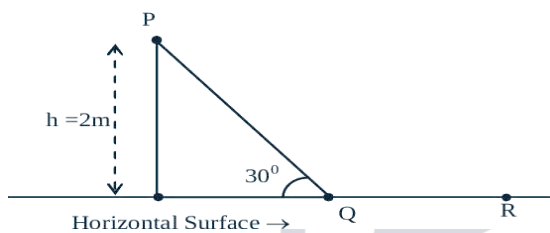


PART A - PHYSICS

- A uniform string of length 20 m is suspended from a rigid support. A short-wave pulse is introduced at its lowest end. It starts moving up the string. The time taken to reach the support is : (take $g = 10 \text{ ms}^{-2}$)
 (a) 2 s (b) $2\sqrt{2}$ s
 (c) $\sqrt{2}$ s (d) $2\pi\sqrt{2}$ s
- A person trying to lose weight by burning fat lifts a mass of 10 kg upto a height of 1 m 1000 times. Assume that the potential energy lost each time he lowers the mass is dissipated. How much fat will he use up considering the work done only when the weight is lifted up? Fat supplies $3.8 \times 10^7 \text{ J}$ of energy per kg which is converted to mechanical energy with a 20% efficiency rate. Take $g = 9.8 \text{ ms}^{-2}$:
 (a) $6.45 \times 10^{-3} \text{ kg}$ (b) $9.89 \times 10^{-3} \text{ kg}$
 (c) $12.89 \times 10^{-3} \text{ kg}$ (d) $2.45 \times 10^{-3} \text{ kg}$
- A point particle of mass m , moves along the uniformly rough track PQR as shown in the figure. The coefficient of friction, between the particle and the rough track equals μ . The particle is released, from rest, from the point P and it comes to rest at a point R. The energies, lost by the ball, over the parts, PQ and QR, of the track, are equal to each other, and no energy is lost when particle changes direction from PQ to QR.



The values of the coefficient of friction μ and the distance $x(= QR)$, are, respectively close to:

- 0.2 and 3.5 m (b) 0.29 and 3.5 m
 (c) 0.29 and 6.5 m (d) 0.2 and 6.5 m
- Two identical wires A and B, each of length ' ℓ ', carry the same current I . Wire A is bent into a circle of radius R and wire B is bent to form a square of side ' a '. If B_A and B_B are the values of magnetic field at the centres of the circle and square respectively, then the ratio $\frac{B_A}{B_B}$ is :
 (a) $\frac{\pi^2}{16\sqrt{2}}$ (b) $\frac{\pi^2}{16}$
 (c) $\frac{\pi^2}{8\sqrt{2}}$ (d) $\frac{\pi^2}{8}$
- A galvanometer having a coil resistance of 100Ω gives a full-scale deflection, when a current of 1 mA is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full-scale deflection for a current of 10 A is:
 (a) 2Ω (b) 0.1Ω
 (c) 3Ω (d) 0.01Ω
- An observer looks at a distant tree of height 10 m with a telescope of magnifying power of 20. To the observer the tree appears:
 (a) 10 times nearer. (b) 20 times taller.
 (c) 20 times nearer. (d) 10 times taller.
- The temperature dependence of resistances of Cu and undoped Si in the temperature range 300 – 400 K, is best described by:
 (a) Linear increase for Cu, exponential increase for Si.
 (b) Linear increase for Cu, exponential decrease for Si.
 (c) Linear decrease for Cu, linear decrease for Si.

(d) Linear increase for Cu, linear increase for Si.

8. Choose the correct statement:

(a) In amplitude modulation the frequency of the high frequency carrier wave is made to vary in proportion to the amplitude of the audio signal.

(b) In frequency modulation the amplitude of the high frequency carrier wave is made to vary in proportion to the amplitude of the audio signal.

(c) In frequency modulation the amplitude of the high frequency carrier wave is made to vary in proportion to the frequency of the audio signal.

(d) In amplitude modulation the amplitude of the high frequency carrier wave is made to vary in proportion to the amplitude of the audio signal.

