

Test Date: 24th June 2022 (First Shift)

PHYSICS, CHEMISTRY & MATHEMATICS

Paper - 1

Time Allotted: 3 Hours

Maximum Marks: 300

 Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.

Important Instructions:

- 1. The test is of 3 hours duration.
- 2. This test paper consists of 90 questions. Each subject (PCM) has 30 questions. The maximum marks are 300.
- 3. This question paper contains **Three Parts. Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics. Each part has only two sections: **Section-A and Section-B**.
- 4. Section A : Attempt all questions.
- 5. Section B : Do any 5 questions out of 10 Questions.
- 6. Section-A (01 20) contains 20 multiple choice questions which have only one correct answer. Each question carries +4 marks for correct answer and –1 mark for wrong answer.
- Section-B (1 10) contains 10 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries +4 marks for correct answer and –1 mark for wrong answer.

PART – A (PHYSICS)

SECTION - A

(One Options Correct Type)

This section contains 20 multiple choice questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE option is correct.

The bulk modulus of a liquid is $3 \times 10^{10} \text{Nm}^{-2}$. The pressure required to reduce the volume Q1. of liquid by 2% is :

(A) 3×10^8 Nm ⁻²	(B) 9×10 ⁸ Nm ⁻²
(C) $6 \times 10^8 \text{Nm}^{-2}$	(D) 12×10 ⁸ Nm ⁻²

Q2. Given below are two statements : One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): In an uniform magnetic field, speed and energy remains the same for a moving charged particle.

- Reason (R) : Moving charged particle experiences magnetic force perpendicular to its direction of motion.
- (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
- (B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).
- (C) (A) is true but (R) is false.
- (D) (A) is false but (R) is true.
- Q3. Two identical cells each of emf 1.5 V are connected in parallel across a parallel combination of two resistors each of resistance 20Ω . A voltmeter connected in the circuit measures 1.2 V. The internal resistance of each cell is :

(B) 4Ω

(D) 10Ω

- (A) 2.5Ω
- (C) 5Ω
- Identify the pair of physical quantities which have different dimensions : Q4. (A) Wave number and Rydberg's constant
 - (B) Stress and Coefficient of elasticity
 - (C) Coercivity and Magnetisation

1 2 1

- (D) Specific heat capacity and Latent heat
- Q5. A projectile is projected with velocity of 25m/s at an angle θ with the horizontal. After t seconds its inclination with horizontal becomes zero. If R represents horizontal range of the projectile, the value of θ will be :

[Use g = 10 m/s²]
(A)
$$\frac{1}{2} \sin^{-1} \left(\frac{5t^2}{4R} \right)$$

(B) $\frac{1}{2} \sin^{-1} \left(\frac{4R}{5t^2} \right)$
(C) $\tan^{-1} \left(\frac{4t^2}{5R} \right)$
(D) $\cot^{-1} \left(\frac{R}{20t^2} \right)$

e of K is :

Q6. A block of mass 10 kg, starts sliding on a surface with an initial velocity of 9.8ms⁻¹. The coefficient of friction between the surface and block is 0.5. The distance covered by the block before coming to rest is :

[used g = 9.8 ms ⁻ 2]	
(A) 4.9 m	(B) 9.8 m
(C) 12.5 m	(D) 19.6 m

Q7. A boy ties a stone of mass 100 g to the end of 2 m long string and whirls it around in a horizontal plane. The string can withstand the maximum tension of 80 N. If the maximum

speed with	which the	stone	can	revolve	is	rev./	min.	The	valu
-						π			

(Assume the string is massless and	l unstretchable)
(A) 400	(B) 300
(C) 600	(D) 800

Q8. A vertical electric field of magnitude 4.9×10^5 N/C just prevents a water droplet of a mass 0.1 g from falling. The value of charge on the droplet will be : (Given g = 9.8 m/s²) (A) 1.6×10^{-9} C (B) 2.0×10^{-9} C (C) 3.2×10^{-9} C (D) 0.5×10^{-9} C

Q9. A particle experiences a variable force $\vec{F} = (4x\hat{i} + 3y^2\hat{j})$ in a horizontal x-y plane. Assume distance in meters and force is Newton. If the particle moves from point (1, 2) to point (2, 3) in the x-y plane, then kinetic Energy changes by : (A) 50.0 J (B) 12.5 J (C) 25.0 J (D) 0 J

Q10. The approximate height from the surface of earth at which the weight of the body becomes $\frac{1}{3}$ of its weight on the surface of earth is :

[Radius of earth R = 6400 km and	$\sqrt{3} = 1.732$]
(A) 3840 km	(B) 4685 km
(C) 2133 km	(D) 4267 km

- Q11. A resistance of 40Ω is connected to a source of alternating current rated 220 V, 50 Hz. Find the time taken by the current to change from its maximum value to the rms value :
 (A) 2.5 ms
 (B) 1.25 ms
 (C) 2.5 s
 (D) 0.25 s
- Q12. The equations of two waves are given by : $y_1 = 5 \sin 2\pi (x - \upsilon t) \text{ cm}$

 $y_2 = 3\sin 2\pi (x - \upsilon t + 1.5) cm$

These waves are simultaneously passing through a string. The amplitude of the resulting wave is :

(A) 2 cm	(B) 4 cm
(C) 5.8cm	(D) 8 cm

 $c = 3 \times 10^8 \,\mathrm{ms}^{-1}$)

Q13. A plane electromagnetic wave travels in a medium of relative permeability 1.61 and relative permittivity 6.44. If magnitude of magnetic intensity is $4.5 \times 10^{-2} \text{ Am}^{-1}$ at a point, what will be the approximate magnitude of electric field intensity at that point ? (Given : Permeability of free space $\mu_0 = 4\pi \times 10^{-7} \text{ NA}^{-2}$, speed of light in vacuum

(A) 16.96 Vm ⁻¹	(B) 2.25×10 ⁻² Vm ⁻¹
(C) 8.48 Vm ⁻¹	(D) 6.75×10 ⁶ Vm ⁻¹

- **Q14.** Choose the correct option from the following options given below :
 - (A) In the ground state of Rutherford's model electrons are in stable equilibrium. While
 - in Thomson's model electrons always experience a net force.
 - (B) An atom has a nearly continuous mass distribution in a Rutherford's model but has a highly non-uniform mass distribution in Thomson's model
 - (C) A classical atom based on Rutherford's model is doomed to collapse.
 - (D) The positively charged part of the atom possesses most of the mass in Rutherford's model but not in Thomson's model.
- Q15. Nucleus A is having mass number 220 and its binding energy per nucleon is 5.6 MeV. It splits in two fragments 'B' and 'C' of mass numbers 105 and 115. The binding energy of nucleons in 'B' and 'C' 6.4 MeV per nucleon. The energy Q released per fission will be : (A) 0.8 MeV (B) 275 MeV
 - (C) 220 MeV (D) 176 MeV
- Q16. A baseband signal of 3.5 MHz frequency is modulated with a carrier signal of 3.5 GHz frequency using amplitude modulation method. What should be the minimum size of antenna required to transmit the modulated signal ? (A) 42.8 m

(A) 42.0 III	(D) 42.0 IIIII
(C) 21.4 mm	(D) 21.4 m

Q17. A cornot engine whose heat sinks at 27°C has an efficiency of 25%. By how many degrees should the temperature of the source be changed to increase the efficiency by 100% of the original efficiency?

(A) Increases by 18°C	(B) Increases by 200°C
(C) Increases by 120°C	(D) Increases by 73°C

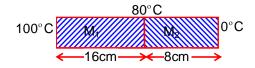
Q18. A parallel plate capacitor is formed by two plates each of area 30π cm² separated by 1 mm. A material of dielectric strength 3.6×10^7 Vm⁻¹ is filled between the plates. If the maximum charge that can be stored on the capacitor without causing any dielectric breakdown is 7×10^{-6} C, the value of dielectric constant of the material is :

[Use $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \mathrm{Nm^2 C^{-2}}$]	
(A) 1.66	(B) 1.75
(C) 2.25	(D) 2.33

Q19. The magnetic field at the centre of a circular coil of radius r, due to current I flowing through it, is B. the magnetic field at a point along the axis at a distance $\frac{r}{2}$ from the centre is :

(A) B/2
(C)
$$\left(\frac{2}{\sqrt{5}}\right)^3$$
 B

(B) 2B
(D)
$$\left(\frac{2}{\sqrt{3}}\right)^3$$
B

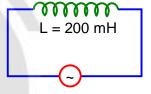


SECTION - B

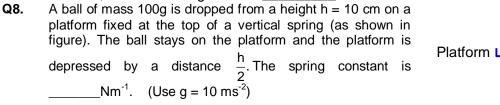
(Numerical Answer Type)

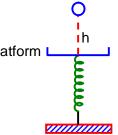
This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

- Q1. 0.056 kg of Nitrogen is enclose in a vessel at a temperature of 127°C. The amount of heat required to double the speed of its molecules is _____k cal. (Take R = 2 cal mole⁻¹ K⁻¹)
- **Q2.** Two identical thin biconvex lenses of focal length 15cm and refractive index 1.5 are in contact with each other. The space between the lenses is filled with a liquid of refractive index 1.25. The focal length of the combination is _____cm.
- Q3. A transistor is used in common-emitter mode in an amplifier circuit. When a signal of 10 mV is added to the base-emitter voltage, the base current changes by 10μA and the collector current changes by 1.5 mA. The load resistance is 5kΩ. The voltage gain of the transistor will be _____.
- **Q4.** As shown in the figure an inductor of inductance 200 mH is connected to an AC source of emf 220 V and frequency 50 Hz. The instantaneous voltage of the source is 0 V when the peak value of current is $\frac{\sqrt{a}}{\pi}$ A. The value of a is



- **Q5.** Sodium light of wavelength 650nm and 655 nm is used to study diffraction at a single slit of aperture 0.5 mm. The distance between the slit and the screen is 2.0 m. The separation between the positions of the first maxima of diffraction pattern obtained in the two cases is $_____\times 10^{-6}$ m.
- **Q6.** When light of frequency twice the threshold frequency is incident on the metal plate, the maximum velocity of emitted electron is v_1 . When the frequency of incident radiation is increased to five times the threshold value, the maximum velocity of emitted electron becomes v_2 . If $v_2 = x v_1$, the value of x will be _____.
- **Q7.** From the top of a tower, a ball is thrown vertically upward which reaches the ground in 6s. A second ball thrown vertically downward from the same position with the same speed reaches the ground in 1.5 s. A third ball released, from the rest from the same location, will reach the ground in _____s.





- **Q9.** In a potentiometer arrangement, a cell gives a balancing point at 75cm length of wire. This cell is now replaced by another cell of unknown emf. If the ratio of the emef's of two cells respectively is 3:2, the difference in the balancing length of the potentiometer wire in above two cases will be _____cm.
- **Q10.** A metre scale is balanced on a knife edge at its centre. When two coins, each of mass 10g are put one on the top of the other at the 10.0 cm mark the scale is found to be balanced at 40.0 cm mark. The mass of the metre scale is found to be $x \times 10^{-2}$ kg. The value of x is _____.



