MHT CET – 2021

24th September (Shift - 1)

Section I

PHYSICS

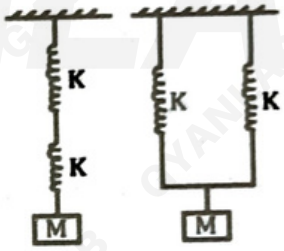
1. Two identical particles each of mass 'm' are separated by a distance 'd'. The axis of rotation passes through the midpoint of 'd' and is perpendicular to the length d. If 'K' is the average rotational kinetic energy of the system, then the angular frequency is

(A) $2d\sqrt{\frac{m}{K}}$ (B) $\frac{d}{2}\sqrt{\frac{K}{m}}$ (C) $\frac{2}{d}\sqrt{\frac{K}{m}}$ (D) $\frac{d}{4}\sqrt{\frac{m}{K}}$

2. An electron makes a transition from an excited state to the ground state of a hydrogen like atom. Out of the following statements which one is correct?
(A) Kinetic energy, potential energy and total energy decreases
(B) Kinetic energy and total energy decreased but potential energy increases
(C) Kinetic energy increases but potential energy and total energy decreases
(D) Kinetic energy decreases, potential energy increases but total energy remains the same.

3. If the horizontal velocity given to a satellite is greater than critical velocity but less than the escape velocity at the height, then the satellite will
(A) be lost in space
(B) falls on the earth along parabolic path
(C) revolve in circular orbit
(D) revolve in elliptical orbit

4. Two identical springs of constant 'K' are connected in series and parallel in shown in figure. A mass 'M' is suspended from them. The ratio of their frequencies is series to parallel combination will be



(A) 1 : 2 (B) 1 : 4
(C) 4 : 1 (D) $1:\sqrt{2}$

5. The radii of curvature of both the surfaces of a convex lens of focal length 'f' and focal power 'P' are equal. One of the surfaces is made plane by grinding. The new focal length and focal power of the lens is respectively

(A) $\frac{1}{2}, 2$ (B) $2f, \frac{P}{2}$ (C) $\sqrt{\frac{2}{f}}, \sqrt{\frac{P}{2}}$ (D) $\frac{2f}{3}, \frac{2}{3}P$

6. A photon has wavelength 3 nm, then its momentum and energy respectively will be
[$h = 6.63 \times 10^{-34}$ Js, c = velocity of light = 3×10^8 m/s]
(A) 2.21×10^{-43} kg ms^{-1}; 6.63×10^{-34} J (B) 2.21×10^{-34} kg ms^{-1}; 6.63×10^{-25} J
(C) 2.21×10^{-25} kg ms^{-1}; 6.63×10^{-17} J (D) 2.21×10^{-16} kg ms^{-1}; 6.63×10^{-19} J

7. A stone is projected vertically upwards with velocity 'V. Another stone of same mass is projected at an angle fo 60° with the vertical with the same speed (V). The ratio of their potential energies at the highest points of their journey, is

[$\sin 30° = \cos 60° = 0.5$, $\cos 30° = \sin 60° = \frac{\sqrt{3}}{2}$]

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

8. A glass slab has refractive index 'μ' with respect to air and the critical angle for a ray of light in going from glass to glass to air is 'θ' If a ray of light is incident from air on the glass with angle of incidence 'θ', then the corresponding angle of refraction is

(A) $\sin^{-1}\left(\frac{1}{\sqrt{\mu}}\right)$ (B) $\sin^{-1}\left(\frac{1}{\mu}\right)$ (C) $\sin^{-1}\left(\frac{1}{\mu^2}\right)$ (D) 90^o

9. A glass tube of uniform cross–section is connected to a tap with a rubber tube. The tap is opened slowly. Initially the flow of water in the tube is streamline. The speed of flow of water to convert it into a turbulent flow is

[radius of tube = 1 cm, $\eta = 1\times10^{-3}\frac{Ns}{m^2}$, $R_n = 2500$ and density of water = 10^3 kg/m^3]

(A) 0.15 m/s (B) 0.125 m/s (C) 0.3 m/s (D) 0.2 m/s

10. A sonometer wire of length 25 cm vibrates in unison with a tuning fork. When its length is decreased by 1 cm, 6 beats are heard per second. What is the frequency of the tuning fork?

(A) 200 Hz (B) 72 Hz (C) 100 Hz (D) 144 Hz

11. The plates of a parallel plate capacitor of capacity 'C_1' are moved closer together until they are half their original separation. The new capacitance 'C_2' is

(A) $C_2 = \frac{C_1}{2}$ (B) $C_2 = C_1$ (C) $C_2 = 2\,C_1$ (D) $C_2 = 3\,C_1$

12. A p–n junction photodiode is fabricated from a semiconductor with a band gap of 2.5 eV. It can detect a signal of wavelength

[Planck's constant = 6.6×10^{-34} Js, $c = 3\times10^8$ m/s, $e = 1.6\times10^{-19}$ C]

(A) 6000 nm (B) 6000 Å (C) 5000 Å (D) 4000 nm

13. Two tuning forks of frequencies 320 Hz and 480 Hz are sounded together to produce sound waves. The velocity of sound in air is 320 ms^{-1}. The difference between wavelengths of these waves is nearly

(A) 48 cm (B) 16.5 cm (C) 33 cm (D) 42 cm

14. A monoatomic ideal gas initially at temperature T_1 is enclosed in a cylinder fitted with a frictionless piston. The gas is allowed to expand adiabatically to a temperature T_2 by releasing the piston suddenly. L_1 and L_2 are the lengths of the gas columns before and after the expansion respectively. Then $\frac{T_2}{T_1}$ is

(A) $\left(\frac{L_2}{L_1}\right)^{2/3}$ (B) $\left(\frac{L_1}{L_2}\right)^{2/3}$ (C) $\left(\frac{L_1}{L_2}\right)^{1/2}$ (D) $\left(\frac{L_2}{L_1}\right)^{1/2}$