9. Half-lives of two radioactive elements A and B are 20 minutes and 40 minutes, respectively. Initially, the samples have equal number of nuclei. After 80 minutes, the ratio of decayed numbers of A and B nuclei will be :

(a) 4:1

(b) 1:4

(c) 5:4

(d) 1:16

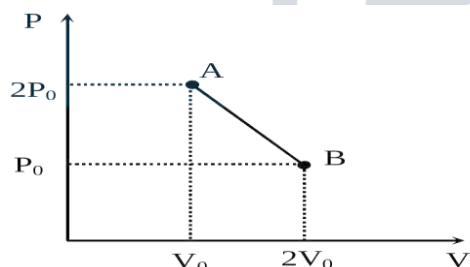
10. 'n' moles of an ideal gas undergoes a process $A \rightarrow B$ as shown in the figure. The maximum temperature of the gas during the process will be:

(a) $\frac{3P_0 V_0}{2nR}$

(b) $\frac{9P_0 V_0}{2nR}$

(c) $\frac{9P_0 V_0}{nR}$

(d) $\frac{9P_0 V_0}{4nR}$



11. An arc lamp requires a direct current of 10 A and 80 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) 0.08H

(b) 0.044H

(c) 0.065H

(d) 80H

12. A pipe open at both ends has a fundamental frequency f in air. The pipe is dipped vertically in water so that half of it is in water. The fundamental frequency of the air column is now:

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

(b) $2f$

(c) f

(d) $\frac{f}{2}$

13. The box of pin hole camera, of length L , has a hole of radius a . It is assumed that when the hole is illuminated by a parallel beam of light of wavelength λ the spread of the spot (obtained on the opposite wall of the camera) is the sum of its geometrical spread and the spread due to diffraction. The spot would then have its minimum size (say $b_{\min}$) when :

(a) $a = \sqrt{\lambda L}$ and $b_{\min} = \left(\frac{2\lambda^2}{L}\right)$

(b) $a = \sqrt{\lambda L}$ and $b_{\min} = \sqrt{4\lambda L}$

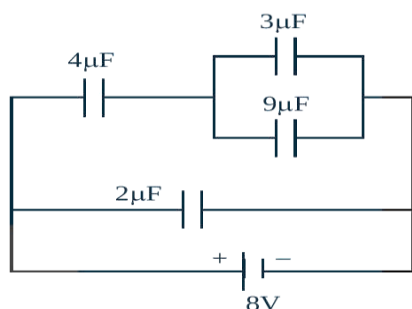
(c) $a = \frac{\lambda^2}{L}$ and $b_{\min} = \sqrt{4\lambda L}$

(d) $a = \frac{\lambda^2}{L}$ and $b_{\min} = \left(\frac{2\lambda^2}{L}\right)$

14. A combination of capacitors is set up as shown in the figure. The magnitude of the electric field, due to a point charge Q (having a charge equal to the sum of the charges on the $4\mu\text{F}$ and $9\mu\text{F}$ capacitors), at a point distant 30 m from it, would equal:

(a) 360 N/C (b) 420 N/C

(c) 480 N/C (d) 240 N/C



15. Arrange the following electromagnetic radiations per quantum in the order of increasing energy :

A : Blue light

B : Yellow light

C : X-ray

D : Radio wave

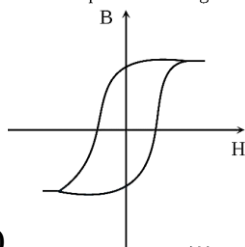
(a) A, B, D, C

(b) C, A, B, D

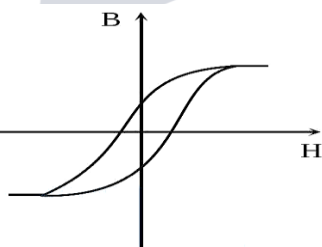
(c) B, A, D, C

(d) D, B, A, C

16. Hysteresis loops for two magnetic materials A and B are given below:



(a)



(b)

These materials are used to make magnets for electric generators, transformer core and electromagnet core. Then it is proper to use:

(a) A for electromagnets and B for electric generators

(b) A for transformers and B for electric generators

(c) B for electromagnets and transformers

(d) A for electric generators and transformers

17. A pendulum clock loses 12 s a day if the temperature is 40°C and gains 4 s a day if the temperature is 20°C . The temperature at which the clock will show correct time, and the co-efficient of linear expansion (α) of the metal of the pendulum shaft are respectively :

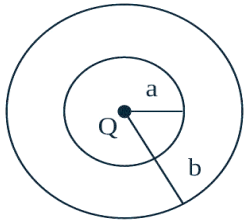
(a) 60°C ; $\alpha = 1.85 \times 10^{-4}/^\circ\text{C}$

(b) 30°C ; $\alpha = 1.85 \times 10^{-3}/^\circ\text{C}$

(c) 55°C ; $\alpha = 1.85 \times 10^{-2}/^\circ\text{C}$

(d) 25°C ; $\alpha = 1.85 \times 10^{-5}/^\circ\text{C}$

18. The region between two concentric spheres of radii ' a ' and ' b ', respectively (see figure), has volume charge density $\rho = \frac{A}{r}$, where A is a constant and r is the distance from the centre. At the center of the spheres is a point charge Q . The value of A such that the electric field in the region between the spheres will be constant, is:



- (a) $\frac{Q}{2\pi(b^2-a^2)}$ (b) $\frac{2Q}{\pi(a^2-b^2)}$
(c) $\frac{2Q}{\pi a^2}$ (d) $\frac{Q}{2\pi a^2}$

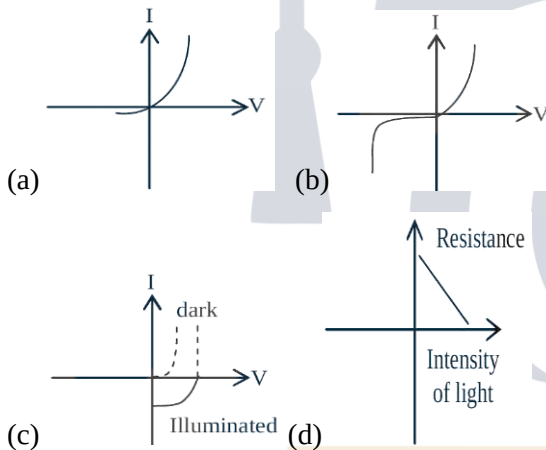
19. In an experiment for determination of refractive index of glass of a prism by $i - \delta$, plot, it was found that a ray incident at angle 35° , suffers a deviation of 40° and that it emerges at angle 79° . In that case which of the following is closest to the maximum possible value of the refractive index?

- (a) 1.6 (b) 1.7
(c) 1.8 (d) 1.5

20. A student measures the time period of 100 oscillations of a simple pendulum four times. The data set is 90 s, 91s, 95 s and 92s. If the minimum division in the measuring clock is 1 s, then the reported mean time should be:

- (a) 92 ± 5.0 s (b) 92 ± 1.8 s
(c) 92 ± 3 s (d) 92 ± 2 s

21. Identify the semiconductor devices whose characteristics are given below, in the order (a), (b), (c), (d):



- (a) Zener diode, Simple diode, Light dependent resistance, Solar cell
(b) Solar cell, Light dependent resistance, Zener diode, Simple diode
(c) Zener diode, Solar cell, Simple diode, Light dependent resistance
(d) Simple diode, Zener diode, Solar cell, Light dependent resistance

22. Radiation of wavelength λ , is incident on a photocell. The fastest emitted electron has speed v . If the wavelength is changed to $\frac{3\lambda}{4}$, the speed of the fastest emitted electron will be :

- (a) $v \left(\frac{4}{3} \right)^{\frac{1}{2}}$ (b) $v \left(\frac{4}{3} \right)^{\frac{1}{2}}$
(c) $v \left(\frac{3}{4} \right)^{\frac{1}{2}}$ (d) $v \left(\frac{4}{3} \right)^{\frac{1}{2}}$

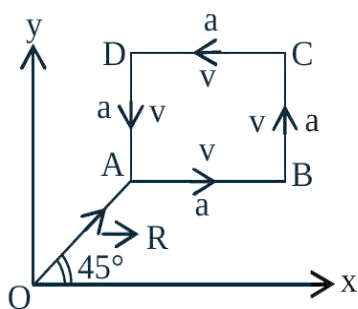
23. A particle performs simple harmonic motion with amplitude A . Its speed is trebled at the instant that it is at a distance $\frac{2A}{3}$ from equilibrium position. The new amplitude of the motion is:

- (a) $3A$ (b) $A\sqrt{3}$
(c) $\frac{7A}{3}$ (d) $\frac{A}{3}\sqrt{41}$

24. A particle of mass m is moving along the side of a square of side ' a ', with a uniform speed v in the $x - y$ plane as shown in the figure: Which of the following statements is false for the angular momentum $\vec{L}$ about the origin?

(a) $\vec{L} = mv \left[\frac{R}{\sqrt{2}} - a \right] \hat{k}$ when the particle is moving from C to D.

(b) $\vec{L} = mv \left[\frac{R}{\sqrt{2}} + a \right] \hat{k}$ when the particle is moving from B to C.



(c) $\vec{L} = \frac{mv}{\sqrt{2}} R \hat{k}$ when the particle is moving from D to A.

(d) $\vec{L} = -\frac{mv}{\sqrt{2}} R \hat{k}$ when the particle is moving from A to B.