PART – B (CHEMISTRY)

SECTION - A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

Q1.	If a rocket runs on a fuel $(C_{15}H_{30})$ and lique CO_2 released for every litre of fuel respect (Given: density of the fuel is 0.756 g / mL) (A) 1188 g and 1296 g (C) 2592 g and 2376 g	•
Q2.	Consider the following pairs of electrons (A) (a) $n = 3, \ell = 1, m_{\ell} = 1, m_s = +\frac{1}{2}$ (b) $n = 3, \ell = 2, m_{\ell} = 1.m_s = +\frac{1}{2}$	
	(B) (a) $n = 3, \ell = 2, m_{\ell} = -2, m_{s} = -\frac{1}{2}$ (b) $n = 3, \ell = 2, m_{\ell} = -1, m_{s} = -\frac{1}{2}$ (C) (a) $n = 4, \ell = 2, m_{\ell} = 2, m_{s} = +\frac{1}{2}$ (b) $n = 3, \ell = 2, m_{\ell} = -2, m_{s} = +\frac{1}{2}$	
	The pairs of electrons present in degener (A) Only (A) (C) Only (C)	ate orbitals is / are: (B) Only (B) (D) (B) and (C)
Q3.	Match List – I with List – II List – I (A) $[PtCl_4]^{2^-}$ (B) BrF ₅ (C) (D) $[Co(NH_3)_6]^{3^+}$ Choose the most appropriate answer fr (A) (A) – (II) – (B) – (IV), (C) – (I), (D) – (II) (B) (A) – (III) , (B) – (IV), (C)- (I), (D) – (II) (C) (A)- (III) , (B)-(I), (C)- (IV), (D) – (II) (D) (A) – (II), (B) – (I), (C)- (IV), (D)-(III)	

Q4. For a reaction at equilibrium

$$A(g) \rightleftharpoons B(g) + \frac{1}{2}C(g)$$

The relation between dissociation constant (K), degree of dissociation (α) and equilibrium pressure (p) is given by

(A)
$$K = \frac{\alpha^{\frac{1}{2}} p^{\frac{3}{2}}}{\left(1 + \frac{3}{2}\alpha\right)^{\frac{1}{2}} (1 - \alpha)}$$

(B) $K = \frac{\alpha^{\frac{3}{2}} p^{\frac{1}{2}}}{\left(2 + \alpha\right)^{\frac{1}{2}} (1 - \alpha)}$
(C) $K = \frac{\left(\alpha p\right)^{\frac{3}{2}}}{\left(1 + \frac{3}{2}\alpha\right)^{\frac{1}{2}} (1 - \alpha)}$
(D) $K = \frac{\left(\alpha p\right)^{\frac{3}{2}}}{\left(1 + \alpha\right) (1 - \alpha)^{\frac{1}{2}}}$

- **Q5.** Given below are two statements:
 - Statement I: Emulsions of oil in water are unstable and sometimes they separate into two layers on standing.
 - Statement II: For stabilization of an emulsion, excess of electrolyte is added. In the light of the above statements, choose the most appropriate answer from the options given below:
 - (A) Both Statement I and Statement II are correct.
 - (B) Both Statement I and Statement II are incorrect.
 - (C) Statement I is correct but Statement II is incorrect.
 - (D) Statement I is incorrect but Statement II is correct.
- Q6. Given below are the oxides: $Na_2O, As_2O_3, N_2O, NO and Cl_2O_7$ Number of amphoteric oxides is : (A) 0 (C) 2

(B) 1 (D) 3

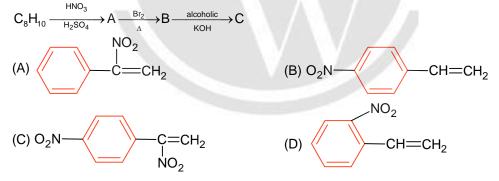
- Q7. Match List I with List- II: List – I
 - List IList II(A) Sphalerite(I) $FeCO_3$ (B) Calamine(II) PbS(C)Galena (III) ZnCO_3(D) Siderite(iv) ZnSChoose the most appropriate answer from the options given below:(A) (A) (IV), (B) (III), (C) (II), (D) (I)
 - (B) (A) (IV), (B)-(I), (C)-(II), (D)- (III) (C) (A)-(II), (B)-(III), (C)- (I), (D)-(IV)

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

Q8. The highest industrial consumption of molecular hydrogen is to produce compounds of element:

(A) Carbon	(B) Nitrogen
(B) Oxygen	(D) Chlorine

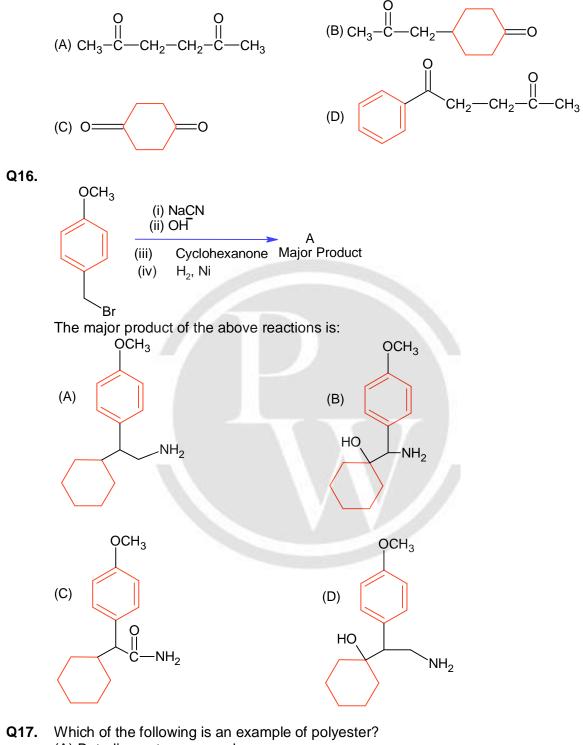
- Q9. Which of the following statements are correct? (A) Both LiCl and MgCl₂ are soluble in ethanol (B) The oxides Li₂O and MqO combine with excess of oxygen to give superoxide. (C) LiF is less soluble in water than other alkali metal fluorides. (D) Li₂O is more soluble in water than other alkali metal oxides Choose the **most appropriate** answer from the options given below: (A) (A) and (C) only (B) (A), (C) and (D) only (D) (B) and (C) only (D) (A) and (D) only Q10. Identify the correct statement fro B_2H_6 from those given below: (A) In B_2H_6 , all B-H bonds are equivalent (B) In B_2H_6 , there are four 3- centre 2- electron bonds. (C) B_2H_6 is a Lewis acid (D) B_2H_6 can be synthesized from both BF_3 and $NaBH_4$. (E) B_2H_6 is planar molecule. Choose the **most appropriate** answer from the options given below: (A) (A) and (E) only (B) (B), (C) and (E) only (C) (C) and (D) only (D) (C) and (E) only Q11. The most stable trihalide of nitrogen is: (B) NCl₃ $(A) NF_3$ (C) NBr₃ $(D) NI_3$
- Q12. Which one of the following elemental forms is not present in the enamel of the teeth? (A) Ca^{2+} (B) p^{3+} (C) F^{-} (D) p^{5+}
- Q13. In the given reaction sequence, the major product 'C' is::



- **Q14.** Two statement are given below:
 - Statement I: The melting point of monocarboxylic acid even number of carbon atoms is higher than that of with odd number of carbon atoms acid immediately below and above it in the series.
 - **Statement II:** The solubility of monocarboxylic acids in water decreases with increases in molar mass.

Choose the **most appropriate** options

- (A) Both Statement I and Statement II are correct.
- (B) Both Statement I and Statement II are incorrect.
- (C) Statement I is correct but Statement II is incorrect.
- (D) Statement I is incorrect but Statement II is correct.



Q15. Which of the following is an example of conjugated diketone?

- - (A) Butadiene-styrene copolymer
 - (B) Melamine polymer
 - (C) Neoprene
 - (D) Poly- β -hyroxybutyrate-co- β -hydroxyvalerate

- **Q18.** A polysaccharide 'X' on boiling with dil H_2SO_4 ate 393 K under 2-3 atm pressure yields 'Y'. 'Y' on treatment with bromine water gives gluconic acid. 'X' contains β -glycosidic linkages only. Compound 'X' is:
 - (A) starch(C) amylose

(B) cellulose

- (D) amylopectin
- Q19.Which of the following is not a broad spectrum antibiotic?
(A) Vancomycin
(C) Ofloxacin(B) Ampicillin
(D) Penicillin G
- **Q20.** During the qualitative analysis of salt with cation y^{2+} , addition of a reagent (X) to alkaline solution of the salt gives a bright red precipitate. The reagent (X) and the cation (y^{2+}) present respectively are:
 - (A) Dimethylglyoxime and Ni²⁺
 - (C) Nessler's reagent and Hg²⁺
- (B) Dimethylglyoxime and Co²⁺
- (D) Nessler's reagent and Ni²⁺



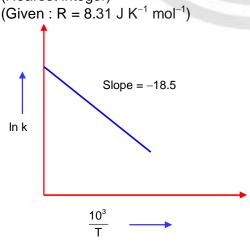
SECTION - B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

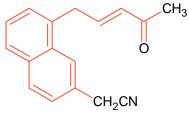
- **Q1.** Atoms of element X from hcp lattice and those of element Y occupy $\frac{2}{3}$ of its tetrahedral voids. The percentage of element X in the lattice is ______. (Nearest integer)
- **Q2.** $2O_3(g) \rightleftharpoons 3O_2(g)$ At 300 K, ozone is fifty percent dissociated. The standard free energy change at this temperature and 1 atm pressure is (-)_____. J mol⁻¹. (Nearest integer) [Given: ln 1.35 = 0.3 and R= 8.3 J K⁻¹ mol⁻¹]
- **Q3.** The osmotic pressure of blood is 7.47 bar at 300K. To inject glucose to a patient intravenously, it has to isotonic with blood. The concentration of glucose solution in gL^{-1} is_____. (Molar mass of glucose = 180 g mol⁻¹ R = 0.083 L bar K⁻¹ mol⁻¹) (Nearest integer)
- Q4. The cell potential for the following cell Pt $|H_2(g)|H^+(aq)||Cu^{2+}(0.01M)|Cu(s)$ Is 0.576 V at 298 K. The pH of the solution is _____. (Nearest integer) (Given: $E^0_{Cu^{2+}/Cu} = 0.34$ V and $\frac{2.303RT}{F} = 0.06$ V)
- **Q5.** The rate constants for decomposition of acetaldehyde have been measured over the temperature range 700 1000 K. The data has been analysed by plotting ln k vs $\frac{10^3}{\tau}$

graph. The value of activation energy for the reaction is ______ kJ mol⁻¹. (Nearest integer)



Q6. The difference in oxidation state of chrominum in chromate and dichromate salts is_____.