15. For a monoatomic gas, the work done at constant pressure is 'W' The heat supplied at constant volume for the same rise in temperature of the gas is

$\left[\gamma = \frac{C_p}{C_v} = \frac{5}{2} \text{ for monoatomic gas}\right]$

(A) 2W (B) W (C) $\frac{W}{2}$ (D) $\frac{3W}{2}$

16. A thin metal disc of radius 'r' floats on water surface and bends the surface downwards along the perimeter making an angle 'θ' with the vertical edge of the dsic. If the weight of water displaced by the disc is 'W', the weight of the metal disc is

[T = surface tension of water]

(A) $2\pi rT\cos\theta + W$ (B) $W - 2\pi rT\cos\theta$ (C) $2\pi rT + W$ (D) $2\pi rT\cos\theta - W$

17. A particle performing linear S.H.M. of amplitude 0.1 m has displacement 0.02 m and acceleration 0.5 m/s^2. The maximum velocity of the particle in m/s is
(A) 0.05 (B) 0.50 (C) 0.01 (D) 0.25

18. The electric field intensity on the surface of a charged solid sphere of radius 'r' and volume charge dentiy'ρ' is given by
(ϵ_0 = permittivity of free space)
(A) zero (B) $\frac{\sigma r}{3\epsilon_0}$ (C) $\frac{1}{4\pi\epsilon_0}\frac{\sigma}{r}$ (D) $\frac{5\sigma r}{6\epsilon_0}$

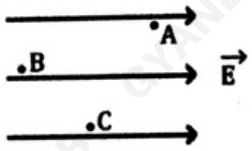
19. A step up transformer operates on 220 V and supplies current of 2 A. The ratio of primary and secondary windings is 1 : 20. The current in the primary is
(A) 5 A (B) 2 A (C) 40 A (D) 20 A

20. The ratio of maximum to minimum wavelength in Balmer series of hydrogen atom is
(A) 36 : 5 (B) 3 :4 (C) 9 : 5 (D) 5 :9

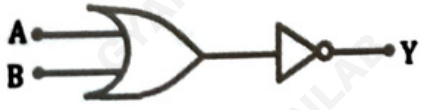
21. The work done in blowing a soap bubble of volume 'V' is 'W'. The work required to blow a soap bubble of volume '2V' is [T = surface tension of soap solution]
(A) $2^{2/3}$ W (B) 2W (C) W (D) $2^{1/3}$ W

22. A current carrying loop is placed in a uniform magnetic field. The torque acting on the loop does not depend upon
(A) area of loop
(B) number of turns in the loop
(C) shape of the loop
(D) strength of the magnetic field

23. Let A, B and C be the three points in a uniform electric field ($\vec{E}$) as shown. The electric potential is
(A) maximum at point C
(B) maximum at point A
(C) maximum at point B
(D) same at all points A, B and C



24. For the output of the following logic circuit to be '1', the values of inputs A and B should be respectively



(A) 0 and 1 (B) 0 and 0 (C) 1 and 1 (D) 1 and 0

25. In photoelectric experiment keeping the frequency of incident radiation and accelerating potential fixed, if the intensity of incident light is increased,
(A) photoelectric current decreases
(B) kinetic energy of emitted photoelectrons decreases
(C) photoelectric current increases
(D) kinetic energy of emitted photoelectrons increases

26. In Young's double slit experiment, in an interference pattern, a minimum is observed exactly in front of one slit. The distance between the two coherent sources is 'd' and 'D' is the distance between the source and screen. The possible wavelengths used are inversely proportional to

(A) D, 5D, 9D, ... (B) D, 3D, 5D,... (C) 3D, 4D, 5D,... (D) 3D, 7D, 10D,...

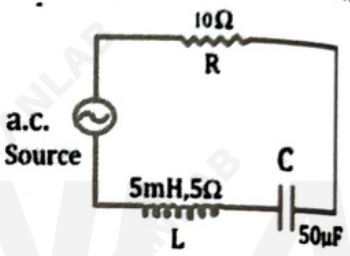
27. A beam of light having wavelength 5400 Å from a distant source falls on a single slit 0.96 mm wide and the resultant diffraction pattern is observed on a screen 2 m away. What is the distance between the first dark fringe on either side of central bright fringe?

(A) 4.8 mm (B) 1.2 mm (C) 2.4 nm (D) 3.6 mm

28. In the part of an a.c. circuit as shown, the resistance R = 0.2 Ω. At a certain instant $(V_A - V_B) =$ 0.5 V, I = 0.5 A and $\frac{\Delta I}{\Delta t} = 8\,A/s$. The inductance of the coil is

(A) 0.04 H (B) 0.02 H (C) 0.08 H (D) 0.05 H

29. In the circuit shown in the figure, a.c. source gives voltage V = 20 cos(2000 t). Impedance and r.m.s current respectively will be



(A) 10 Ω, 0.5 A

(B) 5 Ω, 2 A

(C) 10 Ω, $\sqrt{2}$ A

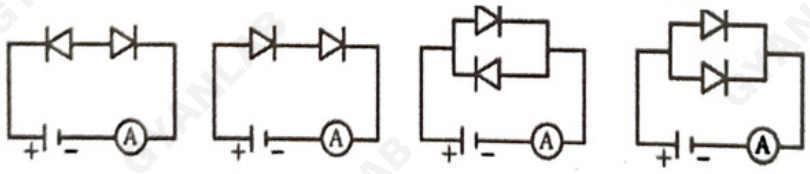
(D) 5 Ω, 1 A

30. When an air column in a pipe open at both ends vibrates such that four antinodes and three nodes are formed, then the corresponding mode of vibration is

(A) first overtone (B) second overtone

(C) fourth overtone (D) third overtone

31. Two identical ideal diodes are connected to an ammeter and a d.c source (1 volt) as shown. In which one of the following circuits, ammeter will not show any deflection?



(a) (b) (c) (d)

(A) (d) (B) (a) (C) (b) (D) (c)

32. The period of revolution of planet A around the sun is 8 times that of planet B. How many times the distance of A from the sun is greater than that of B from the sun?

