FIITJEE

Solutions to JEE(Main) -2023

Test Date: 24th January 2023 (Second 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.*
7. ***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.

Q1. If the distance of the earth from sun is 1.5×10^6 km. Then the distance of an imaginary planet from Sun, if its period of revolution is 2.83 years is :

(A) 6×10^6km
(B) 3×10^6km
(C) 6×10^7km
(D) 3×10^7km

Q2. Let γ_1 be the ratio of molar specific heat at constant pressure and molar specific heat at constant volume of a monoatomic gas and γ_2 be the similar ratio of diatomic gas. Considering the diatomic gas molecule as a rigid rotator, the ratio, $\frac{\gamma_1}{\gamma_2}$ is :

(A) $\frac{27}{35}$
(B) $\frac{35}{27}$
(C) $\frac{25}{21}$
(D) $\frac{21}{25}$

Q3. Given below are two statements : one is labelled as **Assertion A** and other is labelled as **Reason R**

Assertion A : Steel is used in the construction of buildings and bridges.

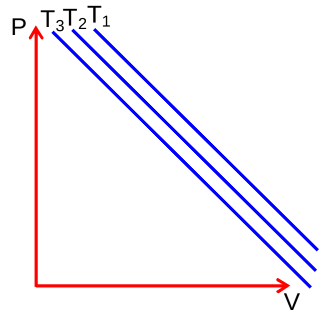
Reason R : Steel is more elastic and its elastic limit is high.

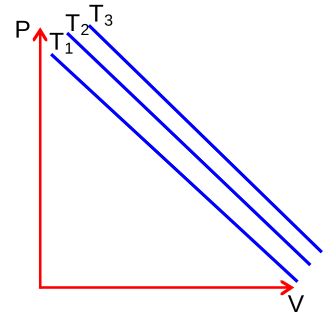
In the light of above statements, choose the most appropriate answer from the given below
(A) Both **A** and **R** are correct and **R** is the correct explanation of **A**
(B) Both **A** and **R** are correct but **R** is **NOT** the correct explanation of **A**
(C) A is not correct but **R** is correct
(D) A is correct but **R** is not correct

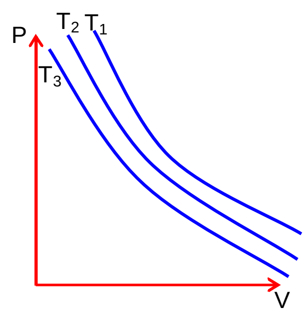
Q4. When a beam of white light is allowed to pass through convex lens parallel to principal axis, the different colours of light converge at different point on the principle axis after refraction. This is called :

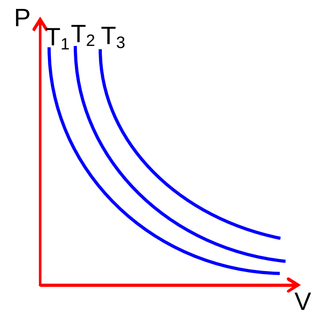
(A) Scattering
(B) Spherical aberration
(C) Polarisation
(D) Chromatic aberration

Q5. In an Isothermal change, the change in pressure and volume of a gas can be represented for three different temperature : $T_3 > T_2 > T_1$ as :

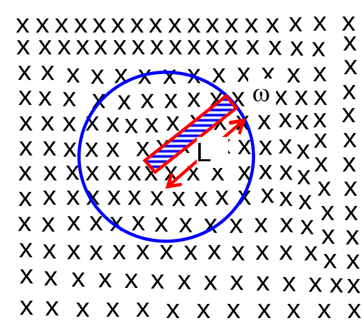
(A)


(B)


(C)


(D)


Q6. An metallic rod of length 'L' is rotated with an angular speed of 'ω' normal to a uniform magnetic field 'B' about an axis passing through one end of rod as shown in figure. The induced emf will be :



(A) $\frac{1}{2}BL^2\omega$

(B) $\frac{1}{4}BL^2\omega$

(C) $\frac{1}{4}B^2L\omega$

(D) $\frac{1}{2}B^2L^2\omega$

Q7. If two vectors $\vec{P} = \hat{i} + 2m\hat{j} + m\hat{k}$ and $\vec{Q} = 4\hat{i} - 2\hat{j} + m\hat{k}$ are perpendicular to each other. Then, the value of m will be :

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

Q8. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R.**

Assertion A : A pendulum clock when taken to Mount Everest becomes fast.
Reason R : The value of g (acceleration due to gravity) is less at Mount Everest than its value on the surface of earth.
In the light of the above statements. choose the most appropriate answer from the options given below
(A) **A** is correct but **R** is not correct
(B) **A** is not correct but **R** is correct
(C) Both **A** and **R** are correct and **R** is the correct explanation of **A**
(D) Both **A** and **R** are correct but **R** is **NOT** the correct explanation of **A**

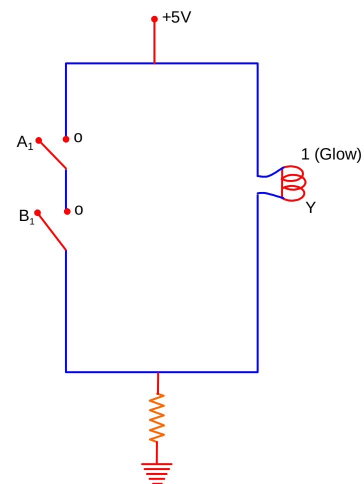
Q9. An α-particle, a proton and an electron have the same kinetic energy. Which one of the following is correct in case of their de-Broglie wavelength :

(A) $\lambda_\alpha < \lambda_p < \lambda_e$ (B) $\lambda_\alpha > \lambda_p < \lambda_e$

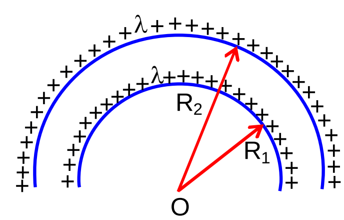
(C) $\lambda_\alpha = \lambda_p = \lambda_e$ (D) $\lambda_\alpha > \lambda_p > \lambda_e$

Q10. The logic gate equivalent to the given circuit diagram is :

(A) OR
(B) NOR
(C) NAND
(D) AND



Q11. The electric potential at the centre of two concentric half rings of radii R_1 and R_2, having same linear charge density λ is :



(A) $\frac{\lambda}{4 \epsilon_0}$ (B) $\frac{2\lambda}{\epsilon_0}$

(C) $\frac{\lambda}{\epsilon_0}$ (D) $\frac{\lambda}{2 \epsilon_0}$

Q12. A cell of emf 90V is connected across series combination of two resistors each of $100\,\Omega$ resistance. A voltmeter of resistance $400\,\Omega$ is used to measure the potential difference across each resistor. The reading of the voltmeter will be :

(A) 40 V (B) 80 V
(C) 90 V (D) 45 V

Q13. A body of mass 200g is tied to a spring constant 12.5 N/m, while the other end of spring is fixed at point O. If the body moves about O in a circular path on a smooth horizontal surface with constant angular speed 5 rad/s. Then the ratio of extension in the spring to its natural length will be :

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

Q14. The frequency (υ) of an oscillating liquid drop may depend upon radius (r) of the drop, density (ρ) of liquid and the surface tension (s) of the liquid as : $v = r^a \rho^b s^c$. The value of a, b, c respectively are

(A) $\left(\frac{3}{2}, \frac{1}{2}, -\frac{1}{2}\right)$ (B) $\left(-\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$

(C) $\left(-\frac{3}{2}, \frac{1}{2}, \frac{1}{2}\right)$ (D) $\left(\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$

Q15. Given below are two statements :
Statement I : Acceleration due to earth's gravity decreases as you go 'up' or 'down' from earth's surface.
Statement II : Acceleration due to earth's gravity is same at a height 'h' and depth 'd' from earth's surface, if h = d.

In the light of above statements, choose the most appropriate answer from the options given below
(A) Statement I is incorrect but statement II is correct
(B) Both Statement I and Statement II are incorrect
(C) Statement I is correct but statement II is incorrect
(D) Both Statement I and II are correct

Q16. The electric field and magnetic field components of an electromagnetic wave going through vacuum is described by
$E_x = E_o \sin(kz - \omega t)$
$B_y = B_o \sin(kz - \omega t)$
Then the correct relation E_o and B_o is given by
(A) $E_o B_o = \omega k$
(B) $\omega E_o = k B_o$
(C) $E_0 = k B_o$
(D) $k E_o = \omega B_o$

Q17. A photon is emitted in transition from n = 4 to n = 1 level in hydrogen atom.
The corresponding wavelength for this transition is (given, $h = 4 \times 10^{-15}$ eVs) :
(A) 94.1 nm
(B) 974 nm
(C) 99.3 nm
(D) 941 nm

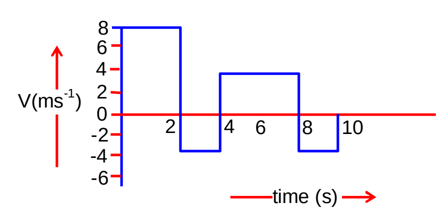
Q18. Match List I with List II

List – I	List – II
A. AM Broadcast	I. 88 – 108 MHz
B. FM Broadcast	II. 540 – 1600 kHz
C. Television	III. 3.7 – 4.2 GHz
D. Satellite Communication	IV. 54 MHz – 890 MHz

Choose the correct answer from the options given below :
(A) A-IV, B-III, C-I, D-II
(B) A-II, B-III, C-I, D-IV
(C) A-II, B-I, C-IV, D-III
(D) A-I, B-III, C-II, D-IV

Q19. A long solenoid is formed by winding 70 turns cm^{-1}. If 2.0A current flows, then magnetic field produced inside the solenoid is______ $\left(\mu_0 = 4\pi \times 10^{-7} TmA^{-1}\right)$
(A) 176×10^{-4} T
(B) 88×10^{-4} T
(C) 352×10^{-4} T
(D) 1232×10^{-4} T

Q20. The velocity time graph of body moving in a straight line is shown in figure.
The ratio of displacement to distance travelled by the body in time 0 to 10s is :



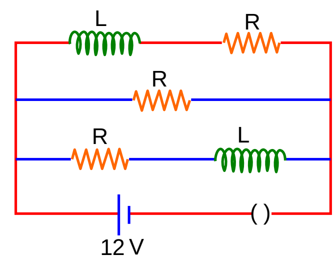
(A) 1 : 1
(B) 1 : 4
(C) 1 : 3
(D) 1 : 2

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. Three identical resistors with resistance $R = 12\Omega$ and two identical inductors with self inductance L = 5 mH are connected to an ideal battery with emf of 12 V shown in figure. The current through the battery long after the switch has been closed will be _________ A.



Q2. A parallel plate capacitor with air between the plate has a capacitance of 15pF. The separation between the plate become twice and the space between them is filled with a medium of dielectric constant 3.5. Then the capacitance becomes $\frac{x}{4}$ pF. The value of x is ________.