- **Q7.** In the cobalt- carbonyl complex : $[Co_2(CO)_8]$, number of Co-Co bonds is "X" and terminal CO lignads is "Y". X + Y = _____.
- Q8. A 0.166 g sample of an organic compound was digested with conc. H₂SO₄ and then distilled with NaOH. The ammonia gas evolved was passed through 50.0 mL of 0.5 N H₂SO₄. The used acid required 30.0 mL of 0.25 N NaOH for complete neutralization. The mass percentage of nitrogen in the organic compound is_____.
- Q9. Number of electrophillic centres in the given compound is______.



Q10. The major product 'A' of the following given reaction has ______ sp² hybridized carbon atoms,

2,7- Dimethyl 1-2-6- octadiene $\xrightarrow{H^+}$ A Major Product

PART – C (MATHEMATICS)

SECTION - A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

Q1.	Let A = $\{z \in C : 1 \le z - (1 + i) \le 2\}$ and B = $\{z \in (A) \text{ is an empty set} (C) \text{ contains exactly three elements} \}$	A : z − (1−i) = 1} . Then, B: (B) contains exactly two elements (D) is an infinite set
Q2.	The remainder when 3 ²⁰²² is divided by 5 is (A) 1 (C) 3	: (B) 2 (D) 4
Q3.		shape being inflated increases at a constant inits and after 5 seconds, it becomes 7 units, (B) 10 (D) 12
Q4.	white balls. One bag is chosen at random a	balls and bag B contains 3 black, 2 red and n nd 2 balls drawn from it at random are found to to both balls come from Bag A is $\frac{6}{11}$, then n is
	equal to (A) 13 (C) 4	(B) 6 (D) 3
Q5.	Let $x^2 + y^2 + Ax + By + C = 0$ be a circle parabola $y = x^2$ at (2, 4). Then A + C is equa (A) 16 (C) 72	passing through (0, 6) and touching the al to (B) 88/5 (D) – 8
Q6.	The number of values of α for which the system $x + y + z = \alpha$ $\alpha x + 2\alpha y + 3z = -1$ $x + 3\alpha y + 5z = 4$ is inconsistent, is	tem of equations:
	(A) 0 (C) 2	(B) 1 (D) 3
Q7.	If the sum of the squares of the recipro $3x^2 + \lambda x - 1 = 0$ is 15, then $6(\alpha^3 + \beta^3)^2$ is equal	cals of the roots α and β of the equation I to :

(A) 18 (B) 24 (C) 36 (D) 96 **Q8.** The set of all values of k for which $(\tan^{-1} x)^3 + (\cot^{-1} x)^3 = k\pi^3$, $x \in R$, is the interval :

(A)
$$\left[\frac{1}{32}, \frac{7}{8}\right]$$
 (B) $\left(\frac{1}{24}, \frac{13}{16}\right)$
(C) $\left[\frac{1}{48}, \frac{13}{16}\right]$ (D) $\left[\frac{1}{32}, \frac{9}{8}\right]$

Q9. Let $S = \{\sqrt{n} : 1 \le n \le 50 \text{ and } n \text{ is odd } \}$.

Let $a \in S$ and $A = \begin{bmatrix} 1 & 0 & a \\ -1 & 1 & 0 \\ -a & 0 & 1 \end{bmatrix}$. If $\sum_{a \in S} det(adjA) = 100\lambda$, then λ is equal to : (A) 218 (C) 663 (B) 221 (D) 1717

- **Q10.** For the function f (x) = $4 \log_e(x-1) 2x^2 + 4x + 5$, x > 1, which one of the following is NOT correct ?
 - (A) f is increasing in (1, 2) and decreasing in $(2, \infty)$
 - (B) f (x) = -1 has exactly two solutions
 - (C) f'(e) f''(2) < 0
 - (D) f (x) =0 has a root in the interval (e, e + 1)
- **Q11.** If the tangent at the point (x_1, y_1) on the curve $y = x^3 + 3x^2 + 5$ passes through the origin, then (x_1, y_1) does NOT lie on the curve:

(A)
$$x^{2} + \frac{y^{2}}{81} = 2$$

(B) $\frac{y^{2}}{9} - x^{2} = 8$
(C) $y = 4x^{2} + 5$
(D) $\frac{x}{3} - y^{2} = 2$

Q12. The sum of absolute maximum and absolute minimum values of the function $f(x) = |2x^2 + 3x - 2| + \sin x \cos x$ in the interval [0, 1] is :

(A)
$$3 + \frac{\sin(1)\cos^2(1/2)}{2}$$
 (B) $3 + \frac{1}{2}(1 + 2\cos(1))\sin(1)$
(C) $5 + \frac{1}{2}(\sin(1) + \sin(2))$ (D) $2 + \sin(\frac{1}{2})\cos(\frac{1}{2})$

Q13. If $\{a_i\}_{i=1}^n$, where n is an even integer, is an arithmetic progression with common difference

1, and
$$\sum_{i=1}^{n} a_i = 192$$
, then n is equal to :
(A) 48 (B) 96 (C) 92 (D) 104

Q14. If x = x(y) is the solution of the differential equation $y \frac{dx}{dy} = 2x + y^3(y + 1)e^y$, x(1) = 0; then

x(e) is equal to :(A) $e^{3}(e^{e} - 1)$ (B) $e^{e}(e^{3} - 1)$ (C) $e^{2}(e^{e} + 1)$ (D) $e^{e}(e^{2} - 1)$

Q15. Let $\lambda x - 2y = \mu$ be a tangent to the hyperbola $a^2x^2 - y^2 = b^2$. Then $\left(\frac{\lambda}{a}\right)^2 - \left(\frac{\mu}{b}\right)^2$ is equal to (B) - 4 (D) 4 (A) - 2 (C) 2

Q16. Let \hat{a}, \hat{b} and be unit vectors. If \vec{c} be vector such that the angle between \hat{a} and \vec{c} is $\frac{\pi}{12}$, and $\hat{\mathbf{b}} = \vec{\mathbf{c}} + 2(\vec{\mathbf{c}} \times \hat{\mathbf{a}})$, then $|6\vec{\mathbf{c}}|^2$ is equal to : (A) $6(3-\sqrt{3})$ (B) $3 + \sqrt{3}$ (C) $6(3+\sqrt{3})$ (D) $6(\sqrt{3}+1)$

Q17. If a random variable X follows the Binomial distribution B(33, p) such that 3P(X = 0) =P(X = 1) then the value of P(X = 15) - P(X = 16). .1.0

P(X=1) then the value of	P(X = 18) - $P(X = 17)$ is equal to :
(A)1320	(B) 1088
(C) $\frac{120}{1331}$	(D) 1088 1089
1331	(5) 1089

 $\cos^{-1}\left(\frac{x^2-5x+6}{x^2-9}\right)$ is : **Q18.** The domain of the function f(x) =

(B) (2,∞) $(A)(-\infty, 1) \cup (2, \infty)$ (D) $\left[-1/2, 1\right) \cup \left(2, \infty\right) - \left\{\frac{3+\sqrt{5}}{2}, \frac{3-\sqrt{5}}{2}\right\}$ (C) $[-1/2, 1] \cup (2,\infty)$

Q19. Let $S = \left\{ \theta \in [-\pi,\pi] - \left\{ \pm \frac{\pi}{2} \right\} : \sin \theta \tan \theta + \tan \theta = \sin 2\theta \right\}$. If $T = \sum_{\theta \in S} \cos 2\theta$, then T + n(S) is equal to (A) 7 + $\sqrt{3}$ (B) 9 (C) $8 + \sqrt{3}$ (D) 10

Q20. The number of choices for $\Delta \in \{\land,\lor,\Rightarrow,\Leftrightarrow\}$, such that $(p \ \Delta \ q) \Rightarrow ((p \ \Delta \ \neg q) \ \lor ((\neg p) \ \Delta \ q))$ is a tautology, is:

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

SECTION - B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

- **Q1.** The number of one-one functions f: $\{a, b, c, d\} \rightarrow \{0, 1, 2, ..., 10\}$ such that 2f(a)- f(b) + 3f(c) + f(d) = 0 is_____.
- **Q2.** In an examination, there are 5 multiple choice questions with 3 choices, out of which exactly one is correct. There are 3 marks for each correct answer, -2 marks for each wrong answer and 0 mark if the question is not attempted. Then, the number of ways a student appearing in the examination gets 5 marks is_____.
- **Q3.** Let $A\left(\frac{3}{\sqrt{a}}, \sqrt{a}\right)$, a>0, be a fixed point in the xy-plane. The image of A in y-axis be B and the image of B in x-axis be C. If $D(3\cos\theta, a\sin\theta)$ is a point in the fourth quadrant such that the maximum area of $\triangle ACD$ is 12 square units, then a is equal to_____.
- **Q4.** Let a line having direction ratios 1, -4, 2 intersect the lines $\frac{x-7}{3} = \frac{y-1}{-1} = \frac{z+2}{1}$ and $\frac{x}{2} = \frac{y-7}{3} = \frac{z}{1}$ at the points A and B. Then (AB)² is equal to_____.
- **Q5.** The number of points where the function $f(x) = \begin{cases} \begin{vmatrix} 2x^2 3x 7 \\ 4x^2 1 \end{vmatrix}$ if $x \le -1$ $\begin{vmatrix} 4x^2 - 1 \\ x + 1 \end{vmatrix}$ if -1 < x < 1, if $x \ge 1$

[t] denotes the greatest integer ≤t is discontinuous is__

Q6. Let $f(\theta) = \sin \theta + \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} (\sin \theta + t \cos \theta) f(t) dt$. Then the value of $\left| \int_{0}^{\frac{\pi}{2}} f(\theta) d\theta \right|$ is

- **Q7.** Let $\max_{0 \le x \le 2} \left\{ \frac{9 x^2}{5 x} \right\} = \alpha \text{ and } \min_{0 \le x \le 2} \left\{ \frac{9 x^2}{5 x} \right\} = \beta$ If $\int_{\beta - \frac{8}{3}}^{2\alpha - 1} \operatorname{Max} \left\{ \frac{9 - x^2}{5 - x}, x \right\} dx = \alpha_1 + \alpha_2 \log_e \left(\frac{8}{15} \right) \text{ then } \alpha_1 + \alpha_2 \text{ is equal to} ____.$
- **Q8.** If two tangents drawn from a point (α, β) lying on the ellipse $25x^2 + 4y^2 = 1$ to the parabola $y^2 = 4x$ are such that the slope of one tangent is four times the other, then the value of $(10\alpha + 5)^2 + (16\beta^2 + 50)^2$ equals_____.

Q9. Let S be the region bounded by the curves $y = x^3$ and $y^2 = x$. The curve y = 2|x| divides S into two regions of areas R₁, and R₂.

If max { R_1 , R_2 } = R_2 , then $\frac{R_2}{R_1}$ is equal to_____.

Q10. If the shortest distance between the lines $\vec{r} = (-\hat{i} + 3\hat{k}) + \lambda(\hat{i} - a\hat{j})$ and $\vec{r} = (-\hat{j} + 2\hat{k}) + \lambda(\hat{i} - a\hat{j})$

 $\mu \Big(\, \hat{i} - \hat{j} + \hat{k} \Big) \, \text{is} \, \sqrt{\frac{2}{3}}$, then the integral value of 'a' is equal to_____.



9.

