therefore$ degree = 2

42. (A)

Required number of arrangements
= (Total number of arrangements)
– (Number of arrangements in which N's are together)

$= \frac{6!}{2!\times 3!} - \frac{5!}{3!}$

= 60 – 20 = 40

43. (B)

Let the coordinates of P be (x_1, y_1).

Then, $y_1 = 3x_1^2 - 2x_1 + 1$ ...(i)

Now, $y = 3x^2 - 2x + 1$

$\therefore \frac{dy}{dx} = 6x - 2$

$\therefore \left(\frac{dy}{dx}\right)_{(x_1, y_1)} = 6x_1 - 2$

Slope of the given line is 4.
Since the tangent is parallel to the given line, slope of the tangent = 4

$\Rightarrow 6x_1 - 2 = 4$

$\Rightarrow x_1 = 1$

From (i), $y_1 = 2$

$\therefore$ The coordinates of P are (1, 2).

44. (B)

Since $\sum_{x=0}^{3} P(X = x) = 1$,

$\frac{1}{10} + \frac{1}{2} + \frac{1}{5} + k = 1$

$\Rightarrow k + \frac{1+5+2}{10} = 1$

$\Rightarrow k = 1 - \frac{4}{5} = \frac{1}{5}$

45. (C)

Since, $f(x)$ is continuous for all x in R.

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

$\therefore$ $f(0) = \lim_{x\to 0^-} f(x)$

$\Rightarrow q = \lim_{x\to 0} \frac{\sin(p+1)x + \sin x}{x}$

$\Rightarrow q = \lim_{x\to 0}\left[(p+1)\times\frac{\sin(p+1)x}{(p+1)x} + \frac{\sin x}{x}\right]$

$\Rightarrow q = (p + 1) + 1$

$\Rightarrow q = p + 2$

The values of p and q in option (C) satisfies this condition.

46. (D)

$\int f(x).g(x)dx = \int x^2.\sin x\,dx$

$= -x^2 \cos x + \int 2x\cos x\,dx$

$= -x^2 \cos x + 2(x \sin x + \cos x) + c$

$= -x^2 \cos x + 2x \sin x + 2\cos x + c$

47. (B)

$\cot\left(\frac{A-B}{2}\right).\tan\left(\frac{A+B}{2}\right)$

$= \frac{\cos\left(\frac{A-B}{2}\right)}{\sin\left(\frac{A-B}{2}\right)}.\frac{\sin\left(\frac{A+B}{2}\right)}{\cos\left(\frac{A+B}{2}\right)}$

$= \frac{2\sin\left(\frac{A+B}{2}\right).\cos\left(\frac{A-B}{2}\right)}{2\cos\left(\frac{A+B}{2}\right).\sin\left(\frac{A-B}{2}\right)}$

$= \frac{\sin A + \sin B}{\sin A - \sin B}$

$= \frac{a+b}{a-b}$ ….[by sine rule]

48. (C)

$\left(\bar{a}\times\bar{b}\right)^2 = \begin{vmatrix} \bar{a}.\bar{a} & \bar{a}.\bar{b} \\ \bar{a}.\bar{b} & \bar{b}.\bar{b} \end{vmatrix} = \bar{a}^2\,\bar{b}^2 - \left(\bar{a}.\bar{b}\right)^2$

Shortcut - 48

If $\bar{a}$, $\bar{b}$ are two vectors, then $\left(\bar{a}\times\bar{b}\right)^2 = \begin{vmatrix} \bar{a}.\bar{a} & \bar{a}.\bar{b} \\ \bar{a}.\bar{b} & \bar{b}.\bar{b} \end{vmatrix}$

49. (B)

Let $f(x) = \sin x$

$\therefore$ $f'(x) = \cos x$

Here, a = 30° and h = 1° = 0.0175^c

$\therefore$ $f(a + h) \approx f(a) + h f'(a)$

$\approx \frac{1}{2} + 0.0175 \times 0.8660$

$\approx 0.5 + 0.01515$

$\therefore$ $\sin(31°) \approx 0.51515$

≈ 0.5152

50. (D)

Required area $= \int_1^3 x^4\,dx = \left[\frac{x^5}{5}\right]_1^3 = \frac{242}{5}$ sq. units

Published by:

Target Publications® Pvt. Ltd.

Transforming lives through learning

B2, 9th Floor, Ashar, Road No. 16/Z, Wagle Industrial Estate, Thane (W)-400604 | 88799 39712 / 14 | 88799 39713 / 15

www.targetpublications.org   mail@targetpublications.org