(A) 5 times (B) 2 times (C) 3 times (D) 6 times

33. Two identical capacitors have the same capacitance 'C'. One of them is charged to potential 'V_1' and the other to V_2. The negative ends of the capacitors are connected together. When positive ends are also connected, the decrease in energy of the combined system is

(A) $\frac{1}{4}C(V_1 - V_2)^2$ (B) $\frac{1}{2}C\left(V_1^2 + V_2^2\right)$ (C) $\frac{1}{2}C\left(V_1^2 - V_2^2\right)$ (D) $\frac{1}{2}C(V_1 + V_2)^2$

34. A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring balance reads 49 N, when the lift is stationary. If the lift moves downward with an acceleration of 5 m/s^2, the reading of the spring balance will be ($g = 9.8\ m/s^2$)

(A) 74 N (B) 15 N (C) 24 N (D) 49 N

35. In a potentiometer experiement, when three cells A, B and C are connected in series, the balancing length is found to be 420 cm. If cells A and B are connected in series the balancing length is 220 cm and for cells B and C connected in series in balanceing length is 320 cm. The emf of cells A, B and C are respectively in the ratio of

(A) 2 : 3 : 5 (B) 5 : 4 : 3 (C) 1 : 1.2 : 2 (D) 1.2 : 1 : 2

36. A current 'I' is flowing in a conductor of length 'L' when it is bent in the form of a circular loop, its magnetic moment will be

(A) $\frac{IL}{4\pi^2}$ (B) $4\pi L^2$ (C) $\frac{4\pi}{IL^2}$ (D) $\frac{IL^2}{4\pi}$

37. Two long conductors, separated by a distance 'd' carry currents 'I_1' and 'I_2' in the same directions. 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 '3d'. The new value of the force between them is

(A) $-2F$ (B) $-F$ (C) $-\frac{2F}{3}$ (D) $\frac{F}{3}$

38. A body attached to one end of a string perfoms motion along a vertical circle. Its centripetal acceleration, when the string is horizontal, will be
[g = acceleration due to gravity]

(A) zero (B) 5g (C) 3g (D) g

39. A coil has an area 0.06 m^2 and it has 600 turns. After placing the coil in a magnetic field of strength $5 \times 10^{-5}\ Wbm^{-2}$, it is rotated through 90° in 0.2 second. The magnitude of average e.m.f induced in the coil is
[$\cos0° = \sin90° = 1$ and $\sin0° = \cos90° = 0$]

(A) 12×10^{-3} V (B) 3 mV (C) 3 V (D) 9×10^{-3} V

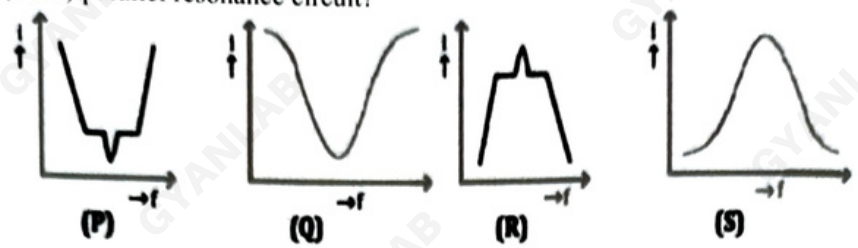
40. If the current of 'I' A gives rise to a magnetic flux 'ϕ' through a coil having 'N' turns then mangetic energy stored in the medium surrounding the coil is

(A) $\frac{N\phi I}{4}$ (B) $\frac{N\phi I}{2}$ (C) $\frac{NI}{2\phi}$ (D) $\frac{N\phi}{2I}$

41. An ideal gas with pressure P, volume V and temperature T is expanded isothermally to a volume 2 V and a final pressure P_i. The same gas is expanded adiabatically to a volume 2V, the final pressure is P_a. In terms of the ratio of the two specific heats for the gas 'γ', the ratio $\frac{P_i}{P_a}$ is

(A) $2^{\gamma+1}$ (B) $2^{\gamma-1}$ (C) $2^{1-\gamma}$ (D) 2^{γ}

42. Which graph shows the correct variation of r.m.s. current 'I' with frequency 'f' of a.c. in case of (LCR) parallel resonance circuit?



(A) Q (B) P (C) R (D) S

43. At what temperature does the average translational kinetic energy of a molecule in a gas becomes equal to kinetic energy of an electron accelerated from rest through potential difference of 'V' volt?
(N = number of molecules, R = gas constant, c = electronic charge)

(A) $\frac{2eVN}{3R}$ (B) $\frac{eVN}{R}$ (C) $\frac{eVN}{4R}$ (D) $\frac{3eVN}{2R}$

44. The temperature difference between two sides of an iron plate, 1.8 cm thick is 9°C. Heat is transmitted through the plate 10 k cal/sm^2 at steady state. The thermal conductivity of iron is

(A) 0.02 $\frac{kcal}{ms\,^\circ C}$ (B) 0.04 $\frac{kcal}{ms\,^\circ C}$ (C) 0.05 $\frac{kcal}{ms\,^\circ C}$ (D) 0.004 $\frac{kcal}{ms\,^\circ C}$

45. Internal energy of n_1 moles of hydrogen at temperature 'T' is equal to internal energy of 'n_2' moles of helium at temperature 2T, then the ratio $n_1 : n_2$ is
[Degree of freedom of He = 3, Degreee of freedom of H_2 = 5]

(A) 5 : 3 (B) 6:5 (C) 2 : 3 (D) 3 : 5

46. A body of mass 'm' and radius of gyration 'K' has an angular momentum L. Its angular velocity is

(A) $\frac{K^2}{mL}$ (B) mK^2L (C) $\frac{mK^2}{L}$ (D) $\frac{L}{mK^2}$

47. Two beams of light having intensities I and 4I interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\pi/2$ at point A and π at point B. Then the difference between the resultatnt intensities at A and B is