Q3. A Spherical ball of radius 1mm and density 10.5g/cc is dropped in glycerine of coefficient of viscosity 9.8 poise and density 1.5 g/cc. Viscous force on the ball when it attains constant velocity is 3696×10^{-x} N. The value of x is (Given, g = 9.8 m/s^2 and $\pi = \frac{22}{7}$)

Q4. A uniform solid cylinder with radius R and length L has moment inertia I_1, about the axis of the cylinder. A concentric solid cylinder of radius $R' = \frac{R}{2}$ and length $L' = \frac{L}{2}$ is carved out of the original cylinder. If I_2 is the moment of inertia of the carved out portion of the cylinder then $\frac{I_1}{I_2} =$

(Both I_1 and I_2 are about the axis of the cylinder)

Q5. A convex lens of refractive index 1.5 and focal length 18cm in air is immersed in water. The change of focal length of the lens will be __________cm.

(Given refractive index of water $= \frac{4}{3}$)

Q6. A body of mass 1kg begins to move under the action of a time dependent force $\vec{F} = \left(t\hat{i} + 3t^2\hat{j}\right)$N, where $\hat{i}$ and $\hat{j}$ are the unit vectors along x and y axis. The power developed by above force, at the time $t = 2s$, will be ________W.

Q7. If a copper wire is stretched to increase its length by 20% . The percentage increase in resistance of the wire is ________%.

Q8. A single turn current loop in the shape of a right angle triangle with sides 5cm, 12cm, 13cm is carrying a current of 2A. The loop is in a uniform magnetic field of magnitude 0.75 T whose direction is parallel to the current in the 13cm side of the loop. The magnitude of the magnetic force on the 5cm side will be $\frac{x}{130}$N. The value of x is ________.

Q9. The energy released per fission of nucleus of ^{240}X is 200 MeV. The energy released if all the atoms in 120g of pure ^{240}X undergo fission is ________ $\times 10^{25}$ MeV.

Q10. A mass m attached to free end of a spring executes SHM with a period of 1s. If the mass is increased by 3kg the period of oscillation increases by one second, the value of mass m is _________kg.

PART – B (CHEMISTRY)

SECTION - A

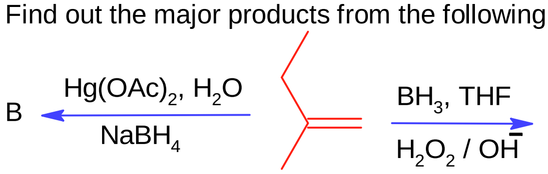
(One Options Correct Type)

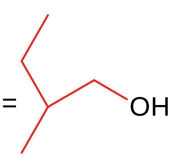
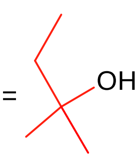
This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

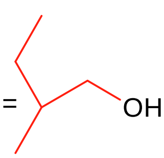
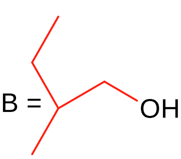
Q1. The number of s-electrons present in an ion with 55 protons in its unipositive state is
(A) 8 (B) 9
(C) 12 (D) 10

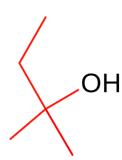
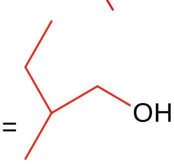
Q2. $K_2Cr_2O_7$ paper acidified with dilute H_2SO_4 turns green when exposed to
(A) Hydrogen sulphide (B) Sulphur trioxide
(C) Carbon dioxide (D) Sulphur dioxide

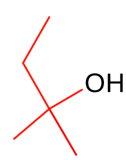
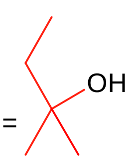
Q3. Find out the major products from the following reactions.



(A) A =  , B = 

(B) A =  , B = 

(C) A =  , B = 

(D) A =  , B = 

Q4. Identify the correct statements about alkali metals.
A. The order of standard reduction potential ($M^+|M$) for alkali metal ions is Na > Rb > Li.
B. CsI is highly soluble in water.
C. Lithium carbonate is highly stable to heat.
D. Potassium dissolved in concentrated liquid ammonia is blue in colour and paramagnetic.
E. All the alkali metal hydrides are ionic solids.
Choose the correct answer from the options given below:
(A) C and E only (B) A, B and E only
(C) A and E only (D) A, B, D only

Q5. What is the number of unpaired electron(s) in the highest occupied molecular orbital of the following species: N_2; N_2^+; O_2; O_2^+?
(A) 0,1,2,1 (B) 2,1,2,1
(C) 2,1,0,1 (D) 0,1,0,1

Q6. Which one amongst the following are good oxidizing agents?
A. Sm^{2+}
B. Ce^{2+}
C. Ce^{4+}
D. Tb^{4+}

Choose the most appropriate answer from the options given below:

(A) C only (B) D only

(C) C & D only (D) A & B only

Q7. Which of the following cannot be explained by crystal field theory?

(A) The order of spectrochemical series

(B) Colour of metal complexes

(C) Stability of metal complexes

(D) Magnetic properties of transition metal complexes

Q8. Given below are two statements:

Statement I: Pure Aniline and other arylamines are usually colourless.

Statement II: Arylamines get coloured on storage due to atmospheric reduction

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) Statement I is correct but Statement II is incorrect

(C) Statement I is incorrect but Statement II is correct

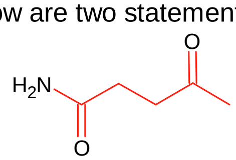
(D) Both statement I and Statement II are incorrect

Q9. The metal which is extracted by oxidation and subsequent reduction from its ore is:

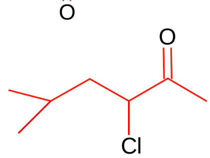
(A) Cu (B) Fe

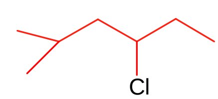
(C) Al (D) Ag

Q10. Given below are two statements:

Statement I: 

under Clemmensen reduction conditions will give 

Statement II: 

under Wolff-Kishner reduction condition will give 

In the light of the above statements, choose the correct answer from the options given below:

(A) Both Statement I and Statement II are false

(B) Statement I is false but Statement II is true

(C) Statement I is true but Statement II is false

(D) Both Statement I and Statement II are true

Q11. Correct statement is:

(A) An average human being consumes 100 times more air than food

(B) An average human being consumes more food than air

(C) An average human being consumes equal amount of food and air

(D) An average human being consumes nearly 15 times more air than food

Q12. In which of the following reactions the hydrogen peroxide acts as a reducing agent?

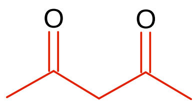
(A) $Mn^{2+} + H_2O_2 \rightarrow Mn^{4+} + 2OH^-$

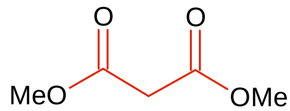
(B) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

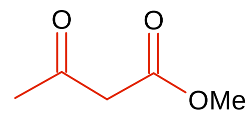
(C) $2Fe^{2+}\ H_2O_2 \rightarrow 2Fe^{3+} + 2OH^-$

(D) $HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$

Q13. Which will undergo deprotonation most readily in basic medium?


a.


b


c.

(A) b only
(B) a only
(C) Both a and c
(D) c only

Q14. Given below are two statements, one is labelled as **Assertion A** and the other is labelled as **Reason R.**
Assertion A: Benzene is more stable than hypothetical cyclohexatriene
Reason R: The delocalized π electron cloud is attracted more strongly by nuclei of carbon atoms.
In the light of the above statements, choose the correct answer from the options given below:
(A) A is true but R is false
(B) Both A and R are correct but R is NOT the correct explanation of A
(C) Both A and R are correct and R is the correct explanation of A
(D) A is false but R is true

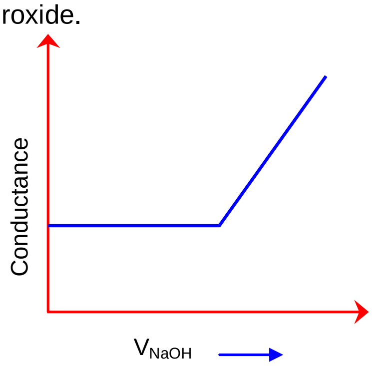
Q15. A student has studied the decomposition of a gas AB_3 at 25^oC. He obtained the following data.

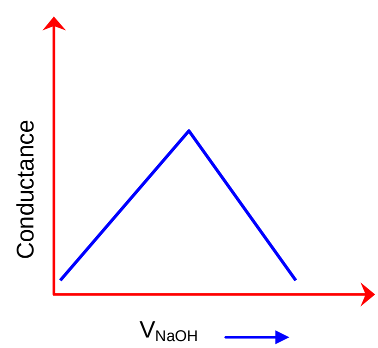
P(mm Hg)	50	100	200	400
Relative $t_{1/2}$(s)	4	2	1	0.5

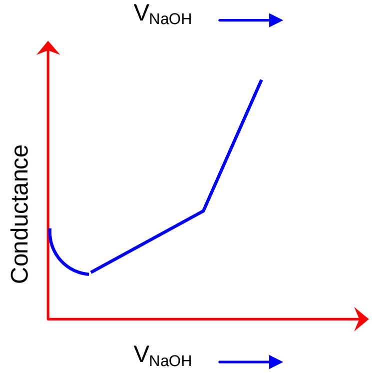
The order of the reaction is
(A) 0.5
(B) 0 (zero)
(C) 1
(D) 2

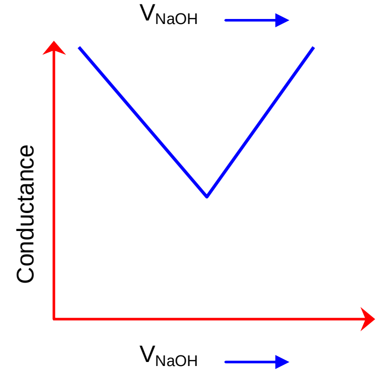
Q16. The hybridization and magnetic behaviour of cobalt ion in $[Co(NH_3)_6]^{3+}$ complex, respectively is
(A) d^2sp^3 and diamagnetic
(B) sp^3d^2 and paramagnetic
(C) sp^3d^2 and diamagnetic
(D) d^2sp^3 and paramagnetic

Q17. Choose the correct representation of conductometric titration of benzoic acid vs sodium hydroxide.

(A)


(B)


(C)


(D)


Q18. Given below are two statements, one is labelled as **Assertion A** and the other is labelled as **Reason R.**

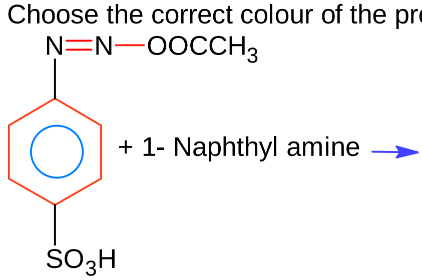
Assertion A: Beryllium has less negative value of reduction potential compared to the other alkaline earth metals.

Reason R: Beryllium has large hydration energy due to small size of Be^{2+} but relatively large value of atomization enthalpy

In the light of the above statements, choose the most appropriate answer from the options given below

(A) Both A and R are correct and R is the correct explanation of A
(B) Both A and R are correct but R is NOT the correct explanation of A
(C) A is true but R is not correct
(D) A is not correct but R is correct

Q19. Choose the correct colour of the product for the following reaction.