25. An ideal gas undergoes a quasi-static, reversible process in which its molar heat capacity C remains constant. If during this process the relation of pressure P and volume V is given by $PV^n = \text{constant}$, then n is given by (Here C_p and C_v are molar specific heat at constant pressure and constant volume, respectively):

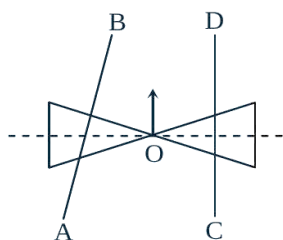
- (a) $n = \frac{C - C_p}{C - C_v}$ (b) $n = \frac{C_p - C}{C - C_v}$
(c) $n = \frac{C - C_v}{C - C_p}$ (d) $n = \frac{C_p}{C_v}$

26. A screw gauge with a pitch of 0.5 mm and a circular scale with 50 divisions is used to measure the thickness of a thin sheet of Aluminium. Before starting the measurement, it is found that when the two jaws of the screw gauge are brought in contact, the 45th division coincides with the main scale line and that the zero of the main scale is barely visible. What is the thickness of the sheet if the main scale reading is 0.5 mm and the 25th division coincides with the main scale line?

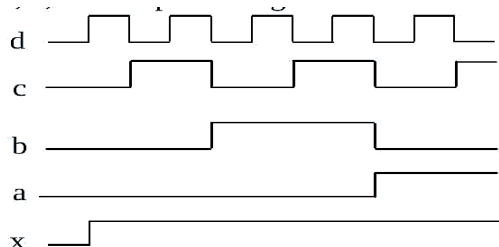
- (a) 0.80 mm (b) 0.70 mm
(c) 0.50 mm (d) 0.75 mm

27. A roller is made by joining together two cones at their vertices O . It is kept on two rails AB and CD which are placed asymmetrically (see figure), with its axis perpendicular to CD and its centre O at the centre of line joining AB and CD (see figure). It is given a light push so that it starts rolling with its centre O moving parallel to CD in the direction shown. As it moves, the roller will tend to:

- (a) turn right (b) go straight
(c) turn left and right alternately (d) turn left



28. If a, b, c, d are inputs to a gate and x is its output, then, as per the following time graph, the gate is:



- (a) AND (b) OR
(c) NAND (d) NOT

29. For a common emitter configuration, if α and β have their usual meanings, the incorrect relationship between α and β is :

- (a) $\alpha = \frac{\beta}{1-\beta}$ (b) $\alpha = \frac{\beta}{1+\beta}$
(c) $\alpha = \frac{\beta^2}{1+\beta^2}$ (d) $\frac{1}{\alpha} = \frac{1}{\beta} + 1$

30. A satellite is revolving in a circular orbit at a height 'h' from the earth's surface (radius of earth R; $h \ll R$). The minimum increase in its orbital velocity required, so that the satellite could escape from the earth's gravitational field, is close to : (Neglect the effect of atmosphere.)

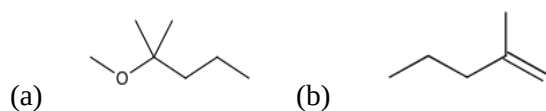
- (a) $\sqrt{gR}$ (b) $\sqrt{gR/2}$
(c) $\sqrt{gR}(\sqrt{2} - 1)$ (d) $\sqrt{2gR}$

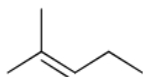
PART B – CHEMISTRY

31. A stream of electrons from a heated filament was passed between two charged plates kept at a potential difference V esu. If e and m are charge and mass of an electron, respectively, then the value of h/λ (where λ is wavelength associated with electron wave) is given by :

- (a) $2meV$ (b) $\sqrt{meV}$
(c) $\sqrt{2meV}$ (d) meV

32. 2-chloro-2-methylpentane on reaction with sodium methoxide in methanol yields:





- (c)
 (a) (a) and (c) (b) (c) only
 (c) (a) and (b) (d) All of these

33. Which of the following compounds is metallic and ferromagnetic?

- (a) CrO_2 (b) VO_2
 (c) MnO_2 (d) TiO_2

34. Which of the following statements about low density polythene is FALSE?

- (a) It is a poor conductor of electricity.
 (b) Its synthesis requires dioxygen or a peroxide initiator as a catalyst.
 (c) It is used in the manufacture of buckets, dust-bins etc.
 (d) Its synthesis requires high pressure.

35. For a linear plot of $\log(x/m)$ versus $\log p$ in a Freundlich adsorption isotherm, which of the following statements is correct? (k and n are constants)

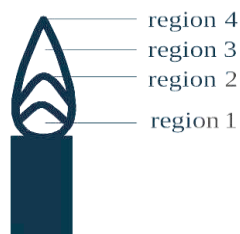
- (a) $1/n$ appear as the intercept.
 (b) Only $1/n$ appears as the slope
 (c) $\log(1/n)$ appears as the intercept.
 (d) Both k and $1/n$ appear in the slope term.