(A) 4I (B) 5I (C) 2I (D) 3I

48. A body is executing S.H.M. under the action of force having maximum magntidue 50 N. When its energy is half kinetic and half potential, the magnitude of the force acting on the particle is

(A) $\frac{25}{\sqrt{2}}$N (B) 50 N (C) 25 N (D) $25\sqrt{2}$ N

49. The peak value of an alternating emf 'e' given by $e = e_0\cos\omega t$ is 10 volt and its frequency is 50 Hz. At time $t = \frac{1}{600}$s, the instantaneous e.m.f is $\left(\cos\frac{\pi}{6} = \sin\frac{\pi}{3} = \frac{\sqrt{3}}{2}\right)$

(A) 10 V (B) $\frac{1}{\sqrt{3}}$V (C) 5 V (D) $5\sqrt{3}$ V

50. The wavelength of sound in any gas depends upon

(A) intensity of sound waves only (B) density and elasticity of the gas
(C) wavelength of sound only (D) amplitude and frequency of sound

CHEMISTRY

51. Which among the following cations will form lowest stability complex if the ligand remains the same?
(A) Cu^{2+} (B) Fe^{2+} (C) Cd^{2+} (D) Ni^{2+}

52. Identify the change in colour when NaCl solution is titrated against $AgNO_3$ solution using fluorescein indicator.
(A) Colourless to reddish pink
(B) Pale yellow to reddish pink
(C) Reddish pink to colourless
(D) Colourless to pale yellow

53. The resistance of 0.2 M solution of an electrolyte is 30 ohm and conductivity is 1.2 S m^{-1}. What is the value of cell constant?
(A) 0.47 cm^{-1} (B) 0.1 cm^{-1} (C) 0.36 cm^{-1} (D) 0.2 cm^{-1}

54. Which from the following alloys is used in gas turbine engines?
(A) Titanium alloy (B) Cupra – nickel (C) Stainless steel (D) Nichrome

55. What is percent dissociation of acetic acid in it's 0.01 M solution if dissociation of acid is 1.34×10^{-2} ?
(A) 13.4 % (B) 4.02 % (C) 2.68 % (D) 1.34 %

56. How many molecules are present in 22400 cm^3 of a gas at STP ?
(A) 22.4×10^{20} (B) 6.022×10^{23} (C) 6.022×10^{20} (D) 22.4×10^{23}

57. Calculate osmotic pressure exerted by a solution containing 0.822 g of solute in 300 mL of water at 300 K.
(Molar mass of solute = 340 g mol^{-1}, R = 0.0821 L atm mol^{-1} K^{-1})
(A) 0.5 atm (B) 0.2 atm (C) 0.1 atm (D) 0.4 atm

58. The pH of monoacidic weak base is 10.9. Calculate the percent dissociation in 0.02 M solution.
(A) 7.92% (B) 3.95% (C) 6.25% (D) 2.51%

59. Crotonyl alcohol is an example of
(A) benzylic alcohol
(B) polyhydric alcohol
(C) allylic alcohol
(D) vinylic alcohol

60. Which among the following is haloalkyne?
(A) Halogen atom is bonded to sp^2 hybridized carbon atom of aromatic a ring.
(B) Halogen atom is bonded to sp^3 hybridized carbon atom next to C=C double bond in aliphatic chain.
(C) Halogen atom is bonded to sp hybridized carbon atom in aliphatic chain.
(D) Halogen atom is bonded to sp^2 hybridized carbon atom in aliphatic chain.

61. Which among the following is a formula of mustard gas?
(A) $SOCl_2$ (B) $COCl_2$ (C) $S(CH_2CH_2Cl)_2$ (D) CCl_3NO_2

62. Identify basic α–amino acid from following.
(A) Alanine (B) Lysine (C) Asparagine (D) Glycine

63. A gas is allowed to expand against a constant external pressure of 2.5 bar from an initial volume 'x' L to final volume of 4.5 L. If amount of work done is 5 dm^3 bar, what is the value of 'x'?

(A) 2.5 L (B) 4.5 L (C) 6.0 L (D) 1.2

64. Identify the species from following that exhibits no bond resonance.

(A) CH_3CH_2Br (B) $CH_3CH_2(+)$ (C) $CH_3CH_2NO_2$ (D) C_6H_6

65. When a mixture of vapours of phenol and hydrogen is passed over nickel catalyst at 433 K, the product obtained is

(A) Benzene (B) Benzaldehyde (C) Cyclohexane (D) Cyclohexanol

66. A metal has BCC structure with edge length of unit cell 400 pm. Density of metal is 4 g cm^{-3}. What is molar mass of metal?

(A) 40 g mol^{-1} (B) 27 g mol^{-1} (C) 92 g mol^{-1} (D) 77 g mol^{-1}

67. Which from the following is the correct relationship between standard Gibbs energy change and standard cell potential?

(A) $-\Delta G^\circ = -nFE^\circ_{cell}$ (B) $\Delta G^\circ = \frac{E^\circ_{cell}}{nF}$

(C) $E^\circ_{cell} = \Delta G^\circ \times nF$ (D) $\Delta G^\circ = -nFE^\circ_{cell}$

68. What type of following solution is obtained from amalgam of mercury with sodium?

(A) liquid in solid (B) solid in gas
(C) solid in solid (D) solid in liquid

69. Lithium shows diagonal relationship with

(A) Mg (B) Al (C) Be (D) Na

70. Which group from following is responsible for (−)R effect?

(A) −COOR (B) −OR (C) −OH (C) −NHR

71. Which of the following reaction is an example of Rosenmund reduction?

(A) $R-CO-R \xrightarrow[KOH,\ ethylene\ glycol]{NH_2-NH_2,\ \Delta} R-CH_2-R$

(B) $R-CHO \xrightarrow[\Delta]{Zn-Hg/conc.HCl} R-CH_3+H_2O$

(C) $R-CO-Cl \xrightarrow[Pd-BaSO_4]{H_2} R-CHO+HCl$

(D) $R-CN \xrightarrow[H_3O^+]{SnCl_2/HCl} R-CHO+NH_4Cl$

72. Which element from following combines with hydrogen to form compound having lowest acidic strength?

(A) Cl (B) Br (C) F (D) I

73. If decomposition of hydrogen peroxide is a first order reaction, it's rate law equation can be represented as

(A) $r = \frac{k}{[H_2O_2]}$

(B) $r = k\,[H_2O_2]$

(C) $r = k\frac{[H_2O][O_2]^{1/2}}{[H_2O_2]}$

(D) $r = k\frac{[H_2O_2]}{[H_2O_2][O_2]^{1/2}}$

74. The FCC unit cell of a compound contains ions of A at the corner and ions of B at the centre of each face, what is the formula of the compound?