25



PART - A (PHYSICS)

SECTION - A

1.	С	2.	Α	3.	С	4.	D
5.	D	6.	В	7.	С	8.	В
9.	С	10.	В	11.	Α	12.	Α
13.	С	14.	С	15.	D	16.	С
17.	В	18.	D	19.	С	20.	В
			OFOTIO				
			<u>SECTIC</u>	<u>)N - E</u>	<u>3</u>		
1.	12	2.	10	3.	750	4.	242
5.	3	6.	2	7.	3	8.	120

PART – B (CHEMISTRY) SECTION – A

10. **6**

1.	С	2.	В	3.	в	4.	В
5.	С	6.	В	7.	Α	8.	В
9.	Α	10.	С	11.	Α	12.	В
13.	В	14.	Α	15.	С	16.	D
17.	D	18	В	19.	D	20.	Α
			<u>SEC</u>	tion - e	3		
1.	43	2.	747	3.	54	4.	5
5.	154	6.	0	7.	7	8.	63
9.	3	10.	2				

<u> PART – C (MATHEMATICS)</u>								
			<u>SE</u>	CTION - A	7			
1.	D	2.	D	3.	Α		4.	С
5.	Α	6.	В	7.	в		8.	Α
9.	в	10.	С	11.	D		12.	в
13.	в	14.	Α	15.	D		16.	С
17.	Α	18.	D	19.	в		20.	В
			<u>SE(</u>	CTION - E	<u>3</u>			
1.	31	2.	40	3.	8		4.	84
5.	7	6.	1	7.	34		8.	2929
9.	19	10.	2					

Solutions to JEE (Main)-2022

PART – A (PHYSICS) SECTION - A

Sol1. We know, $\Delta P = -B\frac{\Delta v}{v}$ $\left[\because B = -\Delta P\left(\frac{v}{\Delta v}\right)\right]$ $\Rightarrow 100 \times \Delta P = -Bx\left[\frac{\Delta v}{v} \times 100\right]$ $\Rightarrow 100 \times \Delta P = -3 \times 10^{10} (-2)$ $\Delta P = \frac{6 \times 10^{10}}{100}$ $\Delta P = 6 \times 10^8 \text{ Nm}^{-2}$

Sol2. Work done in magnetic field is zero.

Sol3.
$$E_{eq} = \frac{E_{1}}{r_{1}} + \frac{E_{2}}{r_{2}} = \frac{F_{1}}{r} + \frac{E}{r} = \frac{2E}{r} = \frac{2E}{r} = E$$

$$r_{eq} = \frac{r_{1}}{r_{1}} + \frac{1}{r_{2}} = \frac{r_{1}}{r} + \frac{1}{r} = \frac{r}{2}$$

$$r_{eq} = \frac{r_{1}}{r_{1}} + \frac{1}{r_{2}} = \frac{r_{1}}{2}$$

$$E_{eq} = E = 1.5v$$

$$r_{eq} = \frac{r}{2}$$

$$v_{A} = 1 \times 10 = 1.2 = \frac{E}{10 + r/2} \times 10$$

$$\Rightarrow 1.2 = \frac{10E}{10 + r/2}$$

$$\Rightarrow 1.2 = \frac{10 \times 1.5}{10 + r/2}$$

$$\Rightarrow 1.2 = \frac{10 \times 1.5}{10 + r/2}$$

$$\Rightarrow 12 + 0.6r = 15$$

$$0.6r = 3$$

$$r = \frac{30}{6} = 5\Omega$$

$$E_{eq} = \frac{r_{eq}}{r_{eq}}$$

Sol4.
$$\Delta \Omega = ms \Delta T \Rightarrow s = \frac{\Delta \Omega}{m\Delta T} \Rightarrow [s] = \frac{ML^2 T^2}{M\Omega} = L^2 T^{-2} Q^{-1}$$
$$\Delta \Omega = mL \Rightarrow [L] = \frac{ML^2 T^2}{M} = L^2 T^{-2}$$

Sol5.
$$T = 2t = \frac{2u\sin\theta}{g} \Rightarrow t = \frac{u\sin\theta}{g}$$
$$R = u\cos\theta(T)$$
$$\Rightarrow R = u\cos\theta(T)$$
$$\Rightarrow R = u\cos\theta(2u\sin\theta)$$
$$\Rightarrow R = u\cos\theta(2u\sin\theta)$$
$$\Rightarrow cos\theta = \frac{R}{50t^2} \times \frac{t}{t}$$
$$\Rightarrow cos\theta = \frac{R}{50t^2} \times \frac{25}{10}$$
$$\cos\theta = \frac{R}{50t^2} \times \frac{25}{10}$$
$$\cos\theta = \frac{R}{50t^2} \times \frac{25}{10}$$
$$\cot\theta = \frac{R}{50t^2} \times \frac{25}{10}$$
$$\cot\theta = \frac{R}{50t^2} \times \frac{25}{10}$$
$$\cos\theta = \frac{R}{50t^2} \times \frac{25}{10}$$
$$\cos\theta = \frac{R}{50t^2} \times \frac{25}{10}$$
$$\cos\theta = \frac{R}{20t^2}$$
$$\theta = \cot^{-1}(\frac{R}{20t^2})$$

Sol6.
$$a = \mu g = 0.5 \times 9.8 = 4.9 \text{m/sec}^2$$
$$u = 9.8 \text{m/sec}$$
$$u = 9.8 \text{m/sec}$$
$$s = ?$$
$$v = 0$$
$$v^2 = u^2 + 2as$$
$$\Rightarrow 0 = 9.8^2 - 2 \times 4.9 \text{s}$$
$$\Rightarrow 0 = 9.8 \times 9.8 - 9.8 \text{s}$$
$$s = \frac{9.8 \times 9.8}{9.8} = 9.8 \text{m}$$

Sol7. By NL M: Tsin \theta = m\omega^2 R - (1)
$$& R = r \sin\theta = m\omega^2 R - (1)$$
$$& R = r \sin\theta = m\omega^2 R - (1)$$
$$& R = r \sin\theta = m\omega^2 R - (1)$$
$$& R = r \sin\theta = m\omega^2 R - (1)$$
$$& R = 0.5 \text{m/s} = 0.5 \text{m/s}^2 = 0.5 \text{m/s}^2$$
$$\Rightarrow 80 = (\frac{100}{1000})\omega^2 \times 2$$
$$\Rightarrow 80 = (\frac{100}{1000})\omega^2 \times 2$$
$$\Rightarrow 80 = (\frac{100}{1000})\omega^2 \times 2$$
$$\Rightarrow 80 = \frac{800}{2} = \omega^2$$
$$\Rightarrow 80 = 400$$

$$\omega = 20 \text{ rad / sec}$$
And ,
$$\omega = \frac{2\pi N}{60}$$

$$N = \frac{20 \times 60}{2\pi}$$

$$N = \frac{600}{\pi} \text{ rpm} = \frac{k}{\pi}$$

Sol8. qE = mg $\Rightarrow q = \frac{mg}{E} = \frac{0.1 \times 9.8}{1000 \times 4.9 \times 10^5}$ $q = 2 \times 10^{-9} C$

Qm

h ↓ Mg'

R

Earth

Sol9.
$$\vec{F} = 4x \hat{i} + 3y^2 \hat{j}$$

 $d\vec{r} = d\vec{s} = dx \hat{i} + dy \hat{j}$
 $\int dw = \int \vec{F} \cdot d\vec{r}$
 $= \int (4x \hat{i} + 3y^2 \hat{j}) \cdot (dx \hat{i} + dy \hat{j})$
 $= \int_{1}^{2} 4x dx + \int_{2}^{3} 3y^2 dy$
 $= \frac{4}{2} [x^2]_{1}^{2} + \frac{3}{3} [y^3]_{2}^{3}$
 $= 2[4 - 1] + [27 - 8]$
 $= 6 + 19 = 25 J$

Sol10.
$$g = \frac{g}{\left(1 + \frac{h}{R}\right)^2}$$
$$\Rightarrow \frac{g}{3} = \frac{g}{\left(1 + \frac{h}{R}\right)^2}$$
$$\Rightarrow \left(1 + \frac{h}{R}\right)^2 = 3$$
$$1 + \frac{h}{R} = \sqrt{3}$$
$$\Rightarrow \frac{h}{R} = \sqrt{3} - 1$$
$$\frac{h}{R} = 1.732 - 1$$
$$\frac{h}{R} = 0.732$$
$$h = 0.732 \times 6400$$
$$= 4684.8 \text{ km} \approx 4685 \text{ km}$$

Sol11. Let
$$I = I_0 \cos \omega t$$

$$I = I_0, \text{ at } t_1 = 0$$

$$I = \frac{I_0}{\sqrt{2}}, \text{ at } \omega t = \frac{\pi}{4} \Rightarrow t_2 = \frac{\pi}{4\omega}$$

$$t_2 = \frac{\pi}{4\omega} = \frac{\pi}{4} \times \frac{T}{2\pi} = \frac{T}{8}$$

$$t_2 = \frac{1}{8} \times \frac{1}{\upsilon} \quad \left(T = \frac{1}{\upsilon}\right)$$

$$t_2 = \frac{1}{8 \times 50}$$

$$t_2 = \frac{1}{4 \times 10^{+2}}$$

$$= 0.25 \times 10^{-2}$$

$$t_2 = 2 \cdot 5 \text{ms}$$

Sol12. $y_1 = 5\sin 2\pi (x - vt) cm$

$$y_{2} = 3\sin 2\pi (x - vt + 1 \cdot 5) \text{ cm}$$

$$\phi = (\text{phase Angle}) = 2\pi \times 1 \cdot 5 = 3\pi$$

$$y_{R} = \sqrt{y_{1}^{2} + y_{2}^{2} + 2y_{1}y_{2}\cos\phi}$$

$$= \sqrt{5^{2} T 3^{2} + 2 \times 5 \times 3\cos 3\pi}$$

$$= \sqrt{25 + 9 + (30 \times -1)}$$

$$= \sqrt{34 - 30}$$

$$= \sqrt{4}$$

$$= 2\text{ cm}$$

Sol13. Velocity of wave in a medium $=\frac{1}{\sqrt{\mu_m \in_m}}$

$$\begin{aligned} v &= \frac{1}{\sqrt{\mu_0 \mu_r \, \in_r \in_0}} \\ v &= \frac{3 \times 10^8}{\sqrt{1 \cdot 61 \times 6 \cdot 44}} = 0.931 \times 10^8 \, \text{m/sec} \\ B &= \mu_m H \\ &= \mu_r \, \mu_0 \, H \\ &= 1.61 \times 4\pi \times 10^{-7} \times 4.5 \times 10^{-2} \\ &= 1.61 \times 4\pi \times 4.5 \times 10^{-9} \\ \hline E &= v \\ E &= v \\ E &= v \\ E &= v \\ E &= 0.931 \times 10^8 \times 1.61 \times 4\pi \times 4.5 \times 10^{-9} \\ &= [0.931 \times 1.61 \times 4\pi \times 4.5] \times 10^{-1} \\ &= 8.476 \\ &\approx 8.476 \, \text{vm}^{-1} \end{aligned}$$