(A) Blue
(B) White
(C) Yellow
(D) Red

Q20. Match List I with List II

	List-I (Type)		List (Name)
A.	Antifertility drug	I.	Norethindrone
B.	Tranquilizer	II.	Meprobomate
C.	Antihistamine	III.	Seldane
D.	Antibiotic	IV.	Ampicillin

Choose the correct answer from the options given below:

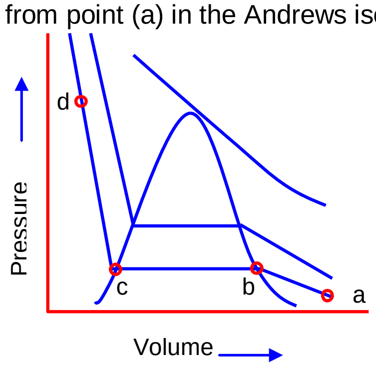
(A) A- IV, B-III, C-II, D- I
(B) A-I, B-II, C-III, D-IV
(C) A-I, B-III, C-II, D-IV
(D) A-II, B-I, C-III, D-IV

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 statement/s, which are **correct** with respect to the compression of carbon dioxide from point (a) in the Andrews isotherm from the following is___________.



A. Carbon dioxide remains as a gas upto point (b)
B. Liquid carbon dioxide appears at point (c)
C. Liquid and gaseous carbon dioxide coexist between points (b) and (c)
D. As the volume decreases from (b) to (c), the amount of liquid decreases

Q2. Maximum number of isomeric monochloro derivatives which can be obtained from 2,2,5,5-tetrametylhexane by chlorination is___________

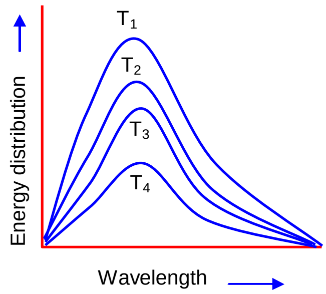
Q3. The number of units which are used to express concentration of solution from the following is____________.
Mass percent, Mole, Mole fraction, Molarity, ppm, Molality

Q4. The number of statement/s which are the characteristics of physisorption is__________.
A. It is highly specific in nature
B. Enthalpy of adsorption is high
C. It decreases with increase in temperature
D. It results into unimolecular layer
E. No activation energy is needed

Q5. Sum of π-bonds present in peroxodisulphuric acid and pyrosulphuric acid is_________.

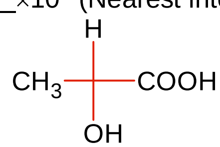
Q6. The total pressure observed by mixing two liquids A and B is 350 mm Hg when their mole fraction are 0.7 and 0.3 respectively.
The total pressure becomes 410 mm Hg if the mole fractions are changed to 0.2 and 0.8 respectively for A and B. The vapour pressure of pure A is _______mm Hg. (Nearest integer). Consider the liquids and solutions behave ideally.

Q7. Following figure shows spectrum of an ideal black body at four different temperatures. The number of **correct** statement/s from the following is______.



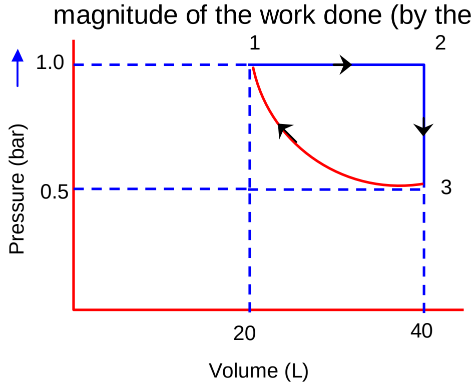
A. $T_4 > T_3 > T_2 > T_1$
B. The black body consists of particles performing simple harmonic motion.
C. The peak of the spectrum shifts to shorter wavelength as temperature increases.
D. $\frac{T_1}{\nu_1} = \frac{T_2}{\nu_2} = \frac{T_3}{\nu_3} \neq$ constant
E. The given spectrum could be explained using quantisation of energy

Q8. If the pKa of lactic acid is 5, then the pH of 0.005 M calcium lactate solution at 25°C is ________$\times 10^{-1}$(Nearest integer)

Lactic acid 

Q9. Total number of tripeptides possible by mixing of valine and proline is____________

Q10. One mole of an ideal monoatomic gas is subjected to changes as shown in the grap. The magnitude of the work done (by the system or on the system) is_____ J (nearest integer)



Given: log 2 = 0.3
ln 10 = 2.3

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 $y = y(x)$ be the solution of the differential equation $(x^2 - 3y^2)dx + 3xy\,dy = 0,\ y(1) = 1$. Then $6y^2(e)$ is equal to

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

Q2. The number of real solutions of the equation $3\left(x^2 + \frac{1}{x^2}\right) - 2\left(x + \frac{1}{x}\right) + 5 = 0$, is

(A) 4 (B) 0
(C) 2 (D) 3

Q3. Let $f(x)$ be a function such that $f(x+y) = f(x)\cdot f(y)$ for all $x, y \in N$. If $f(1) = 3$ and $\sum_{k=1}^{n} f(k) = 3279$, then the value of n is

(A) 8 (B) 7
(C) 9 (D) 6

Q4. If the system of equations

$x + 2y + 3z = 3$
$4x + 3y - 4z = 4$
$8x + 4y - \lambda z = 9 + \mu$

has infinitely many solutions, then the ordered pair (λ, μ) is equal to :

(A) $\left(-\frac{72}{5}\cdot -\frac{21}{5}\right)$ (B) $\left(\frac{72}{5}, -\frac{21}{5}\right)$
(C) $\left(\frac{72}{5}, \frac{21}{5}\right)$ (D) $\left(-\frac{72}{5}, \frac{21}{5}\right)$

Q5. The number of integers, greater than 7000 that can be formed, using the digits 3,5,6,7,8 without repetition, is

(A) 48 (B) 168
(C) 120 (D) 220

Q6. The locus of the mid points of the chords of the circle $C_1 : (x-4)^2 + (y-5)^2 = 4$ which subtend an angle θ_1 at the centre of the circle C_1, is a circle of radius r_1. If $\theta_1 = \frac{\pi}{3}, \theta_3 = \frac{2\pi}{3}$ and $r_1^2 = r_2^2 + r_3^2$, then θ_2 is equal to

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

Q7. If $f(x) = x^3 - x^2 f'(1) + x f''(2) - f'''(3),\ x \in R$, then

(A) $2f(0) - f(1) + f(3) = f(2)$
(B) $f(3) - f(2) = f(1)$
(C) $3f(1) + f(2) = f(3)$
(D) $f(1) + f(2) + f(3) = f(0)$

Q8. If $\left({}^{30}C_1\right)^2 + 2\left({}^{30}C_2\right)^2 + 3\left({}^{30}C_3\right)^2 + \ldots + 30\left({}^{30}C_{30}\right)^2 = \dfrac{\alpha 60!}{(30!)^2}$ then α is equal to :

(A) 15
(B) 10
(C) 60
(D) 30

Q9. Let the plane containing the line of intersection of the planes $P1: x + (\lambda + 4)y + z = 1$ and $P2: 2x + y + z = 2$ pass through the points $(0,1,0)$ and $(1,0,1)$. Then the distance of the point $(2\lambda, \lambda, -\lambda)$ from the plane P2 is

(A) $2\sqrt{6}$
(B) $5\sqrt{6}$
(C) $3\sqrt{6}$
(D) $4\sqrt{6}$

Q10. Let the six numbers $a_1, a_2, a_3, a_4, a_5, a_6$, be in A.P. and $a_1 + a_3 = 10$. If the mean of these six numbers is $\dfrac{19}{2}$ and their variance is σ^2, then $8\sigma^2$ is equal to :

(A) 105
(B) 220
(C) 210
(D) 200

Q11. Let p and q be two statements. Then $\sim(p \wedge (p \Rightarrow \sim q))$ is equivalent to

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

Q12. The set of all values of a for which $\lim\limits_{x \to a}([x - 5] - [2x + 2]) = 0$, where $[\alpha]$ denotes the greatest integer less than or equal to α is equal to

(A) $(-7.5, -6.5]$
(B) $[-7.5, -6.5]$
(C) $(-7.5, -6.5)$
(D) $[-7.5, -6.5)$

Q13. If $f(x) = \dfrac{2^{2x}}{2^{2x} + 2},\ x \in R$, then $f\left(\dfrac{1}{2023}\right) + f\left(\dfrac{2}{2023}\right) + \ldots. + f\left(\dfrac{2022}{2023}\right)$ is equal to

(A) 1010
(B) 1011
(C) 2011
(D) 2010

Q14. The equations of the sides AB and AC of a triangle ABC are $(\lambda + 1)x + \lambda y = 4$ and $\lambda x + (1 - \lambda)y + \lambda = 0$ respectively. Its vertex A is on the y-axis and its orthocentre is $(1,2)$. The length of the tangent from the point C to the part of the parabola $y^2 = 6x$ in the first quadrant is :

(A) $2\sqrt{2}$
(B) 2
(C) $\sqrt{6}$
(D) 4

Q15. The value of $\left(\dfrac{1+\sin\frac{2\pi}{9}+i\cos\frac{2\pi}{9}}{1+\sin\frac{2\pi}{9}-i\cos\frac{2\pi}{9}}\right)^3$ is

(A) $\frac{1}{2}\left(1-i\sqrt{3}\right)$ (B) $-\frac{1}{2}\left(1-i\sqrt{3}\right)$
(C) $\frac{1}{2}\left(\sqrt{3}+i\right)$ (D) $-\frac{1}{2}\left(\sqrt{3}-i\right)$

Q16. Let $\vec{\alpha}=4\hat{i}+3\hat{j}+5\hat{k}$ and $\vec{\beta}=\hat{i}+2\hat{j}-4\hat{k}$. Let $\vec{\beta}_1$ be parallel to $\vec{\alpha}$ and $\vec{\beta}_2$ be perpendicular to $\vec{\alpha}$. If $\vec{\beta}=\vec{\beta}_1+\vec{\beta}_2$, then the value of $5\vec{\beta}_2\cdot\left(\hat{i}+\hat{j}+\hat{k}\right)$ is

(A) 7 (B) 9
(C) 6 (D) 11

Q17. $\int_{\frac{3\sqrt{2}}{4}}^{\frac{3\sqrt{3}}{4}}\frac{48}{\sqrt{9-4x^2}}dx$ is equal to

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

Q18. Let A be a 3 x 3 matrix such that $\left|\text{adj}\left(\text{adj}\left(\text{adj } A\right)\right)\right|=12^4$. Then $\left|A^{-1}\,\text{adj}A\right|$ is equal to

(A) $2\sqrt{3}$ (B) 1
(C) $\sqrt{6}$ (D) 12

Q19. If the foot of the perpendicular drawn from $(1,9,7)$ to the line passing through the point $(3,2,1)$ and parallel to the planes $x+2y+z=0$ and $3y-z=3$ is (α,β,γ), then $\alpha+\beta+\gamma$ is equal to

(A) 1 (B) 3
(C) 5 (D) -1

Q20. The number of square matrices of order 5 with entries from the set $\{0,1\}$, such that the sum of all the elements in each row is 1 and the sum of all the elements in each column is also 1, is

(A) 120 (B) 125
(C) 225 (D) 150

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. Let $S=\{\theta\in[0,2\pi):\tan(\pi\cos\theta)+\tan(\pi\sin\theta)=0\}$. Then $\sum_{\theta\in S}\sin^2\left(\theta+\frac{\pi}{4}\right)$ is equal to..........