(A) AB_2 (B) A_2B (C) AB_3 (D) AB

75. To obtain 3–methylbutan–2–ol from acetaldehyde, the Grignard's reagent used is

(A) CH_3MgBr

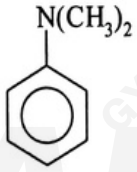
(B) $CH_3CH_2CH_2Mg\,Br$

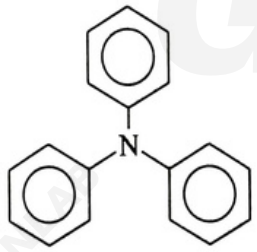
(C) CH_3CH_2MgBr

(D) $H_3C-\underset{\displaystyle CH_3}{\underset{|}{CH}}-MgBr$

76. Which of the following is an example of symmetrical tertiary amine?

(A) CH_3NHCH_3

(B) 

(C) 

(D) $H_3C-\underset{\displaystyle CH_3}{\underset{|}{CH}}-NH_2$

77. Which among the following is benzylic halide?

(A) 4–Iodotoluene
(B) 1–Iodo–2–phenylethane
(C) Iodobenzene
(D) Iodophenylmethane

78. What is the geometry of SbF_5 molecule?

(A) Trigonal pyramidal
(B) Trigonal planar
(C) Square pyramidal
(D) Trigonal bipyramidal

79. Identify the product (A) obtained in the following reaction.

$$\text{Phenol} + \text{concentrated Nitric acid} \xrightarrow[H_2SO_4]{\text{concentrated}} A$$

(A) o–Nitrophenol
(B) p–Nitrophenol
(C) mixture of o–Nitrophenol and p–Nitrophenol
(D) 2, 4, 6–Trinitrophenol

80. What is the volume occupied by particles in BCC structure if 'a' is edge length of unit cell?

(A) $\frac{\sqrt{3}\pi a^3}{8}$ (B) $\frac{\pi a^3}{3\sqrt{2}}$ (C) $\frac{\pi a^3}{12\sqrt{2}}$ (D) $\frac{\sqrt{3}\pi a^3}{16}$

81. A reaction is first order with respective to A and second order with respective to B. What is the effect on reaction rate if concentration of B is increased 3 times?

(A) Rate increases 6 times
(B) Rate increases 2 times
(C) Rate increases 9 times
(D) Rate increases 3 times

82. Which of the following is an example of primary amine?

(A) N–methyl aniline
(B) N–phenylbenzenamine
(C) Methyl phenylamine
(D) Isopropyl amine

83. Which among following statements is true about $Na_4[Fe(CN)_6]$?

(A) The complex ion carries –4 charge.
(B) It is a neutral complex.
(C) The oxidation state of Fe in this complex is +6.
(D) The C.N. of Fe in this complex is 10.

84. What is the change in oxidation number of nitrogen in following conversion?

$NO_3^- \longrightarrow NO_2$

(A) +4 to +5 (B) +3 to +5 (C) +5 to +4 (D) –3 to +5

85. How many values of magnetic quantum number are possible for each value of azimuthal quantum number?

(A) $n\ell$ (B) $2\ell+1$ (C) $n-\ell$ (D) 2ℓ

86. What is vapour pressure of solution containing 0.1 mole solute dissolved in 1.8×10^{-2} kg H_2O?
($P_1^0 = 24$ mm Hg)

(A) 12.40 mm Hg (B) 18.12 mm Hg (C) 15.72 mm Hg (D) 21.84 mm Hg

87. Which from following reagents is used to identify straight chain of glucose?

(A) HI (B) dil. HNO_3 (C) HCN (D) Acetic anhydride

88. Which of the following aldehyde has buttery odour?

(A) Crotonaldehyde
(B) Benzaldehyde
(C) Butyraldehyde
(D) Cinnamaldehyde

89. At 300 K, 22 g of CO_2 gas exerts a pressure of 5 atmosphere. What is the volume of the gas at the same temperature? ($R = 0.0821$ L atm K^{-1} mol^{-1})

(A) 5.61 dm^3 (B) 8.20 dm^3 (C) 2.46 dm^3 (D) 3.80 dm^3

90. Which among the following is NOT benzylic halide?

(A) 2–Chloro–2–phenylpropane
(B) 1–Chloro–2–Phenylbutane
(C) Chlorophenyl methane
(D) 1–Chloro–1–phenylethane

91. Which of the following polymers is used to obtain shopping bags?

(A) HDPE (B) LDPE (C) Polypropylene (D) PVC

92. In a process, a system performs 238 J of work on it's surrounding by absorbing 54 J of heat. What is the change in internal energy of system during this operation?

(A) 222 J (B) −192 (C) 54 J (D) −184 J

93. When x kJ heat is provided to a system, work equivalent to y J is done on it. What is internal energy change during this operation?

(A) (1000x + y) J
(B) 1000(x + y) J
(C) (x + 1000 y) J
(D) x + y J

94. When 2–Chlorobutane is boiled with concentrated alcoholic solution of KOH, the major product formed is

(A) But–1–ene (B) But–2–ene (C) Butan–2–ol (D) Butan–1–ol

95. Which element from following is a soft element?

(A) Mn (B) Zn (C) Co (D) Ni

96. For the reaction A + B → product, rate of reaction is 3.6×10^{-2} mol $dm^{-3} sec^{-1}$. When [A] = 0.2 mol dm^{-3} and [B] = 0.1 mol dm^{-3}, find rate constant of reaction if it is second order with respective to both reactants.