- **Sol14.** According to Rutherford, e⁻ revolves around in nucleus in circular orbit. Thus e⁻ is always accelerating (centripetal acceleration). An accelerating change emits EM radiation and thus e⁻ should loose energy and finally should collapse in the nucleus.
- **Sol15.** A \longrightarrow^{105} B $+^{115}$ C \Rightarrow Q = [105 × 6.4 + 115 × 6.4] - [220 × 5.6] Mev Q = 176 Mev
- Sol16. Baseband Signal frequency 3.5 MHz

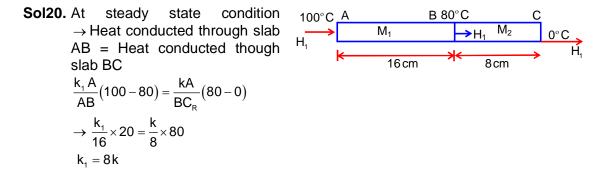
& Carrier signal frequency = 3.5 GHz

$$v_c = 3.5 \text{ GHz} = 3.5 \times 10^9$$

 $\lambda = \frac{C}{v_c} = \frac{3 \times 10^8}{3.5 \times 10^9} = \frac{3}{3.5} \times 10$
 $= \frac{30}{35} \times 10$
 $= \frac{60}{7}$
 \therefore Size of antenna = $\frac{\lambda}{4} = \frac{60}{7 \times 4}$
 $= 21.4 \text{ mm}$
Sol17. $0.25 = 1 - \frac{T_2}{T_1}$
 $0.25 = 1 - \frac{(27 + 273)}{T_1} \Rightarrow \frac{300}{T_1} = 1 - 0.25$
 $\Rightarrow \frac{300}{T_1} = 0.75$
 $T_1 = \frac{300 \times 100}{75}$
 $T_1 = 400 \text{ k}$
Now, efficiency increases by 100%

$$\begin{split} \eta_2 &= 100\% \ \eta_1 + \eta_1 \\ &= 2 \ \eta_1 \\ &= 0.25 \times 2 \\ &= 0.50 \\ 0.50 &= 1 - \frac{T_2'}{T_1} \\ &\Rightarrow \frac{T_2'}{T_1} = 0.50 \\ T_1' &= \frac{300}{0.5} \\ T_1' &= 600k \\ T_1' - T_1 &= (600 - 400) = 200k \ \text{or} \ 200^\circ \text{C} \end{split}$$

Sol18. A = 30π cm² = 30π × 10^{-4} m² $= 10^{-3}$ m d = 1mmE = (dielectric strength for breakdown) $= 3.6 \times 10^7 \, v / m$ $Q = 7 \times 10^{-6} C$ $\frac{\sigma}{\in_0} = \mathsf{E}$ $\Rightarrow \frac{\mathsf{Q}}{\mathsf{k}\,\mathsf{A}\,{\in_{_0}}} = \mathsf{E}$ $k = \frac{Q}{A \in_0 E}$ $= \frac{7 \times 10^{^{-6}} \times 4 \pi \times 9 \times 10^9}{30 \pi \times 10^{^{-4}} \times 1 \times 3.6 \times 10^7}$ $=\frac{7\times4\pi\times9}{30\pi\times3.6}$ $=\frac{7\times4\times9\times10}{30\times36}$ $=\frac{70}{30}$ $k = \frac{7}{3} = 2.33$ **Sol19.** $B_c = \frac{\mu_0 I}{2r} = B$ -(1) $B_{P} = \frac{\mu_0 \, I \, r^2}{2 \left(r^2 + \frac{r^2}{4}\right)^{3/2}}$ С $B_{P} = \frac{\mu_{0} \, I \, r^{2}}{2 \times r^{3} \left(\frac{5}{4}\right)^{3/2}}$ $B_{P} = \frac{\mu_0 I}{2r \left(\frac{5}{4}\right)^{3/2}}$ Č r⁄2 $\Rightarrow \mathsf{B}_{\mathsf{P}} = \frac{\mathsf{B} \; \mathsf{4}^{3/2}}{\mathsf{5}^{3/2}}$ $B_{P} = B \frac{2^{3}}{\left(\sqrt{5}\right)^{3}}$ $B_{P} = \left(\frac{2}{\sqrt{5}}\right)^{3} B$



SECTION - B

Sol1.
$$V_{rms} \alpha \sqrt{T} |T_{i} = 127^{\circ}C = 400k.$$

 $V_{rms^{-1}} = 2V_{rms}, m = 0.056kg = 56g$
 $T_{i} = 4T_{i} = 4 \times 400 = 1600k$
 $Q = n c_{v} \Delta T = \left(\frac{m}{M}\right)C_{v} \Delta T$
 $= \left(\frac{56}{28}\right)\frac{5}{2}R\Delta T$
 $= 2 \times \frac{5}{2} \times 2 \times 1200$
 $Q = 12 \times 10^{3} cal$
 $= 12k cal$
Sol2. $f_{i} = 15cm$
 $P_{i} = \frac{1}{15} \times 100 = \frac{100}{15}D$
 $P_{3} = \frac{100}{15}D$
 $\frac{1}{f_{2}} = (\mu_{2} - 1)\left(\frac{1}{R_{1}} - \frac{1}{R_{2}}\right)$
 $= (1.25 - 1) \times \frac{-2}{R}$
 $\frac{1}{f_{2}} = \frac{0.25 \times -2}{15}$
 $\frac{1}{f_{2}} = \frac{-1}{30} cm^{-1}$

 $p_2 = \frac{1}{f_2} = -\frac{100}{30}$

 $\mathbf{P}_{\mathrm{R}}=\mathbf{P}_{\mathrm{1}}+\mathbf{P}_{\mathrm{2}}+\mathbf{P}_{\mathrm{3}}$

 $P_{R} = 10D$

 $P_{\rm R} = \frac{100}{15} - \frac{100}{30} + \frac{100}{15}$

$$P_{R} = \frac{1}{f_{R}}$$
$$f_{R} = \frac{1}{10} \times 100 \text{ cm}$$
$$f_{R} = 10 \text{ cm}$$

 $\begin{array}{ll} \textbf{Sol3.} \quad \textbf{I}_{b} = 10 \mu A \\ \textbf{I}_{c} = 1.5 m A \end{array}$

A_{.v} = 750

$$\begin{split} &\mathsf{R}_{L} = 50 \, \mathsf{k} \, \Omega \text{ or } \left(\mathsf{Rc}\right) \\ &\mathsf{Base} - \mathsf{emitter voltage} = 10 \, \mathsf{mv} \\ &\mathsf{R}_{B} = \frac{V_{B}}{I_{B}} = \frac{10 \times 10^{-3}}{10 \times 10^{-6}} = 10^{3} \, \Omega \\ &\mathsf{A}_{v} = \left(\frac{\Delta I_{c}}{\Delta I_{B}}\right) \times \left(\frac{\mathsf{R}_{c}}{\mathsf{R}_{B}}\right) \\ &= \frac{1.5 \times 10^{-3}}{10 \times 10^{-6}} \times \frac{5 \times 10^{3}}{10^{3}} \end{split}$$

Sol4. Let
$$I = I_0 \cos \omega t$$

Then $v = v_0 \sin \omega t$
at $t = 0, v = 0$
but $I = I_0$
 $I_{rms} = \frac{I_0}{\sqrt{2}}$
 $V_{ms} = I_{rms} z$
 $\Rightarrow 220 = \frac{I_0}{\sqrt{2}} (X_L)$
 $\Rightarrow 220 = \frac{I_0}{\sqrt{2}} (2\pi \times 50 \times 200 \times 10^{-3})$
 $\Rightarrow 220 = \frac{I_0}{\sqrt{2}} (20\pi)$
 $I_0 = \frac{220\sqrt{2}}{20\pi}$
 $I_0 = \frac{11\sqrt{2}}{\pi} = \frac{\sqrt{a}}{\pi}$
 $a = 121 \times 2$
 $a = 242$

Sol5. for maxima = y = $(2n + 1) \frac{\lambda}{2} \frac{D}{a}$ For 1st maxima for λ_1 wavelength (n = 1) $y_1 = \frac{3\lambda_1}{2} \frac{D}{a}$ - (1)

First maxima for
$$\lambda_{z}$$
 wavelength

$$y_{z} = \frac{3}{2}\lambda_{z} \frac{D}{a} - (2)$$

$$\Rightarrow y_{z} - y_{z} = \frac{3}{2} \frac{D}{a} [\lambda_{z} - \lambda_{1}]$$

$$= \frac{3}{2} \times \frac{2 \times 5 \times 10^{-3}}{0.5 \times 10^{-3}}$$

$$= \frac{3}{10^{-3}} \times 10^{-5}$$

$$\Delta y = 3 \times 10^{-5}$$
Sol6. $hv = hv_{0} + K.E$
Cases $v = 2v_{0}$
 $h2v_{0} = hv_{0} + K.E$
Cases $v = 2v_{0}$
 $h2v_{0} = hv_{0} + K.E$,
 $K.E, = hv_{0}$
 $\frac{1}{2}mv_{1}^{2} = hv_{0}$
 $v_{z} = \frac{\sqrt{2hv_{0}}}{m} - (1)$
Now, case 2
 $h5v_{0} = hv_{0} + K.E_{2}$
 $k.E_{z} = 4hv_{0}$
 $\frac{1}{2}mv_{2}^{2} = 4hv_{0}$
 $v_{z} = \sqrt{\frac{8hv_{0}}{m}} - (2)$
 $\frac{v_{z}}{v_{z}} = \sqrt{\frac{8}{2}} - 2$
 $v_{z} = 2v_{1}$
Sol7. For first ball
 $s = ut + \frac{1}{2}at^{2}$
 $\Rightarrow -h = u \times 6 - \frac{1}{2} \times 10 \times 6 \times 6$
 $\Rightarrow -h = 6u - 180$
 $h = 180 - 6u - (1)$
for second boy
 $h = ut + \frac{1}{2}at^{2}$

$$\begin{array}{l} h = u \times 1.5 + \frac{1}{2} \times 10 \times 1.5 \times 1.5 \\ h = 1.5u + 11.25 \\ h = 1.5u + 11.25 \\ (1) \& (2) \\ 180 - 6u = 1.5u + 11.25 \\ 7.5u = 180 - 11.25 \\ u = \frac{168.75}{7.5} = 22.5 \\ h = 180 - 6u \\ = 180 - 6u \\ = 180 - 6u \\ = 180 - 6 \times 22.5 \\ = 45m \\ \text{for third ball} \\ h = ut + \frac{1}{2}at^2 \\ h = 0 \times t + \frac{1}{2} \times 10t^2 \\ \Rightarrow 45 = 5t^2 \\ t^2 = 9 \\ t = 3 \text{ sec} \end{array}$$

$$\begin{array}{l} \textbf{Sol8. COME} \\ k \cdot E_i + P \cdot E_i = k \cdot E_r + P \cdot E_r \\ \Rightarrow 0 + mg \left(h + \frac{h}{2}\right) = 0 + \frac{1}{2}k \left(\frac{h}{2}\right)^2 \\ \Rightarrow 3 mgh = \frac{k}{4}h^2 \Rightarrow 12 \frac{mg}{h} = k \Rightarrow k = \frac{12 \times 0.1 \times 10}{0.1} \\ k = 120 \text{ Nm}^{-1} \end{array}$$