Q2. The minimum number of elements that must be added to the relation $R=\{(a,b),(b,c),(b,d)\}$ on the set $\{a,b,c,d\}$ so that it is an equivalence relation, is.......

Q3. The equations of the sides AB, BC and CA of a triangle ABC are : $2x+y=0, x+py=21a, (a\neq 0)$ and $x-y=3$ respectively. Let $P(2,a)$ be the centroid of ΔABC. Then $(BC)^2$ is equal to

Q4. If $\dfrac{1^3+2^3+3^3+\text{...up to n terms}}{1\cdot 3+2\cdot 5+3\cdot 7+\text{...up to n terms}}=\dfrac{9}{5}$, then the value of n is

Q5. Let f be a differentiable function defined on $\left[0,\frac{\pi}{2}\right]$ such that $f(x)>0$ and $f(x)+\int_0^x f(t)\sqrt{1-(\log_e f(t))^2}\,dt=e, \forall x\in\left[0,\frac{\pi}{2}\right]$. Then $\left(6\log_e f\left(\frac{\pi}{6}\right)\right)^2$ is equal to......

Q6. If the shortest between the lines $\dfrac{x+\sqrt{6}}{2}=\dfrac{y-\sqrt{6}}{3}=\dfrac{z-\sqrt{6}}{4}$ and $\dfrac{x-\lambda}{3}=\dfrac{y-2\sqrt{6}}{4}=\dfrac{z+2\sqrt{6}}{5}$ is 6, then the square of sum of all possible values of λ is

Q7. If the area of the region bounded by the curves $y^2-2y=-x, x+y=0$ is A, then 8A is equal to

Q8. Three urns A, B and C contain 4 red, 6 black; 5 red, 5 black; and λ red, 4 black balls respectively. One of the urns is selected at random and a ball is drawn. If the ball drawn is red and the probability that it is drawn from urn C is 0.4 then the square of the length of the side of the largest equilateral triangle, inscribed in the parabola $y^2=\lambda x$ with one vertex at the vertex of the parabola, is

Q9. Let the sum of the coefficients of the first three terms in the expansion of $\left(x-\frac{3}{x^2}\right)^n, x\neq 0, n\in N$, be 376. Then the coefficient of x^4 is......

Q10. Let $\vec{a}=\hat{i}+2\hat{j}+\lambda\hat{k}, \vec{b}=3\hat{i}-5\hat{j}-\lambda\hat{k}, \vec{a}\cdot\vec{c}=7, 2\vec{b}\cdot\vec{c}+43=0, \vec{a}\times\vec{c}=\vec{b}\times\vec{c}$. Then $|\vec{a}\cdot\vec{b}|$ is equal to

FIITJEE

KEYS to JEE (Main)-2023

PART – A (PHYSICS)

SECTION - A

1.	B	2.	C	3.	A	4.	D
5.	D	6.	A	7.	B	8.	B
9.	A	10.	C	11.	D	12.	A
13.	D	14.	B	15.	C	16.	D
17.	A	18.	C	19.	A	20.	C

SECTION – B

1.	3	2.	105	3.	7	4.	32
5.	54	6.	100	7.	44	8.	9
9.	6	10.	1				

PART – B (CHEMISTRY)

SECTION - A

1.	D	2.	D	3.	A	4.	C
5.	A	6.	C	7.	A	8.	B
9.	D	10.	C	11.	D	12.	D
13.	B	14.	C	15.	D	16.	A
17.	C	18	A	19.	D	20.	B

SECTION - B

1.	2	2.	3	3.	5	4.	2
5.	8	6.	314	7.	2	8.	85
9.	8	10.	620				

PART – C (MATHEMATICS)

SECTION - A

1.	D	2.	B	3.	B	4.	B
5.	B	6.	D	7.	A	8.	A
9.	C	10.	C	11.	C	12.	C
13.	B	14.	A	15.	D	16.	A
17.	B	18	A	19.	C	20.	A

SECTION - B

1.	2	2.	13	3.	29	4.	5
5.	27	6.	384	7.	36	8.	432
9.	405	10.	8				

FIITJEE

Solutions to JEE (Main)-2023

PART – A (PHYSICS)

SECTION – A

Sol1. $T^2 \propto a^3$

$\Rightarrow T \propto a^{3/2}$

$\Rightarrow 1 \propto \left(1.5\times10^6\right)^{3/2}$

$2.83 \propto (a)^{3/2}$

$\Rightarrow \dfrac{1}{2.83} = \left(\dfrac{1.5\times10^6}{a}\right)^{3/2}$

$\Rightarrow \dfrac{1}{(2.83)^{2/3}} = \dfrac{1.5\times10^6}{a} \Rightarrow a = 1.5\times(2.83)^{2/3}\times10^6$

$= 3\times10^6 \text{km}$

Sol2. $\gamma_1 = \dfrac{5}{3}, \gamma_2 = \dfrac{7}{5}$

$\Rightarrow \dfrac{\gamma_1}{\gamma_2} = \dfrac{25}{21}$

Sol3. Steel is more elastic so it is used in buildings and bridges.

Sol4. It is called chromatic aberration.

Sol5. For constant volume: $P_3 > P_2 > P_1$ and graph will be hyperbolic in nature.

Sol6. Emf across its end $= \dfrac{1}{2}B\omega L^2$

Sol7. $\vec{P}.\vec{Q} = 0$

$\Rightarrow 4 - 4m + m^2 = 0$

$\Rightarrow (m-2)^2 = 0$

$\Rightarrow m = 2$

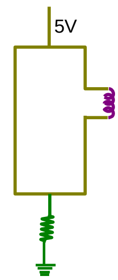
Sol8. At Mount Everest g will decrease so time period will increase and clock will slow.

Sol9. $\lambda = \dfrac{h}{mv} = \dfrac{h}{\sqrt{2km}}$

$\lambda \propto \dfrac{h}{\sqrt{m}}$

$\lambda_\infty < \lambda_p < \lambda_e$

Sol10. When bath switch is open or any one of the switch is closed bulb will glow. If bath switch is closed; It will not glow.



A	B	
0	0	1
1	0	1
0	1	1
1	1	0

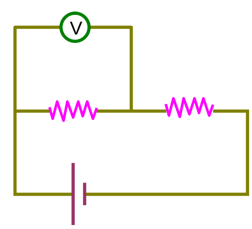
Sol11. $V = \frac{K(\lambda\pi R_1)}{R_1} + \frac{(\lambda\pi R_2)}{R_2}$

$= 2K\lambda\pi = \frac{\lambda}{2\varepsilon_0}$

Sol12. $R_{equ} = 180 - \Omega$

$i = \frac{1}{2} A$

$v = 40v$



Sol13. $K\Delta x = mw^2(\ell + \Delta x)$

$\Rightarrow 12.5\Delta x = \frac{1}{5} \times 25(\ell + \Delta x)$

$\Rightarrow \frac{\Delta x}{\ell + \Delta x} = \frac{5}{15.5} = \frac{2}{5}$

$\Rightarrow 5\Delta x = 2\ell + 2\Delta x$

$\Rightarrow 3\Delta x = 2\ell \Rightarrow \frac{\Delta x}{\ell} = 2:3$

Sol14. $V = r^a s^b s^c$

$\Rightarrow T^{-1} = (L^a)(ML^{-3})^b (MT^{-2})^C$

$b + c = 0 \Rightarrow b = -c$

$a - 3b = 0$

$-1 = 2c \Rightarrow c = \frac{1}{2}$

Sol15. $g = \frac{GM}{r^2}$ for outside

$g = \frac{gMr}{R^3}$ for inside

Sol16. $E = Bv$

$\Rightarrow E = B\frac{w}{k}$

Sol17. $E = \frac{-13.6}{n^2} \Rightarrow \Delta E = 13.6\left(1 - \frac{1}{16}\right) = 13.6 \times \frac{15}{16} eV$

$$\lambda = \frac{hc}{\Delta E} = \frac{4\times10^{-15}\times3\times10^{8}}{13.6\times\frac{15}{16}} = \frac{12\times10^{-7}}{13.6\times\frac{15}{16}} = 94.1nm$$

Sol18. Using frequency range data

Sol19. $B = \mu_0 ni$

$= 4\pi\times10^{-7}\times7000\times2$

$= 56\times\frac{22}{7}\times10^{-4}$

$= 176\times16^{-4}$

Sol20. Displacement = $8\times2-2\times4+4\times4-2\times4 = 32-16 = 16$

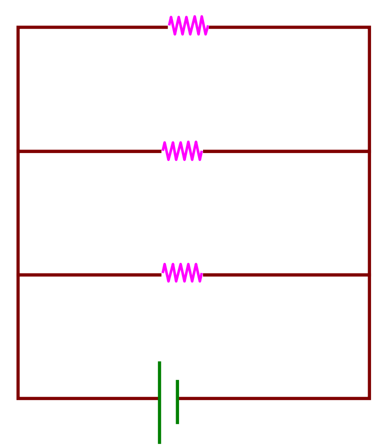
Distance $= 8\times2+2\times4+4\times4+2\times4$

$= 48$

SECTION - B

Sol1. At steady state:

$$i = \frac{V}{\frac{R}{3}} = \frac{3V}{R} = 3A$$



Sol2. $C_o = \frac{\in A}{d} = 15pf$

$$C = \frac{K\varepsilon_0 A}{2d} = \frac{K}{2}\left(\frac{\varepsilon_0 A}{d}\right) = \frac{105}{4}pf$$

Sol3. $f_r = mg - B$

$= \sigma vg - v\delta g$

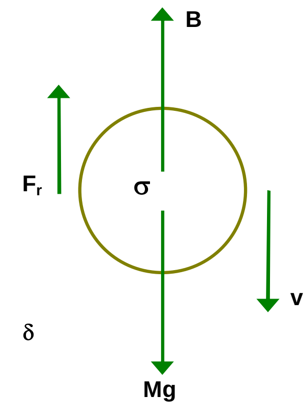
$= (\sigma - \delta)vg$

$= \frac{9\times10^{-3}}{10^{-6}} \times \frac{4}{3}\pi \times \left(\frac{1}{10^3}\right)^3 \times 9.8$

$= 9\times10^3 \times \frac{4}{3} \times \frac{22}{7} \times \frac{1}{10^9} \times 9.8$