(A) 18 mol^{-3} dm^9 sec^{-1}
(B) 90 mol^{-3} dm^9 sec^{-1}
(C) 72 mol^{-3} dm^9 sec^{-1}
(D) 36 mol^{-3} dm^9 sec^{-1}

97. Identify conjugate acid–base pair in the following reaction.

$$HCl_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + Cl^-_{(aq)}$$

(A) $H_3O^+_{(aq)}$ and $Cl^-_{(aq)}$
(B) $H_3O^+_{(aq)}$ and $H_2O_{(l)}$
(C) $HCl_{(aq)}$ and $H_2O_{(l)}$
(D) $Cl^-_{(aq)}$ and $H_2O_{(l)}$

98. The conductivity of 0.04 M $BaCl_2$ solution is 0.0112 Ω^{-1} cm^{-1} at 25°C. What is it's molar conductivity?

(A) 357.0 Ω^{-1} cm^2 mol^{-1}
(B) 140.0 Ω^{-1} cm^2 mol^{-1}
(C) 44.8 Ω^{-1} cm^2 mol^{-1}
(D) 280.0 Ω^{-1} cm^2 mol^{-1}

99. Which from following polymers is used to manufacture tyres?

(A) Neoprene (B) SBR (C) Bakelite (D) Polyacrylonitrile

100. Which among following is an example of cyclic amide?

(A) PAN (B) Terylene (C) ε-caprolactam (D) Teflon

Section II

MATHEMATICS

101. $\int_0^4 x[x]\,dx =$

(where [x] denotes greatest integer function not greater than x]

(A) 17 (B) 24 (C) $\frac{21}{2}$ (D) $\frac{33}{2}$

102. $\lim_{x\to 1}\frac{ab^x - a^x b}{x^2-1} =$

(A) $\frac{-ab}{2}\log\left(\frac{b}{a}\right)$ (B) $\frac{ab}{2}\log\left(\frac{b}{a}\right)$ (C) $ab\log\left(\frac{b}{a}\right)$ (D) $-ab\log\left(\frac{b}{a}\right)$

103. The maximum area of the rectangle that can be inscribed in a circle of radius r is '

(A) $2r^2$ sq. units (B) $\frac{\pi r^2}{4}$ sq. units (C) πr^2 units (D) r^3 sq units

104. The difference between the maximum values of ${}^6C_r$ and ${}^nC_r$ is 16, then n =

(A) 3 (B) 5 (C) 2 (D) 4

105. If $f(x)=\frac{x}{2x+1}$ and $g(x)=\frac{x}{x+1}$, then $(fog)(x)=$

(A) $\frac{2x-1}{x+1}$ (B) $\frac{x}{3x+1}$ (C) $\frac{x+1}{x+2}$ (D) $\frac{x-1}{2x+1}$

106. If the population grows at the rate of 8% per year, then the time taken for the population to be doubled is (Given log 2 = 0.6912)

(A) 6.8 year (B) 4.3 years (C) 10.27 years (D) 8.64 years

107. If the lines respresented by $ax^2 - bxy - y^2 = 0$ make angle α and β with the positive direction of X–axis, then $\tan(\alpha+\beta) =$

(A) $\frac{a}{a+b}$ (B) $\frac{b}{1+b}$ (C) $\frac{b}{1+a}$ (D) $\frac{-b}{1+a}$

108. If the probability distribution function of a random variable X is given as

$X=x_i$	−2	−1	0	1	2
$P(X=x_i)$	0·2	0·3	0·15	0·25	0·1

Then F(0) is equal to

(A) P(X > 0) (B) 1 − P(X > 0) (C) 1 − P(X < 0) (D) P(X < 0)

109. The particular solution of the differential equation $\frac{dy}{dx}=\frac{x+y+1}{x+y-1}$ when $x=\frac{2}{3}$ and $y=\frac{1}{3}$ is

(A) $2x + 2y - 2 = \log|x + y|$ (B) $y-x+\frac{1}{3}=\log|x+y|$

(C) $x+y-1=\log|x+y|$ (D) $4x - 5y - 1 = \log|x + y|$

110. If $a\sin\theta = b\cos\theta$, where $a, b \neq 0$, then $a\cos2\theta + b\sin2\theta =$

(A) ab (B) a (B) b (D) $\frac{a}{b}$

111. $\vec{a}=4\hat{i}+13\hat{j}-18\hat{k}$, $\vec{b}=\hat{i}-2\hat{j}+3\hat{k}$ and $\vec{c}=2\hat{i}+3\hat{j}-4\hat{k}$ are three vectors such that $\vec{a}=x\vec{b}+y\vec{c}$, then $x+y=$

(A) -1 (B) -2 (C) 5 (D) 1

112. If the lines $\frac{x-1}{2}=\frac{y+1}{3}=\frac{z-1}{4}$ and $\frac{x-2}{1}=\frac{y+m}{2}=\frac{z-2}{1}$ intersect each other, then value of m is

(A) 1 (B) -2 (C) 2 (D) -1

113. The length of perpendicular drawn from the point $2\hat{i}-\hat{j}+5\hat{k}$ to the line $\vec{r}=(11\hat{i}-2\hat{j}-8\hat{k})+\lambda(10\hat{i}-4\hat{j}-11\hat{k})$ is

(A) $\sqrt{14}$ units (B) 14 units (C) 237 units (D) $\sqrt{237}$ units

114. If $u=\cos^3 x$, $v=\sin^3 x$, then $\left(\frac{dv}{du}\right)_{x=\frac{\pi}{4}}$ is equal to

(A) -2 (B) 2 (C) 1 (D) -1

115. The arithmetic mean of marks in Mathematics for four divisions A, B, C and D were 80, 75, 70 and 72 respectively. Their standard deviations were 12, 6, 8 and 10 respectively. Then, division ___ has more uniformity.