$$E_2 \quad \ell_2$$

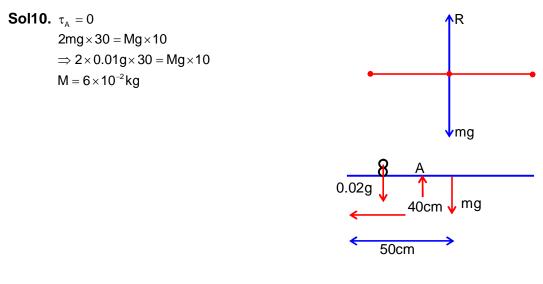
$$\Rightarrow \frac{3}{2} = \frac{75}{\ell_2}$$

$$\ell_2 = \frac{75 \times 2}{3}$$

$$\ell_2 = 50 \text{ cm}$$

$$\& \ \ell_1 = 75 \text{ cm}$$

$$\Delta \ell = \ell_1 - \ell_2 = 25 \text{ cm}$$



<u>PART – B (CHEMISTRY)</u> <u>SECTION – A</u>

Sol1. Mass of $C_{15}H_{30}$ = volume × Density = 1000 m ℓ × 0.756 gm / m ℓ = 756 gram $C_{15}H_{30}$ + 22.5 $O_2 \longrightarrow 15CO_2$ + 15H₂O No. of moles of $C_{15}H_{30} = \frac{756}{210}$ moles No. of moles of O_2 required = $\left(22.5 \times \frac{756}{210}\right)$ moles Mass of O_2 required = $22.5 \times \frac{756}{210} \times 32 = 2592$ gm No. of moles of CO_2 liberated = $15 \times \left(\frac{756}{210}\right)$ moles Mass of O_2 liberated = $15 \times \left(\frac{756}{210} \times 44 = 2376$ gm

Sol2. Degenerate orbitals must have same value of energy
 ∴ Orbitals with same n and ℓ values are degenerate orbitals.

Sol3. $[PtCl_4]^{2^-} \rightarrow Pt$ has dsp^2 hybridization BrF₅ \rightarrow Br has sp^3d^2 hybridization PCl₅ \rightarrow P has sp^3d hybridization $[Co(NH_3)_6]^{3^+} \rightarrow Co$ has d^2sp^3 hybridization.

 $\frac{1}{2}C(g)$ Sol4. $A(g) \rightleftharpoons$ B(g) + 0 t = 0a moles $+\frac{a\alpha}{2}$ moles -aα moles +a αmoles Eq. $a(1-\alpha)$ $(a\alpha/2)$ aα Moles moles moles Total no. of moles at equilibrium = nA + nB + nC $= a(1-\alpha) + a\alpha + \frac{a\alpha}{2} = a\left[1+\frac{\alpha}{2}\right]$ $\left(\mathsf{P}_{\mathsf{A}}\right)_{\mathsf{eq}} = \left(\mathsf{x}_{\mathsf{A}}\right)_{\mathsf{eq}} \times \mathsf{P}_{\mathsf{eq}} = \frac{\mathsf{a}(1-\alpha)}{(1+\alpha/2)}\mathsf{P} = \frac{(1-\alpha)}{(1+\alpha/2)}\mathsf{P}$ $(\mathsf{P}_{\mathsf{B}})_{\mathsf{eq}} = (\mathsf{x}_{\mathsf{B}})_{\mathsf{eq}} \times \mathsf{P}_{\mathsf{eq}} = \frac{\mathbf{a}\alpha}{\mathbf{a}(1+\alpha/2)}\mathsf{P} = \frac{\alpha}{(1+\alpha/2)}\mathsf{P}$ $(\mathsf{P}_{\mathsf{C}})_{\mathsf{eq}} = (\mathsf{x}_{\mathsf{C}})_{\mathsf{eq}} \times \mathsf{P}_{\mathsf{eq}} = \frac{\mathrm{a}\alpha/2}{\mathrm{a}(1+\alpha/2)}\mathsf{P} = \frac{\alpha/2}{(1+\alpha/2)}\mathsf{P}$ $K_{p} = \frac{(P_{B})_{eq} \times (P_{C})_{eq}^{1/2}}{(P_{A})_{eq}} = \frac{(\alpha)^{3/2} P^{1/2}}{(1-\alpha)(2+\alpha)^{1/2}}$

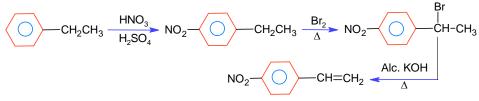
- **Sol5.** Emulsions gets separated into two layers on standing. For stabilization of emulsion. Emulsifying agents added into it but not electrolyte.
- **Sol6.** Acidic oxide \Rightarrow Cl₂O₇ Neutral oxide \Rightarrow N₂O, NO Basic oxide \Rightarrow Na₂O Amphoteric oxide \Rightarrow As₂O₃
- Sol7.SphalariteZnSCalamineZnCO3GalenaPbSSideriteFeCO3
- **Sol8.** The highest industrial consumption of hydrogen gas is in the synthesis of ammonia gas (Having use in manufacturing of N- based fertizers)
- **Sol9.** Due to higher extent of polarization by Li⁺ and Mg²⁺, LiCl and MgCl₂ have covalent character. Therefore they are soluble in ethanol. Due to very high value of lattice energy, LiF is having very less solubility in water.
- Sol10. B₂H₆ has 4 2c -2e bonds and 2 3c-2e bonds.
 Bridging (B-H) bonds have more value of bond- length then terminal (B-H) bonds
 Bridging bonds are in one plane, but terminal bonds are in perpendicular plane.

Due to presence of (3c-2e) bonds, it behaves as electrons deficient and prone to get attached by lewis base.

 $3NaBH_4 + 4BF_3 \xrightarrow{\Lambda} 3NaBF_4 + 2B_2H_6$

- **Sol11.** NF₃ is stable due to high N-F bond energy. Other halides of nitrogen (NCl₃ NBr₃, Nl₃) are explosive
- **Sol12.** Enamel has calcium hydroxyl apatite $[Ca_{10}(PO_4)_6(OH)_2]$, CaCO₃, CaF₂ and Mg₃(PO₄)₂ \therefore Ca²⁺, P⁵⁺ and F⁻ are present

Sol13.



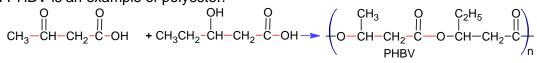
Sol14. Melting point of monocarboxlyic acids with even number of carbon is more than that with odd number of carbon due to lattice energy.

With increase in molar mass of monocarboxylic acids size of alkyl group (Hydrophobic portion) increases and therefore solubility in water decreases.

Sol15.

Sol16.

Sol17. PHBV is an example of polyester.



Sol18. Cellulose $\xrightarrow{H^+/H_2O} \beta - D - Glucose \xrightarrow{Br_2} Gluconic acid$

Sol19. Penicillin is not a broad spectrum artibiotic and is used to treat only certain infections caused by streptococci and staphylococci such as pneumonia.

Sol20. Ni²⁺ + 2dmg $\longrightarrow [Ni(dmg)_2] \downarrow$ Rosy-red precipitate

SECTION - B

- **Sol1.** Unit cell = Hexagonal close packing (hcp) No. of X in one unit cell = 6 No. of tetrahedral voids in one unit cell = 12 No. of Y in one unit cell = $\frac{2}{3} \times 12 = 8$ Formula $\Rightarrow X_6 Y_8 \Rightarrow X_3 Y_4$ % of X in unit cell = $\frac{3}{7} \times 100\% = 43\%$
- Sol2.

 $\begin{array}{c} 2O_3(g) \longrightarrow 3O_2 \\ t=0 & a \text{ moles} & 0 \\ \underline{-0.5a \text{ mole}} & \pm 0.75a \text{ mole} \\ \text{At Eq. } \underline{0.5a \text{ mole}} & \underline{0.75a \text{ mole}} \\ \text{Total moles at eq} = 0.5a \pm 0.75a = 1.25a \\ P_{O_3} = x_{O_3} \times P_T = \frac{0.5a}{1.25a} \times 1 = \frac{2}{5} \text{ atm} \\ P_{O_2} = x_{O_2} \times P_T = \frac{0.75a}{1.25a} \times 1 = \frac{3}{5} \text{ atm} \end{array}$

$$K_{p} = \frac{\left(P_{O_{2}}\right)_{eq}^{3}}{\left(P_{O_{3}}\right)_{eq}^{3}} = \frac{\left(\frac{3}{5}\right)^{3}}{\left(2/5\right)^{2}} = 1.35 \text{ atm}$$

$$\Delta G^{o} = -RT \, \ell n Kp$$

$$= -8.3 \times 300 \, \ell n 1.35$$

$$= -747 \, J / mole$$

Sol3. For isotonic solution $\pi_{injector} = \pi_{Blood}$

 $\Rightarrow C \times 0.082 \times 300 = 7.47$ $\Rightarrow C = 0.3 \text{ mole / } \ell$ $= 0.3 \times 180 \text{ gm / } \ell = 54 \text{ gm / } \ell$

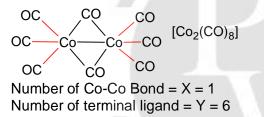
Sol4. Anode, $H_2(g) \rightarrow 2H^+ + 2e^-$ Cathode, $Cu^{2+} + 2e \rightarrow Cu(s)$ Net cell reaction $H_2 + Cu^{2+} \rightarrow 2H^+ Cu(s)$ $E_{cell}^0 = E_{Cu^{2+}/Cu}^0 - E_{H^+/H_2}^0$ = 0.34 V - 0= 0.34 V $E_{cell} = E_{Cell}^0 - \frac{0.06}{2} \log \frac{\left[H^+\right]^2}{\left[Cu^{2+}\right]}$

$$\Rightarrow 0.576 = 0.34 - \frac{0.06}{2} \log \frac{\left[H^{+}\right]^{2}}{0.01}$$
$$\Rightarrow -\log\left[H^{+}\right] = 4.93$$
$$\Rightarrow \text{pH of solution} = 4.93 \sim 5$$

Sol5.
$$k = A.e^{-\left(\frac{Ea}{RT}\right)}$$
$$\ell nk = \ell nA - \frac{Ea}{RT}$$
$$\Rightarrow \ell nk = \ell nA + \left(-\frac{Ea}{1000R}\right) \cdot \frac{1000}{T}$$
$$Slope = \frac{-Ea}{1000R} = -18.5$$
$$\Rightarrow Ea = 18.5 \times 1000 \times 8.31 = 153.735 \times 10^{3} \text{ J} = 154 \text{ KJ}$$

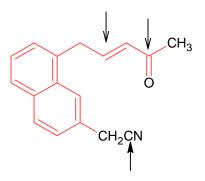
Sol6. In chromate; CrO_4^{2-} oxidation state of Cr = +6In dichromate; $Cr_2O_7^{2-}$ oxidation state of Cr = +6

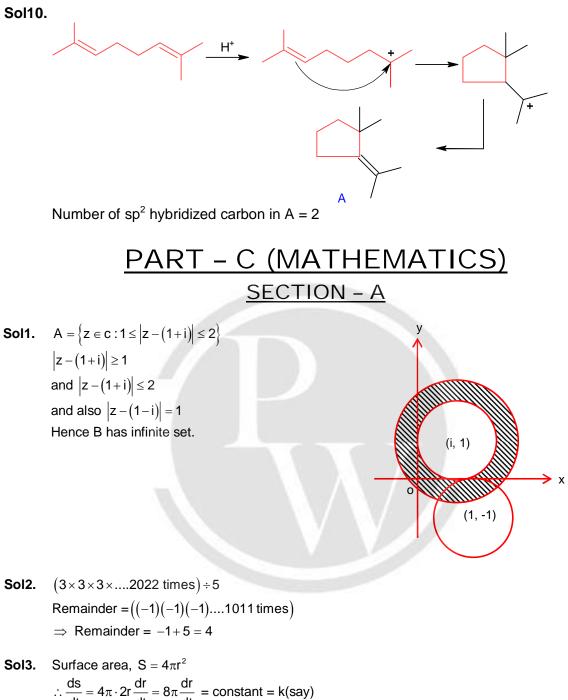
Sol7.