36. The heats of combustion of carbon and carbon monoxide are -393.5 and $-283.5 \text{ kJ mol}^{-1}$, respectively.

The heat of formation (in kJ) of carbon monoxide per mole is :

- (a) 676.5 (b) -676.5
 (c) -110.5 (d) 110.5

37. The hottest region of Bunsen flame shown in the figure below is :



- (a) region 2 (b) region 3
 (c) region 4 (d) region 1

38. Which of the following is an anionic detergent?

- (a) Sodium lauryl sulphate
 (b) Cetyltrimethylammonium bromide
 (c) Glyceryl oleate
 (d) Sodium stearate

39. 18 g glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) is added to 178.2 g water. The vapour pressure of water (in torr) for this aqueous solution is:

- (a) 76.0 (b) 752.4
 (c) 759.0 (d) 7.6

40. The distillation technique most suited for separating glycerol from spent-lye in the soap industry is:

- (a) Fractional distillation
 (b) Steam distillation
 (c) Distillation under reduced pressure
 (d) Simple distillation

41. The species in which the N atom is in a state of sp hybridization is:

- (a) NO_2^- (b) NO_3^-
(c) NO_2 (d) NO_2^+

42. Decomposition of H_2O_2 follows a first order reaction. In fifty minutes, the concentration of H_2O_2 decreases from 0.5 to 0.125M in one such decomposition. When the concentration of H_2O_2 reaches 0.05M, the rate of formation of O_2 will be :

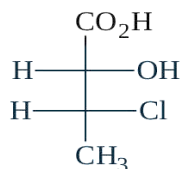
- (a) $6.93 \times 10^{-4} \text{ mol min}^{-1}$
(b) 2.66 L min^{-1} at STP
(c) $1.34 \times 10^{-2} \text{ mol min}^{-1}$
(d) $6.93 \times 10^{-2} \text{ mol min}^{-1}$

43. The pair having the same magnetic moment is :

[At. No.: Cr = 24, Mn = 25, Fe = 26, Co = 27]

- (a) $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$
(b) $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$
(c) $[\text{CoCl}_4]^{2-}$ and $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$
(d) $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{CoCl}_4]^{2-}$

44. The absolute configuration of



- (a) (2S, 3R) (b) (2S, 3S)
(c) (2R, 3R) (d) (2R, 3S)

45. The equilibrium constant at 298 K for a reaction $\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$ is 100. If the initial concentration of all the four species were 1M each, then equilibrium concentration of D (in mol^{-1}) will be:

- (a) 0.818 (b) 1.818
(c) 1.182 (d) 0.182

46. Which one of the following ores is best concentrated by froth floatation method?

- (a) Siderite (b) Galena
(c) Malachite (d) Magnetite

47. At 300 K and 1 atm, 15 mL of a gaseous hydrocarbon requires 375 mL air containing 20% O_2 by volume for complete combustion. After combustion the gases occupy 330 mL. Assuming that the water formed is in liquid form and the volumes were measured at the same temperature and pressure, the formula of the hydrocarbon is:

- (a) C_3H_8 (b) C_4H_8
(c) C_4H_{10} (d) C_3H_6

48. The pair in which phosphorous atoms have a formal oxidation state of +3 is:

- (a) Pyro phosphorous and hypo phosphoric acids
(b) Ortho phosphorus and hypo phosphoric acids
(c) Pyro phosphorous and pyrophosphoric acids
(d) Ortho phosphorous and pyro phosphorous acids

49. Which one of the following complexes shows optical isomerism?

- (a) $\text{cis}[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$ (b) $\text{trans}[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$
(c) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$ (d) $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$
(en = ethylenediamine)

50. The reaction of zinc with dilute and concentrated nitric acid, respectively, produces:

- (a) NO_2 and NO (b) NO and N_2O
(c) NO_2 and N_2O (d) N_2O and NO_2

51. Which one of the following statements about water is FALSE?

- (a) Water can act both as an acid and as a base.
(b) There is extensive intramolecular hydrogen bonding in the condensed phase.
(c) Ice formed by heavy water sinks in normal water
(d) Water is oxidized to oxygen during photosynthesis

52. The concentration of fluoride, lead, nitrate and iron in a water sample from an underground lake was found to be 1000ppb, 40ppb, 100ppm and 0.2ppm, respectively. This water is unsuitable for drinking due to high concentration of :

- (a) Lead (b) Nitrate
(c) Iron (d) Fluoride

53. The main oxides formed on combustion of Li, Na and K in excess of air are, respectively:

- (a) LiO_2 , Na_2O_2 and K_2O
(b) Li_2O_2 , Na_2O_2 and KO_2
(c) Li_2O , Na_2O_2 and KO_2
(d) Li_2O , Na_2O and KO_2

54. Thiol group is present in:

- (a) Cystine (b) Cysteine
(c) Methionine (d) Cytosine

55. Galvanization is applying a coating of:

- (a) Cr (b) Cu
(c) Zn (d) Pb

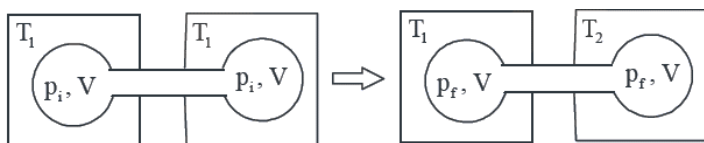
56. Which of the following atoms has the highest first ionization energy?