(A) D (B) B (C) C (D) A

116. If the angle between the lines is $\frac{\pi^c}{4}$ and slope of one of the lines is $\frac{1}{2}$, then slope of the other line is

(A) 3 or $-\frac{1}{3}$ (B) 4 or $-\frac{1}{4}$ (C) 2 or $-\frac{1}{2}$ (D) 3 or -3

117. $f(x)=\log|\sin x|$, where $x\in(0,\pi)$ is strictly increasing on

(A) $\left(\frac{\pi}{2},\pi\right)$ only (B) $(0,\pi)$ only (C) $\left(0,\frac{\pi}{2}\right)$ only (D) $\left(\frac{\pi}{4},\frac{3\pi}{4}\right)$ only

118. The velocity of a particle at time t is given by the relation $v=6t-\frac{t^2}{6}$. Its displacement S is zero at $t=0$, then the distance travelled in 3 sec is

(A) $\frac{51}{2}$ units (B) $\frac{39}{2}$ units (C) $\frac{57}{2}$ units (D) $\frac{33}{2}$ units

119. The order of the differetntial equation whose solution is $y=a\cos x+b\sin x+ce^{-x}$ is

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

120. The squre roots of the complex number $(-5-12i)$ are

(A) $\pm(2-3i)$ (B) $\pm(3+2i)$ (C) $\pm(2+3i)$ (D) $\pm(3-2i)$

121. If $\vec{a}=\hat{i}+\hat{j}+\hat{k}$, $\vec{c}=\hat{j}-\hat{k}$, $\vec{a}\times\vec{b}=\vec{c}$ and $\vec{a}\cdot\vec{b}=1$, then $\vec{b}$

(A) $\hat{i}$ (B) $-\hat{i}$ (C) $\hat{j}$ (D) $\hat{k}$

122. Equation of the plane passing through the point (1, 2, 3) and parallel to the plane $2x + 3y - 4z = 0$

(A) $2x + 3y + 4z - 8 = 0$ (B) $2x + 3y - 4z + 4 = 0$
(C) $2x + 3y + 4z + 4 = 0$ (D) $2x + 3y + 4z = 20$

123. The negation of $p \wedge (q \rightarrow r)$ is

(A) $\sim p \wedge (\sim q \rightarrow \sim r)$ (B) $\sim p \vee (q \wedge \sim r)$ (C) $\sim p \vee (\sim q \rightarrow \sim r)$ (D) $p \vee (\sim p \vee r)$

124. The general solution of the differential equation $(2y - 1)dx - (2x + 3)dy = 0$ is

(A) $(2x + 3)^2 = c(2y - 1)$ (B) $\frac{2x+3}{2y-1} = c$
(C) $(2x + 3)(2y - 1) = c$ (D) $(2x + 3)(2y - 1)^2 = c$

125. If $y = \log_{10} x + \log_x 10 + \log_x x + \log_{10} 10$, then $\frac{dy}{dx} =$

(A) $\frac{1}{x\log_e 10} + \frac{1}{x\log_{10} e}$ (B) $\frac{1}{x\log_e 10} + \frac{\log_e 10}{x(\log_{10} e)^2}$
(C) $\frac{1}{x\log_e 10} - \frac{1}{x\log_{10} e}$ (D) $\frac{1}{x\log_e 10} - \frac{\log_e 10}{x(\log_e x)^2}$

126. If the vectors $\vec{a} = 2\hat{i} + p\hat{j} + 4\hat{k}$ and $\vec{b} = 6\hat{i} - 9\hat{j} + q\hat{k}$ are collinear, then p and q are

(A) $p = 3, q = -12$ (B) $p = 3, q = 12$ (C) $p = -3, q = 12$ (D) $p = -3, q = -12$

127. If $y = \tan^{-1}\left[\frac{\log\left(\frac{e}{x^2}\right)}{\log(ex^2)}\right] + \tan^{-1}\left[\frac{3+2\log x}{1-6\log x}\right]$, then $\frac{d^2y}{dx^2} =$

(A) $\frac{2}{1+x^2}$ (B) $\frac{1}{1+x^2}$ (C) $\frac{3}{1+x^2}$ (D) 0

128. If the function $f(x) = 3ax + b$, for $x < 1$
$= 11$, for $x = 1$
$= 5ax - 2b$, for $x > 1$
is continuous at $x = 1$. Then, the values of a and b are

(A) $a = 2, b = 3$ (B) $a = 3, b = 3$ (C) $a = 2, b = 2$ (D) $a = 3, b = 2$

129. If $P(A) = \frac{3}{10}$, $P(B) = \frac{2}{5}$, $P(A \cup B) = \frac{3}{5}$, then $P(A/B) \times P(B/A) =$

(A) $\frac{1}{3}$ (B) $\frac{1}{12}$ (C) $\frac{1}{10}$ (D) $\frac{1}{4}$

130. $\int_0^{\pi/2} \log\left(\frac{4+3\sin x}{4+3\cos x}\right)dx =$

(A) 0 (B) 4log3 (C) $\frac{1}{2}$ (D) 2 log4

131. Area bounded by the lines $y = x$, $x = -1$, $x = 2$ and the X–axis is

(A) $\frac{1}{2}$sq.units (B) $\frac{3}{2}$sq.units (C) $\frac{5}{2}$sq.units (D) $\frac{7}{4}$sq.units

132. $\int \frac{dx}{32-2x^2} = A\log(4-x)+B\log(4+x)+c$, then the values of A and B are respectively (where c is a constant of integration)

(A) $\frac{-1}{8}, \frac{1}{8}$ (B) $\frac{1}{8}, \frac{-1}{8}$ (C) $\frac{-1}{16}, \frac{1}{16}$ (D) $\frac{1}{8}, \frac{1}{8}$

133. If A and B are the foot of the perpendicular drawn from the point Q(a, b, c) to the planes YZ and ZX respectively, then the equation of the plane through the points A, B, and O is (where O is the origin)