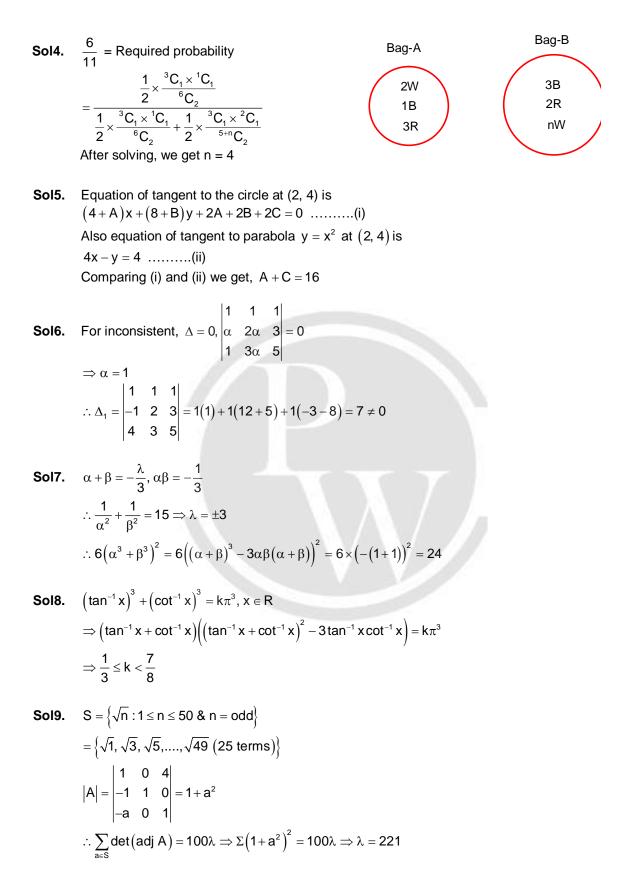
Sol8. Meq of NH₃ = Meq of used H₂SO₄ = Meq of NaOH = $0.25 \times 30=7.5$ Millmoles of N = millimoles of NH₃ =7.5 (As n factor =1) Mass of nitrogen = $7.5 \times 14 \times 10^{-3} = 0.105$ gm % of Nitrogen = $\frac{0.105}{0.166} \times 100\% = 63.25\% \sim 63\%$

Sol9.





$$\therefore \frac{ds}{dt} = 4\pi \cdot 2r \frac{dt}{dt} = 8\pi \frac{dt}{dt} = \text{constant} = \text{k(sa)}$$
$$\therefore \frac{ds}{dt} = k \Rightarrow s = kt + c$$
$$\therefore 4\pi r^2 = kt + c$$
Initially $t = 0, r = 3$
$$c = 36\pi$$
When $t = 5, r = 7, k = 32\pi$ When $t = 9, r = r, r = 9$



Sol10.
$$f(x) = 4\log_{e}(x-1) - 2x^{2} + 4x + 5, x > 1$$

(A) $f'(x) = \frac{4}{x-1} - 4x + 4$
 $\Rightarrow f'(x) > 0 \Rightarrow \frac{x(-x+2)}{x-1} > 0$
 $+ \frac{1}{0} - \frac{1}{1} + \frac{1}{2}$
option (A) is correct.
(B) $f(x) = -1$, has two solution
option (B) is correct
(C) $f''(x) = -\frac{4}{(x-1)^{2}} - 4$
 $f'(e) - f''(2) = \frac{4e(2-e)}{e-1} + 8 > 0$
option (C) is not correct
(D) $f(e) = 4\log_{e}(e-1) - 2(e^{2} - 2e + 1) + 7 > 0$
 $f(e+1) = 4 - 2(e+1)^{2} + 4(e+1) + 5 < 0$
option (D) is correct
Sol11. $y = x^{3} + 3x^{2} + 5$
 $\frac{dy}{dx}$ at $(x_{1}, y_{1}) = (3x_{1}^{2} + 6x_{1})$
Equation of tangent at (x_{1}, y_{1})
 $y - y_{1} = 3x_{1}(x_{1} + 2)(x - x_{1})$
It passes through (0, 0), $y_{1} = 3x_{1}^{3} + 6x_{1}^{2}$ (i)
and also (x_{1}, y_{1}) lies on the given curve
 $y_{1} = x_{1}^{3} + 3x_{1}^{2} + 5$ (ii)
Solving (i) & (ii), we get, $y_{1} = \frac{3}{2}x_{1}^{2} + \frac{15}{2}$
Hence, equation is $y = \frac{3}{2}x^{2} + \frac{15}{2}$
Hence, equation is $y = \frac{3}{2}x^{2} + \frac{15}{2}$
Hence, $e^{2y} - 5 + \frac{y^{2}}{81} = 2 \Rightarrow y^{2} + 54y - 567 = 0$
Hence, $D \ge 0$, so this curve intersected (iii)
(B) from (iv) $\frac{y^{2}}{9} - \frac{2y}{3} + 5 = 8 \Rightarrow y^{2} - 6y - 27 = 0$,
Hence $D \ge 0$, so this curve intersected (iii)
(C) $y = 4\left(\frac{2y}{3} - 5\right) \Rightarrow y = 12$
Hence this curve intersect eq (iii)
(D) $\frac{x}{3} - y^{2} = 2 \Rightarrow \frac{x}{3} - y^{2} = 2 \Rightarrow x = 3(y^{2} + 2)$

 $\therefore y^2 = \frac{-2 \pm \sqrt{\frac{2y}{3} - 5}}{3}$, hence this curve does not give the all values of y. Hence (D) is correct.

Sol12.
$$f(x) = |2x^{2} + 3x - 2| + \sin x \cos x$$
$$= |(2x - 1)(x + 2)| + \sin x \cos x$$
$$f(x) = \begin{cases} -2x^{2} - 3x + 2 + \sin x \cos x, & 0 < x < \frac{1}{2} \\ 2x^{2} + 3x - 2 + \sin x \cos x, & \frac{1}{2} \le x < 1 \end{cases}$$
$$f'(x) = \begin{cases} -4x - 3 + \cos 2x, & 0 < x < \frac{1}{2} \\ 4x + 3 + \cos 2x, & \frac{1}{2} \le x < 1 \end{cases}$$
$$f(1) = 3 + \sin 1 \cos 1 \text{ and } f\left(\frac{1}{2}\right) = \sin \frac{1}{2} \cos \frac{1}{2}$$
$$\therefore f(1) + f\left(\frac{1}{2}\right) = 3 + \frac{\sin 2}{2} + \frac{\sin 1}{2} = 3 + \frac{1}{2}(\sin 1 + \sin 2)$$
$$= 3 + \frac{\sin 1}{2}(1 + 2\cos 1)$$

Sol13.
$$\sum_{i=1}^{n} a_i = 192 \Rightarrow a_1 + a_2 + a_3 + \dots + a_n = 192$$
$$\therefore n(a_1 + a_n) = 384 \dots (i)$$
and
$$\sum_{i=1}^{n/2} a_{2i} = 120 \Rightarrow a_2 + a_4 + a_6 + \dots + a_n = 120$$
$$n(a_2 + a_n) = 480 \dots (ii)$$
$$n(a_2 - a_1) = 96$$
$$\therefore n = 96$$

Sol14.
$$y \frac{dx}{dy} = 2x + y^3 (y + 1)e^y$$

 $\frac{dx}{dy} - \frac{2}{y}x = y^3 (1 + y)e^y$ (i)
Equation (i) is in linear form, so I.F. = y^{-2}
 $\therefore xy^{-2} = ye^y + c \Rightarrow 0 = e + c \Rightarrow c = -e$
 $\therefore x = e^3 (e^e - 1)$

Sol15.
$$\lambda x - 2y = \mu$$
(i) and $\frac{x^2}{\left(\frac{b^2}{a^2}\right)} - \frac{y^2}{b^2} = 1$ (ii)

Let (x_1, y_1) be a point on the curve equation of tangent of eq (ii)

Sol16.
$$|\hat{a}| = 1, \ |\hat{b}| = 1$$

 $|\hat{b}|^2 = |\vec{c} + 2(\vec{c} \times \hat{a})|^2$
 $\Rightarrow 1 = |\vec{c}|^2 + 4|\vec{c}|^2 \left(\frac{\sqrt{3} - 1}{2\sqrt{2}}\right)^2$
 $= |\vec{c}|^2 \left[1 + 4 \times \frac{(\sqrt{3} - 1)^2}{8}\right] = |\vec{c}|^2 (3 - \sqrt{3})^2$
 $\therefore |\vec{c}|^2 = \frac{1}{3 - \sqrt{3}} = \frac{3 + \sqrt{3}}{6}$
 $\Rightarrow |6\vec{c}|^2 = 6(3 + \sqrt{3})$

Sol17. n = 33, p = success, q = failure

$$3P(x = 0) = P(x = 1)$$

 $\Rightarrow {}^{33}C_0 p^0 q^{33} = {}^{33}C_1 pq^{32}$
 $\Rightarrow p = \frac{1}{12}, q = \frac{11}{12} \Rightarrow \frac{q}{p} = 11$
 $\frac{P(x = 15)}{P(x = 18)} = \frac{{}^{33}C_{15} p^{15} q^{18}}{{}^{33}C_{18} p^{18} q^{15}} = \left(\frac{q}{p}\right)^3 = 11^3$ (i)
and $\frac{P(x = 16)}{P(x = 17)} = \frac{{}^{33}C_{16} p^{16} q^{17}}{{}^{33}C_{17} p^{17} q^{16}} = \frac{q}{p} = 11$ (ii)
 \therefore Subtracting, (ii) – (i), we get 1320