$= 369.6\times10^{-6}$

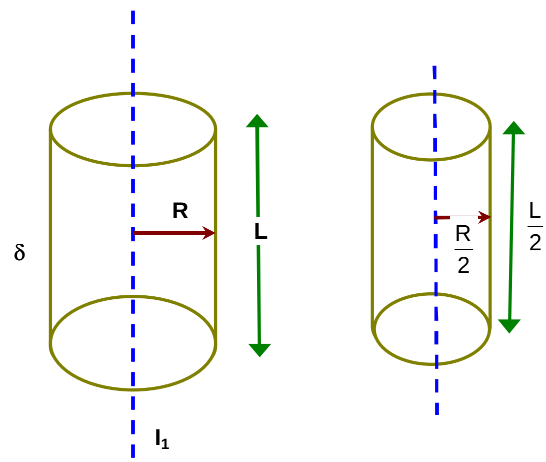
$= 3696\times10^{-7}$



Sol4. $I_1 = \frac{MR^2}{2} = \frac{1}{2}(\delta AL)R^2$

$I_2 = \frac{1}{2}\left(\delta \frac{A}{4}\frac{L}{2}\right)\left(\frac{R}{2}\right)^2$

$\frac{I_1}{I_2} = \frac{1}{\frac{1}{32}} = 32$



Sol5. $\frac{1}{18} = \left(\frac{\frac{3}{2}}{1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f} = \left(\frac{\frac{3}{2}}{\frac{4}{3}} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\Rightarrow \frac{f}{18} = \frac{\frac{1}{2}}{\frac{1}{8}} = 4$

$\Rightarrow f = 72$

$\Delta f = 54cm$

Sol6. $\vec{f} = \left(t\hat{i} + 3t^2\hat{j}\right)N$

$\vec{a} = t\hat{i} + 3t^2\hat{j}$

$\vec{v} = \frac{t^2}{2}\hat{i} + \frac{3t^3}{3}\hat{j} = \frac{t^2}{2}\hat{i} + t^3\hat{j}$

$$p = \vec{f}.\vec{v} = \frac{t^3}{3} + 3t^5 = \frac{8}{2} + 3(2)^5 = 4 + 96 = 100$$

Sol7. $R = \delta \frac{\ell_0}{A_0}$

$\ell_0 A_0 = 1.2\ell_0 A \Rightarrow A = \frac{A_0}{1.2}$

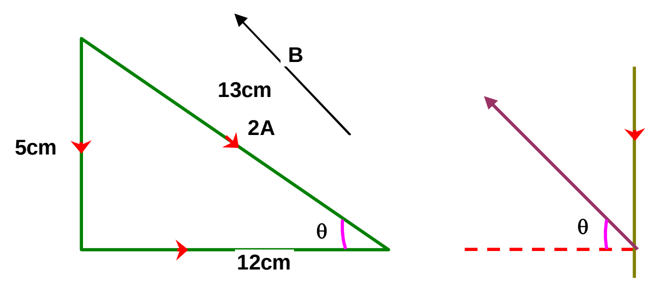
$R' = \delta \frac{1.2\ell_0}{\frac{A_0}{1.2}} = 1.44\delta \frac{\ell_0}{A_0}$

$\frac{\Delta R}{R} = 44\%$

Sol8. $f = (B\cos\theta)i\ell$

$= \frac{3}{4} \times \frac{12}{13} \times 2 \times \frac{1}{20}$

$= \frac{9}{130}$



Sol9. $n = \frac{120}{240} = \frac{1}{2}$

$= \frac{1}{2} \times N_A$

$= \frac{1}{2} \times 6.2 \times 10^{23} \times 200\,\text{MeV}$

$= 6.2 \times 10^{25}\,\text{MeV}$

Sol10. $T = 2\pi\sqrt{\frac{m}{k}}$

$1 = 2\pi\sqrt{\frac{m}{k}}$

$2 = 2\pi\sqrt{\frac{m+3}{k}}$

$\Rightarrow \frac{1}{2} = \sqrt{\frac{m}{m+3}} \Rightarrow \frac{1}{4} = \frac{m}{m+3} \Rightarrow m + 3 = 4m \Rightarrow m = 1$

PART – B (CHEMISTRY)

SECTION – A

Sol1. Z = 55. The element is Cs.

$Cs(55) = [Xe]6s^1$ $Cs^+ = [Xe]6s^0$

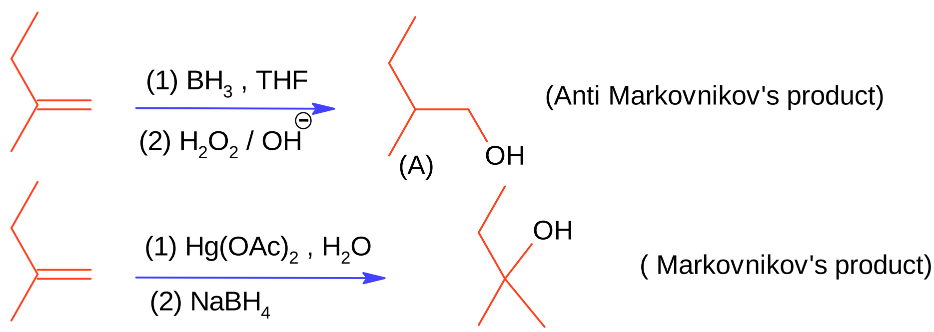
The number of s-orbitals is 1s, 2s, 3s, 4s and 5s

$\therefore$ Total electron $= 5 \times 2 = 10$

Sol2. $K_2Cr_2O_7 + SO_2 + H_2SO_4 \longrightarrow \underset{\text{(green)}}{Cr_2(SO_4)_3} + K_2SO_4 + H_2O$

Due to formation of Cr^{+3} - salt green colour is obtained.

Sol3.



Sol4. (a) Reduction potential of Na> Rb> Li is correct

$E^0_{Li^+}/Li$ = R.P of $Li = -3.05\,V$

$E^0_{Na^+}/Na$ = R.P of $Na = -2.71V$

$E^0_{Rb^+}/Rb$ = R.P of $Rb = -2.93\,V$

(b) CsI is least soluble due to low hydration energy.

(c) Li_2CO_3 has maximum polarization due to smaller size of Li, thus covalent nature & unstable towards heat.

(d) K + conc. NH_3 solution $\longrightarrow$ Blue colour changes to bronze

$\longrightarrow$ due to metal cluster formation.

(e) Metal hydrides of 1^{st} group are ionic in nature

Sol5. HOMO is highest occupied molecular orbital

$N_2 = \sigma_{1s}^2\, \sigma_{1s}^{*2}\, \sigma_{2s}^2\, \sigma_{2s}^{*2}\, \pi_{2px}^2 \equiv \pi_{2py}^2 \boxed{\sigma_{2pz}^2} \rightarrow$ HOMO orbital No. of u.e = 0

$N_2^+ = \sigma_{1s}^2\, \sigma_{1s}^{*2}\, \sigma_{2s}^2\, \sigma_{2s}^{*2}\, \pi_{2px}^2 \equiv \pi_{2py}^2 \boxed{\sigma_{zpz}^1} \rightarrow$ HOMO No. of u.e = 1

$O_2 = \sigma_{1s}^2\, \sigma_{1s}^{*2}\, \sigma_{2s}^2\, \sigma_{2s}^{*2}\, \sigma_{2pz}^2\, \pi_{2px}^2 \equiv \pi_{2py}^2 \boxed{\pi_{2px}^{*1} \equiv \pi_{2py}^{*1}} \rightarrow$ HOMO orbital No. of u.e = 2

$O_2^+ = \sigma_{1s}^2\, \sigma_{1s}^{*2}\, \sigma_{2s}^2\, \sigma_{2s}^{*2}\, \sigma_{2pz}^2\, \pi_{2px}^2 \equiv \pi_{2py}^2 \boxed{\pi_{2px}^{*1} \equiv \pi_{2py}^{*0}} \rightarrow$ HOMO No. of u.e = 1

Sol6. The most stable O.S of Lanthanoid = (+3)

Hence Ce^{+4} and Tb^{+4} tends to get (+3) O.S thus behaves like O.A

$Ce^{+4} + e^- \longrightarrow Ce^{+3}$

$$Tb^{+4} + e^- \longrightarrow Tb^{+3}$$

Sol7. C.F.T does not explain the order of Spectrochemical series because it is an experimentally determined series. C.F.T introduces spectrochemical series on the basis of experiment value of Δ.

Sol8. Amines & anilines are almost colourless It becomes cloured compound, when exposed in air for a long time due to oxidation .

$$\text{Aniline} \xrightarrow[\text{Long time}]{O_2} \text{dark brown}$$

Sol9. Ag & Au extracted by oxidation (Leaching) and reduction (hydrometallurgy) process.

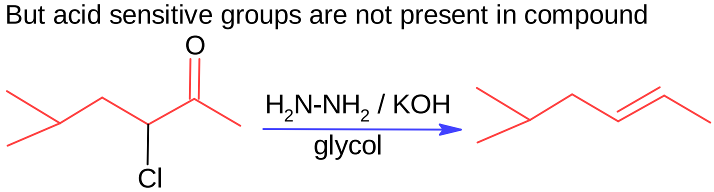
$$4Ag + 8CN^- + O_2 + 2H_2O \longrightarrow \left[Ag(CN)_2\right]^- + 4OH^-$$

$$2\left[Ag(CN)_2\right]^- + Zn \longrightarrow 2Ag\downarrow + \left[Zn(CN)_4\right]^{-2}$$

Sol10.

$\longrightarrow$ It reduces $>C{=}O$ group to $>C(H)H$

But acid sensitive groups are not present in compound



$\rightarrow$ It reduces >C=O group to >CH_2 but further elimination takes place due to OH^- group.

Sol11. An average human consumes 15 times more air than food. An average human consumes 5-6 ml O_2 per minute.

Sol12.

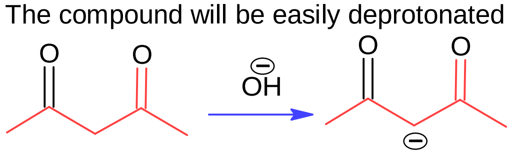
Oxidation

$$\overset{+1}{HOCl} + H_2\overset{(-1)}{O_2} \longrightarrow H_3O^+ + Cl^- + \overset{(0)}{O_2}$$

Reduction

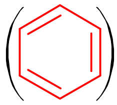
$\rightarrow$ H_2O_2 undergoes oxidation thus behaves like reducing agent.

Sol13. The compound will be easily deprotonated in which conjugate base is readily stabilized.



Maximum stable conjugate base.
In other compound (+M) effect of RO^- group decreases the stability of conjugate base.

Sol14. The $\Delta H_{\text{Hydrogenation}}$ of cyclohexatriene 36K.Cal/mole more than benzene therefore.

Benzene  is more stable than cyclohexatriene.

Sol15. $t_{1/2} \propto (P_0)^{1-n}$

$\therefore \left(\frac{50}{100}\right)^{1-n} = \frac{4}{2}$

$\therefore \left(\frac{1}{2}\right)^{1-n} = 2^1$

$\therefore (2)^{n-1} = 2^1$

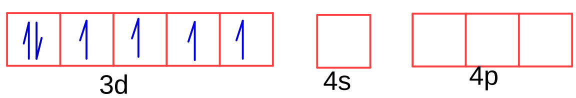
$\therefore n-1=1$

$\therefore \boxed{n=2}$

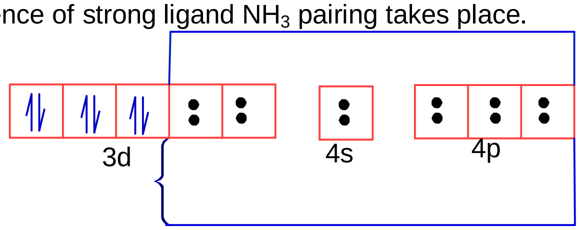
Order of reaction is 2

Sol16. $\left[Co(NH_3)_6\right]^{+3}$ O.S.of Co $= (+3)$

$\therefore Co^{+3} = 4s^o 3d^6$

Co^{+3} = 

In presence of strong ligand NH_3 pairing takes place.