(A) $\frac{x}{a}-\frac{y}{b}-\frac{z}{c}=0$ (B) $\frac{x}{a}+\frac{y}{b}-\frac{z}{c}=0$ (C) $\frac{x}{a}-\frac{y}{b}+\frac{z}{c}=0$ (D) $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=0$

134. If $|\vec{a}|=4, |\vec{b}|=5$, then the values of k for which $\vec{a}+k\vec{b}$ is perpendicular to $\vec{a}-k\vec{b}$ are

(A) $\pm\frac{5}{4}$ (B) $\pm\frac{2}{5}$ (C) $\pm\frac{16}{25}$ (D) $\pm\frac{4}{5}$

135. If p : It is raining and q : It is pleasant, then the symbolic form of "It is neither raining nor pleasant" is

(A) $\sim p \wedge q$ (B) $\sim p \vee q$ (C) $(\sim p) \wedge (\sim q)$ (D) $(\sim p) \vee (\sim q)$

136. Equationof the chord of the circle $x^2+y^2-4x-10y+25=0$ having mid-point (1, 2) is

(A) $-x+3y=5$ (B) $x+3y=7$ (C) $5x+y=7$ (D) $3x+y=5$

137. $\int \cos^3 x \cdot e^{\log(\sin x)} dx =$

(A) $\frac{-e^{\sin x}}{4}+c$ (B) $\frac{-\cos^4 x}{4}+c$ (C) $\frac{-\sin^4 x}{4}+c$ (D) $\frac{-e^{\sin x}}{4}+c$

138. The probability distribution of a discrete random variable X is

X	1	2	3	4	5	6
P(X)	K	2K	3K	4K	5K	6K

Find the value of $P(2 < X < 6)$

(A) $\frac{4}{21}$ (B) $\frac{1}{21}$ (C) $\frac{10}{21}$ (D) $\frac{4}{7}$

139. If A = (–2, 2, 3) , B = (3, 2, 2), C= (4, –3, 5) and D = (7, –5, –1)
Then the projection of $\overline{AB}$ on $\overline{CD}$ is

(A) 4 (B) 3 (C) $\frac{12}{\sqrt{7}}$ (D) None of these

140. If $A=\begin{bmatrix}2 & -2\\ 2 & -3\end{bmatrix}$, $B=\begin{bmatrix}0 & -1\\ 1 & 0\end{bmatrix}$, then $(B^{-1}A^{-1})^{-1}=?$

(A) $A=\begin{bmatrix}-2 & -2\\ -3 & -2\end{bmatrix}$ (B) $A=\begin{bmatrix}2 & 2\\ -2 & -3\end{bmatrix}$ (C) $A=\begin{bmatrix}3 & -2\\ 2 & 2\end{bmatrix}$ (D) $A=\begin{bmatrix}1 & -1\\ -2 & 3\end{bmatrix}$

141. The value of $\sin^{-1}\left(\frac{-1}{2}\right)+\sin^{-1}\left(\frac{-\sqrt{3}}{2}\right)$ is,

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

142. If one of the lines given by $kx^2 + xy - y^2 = 0$ bisect the angle between the co-ordinate axes, then the values of k are

(A) 1 and 2 (B) 0 and 2 (C) 0 and -2 (D) -1 and 2

143. If $A = \begin{bmatrix} 1 & 2 & 3 \\ 1 & 1 & a \\ 2 & 4 & 7 \end{bmatrix}$ and $B = \begin{bmatrix} 13 & 2 & b \\ -3 & -1 & 2 \\ -2 & 0 & 1 \end{bmatrix}$ where matrix B is inverse of matrix A, then the value of a and b are

(A) $a = -5, b = 7$ (B) $a = 7, b = -5$ (C) $a = -7, b = 5$ (D) $a = 5, b = -7$

144. The differential equation of the family of parabolas with focus at the origin and the X – axis as axis, is

(A) $-y\left(\frac{dy}{dx}\right)^2 = 2x\frac{dy}{dx} - y$ (B) $y\left(\frac{dy}{dx}\right)^2 + 2xy\frac{dy}{dx} + y = 0$

(D) $y\left(\frac{dy}{dx}\right)^2 + 4x\frac{dy}{dx} = 4xy$ (D) $y\left(\frac{dy}{dx}\right)^2 + y = 2xy\frac{dy}{dx}$

145. A die is thrown four times. The probability of getting perfect square in at least one throw is

(A) $\frac{58}{61}$ (B) $\frac{16}{81}$ (C) $\frac{65}{81}$ (D) $\frac{23}{81}$

146. For a 3×3 matrix A, if $A(\text{adj } A) = \begin{bmatrix} -10 & 0 & 0 \\ 0 & -10 & 2 \\ 0 & 0 & -10 \end{bmatrix}$, then the value of determinant of A is

(A) 100 (B) -1000 (C) -10 (D) 20

147. In any ΔABC, with usual notations, $c(a\cos B - b\cos A) =$

(A) $a^2 - b^2$ (B) $\frac{1}{a^2} - \frac{1}{b^2}$ (C) $a^2 + b^2$ (D) $\frac{1}{a^2} + \frac{1}{b^2}$

148. If in a ΔABC, with usual notations, a^2, b^2, c^2 are in A.P. then $\frac{\sin 3B}{\sin B} =$

(A) $\frac{a^2 - c^2}{2ac}$ (B) $\left(\frac{a^2 - c^2}{2ac}\right)^2$ (C) $\frac{a^2 - c^2}{ac}$ (D) $\left(\frac{a^2 - c^2}{ac}\right)^2$

149. The common region of the solutions of the inequations $x + 2y \geq 4$, $2x - y \leq 6$ and $x, y > 0$ is

(A) bounded and origin side (B) unbounded and non-origin side
(C) unbounded and origin side (D) bounded and non-origin side

150. If $\int \frac{(\cos x - \sin x)}{8 - \sin 2x} dx = \frac{1}{p}\log\left[\frac{3 + \sin x + \cos x}{3 - \sin x - \cos x}\right] + c$, then $p =$
(where c is a constant of integration)

(A) 12 (B) $\frac{1}{6}$ (C) 6 (D) 3