Sol18.
$$\frac{x^2 - 5x + 6}{x^2 - 9} \ge -1 & \& \frac{x^2 - 5x + 6}{x^2 - 9} \le 1$$
$$\frac{2x + 1}{x + 3} \ge 0, x \ne -3 & \& \frac{1}{x + 3} \ge 0, x \ne -3 \implies x > -3$$
$$x \in \left[-\frac{1}{2}, \infty \right] \dots \dots \dots (i)$$
$$x^2 - 3x + 2 > 0 \text{ and } x^2 - 3x + 1 \ne 0$$
$$(x - 2) (x - 1) > 0 \text{ and } x \ne \frac{3 \pm \sqrt{5}}{2}$$

$$\begin{aligned} x \in (-\infty, 1) \cup (2, \infty) - \left\{ \frac{3 \pm \sqrt{5}}{2} \right\} \\ \text{From (i) and (ii) } x \in \left[-\frac{1}{2}, 1 \right] \cup (2, \infty) - \left\{ \frac{3 \pm \sqrt{5}}{2} \right\} \end{aligned}$$

$$\begin{aligned} \text{Sol19.} \quad \frac{\sin \theta \sin \theta}{\cos \theta} + \frac{\sin \theta}{\cos \theta} = 2 \sin \theta \cos \theta \\ \Rightarrow \frac{\sin \theta}{\cos \theta} \left[\sin \theta + 1 \right] = 2 \sin \theta \cos \theta \\ \Rightarrow \sin \theta = 0 \text{ and } 1 + \sin \theta = 2 \cos^2 \theta = 2 - 2 \sin^2 \theta \dots (i) \\ \theta = n\pi \\ \theta = -\pi, \pi, 0 \end{aligned}$$

$$\begin{aligned} \text{From (i), } 2 \sin^2 \theta + \sin \theta - 1 = 0 \\ (2 \sin \theta - 1) (\sin \theta + 1) = 0 \end{aligned}$$

$$\begin{aligned} \sin \theta = -1, \frac{1}{2} \\ \theta = \frac{3\pi}{2}, \theta = \frac{\pi}{6}, \frac{5\pi}{6} \\ \theta = \frac{3\pi}{2} \text{ is rejected.} \end{aligned}$$

$$\begin{aligned} \text{T} = \cos(-2\pi) + \cos 2\pi + \cos \theta + \cos \frac{\pi}{3} + \cos \frac{5\pi}{3} = 4 \\ \therefore \text{T} + n(s) = 4 + 5 = 9 \end{aligned}$$

$$\begin{aligned} \text{Sol20.} \quad (p\Delta q) \Rightarrow (p\Delta - q) \lor (-p\Delta q) \end{aligned}$$

$$\begin{aligned} \frac{\text{Case I}}{\text{When } \Delta \text{ is same as } \land \\ \text{Then } (p\Lambda - q) \lor (-p\Lambda q) \text{ becomes} \end{aligned}$$

$$\begin{aligned} (p \lor q) \Rightarrow (p \land - q) \lor (-p \land q) \text{ becomes} \end{aligned}$$

 $p \land q$ is T, then $(p \land \neg q) \lor (\neg p \land q)$ is false, so x cannot be tautology.

Case III

When Δ is same as \Rightarrow

Then $(p \Rightarrow \ \ q) \lor (-p \Rightarrow q)$ is same as $(\sim p \lor \sim q) \lor (p \lor q)$ which is true, so x becomes tautology. Case IV

When Δ is same as \Leftrightarrow

Then $(p \Leftrightarrow q) \Rightarrow (p \Leftrightarrow \neg q) \lor (\neg p \Leftrightarrow q)$

 $p \Leftrightarrow q$ is true when p and q have same truth values $p \Leftrightarrow q$ and $\sim p \Leftrightarrow q$ both are false. Hence x cannot be tautology.

SECTION - B

Sol1.	f(b) = 2f(a) + 3f(c) + f(d) Value of f(c)	Value of f(a)	Number of functions
	0	2 3 4 0	5 3 2 6
	1	2 3	2
	2	0	3 1
	3	0 Total number of function	1 31
Sol2.	Let x = correct answer, y = in \therefore 3x - 2y = 5, x + y \le 5, x, y \in		
	only possible (x,y) is (3, 2)		
	Required number of ways	$S = {}^{5}C_{3}(1)^{3} \cdot (2)^{2} = 40$	
Sol3.	$B\left(-\frac{3}{\sqrt{a}},\sqrt{a}\right)$ and $c\left(-\frac{3}{\sqrt{a}},-\frac{3}{\sqrt{a}},-\frac{3}{\sqrt{a}}\right)$		
	$\therefore \text{ Area of } \Delta \text{ACD} = \frac{1}{2} \begin{vmatrix} \frac{3}{\sqrt{a}} \\ \frac{-3}{\sqrt{a}} \\ 3\cos\theta \end{vmatrix}$	$\sqrt{a} 1$ $-\sqrt{a} 1 = 12$ $\theta a \sin \theta 1$	
	$\Rightarrow \Delta = 3\sqrt{a} \left \cos \theta + \sin \theta \right = 12$		
	$\therefore \Delta \max = 3\sqrt{a} \cdot \sqrt{2} = 12 \Longrightarrow a$	a = 8	
Sol4.	$\frac{x-7}{3} = \frac{y-1}{-1} = \frac{z+2}{1} = r_1$ A(3r_1 + 7, 1-r_1, -2+r_1)		
	and $\frac{x}{2} = \frac{y-7}{3} = \frac{z}{1} = r_2$		

 $B(2r_2, 7+3r_2, r_2)$

 \Rightarrow r₁ = -5, r₂ = -3

 $AB^{2} = 84$

A/q, $\frac{3r_1 - 2r_2 + 7}{1} = \frac{3r_2 + r_1 + 6}{4} = \frac{r_1 - r_2 - 2}{2}$

 \therefore A(-8, 6, -7) and B(-6, -2, -3)

$$\begin{split} f\left(x\right) = \begin{cases} \left|2x^2 - 3x - 7\right| &, \quad x \leq -1 \\ \left[4x^2 - 1\right] &, \quad -1 < x < 1 \\ \left|x + 1\right| + \left|x - 2\right| &, \quad x \geq 1 \end{cases} \\ f\left(-1\right) = 1 \\ f\left(1\right) = 3 \end{split}$$

Hence f(x) will be discontinuous at x = 1 and also $4x^2 - 1 = 0, 1, 2$

$$\Rightarrow x = \pm \frac{1}{2}, \pm \frac{1}{\sqrt{2}}, \pm \frac{\sqrt{3}}{2}$$

7 points of discontinuous

Sol5.
$$y = 2 \left| x^{2} - \frac{3}{2} x - \frac{7}{2} \right|$$
$$= 2 \left| \left(x - \frac{3}{4} \right)^{2} - \frac{65}{16} \right|$$
$$Sol6. \quad f(\theta) = \sin\theta + \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} (\sin\theta + t\cos\theta) f(t) dt$$
$$= \sin\theta + \sin\theta \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} f(t) dt + \cos\theta \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} tf(t) dt$$
$$= \left(1 + \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} f(t) dt \right) \sin\theta + \left(\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} tf(t) dt \right) \cos\theta$$
$$f(\theta) = a\sin\theta + b\cos\theta$$
$$\therefore a = 1 + \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} f(t) dt = 1 + \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} (a\sin t + b\cos t) dt$$
$$\therefore a = 2b + 1 \dots \dots (i)$$
$$b = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} tf(t) dt = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} (a\sin t + b\cos t) dt$$
$$\therefore b = 2a \dots \dots (ii)$$
$$Solving (i) & (ii) we get a = -\frac{1}{3}, b = -\frac{2}{3}$$
$$\therefore \left| \int_{0}^{\frac{\pi}{2}} f(\theta) d\theta \right| = 1$$

Sol7. Let
$$f(x) = \frac{x^2 - 9}{x - 5}$$

 $f'(x) = \frac{2x(x-5) - (x^2 - 9)}{(x-5)^2}$
 $= \frac{x^2 - 10x + 9}{(x-5)^2} = \frac{(x-1)(x-9)}{(x-5)^2}$
 $\alpha = f(1) - 2, \beta = \{f(0), f(2)\} = \frac{5}{3}$
 $\alpha = f(1) - 2, \beta = \{f(0), f(2)\} = \frac{5}{3}$
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 $\alpha = 18, \alpha_2 = 16$
 $\alpha_1 + \alpha_2 = 34$
Sol8. $\frac{x^2}{1} + \frac{y^2}{1} = 1$
 $25\alpha^2 + 4\beta^2 = 1$ (i)
Equation of tangent to parabola $y = mx + \frac{1}{m}$ passes
through (α, β)
 $\alpha m^2 - \beta m + 1 = 0$
 $m_1 + m_2 = \frac{\beta}{\alpha}, 4m_1^2 = \frac{1}{\alpha}$
 \therefore from (i) & (ii)
 $25(\alpha^2 + \alpha) = 1$ (iii)
 $\therefore (10\alpha + 5)^2 + (16\beta^2 + 50)^2 = 2929$
 $\therefore a = 1 + 0 + b\left(\sin - \frac{\pi}{2}\right)^{\frac{1}{2}} = 2b + 1$
Sol9. $R_2 = \frac{1}{9}(x - x^3)dx = \left(\frac{2x^{3/2}}{3} - x^2\right)_0^{\frac{1}{9}} = \frac{1}{12} - \frac{1}{16}$
 $= \frac{4 - 3}{48} = \frac{1}{48}$
 $R_1 + R_2 = \frac{1}{9}(\sqrt{x} - x^3)dx = \left(\frac{2x^{3/2}}{3} - \frac{x^4}{4}\right)_0^1 = \frac{2}{3} - \frac{1}{4} = \frac{5}{12}$
 $\frac{R_1 + R_2}{R_1} = 1 + \frac{R_2}{R_1} = \frac{5}{\frac{1}{48}} = 20$ $\therefore \frac{R_2}{R_1} = 19$

Sol10.
$$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -a & 0 \\ 1 & -1 & 1 \end{vmatrix} = -a\hat{i} - \hat{j} + (a-1)\hat{k}$$

 $\vec{a}_1 - \vec{a}_2 = -\hat{i} + \hat{j} + \hat{k}$
Shortest distance $= \begin{vmatrix} (\vec{a}_1 - \vec{a}_2) \cdot (\vec{b}_1 \times \vec{b}_2) \\ |\vec{b}_1 \times \vec{b}_2| \end{vmatrix}$
 $= \frac{2(a-1)}{\sqrt{a^2 + 1 + (a-1)^2}} = \sqrt{\frac{2}{3}} = \frac{4(a-1)^2}{a^2 + 1 + (a-1)^2} = \frac{2}{3}$
 $12(a-1)^2 = 2(a^2 + 1) + 2(a-1)^2$
 $10(a-1)^2 = 2(a^2 + 1)$
 $5a^2 - 10a + 5 = a^2 + 1 \Longrightarrow 4a^2 - 10a + 4 = 0$
 $2a^2 - 5a + 2 = 0$
 $(2a-1)(a-2) = 0$
 $\therefore a = \frac{1}{2}, 2$

Hence integral value = 2