- (a) Na (b) K
(c) Sc (d) Rb

57. In the Hofmann bromamide degradation reaction, the number of moles of NaOH and Br_2 used per mole of amine produced are:

- (a) Four moles of NaOH and two moles of Br_2 .
(b) Two moles of NaOH and two moles of Br_2
(c) Four moles of NaOH and one mole of Br_2
(d) One mole of NaOH and one mole of Br_2

58. Two closed bulbs of equal volume (V) containing an ideal gas initially at pressure p_i and temperature T_1 are connected through a narrow tube of negligible volume as shown in the figure below. The temperature of one of the bulbs is then raised to T_2 . The final pressure p_f is

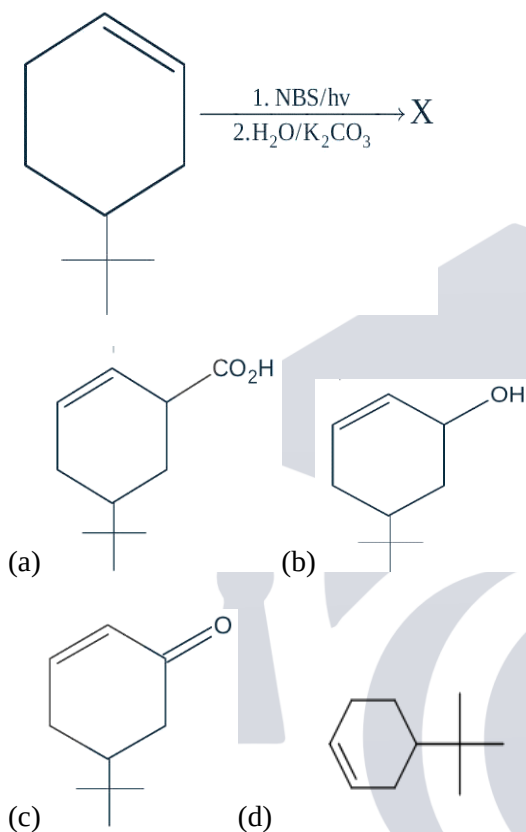


- (a) $2p_i \left(\frac{T_1}{T_1 + T_2} \right)$ (b) $2p_i \left(\frac{T_2}{T_1 + T_2} \right)$
 (c) $2p_i \left(\frac{T_1 T_2}{T_1 + T_2} \right)$ (d) $p_i \left(\frac{T_1 T_2}{T_1 + T_2} \right)$

59. The reaction of propene with $\text{HOCl}(\text{Cl}_2 + \text{H}_2\text{O})$ proceeds through the intermediate:

- (a) $\text{CH}_3 - \text{CH}^+ - \text{CH}_2 - \text{Cl}$
 (b) $\text{CH}_3 - \text{CH}(\text{OH}) - \text{CH}_2^+$
 (c) $\text{CH}_3 - \text{CHCl} - \text{CH}_2^+$
 (d) $\text{CH}_3 - \text{CH}^+ - \text{CH}_2 - \text{OH}$

60. The product of the reaction given below is:



PART C - MATHEMATICS

61. Two sides of a rhombus are along the lines, $x - y + 1 = 0$ and $7x - y - 5 = 0$. If its diagonals intersect at $(-1, -2)$, then which one of the following is a vertex of this rhombus?

- (a) $(-3, -8)$ (b) $\left(\frac{1}{3}, -\frac{8}{3}\right)$
 (c) $\left(-\frac{10}{3}, -\frac{7}{3}\right)$ (d) $(-3, -9)$

62. If the 2nd, 5th and 9th terms of a non-constant A.P. are in G.P., then the common ratio of this G.P. is:

- (a) $\frac{4}{3}$ (b) 1
 (c) $\frac{7}{4}$ (d) $\frac{8}{5}$

63. Let P be the point on the parabola, $y^2 = 8x$ which is at a minimum distance from the centre C of the circle, $x^2 + (y + 6)^2 = 1$. Then the equation of the circle, passing through C and having its centre at P is:

- (a) $x^2 + y^2 - x + 4y - 12 = 0$
 (b) $x^2 + y^2 - \frac{x}{4} + 2y - 24 = 0$

$$(c) x^2 + y^2 - 4x + 9y + 18 = 0$$

$$(d) x^2 + y^2 - 4x + 8y + 12 = 0$$

64. The system of linear equations

$$x + \lambda y - z = 0$$

$$\lambda x - y - z = 0$$

$$x + y - \lambda z = 0$$

has a non-trivial solution for:

- (a) exactly one value of λ . (b) exactly two values of λ .
(c) exactly three values of λ . (d) infinitely many values of λ .