Co^{+3} = 

Hybridization $= \boxed{d^2sp^3}$

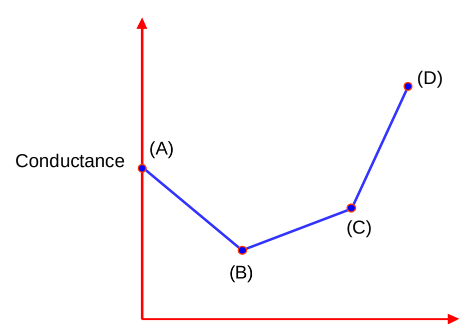
u.e = o (Diamagnetic)

Sol17. $C_6H_5COOH + NaOH \longrightarrow C_6H_5COONa + H_2O$

A to B $\rightarrow$ Free $H^{\oplus}$ ions are replaced by slow moving $Na^{\oplus}$ ion thus conductance decreases

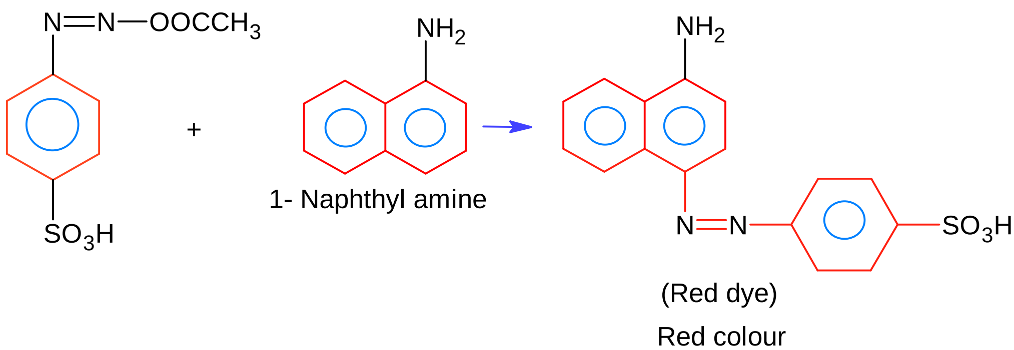
B to C $\rightarrow$ Undissociated benzoic acid forms salt with NaOH which increases ions thus

C to D $\rightarrow$ After equivalence point NaOH further increases fast moving OH^- thus



Sol18. Reduction potential depends on
(I) $\Delta H_{atomisation}$ (II) Ionisation energy (III) $\Delta H_{hydration}$
Be has less (-ve) value of reduction pot due to
(a) its high $\Delta H_{Hydration}$ and
(b) High $\Delta H_{atomisation}$.

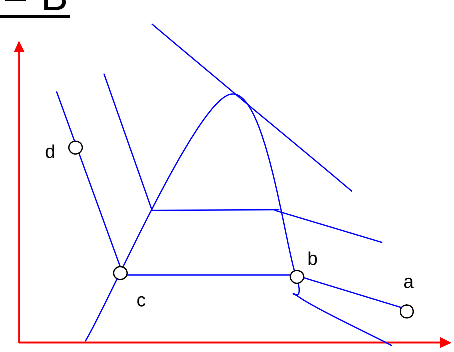
Sol19.



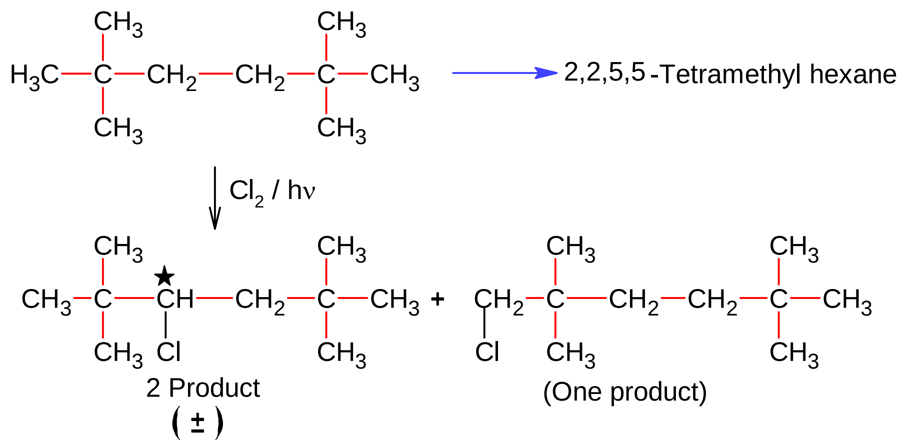
Sol20. Norethindrone ⟶ Antifertility drug
⟶ It is a synthetic progesterone
Meprobomate ⟶ Tranquilizer
⟶ used to treat anxiety disorder
Seldane ⟶ Antihistamine
⟶ Used to prevent sneezing itching , running nose like allergic symptoms
Amplicilin ⟶ Antibotic
⟶ Used for infection caused by bacteria.

SECTION – B

Sol1. (a) →(b)CO_2 exist as gas
(b) → Liquefaction starts
(c) → Liquefaction ends
(d) → CO_2 exist as liquid
In between (b) & (c) liquid and gaseous CO_2 coexist.
As volume decreases from (b) to (c) thus gas Decreases and liquid increases



Sol2.

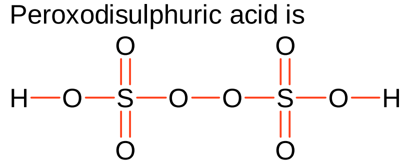


Total isomeric product = 3

Sol3. Concentration of solution expressed is
(1) Mass percent
(2) Mole fraction
(3) Molarity
(4) ppm
(5) Molality

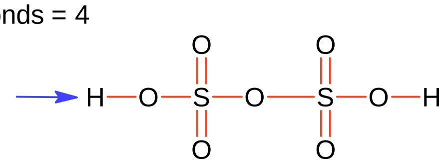
Sol4. Characteristics of physisorption are
(a) It decreases with increase in temperature due to weak forces(Low temperature is favorable)
(b) Less activation energy is required.

Sol5. Peroxodisulphuric acid is



$\therefore$ Number of π-bonds = 4

Pyrosulphuric acid



Number of π-bonds = 4
$\therefore$ Total π-bonds = (4+4) = 8

Sol6. V.P of pure $A = P_A^o$

V.P of pure $B = P_B^o$

Case-I

$P_T = P_A^o X_A + P_B^o X_B$

$350 = 0.7 \times P_A^o + 0.3 \times P_B^o$ ---------------------------------- (I)

Case-II

$410 = 0.2 \times P_A^o + 0.8 \times P_B^o$ ---------------------------------- (II)

(II)- (i)

$60 = -0.5 \times P_A^o + 0.5 \times P_B^o$

$$\therefore P_B^o - P_A^o = \frac{60}{0.5} = \frac{600}{5} = 120$$

$$P_B^o = \left(120 + P_A^o\right)$$

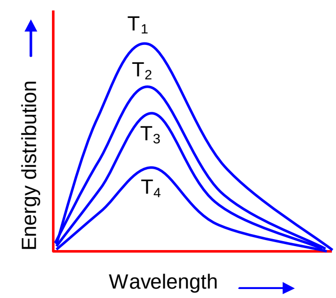
$$\therefore 350 = 0.7 \times P_A^o + 0.3\left(120 + P_A^o\right)$$

$$350 = P_A^o + 36$$

$$P_A^o = 350 - 36 = 314 \text{ mm Hg}$$

$$P_B^o = 120 + 314 = 434 \text{ mm Hg}$$

Sol7. $T_1 > T_2 > T_3 > T_4$
When temperature increases peak of spectrum shifted to shorter wavelength or higher frequency
$\rightarrow$ Spectrum of black body radiation is explained by using quantization of energy.



Sol8. $\left[Ca(Lac)_2\right] = 0.05M \qquad = 5\times10^{-3}(M)$

$$\therefore \left[Lac^-\right] = 2\times5\times10^{-3} = 10^{-2}(M)$$

Calcium lactate is salt of weak acid and strong base.

$$\therefore pH = 7 + \frac{1}{2}(Pka + \log C)$$

$$= 7 + \frac{1}{2}\left[5 + \log\left(10^{-2}\right)\right]$$

$$= 7 + \frac{1}{2}(5-2) = 7 + \frac{3}{2}$$

$$= 8.5 = 85\times10^{-1}$$

Sol9. Total number of tripeptide by mixing valine and proline = 2^3 = 8

Val– Val – Val	Pro – Pro –Pro
Val–Pro–Pro	Pro – Val – Pro
Val–Val–Pro	Val – Pro –Val
Pro–Pro–Val	Pro – Val – Val

Sol10. $1\to2 \longrightarrow$ Isobaric process
$2\to3 \longrightarrow$ Isochoric process
$3\to1 \longrightarrow$ Isothermal process
Total work = $W_{1\to2} + W_{2\to3} + W_{3\to1}$

$$= -P\left(V_2 - V_1\right) + 0 + \left[-P_1V_1\ell n\left(\frac{V_2}{V_1}\right)\right]$$

$$= -\left(40-20\right) - 1\times 20\ell n\left(\frac{20}{40}\right)$$

$$= -20 + 20\ell n\left(\frac{40}{20}\right)$$

$= -20 + 20\ell n2$
$= -20 + 20 \times 0.3 \times 2.3$
$= -6.2\,\text{bar lit}$
Magnitude of work done = 6.2 bar lit = 620J

PART – C (MATHEMATICS)

SECTION – A

Sol1. $\left(x^3 - 3y^2\right)dx + 3xy\,dy = 0,\ y(1) = 1$

$\frac{dy}{dx} = \frac{3y^2 - x^2}{3xy}$

Put $y = vx$

$v + x\frac{dv}{dx} = \frac{3v^2 - 1}{3v}$

$x\frac{dv}{dx} = \frac{3v^2 - 1}{3v} - v$

$3vdv = -\frac{dx}{x}$

$\frac{3}{2}v^2 = -\log_e|x| + \frac{3}{2}$

$\frac{3}{2}\left(\frac{y}{x}\right)^2 = -\log_e|x| + c = -\log_e|x| + \frac{3}{2}$

$y(1) = l,\ c = \frac{3}{2}$

$\frac{3}{2}\left(\frac{y}{x}\right)^2 = -\log_e|x| + \frac{3}{2}$

$x = e$

$y^2(e) = \frac{e^2}{3}$

$6y^2(e) = 6 \cdot \frac{e^2}{3} = 2e^2$

Sol2. $3\left(x^2 + \frac{1}{x^2}\right) - 2\left(x + \frac{1}{x}\right) + 5 = 0$

$3\left[\left(x + \frac{1}{x}\right)^2 - 2\right] - 2\left(x + \frac{1}{x}\right) + 5 = 0$

$t = x + \frac{1}{x}$

$t \in (-\infty, -2] \cup [2, \infty)$

$3t^2 - 2t - 1 = 0$

$t = 1,\ t = -\frac{1}{3}$ not lies on range.

Sol3. $f(x+y) = f(x)\cdot f(y) \forall\ x, y \in N$

$f(1) = 3$

$f(1+1) = f(2) = f(1)\cdot f(1) = (f(1))^2 = 3^2$

$f(3) = 3^3$

$f(1) + f(2)\text{.......} + f(n) = 3279$

$3 + 3^2\text{........} + 3^n = 3279$

$3\left(\frac{3n-1}{3-1}\right) = 3279$

$3^{n+1} = 6561$

$3^{n+1} = 3^8$

$n + 1 = 8$

$n = 7$

Sol4. $x + 2y + 3z = 3$

$4x + 3y - 4z = 4$

$8x + 4y - \lambda z = 9 + \mu$

$D = 0$

$$\begin{vmatrix} 1 & 2 & 3 \\ 4 & 3 & -4 \\ 8 & 4 & -\lambda \end{vmatrix} = 0$$

$\lambda = \frac{72}{5}$

$D_3 = 0$

$$\begin{vmatrix} 1 & 2 & 3 \\ 4 & 3 & \mu \\ 8 & 8 & 9+4 \end{vmatrix} = 0$$

$\mu = \frac{-21}{5}$

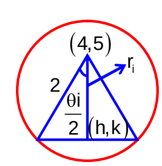
Sol5. Formed digit greater then 7000.

(i) using all digit (5 digit number > 4 digit number) $= \underline{|5} = 120$

(ii) using 4 digit = …………= $2C_1 \times 4C_3 \times \underline{|3} = 48$

Total digit = 168

Sol6. $(h-4)^2 + (k-5)^2 = r_i^2$



$\cos\left(\frac{\theta_i}{2}\right) = \frac{r}{2}, r_i = 2\cos\left(\frac{\theta_i}{2}\right)$

$(h-4)^2 + (k-5)^2 = 4\cos^2\frac{\theta_i}{2}$

$r_i^2 = 4\cos^2\theta_i$

$r_i = \frac{2\cos\theta i}{2}$

$\theta_i = 60^0$

$r_1 = \sqrt{3}$

$r_3 = 1$

$r_1^2 = r_2^2 + r_3^2$

$3 = r_2^2 + 1$

$2 = \frac{4\cos^2\theta_2}{2}$

$\frac{\cos^2\theta_2}{2} = \frac{1}{2}$

$\frac{\theta_2}{2} = 45^0$

$\theta_2 = 90^0$

Sol7. $f(x) = x^3 - x^2 f'(1) + xf''(2) - f'''(3)\ \forall x \in R$

Let $f'(1) = 9, f''(2) = b, f'''(3) = c$

$f(x) = x^3 - ax^2 + bx - c$

$f'(x) = 3x^2 - 2ax + b$

$f''(x) = 6x - 29$

$f'''(3) = 6 = c$

$f'(1) = a$

$3a - b = 3$

$f''(2) = b$

$6 \times 2 - 2a = b$

$2a + b = 12$

$a = 3, b = 6$

Sol8. $S = 0\cdot\left({}^{30}C_0\right)^2 + 1\cdot\left({}^{30}C_1\right)^2 + 2\left({}^{30}C_2\right)^2 ......30\left({}^{30}C_{30}\right)^2$

$S = 30\left({}^{30}C_{30}\right)^2 + 29\left({}^{30}C_{29}\right)^2 ......+0\left({}^{30}C_0\right)^2$

$2S = 30\left[C_{30}^2 + C_{29}^2 ..... + C_{30}^2\right]$

$S = 15\left[C_0^2 + C_1^2 ..... + C_{30}^{2-}\right]$

$C_0^2 + C_1^2 ..... + C_x^2 = \frac{\underline{|24}}{\underline{|x}\underline{|x}}$

$S = 15\cdot\frac{\underline{|60}}{\underline{|30}\,\underline{|30}}$

$\alpha = 15$

Sol9. $P_1 " x + (\lambda+4)y + z = 1, P_2 \equiv 2x + y + z = 2$

$(x + (\lambda+4)y + z - 1) + \mu(2x + y + z - 2) = 0$

passing through $(0, 1, 0)$

$1 + \mu = 0$

$\mu = -1$

also passes through $(1, 0, 1)$

$\lambda = -4$
$= (2\lambda, -\lambda, -\lambda) \equiv (-8, -4, 4)$
distance from P_2 is $= \left|\frac{2\times -8-4+9-2}{\sqrt{6}}\right|$
$= \frac{18}{\sqrt{6}} = 3\sqrt{6}$

Sol10. $\frac{a_1+a_2+a_3....a_6}{3} = \frac{19}{2}$
$a_1+a_2.....+a_6 = 57$
$a_1 = a, a_2 = a+d, a_3 = a+2d$
$6a+15d = 19$
$a+d = 5$
$a = 2, d = 3$
Number are $2, 5, 8, 11, 14, 17$
Variance $(\sigma^2) = \frac{105}{4}$
$8\sigma^2 = \frac{8\times 105}{4} = 210$

Sol11. $\sim(p\wedge(p\to\sim q))$
$\sim p\vee\sim(\sim p\vee\sim q)$
$\sim p\vee(p\wedge q)$
$\sim(p\vee q)\wedge(\sim p\vee q)$
$\wedge(\sim p\vee q)$
$\sim(p\vee q)$

Sol12. $\lim\limits_{x\to a}([x-5]-[2x+2]) = 0$
Put $-7\cdot 5$
$[-7\cdot 5-5]-[-15+2]$
$[-12\cdot 5]-[-13]$
$-13+13 = 0$
Put $a = 6\cdot 5$
$[-6\cdot 5-5]-[-13+2]$
$\Rightarrow [-11\cdot 5]-[-11]$
Put $a = -64$
$[-6\cdot 4-5]-[-12\cdot 8+2]$
$\Rightarrow [-11\cdot 4]-[-10\cdot 8]$

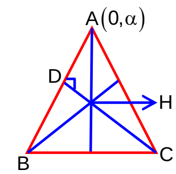
Sol13. $f(x) = \frac{2^{2x}}{2^{2x}+2} = \frac{4^x}{4^x+2}$
$f(1-x) = \frac{4^{1-x}}{4^{1-x}+2}$

$f(x)+f(1-x)=1$

$f\left(\frac{1}{2023}\right)+f\left(\frac{2}{2023}\right)......+f\left(\frac{2022}{2023}\right)$

$f\left(\frac{1}{2023}\right)+f\left(\frac{2022}{2023}\right)+f\left(\frac{2}{2023}\right)+......=1011$

Sol14. $H\equiv(1,2)$



$AB::(\lambda+1)x+\lambda y=4$

$AC\equiv\lambda x+(1-\lambda)y+\lambda=0$

$\alpha\lambda=4$ ....(i) (A lies on AB & AC)

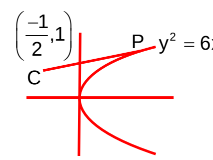
$\alpha=\lambda(\alpha-1)$

$\alpha=2$

$A\equiv(0,2)$

wrt equation (i) $2x-3y+4=0$

Solving AC & CD $\left(-\frac{1}{2},1\right)$



$P\equiv\left(\frac{3}{2},3\right)$

$ty=x+at^2,\ a=\frac{3}{2}$

passing $\left(\frac{-1}{2},1\right)$

$3t^2-2t-1=0$

$t=1,-\frac{1}{3}$

$P\equiv\left(\frac{3}{2},3\right)$

$PC=\sqrt{4+4}=2\sqrt{3}$

Sol15. $\left[\dfrac{\sin\frac{2\pi}{9}+i\cos\frac{2\pi}{9}}{1+\sin\frac{2\pi}{9}-i\cos\frac{2\pi}{9}}\right]$

$\frac{1+z}{1+\bar{z}},\ z\bar{z}=1$

$=z^3$

$=\left[\frac{1}{i}i\left(\sin\frac{2\pi}{9}+i\cos\frac{2\pi}{9}\right)\right]^3$

$=\frac{1}{a^3}\left[\ell^2\cos\frac{2\pi}{9}+\ell\sin\frac{2\pi}{9}\right]$

$=\frac{i}{\ell^4}\left[-\cos\frac{2\pi}{9}+i\sin\frac{2\pi}{9}\right]$

$$-i\left[\frac{\cos 2\pi}{9} - i\sin\frac{2\pi}{9}\right]$$
$$= -i\left[e^{-i\cdot\frac{2\pi}{9}}\right] = \frac{1}{2} + \frac{\sqrt{3}}{2}i.$$

Sol16. $\bar{\alpha} = (4,3,5), \vec{\beta} = (1, 2, -4)$

$$\vec{\beta}_1 = \lambda\left(4\hat{i} + 3\hat{j} + 5\hat{k}\right)$$
$$\vec{\beta}_2 = \vec{\beta} - \vec{\beta}\ \hat{j}$$
$$= (1, 2, -4) - \lambda(4,3,5)$$
$$\left[1 - 4\lambda, 2 - 3\lambda, -4 - 5\lambda\right]$$
$$\vec{\beta}_2 \cdot \alpha = 0$$
$$\alpha = \frac{-1}{5}$$
$$\vec{\beta}_2 = \left(\frac{9}{5}, \frac{13}{5}, -3\right)$$
$$5\vec{\beta}_2 \cdot (1,1,1)$$
$$5\left(\frac{9}{5}, \frac{13}{5}, -3\right)(1,1,1) = 7$$

Sol17. $\displaystyle\int_{\frac{3\sqrt{2}}{4}}^{\frac{3\sqrt{3}}{4}} \frac{48\,dx}{\sqrt{9 - 4x^2}}$

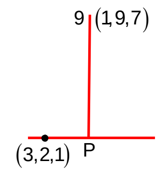
$$= 48 \cdot \int_{\frac{3\sqrt{2}}{4}}^{\frac{3\sqrt{3}}{4}} \frac{dx}{\sqrt{3 - (2x)^2}}$$
$$= 48\frac{1}{2}\left[\sin^{-1}\frac{2x}{3}\right]_{\frac{3\sqrt{2}}{4}}^{\frac{3\sqrt{3}}{4}}$$
$$\frac{48}{2}\left[\sin^{-1}\frac{\sqrt{3}}{2} - \sin^{-1}\frac{1}{\sqrt{2}}\right]$$
$$\frac{48}{2}\left[\frac{\pi}{3} - \frac{\pi}{4}\right]$$
$$\frac{48}{2} \times \frac{\pi}{12} = 2\pi$$

Sol18. $A = [A]_{3\times 3}$

$$\left|\text{adj}\left(\text{adj}(\text{adj } A)\right)\right| = 12^4$$
$$\Rightarrow |A|^{(n-1)^m}$$
$$\Rightarrow |A|^{2^3} = 12^4$$

$$|A|^8 = 12^4$$
$$|A| = \pm 2\sqrt{3}$$
$$\left|A^{-1}\text{Adj }A\right| = \left|A^{-1}\right|\left|\text{Adj }A\right|$$
$$= \left(|A|\right)^{-1} \times |A|^2 = |A| = 2\sqrt{3}$$