65. If $f(x) + 2f\left(\frac{1}{x}\right) = 3x, x \neq 0$, and $S = \{x \in \mathbb{R} : f(x) = f(-x)\}$; then S :

- (a) contains exactly one element.
(b) contains exactly two elements.
(c) contains more than two elements.
(d) is an empty set.

66. Let $p = \lim_{x \rightarrow 0^+} (1 + \tan^2 \sqrt{x})^{\frac{1}{2x}}$ then $\log p$ is equal to:

- (a) 1 (b) $\frac{1}{2}$
(c) $\frac{1}{4}$ (d) 2.

67. A value of θ for which $\frac{2+3i\sin\theta}{1-2i\sin\theta}$ is purely imaginary, is:

- (a) $\frac{\pi}{6}$ (b) $\sin^{-1}\left(\frac{\sqrt{3}}{4}\right)$
(c) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ (d) $\frac{\pi}{3}$

68. The eccentricity of the hyperbola whose length of the latus rectum is equal to 8 and the length of its conjugate axis is equal half of the distance between its foci, is:

- (a) $\frac{4}{\sqrt{3}}$ (b) $\frac{2}{\sqrt{3}}$
(c) $\sqrt{3}$ (d) $\frac{4}{3}$

69. If the standard deviation of the numbers 2, 3, a and 11 is 3.5, then which of the following is true?

- (a) $3a^2 - 32a + 84 = 0$
(b) $3a^2 - 34a + 91 = 0$
(c) $3a^2 - 23a + 44 = 0$
(d) $3a^2 - 26a + 55 = 0$

70. The integral $\int \frac{2x^{12}+5x^9}{(x^5+x^3+1)^3} dx$ is equal to:

- (a) $\frac{x^{10}}{2(x^5+x^3+1)^2} + C$ (b) $\frac{x^5}{2(x^5+x^3+1)^2} + C$
(c) $\frac{-x^{10}}{2(x^5+x^3+1)^2} + C$ (d) $\frac{-x^5}{(x^5+x^3+1)^2} + C$

where C is an arbitrary constant?

71. If the line, $\frac{x-3}{2} = \frac{y+2}{-1} = \frac{z+4}{3}$ lies in the plane, $lx + my - z = 9$, then $l^2 + m^2$ is equal to:

- (a) 18 (b) 5
(c) 2 (d) 26

72. If $0 \leq x < 2\pi$, then the number of real values of x , which satisfy the equation $\cos x + \cos 2x + \cos 3x + \cos 4x = 0$ is:

- (a) 5 (b) 7
(c) 9 (d) 3

73. The area (in sq. units) of the region $\{(x, y): y^2 \geq 2x \text{ and } x^2 + y^2 \leq 4x, x \geq 0, y \geq 0\}$ is:

- (a) $\pi - \frac{8}{3}$ (b) $\pi - \frac{4\sqrt{2}}{3}$
(c) $\frac{\pi}{2} - \frac{2\sqrt{2}}{3}$ (d) $\pi - \frac{4}{3}$

74. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three-unit vectors such that $\vec{a} \times (\vec{b} \times \vec{c}) = \frac{\sqrt{3}}{2}(\vec{b} + \vec{c})$. If $\vec{b}$ is not parallel to $\vec{c}$, then the angle between $\vec{a}$ and $\vec{b}$ is:

- (a) $\frac{\pi}{2}$ (b) $\frac{2\pi}{3}$
(c) $\frac{5\pi}{6}$ (d) $\frac{3\pi}{4}$

75. A wire of length 2 units is cut into two parts which are bent respectively to form a square of side = x units and a circle of radius = r units. If the sum of the areas of the square and the circle so formed is minimum, then:

- (a) $(4 - \pi)x = \pi r$ (b) $x = 2r$
(c) $2x = r$ (d) $2x = (\pi + 4)r$

76. The distance of the point $(1, -5, 9)$ from the plane $x - y + z = 5$ measured along the line $x = y = z$ is:

- (a) $10\sqrt{3}$ (b) $\frac{10}{\sqrt{3}}$
(c) $\frac{20}{3}$ (d) $3\sqrt{10}$

77. If a curve $y = f(x)$ passes through the point $(1, -1)$ and satisfies the differential equation, $y(1 + xy)dx = x dy$, then $f\left(-\frac{1}{2}\right)$ is equal to:

- (a) $-\frac{4}{5}$ (b) $\frac{2}{5}$
(c) $\frac{4}{5}$ (d) $-\frac{2}{5}$

78. If the number of terms in the expansion of $\left(1 - \frac{2}{x} + \frac{4}{x^2}\right)^n, x \neq 0$, is 28, then the sum of the coefficients of all the terms in this expansion, is:

- (a) 2187 (b) 243
(c) 729 (d) 64

79. Consider $f(x) = \tan^{-1}\left(\sqrt{\frac{1+\sin x}{1-\sin x}}\right), x \in \left(0, \frac{\pi}{2}\right)$. A normal to $y = f(x)$ at $x = \frac{\pi}{6}$ also passes through the point:

- (a) $\left(0, \frac{2\pi}{3}\right)$ (b) $\left(\frac{\pi}{6}, 0\right)$
(c) $\left(\frac{\pi}{4}, 0\right)$ (d) $(0, 0)$

80. For $x \in \mathbb{R}, f(x) = |\log 2 - \sin x|$ and $g(x) = f(f(x))$, then:

- (a) $g'(0) = \cos(\log 2)$
(b) $g'(0) = -\cos(\log 2)$
(c) g is differentiable at $x = 0$ and $g'(0) = -\sin(\log 2)$
(d) g is not differentiable at $x = 0$

81. Let two fair six-faced dice A and B be thrown simultaneously. If E_1 is the event that die A shows up four, E_2 is the event that die B shows up two and E_3 is the event that the sum of numbers on both dice is odd, then which of the following statements is NOT true?

- (a) E_2 and E_3 are independent.
(b) E_1 and E_3 are independent.
(c) E_1, E_2 and E_3 are independent.
(d) E_1 and E_2 are independent.

82. If $A = \begin{bmatrix} 5a & -b \\ 3 & 2 \end{bmatrix}$ and $A \text{ adj } A = AA^T$, then $5a + b$ is equal to:

- (a) 5 (b) 4
(c) 13 (d) -1

83. The Boolean Expression $(p \wedge \sim q) \vee q \vee (\sim p \wedge q)$ is equivalent to:

- (a) $p \wedge q$ (b) $p \vee q$
(c) $p \vee \sim q$ (d) $\sim p \wedge q$

84. The sum of all real values of x satisfying the equation

$$(x^2 - 5x + 5)^{x^2 + 4x - 60} = 1 \text{ is}$$

- (a) -4 (b) 6
(c) 5 (d) 3

85. The center's of those circles which touch the circle, $x^2 + y^2 - 8x - 8y - 4 = 0$, externally and also touch the x -axis, lie on:

- (a) an ellipse which is not a circle.
(b) a hyperbola.
(c) a parabola.
(d) a circle.

86. If all the words (with or without meaning) having five letters, formed using the letters of the word SMALL and arranged as in a dictionary; then the position of the word SMALL is:

- (a) 59th (b) 52nd
(c) 58th (d) 46th

87. $\lim_{n \rightarrow \infty} \left(\frac{(n+1)(n+2)\dots 3n}{n^{2n}} \right)^{1/n}$ is equal to:

- (a) $\frac{27}{e^2}$ (b) $\frac{9}{e^2}$
(c) $3\log 3 - 2$ (d) $\frac{18}{e^4}$

88. If the sum of the first ten terms of the series $\left(1\frac{3}{5}\right)^2 + \left(2\frac{2}{5}\right)^2 + \left(3\frac{1}{5}\right)^2 + 4^2 + \left(4\frac{4}{5}\right)^2 + \dots$, is $\frac{16}{5} m$, then m is equal to:

- (a) 101 (b) 100
(c) 99 (d) 102

89. If one of the diameters of the circle, given by the equation, $x^2 + y^2 - 4x + 6y - 12 = 0$, is a chord of a circle S , whose centre is at $(-3, 2)$, then the radius of S is:

- (a) $5\sqrt{3}$ (b) 5
(c) 10 (d) $5\sqrt{2}$

90. A man is walking towards a vertical pillar in a straight path, at a uniform speed. At a certain point A on the path, he observes that the angle of elevation of the top of the pillar is 30° . After walking for 10 minutes from A in the same direction, at a point B , he observes that the angle of elevation of the top of the pillar is 60° . Then the time taken (in minutes) by him, from B to reach the pillar, is:

- (a) 10 (b) 20
(c) 5 (d) 6