Sol19. d.r of line = $\begin{vmatrix} i & j & k \\ 1 & 2 & 1 \\ 0 & 3 & -1 \end{vmatrix} = -5\,\hat{i} + \hat{j} + 3\hat{k}$



$$\frac{x-3}{-5} = \frac{y-2}{1} = \frac{z-1}{3}$$
$$p \equiv \left(-5\lambda+3,\ \lambda+2,\ 3\lambda+1\right)$$
$$\left(5\lambda+2,\ \lambda-7,\ 3\lambda-6\right)$$
$$\left[5\lambda+2,\ \lambda-7,\ 3\lambda-6\right]\left[-5,1,3\right] = 0$$
$$35\lambda = 35$$
$$\lambda = 1$$
$$p \equiv \left(-2,\ 3,\ 4\right)$$
$$\alpha+\beta+\gamma = -2+3+4 = 5$$

Sol20. $5\times4\times3\times2\times1 = 120$

SECTION – B

Sol1. $\theta \in \left[0,\ 2\pi\right]$

$$\tan\left(\pi\cos\theta\right) + \tan\left(\pi\sin\theta\right) = 0$$
$$\tan\left(\pi\cos\theta\right) = \tan\left(-\pi\sin\theta\right)$$
$$\pi\cos\theta = n\pi + \left(-1\right)^n\left(-\pi\sin\theta\right)$$
$$\cos\theta = n + \left(-1\right)^n\left(-\sin\theta\right)$$
$$n = 0$$
$$\cos\theta + \sin\theta = 0 \Rightarrow \cos\theta + \sin\theta \in \left[-\sqrt{2},\ \sqrt{2}\right]$$
$$n = 1$$
$$\cos\theta - \cos\theta = 1$$
$$n = -1$$
$$\cos\theta = -1 + \sin\theta$$
$$\cos\theta - \sin\theta = -1$$
$$\theta = \left\{0,\ \frac{\pi}{2}, \frac{3\pi}{4}, \frac{7\pi}{4}, \frac{3\pi}{2}\pi\right\} = \Sigma\sin^2\left(\theta + \frac{\pi}{4}\right) = 2$$

Sol2. Given $\alpha = \left\{(a,b),\ (b,c),\ (b,d)\right\}$

To make equivalence.

$(a,a)(b,b)(c,c)(d,d)(a,b)(b,a)(b,c)$

$(c,b)(b,d),(d,b)(a,c)(a,d)\cdot(c,d)(d,c)(c,a)(d,a)$

13 more element added.

Sol3. $AB :: 2x+y=0$

$AC :: x-y=3$

$A \equiv (1,-2)$

$y=-2x$

$G=P\equiv(2,a)$

$\frac{1+a+b+3}{3}=2$

$a+b+4=6$

$a+b=2$

$\frac{-2-2a+b}{3}=a$

$-2-2a+b=3a$

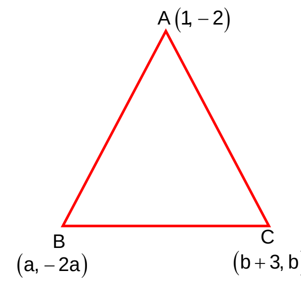
$5a-b=-2$

$\underline{a+b=2}$

$a=0, b=2$

$\beta\equiv(0,0), C\equiv(5,2)$

$\beta C=\sqrt{25+4}=29$



Sol4. $\frac{1^3+2^3.......+n^3}{1\cdot3+2\cdot5+3\cdot7......\text{upto n term}}=\frac{9}{5}$ find n.

$$\Rightarrow \frac{\left[\frac{n(n+1)}{2}\right]^2}{\sum_{r=1}^{n} r(2r+1)}=\frac{9}{5}$$

$$\frac{\frac{n^2(n+1)^2}{4}}{\frac{n(n+1)(4n+5)}{6}}=\frac{9}{5}$$

$n=5, n=\frac{-6}{5}$

n = 5

Sol5. $f(x)+\int_0^2 f(t)\sqrt{1-(\log_e(f(t)))^2}\,dt=c$

$\left(6\log_e f\left(\frac{\pi}{6}\right)\right)^2$

$f'(x)+f(x)\sqrt{1-(\log_e(f(x))^2}=0$

$\frac{dy}{dx}+y\sqrt{1-(\log_e y)^2}=0$

$\int\frac{dy}{y\sqrt{1-(\log_e y)^2}}=-\int dx$

$$\int \frac{dz}{\sqrt{1-z^2}} = -x + c$$
$$\sin^{-1}(z) + x = c$$
$$\sin^{-1}(\log_e y) + x = c$$
$$c = \frac{\pi}{2}$$
$$\sin^{-1}(\log_e f(x)) + x = \frac{\pi}{2}$$
$$\sin^{-1}\left(\log_e f\left(\frac{\pi}{6}\right)\right) = \frac{\pi}{3}$$
$$\log_e\left(f\left(\frac{\pi}{6}\right)\right) = \frac{\sqrt{3}}{2}$$
$$= \left(6 \cdot \frac{\sqrt{3}}{2}\right)^2 = 27$$

Sol6. $\frac{x+\sqrt{6}}{2} = \frac{y-\sqrt{6}}{3} = \frac{z-\sqrt{6}}{4}$

$$\frac{x-\lambda}{3} = \frac{y-2\sqrt{6}}{4} = \frac{z+2\sqrt{6}}{3}$$
$$S.D = \left|\frac{(\vec{a}_2 - \vec{a}_1)\cdot(\vec{b}_1 \times \vec{b}_2)}{|\vec{b}_1 \times \vec{b}_2|}\right| = 6$$
$$\vec{b}_1 \times \vec{b}_2 = -\hat{i} + 2\hat{j} + \hat{k}$$
$$|\vec{b}_1 \times \vec{b}_2| = \sqrt{6}$$
$$\vec{a}_2 - \vec{a}_1 = \left[\lambda + \sqrt{6}, \sqrt{6}, -3\sqrt{6}\right]$$
$$\left|\frac{(\lambda + \sqrt{6}, \sqrt{6}, -3\sqrt{6})(-1, 2, -1)}{\sqrt{6}}\right| = 6$$
$$-\lambda - \sqrt{6} + 2\sqrt{6} + 3\sqrt{6} = \pm 6\sqrt{6}$$
$$\lambda = -2\sqrt{6}, \lambda = 10\sqrt{6}$$
$$(+10\sqrt{6} - 2\sqrt{6})^2 = (8\sqrt{6})^2 = 64 \times 6 = 384$$

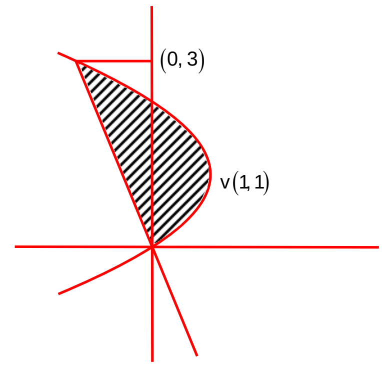
Sol7. $y^2 - 2y = -x$

$(y-1)^2 = -(x-1)$

$A = \int_0^3 \text{Right} - \text{left}$

$A = \int_0^3 (3y - y^2)dy$

$= \frac{9}{2} = 8A = 36$



Sol8.

A	B
R = 4	R = 5
B = 6	B = 5

$$p\left(\frac{C}{R}\right) = \frac{\frac{1}{3}\cdot\frac{\lambda}{\lambda+4}}{\frac{1}{3}\cdot\frac{4}{10}+\frac{1}{3}\frac{5}{10}+\frac{1}{3}\frac{\lambda}{\lambda+4}}$$

$\lambda = 6$

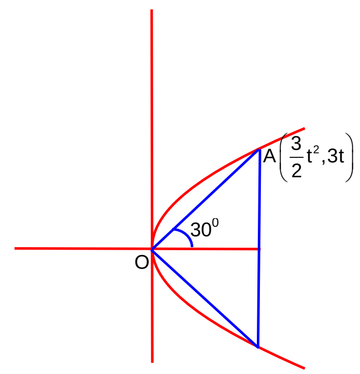
$y^2 = 6x$

$\tan 30^0 = \frac{3t}{\frac{3}{2}t^2}$

$t = 2\sqrt{3}$

$OA = a\,(\text{length}) = \sqrt{18^2 + (6\sqrt{3})^2} = \sqrt{432}$

$A \equiv (18, 6\sqrt{3}) \Rightarrow (OA)^2 = a^2 = 432$



Sol9. $\left(x - \frac{3}{x^2}\right)^n \quad x \neq 0, n \in N$

$^nC_0(x^n)\left(\frac{-3}{x^2}\right)^0 + {}^nC_i(x)^{n-1}\left(\frac{-3}{x^2}\right)^1 + {}^nC_2x^{n-2}\left(\frac{-3}{x^2}\right)^2$

$^nC_0 - 3\cdot{}^nC_1 + 9\cdot{}^nC_2 = 376$

$1 - 3n + 9\cdot\frac{h(n-1)}{2} = 376$

$2 - 6n + 9n(n-1) = 752$

$9n^2 - 15n = 750$

$3x^2 - 5h - 250 = 0$

$n = 10$

Coefficient of $x^4 \ell n\left(x - \frac{3}{x^2}\right)^{10}$

$= {}^{10}C_2(x^8)\left(\frac{-3}{x^2}\right)^2 = 4$

$405\,x^4$

As 405

Sol10. $\hat{i}+2\hat{j}+\lambda\hat{k}$

$3\hat{i}-5\hat{j}-\lambda\hat{k}$

$\vec{a}\cdot\vec{c}=7$

$2\vec{b}\cdot\vec{c}+43=0$

$\vec{a}\times\vec{c}=\vec{b}\times\vec{c}$

$\left(\vec{a}-\vec{b}\right)\times\vec{c}=0 \qquad \vec{c}\,\|\left(\vec{a}-\vec{b}\right)$

$\vec{c}=\mu\left(\vec{a}-\vec{b}\right)$

$\vec{c}=\mu\left(-2,\,7,2\lambda\right)$

$\vec{c}=\left(-2\mu,\,7\mu,\,7\lambda\mu\right)$

$\left(1,2,\lambda\right)\left(-2\mu,7\mu,7\lambda\mu\right)=7$

$12\mu+2\lambda^2\mu=7$ ……..(i)

$2\vec{b}\cdot\vec{c}+43=0$

$2\vec{b}\cdot\vec{c}+43=0$

$2\left(3,\,-5,\,-\lambda\right)\left(-2\mu,\,7\mu,\,2\lambda\mu\right)=-43$

$-12\mu-70\mu-4\lambda^2\mu=-43$

$82\mu+4\lambda^2\mu=43$

Solving (i) & (ii),

$\lambda=\pm1,\ \mu=\dfrac{1}{2}$

$\left|\left(1,2,1\right)\left(3,\,-5,\,-1\right)\right|$

$=\left|3-10-1\right|=8$

$=\left|\left(1,2,1\right)\left(3,-5,-1\right)\right|=\left|-8\right|=8$