Santosh Academia
Solutions to JEE (Main) - 2021

Test Date: 1st September 2021 (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 (01 – 10)*** *contains 10 Numerical based questions with answer as numerical value. Each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

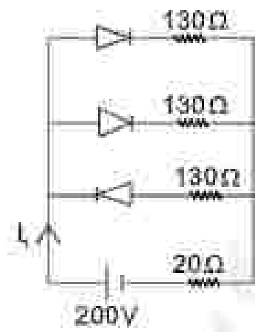
PART – A (PHYSICS)

SECTION - A

(One Options Correct Type)

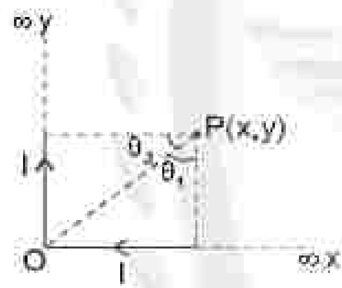
This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

Q1. In the given figure, each diode has a forward bias resistance of 30 Ω and infinite resistance in reverse bias. The current I_1 will be:



(A) 3.75 A
(B) 2.73 A
(C) 2.35 A
(D) 2 A

Q2. There are two infinitely long straight current carrying conductors and they are held at right angles to each other so that their common ends meet at the origin as shown in the figure given below. The ratio of current in both conductor is 1 : 1. The magnetic field at point P is



(A) $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}-(x+y)\right]$

(B) $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}+(x+y)\right]$

(C) $\frac{\mu_0 I xy}{4\pi}\left[\sqrt{x^2+y^2}-(x+y)\right]$

(D) $\frac{\mu_0 I xy}{4\pi}\left[\sqrt{x^2+y^2}+(x+y)\right]$

Q3. The half life period of radioactive element x is same as the mean life time of another radioactive element y. Initially they have the same number of atoms. Then:
(A) x and y have same decay rate initially and later on different decay rate.
(B) x and y decay at the same rate always.
(C) x-will decay faster than y.
(D) y-will decay faster than x.

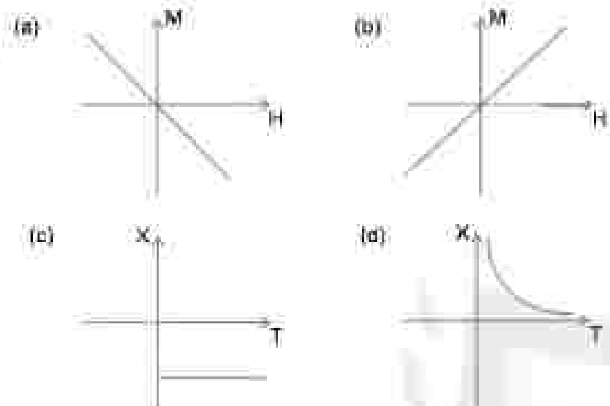
Q4. A glass tumbler having inner depth of 17.5 cm is kept on a table. A student starts pouring water (μ = 4/3) into it while looking at the surface of water from the above. When he feels that the tumbler is half filled, he stops pouring water. Up to what height, the tumbler is actually filled?
(A) 11.7 cm
(B) 8.75 cm
(C) 7.5 cm
(D) 10 cm

Q5. A capacitor is connected to a 20 V battery through a resistance of 10 Ω. It is found that the potential difference across the capacitor rises to 2 V in 1 μs. The capacitance of the capacitor is ________μF.

Given $\ln\left(\frac{10}{9}\right) = 0.105$

(A) 1.85 (B) 0.95
(C) 0.105 (D) 9.52

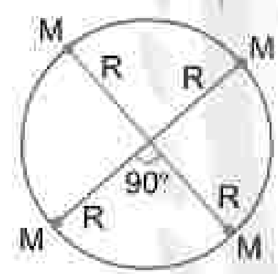
Q6. Following plots show Magnetization (M) vs Magnetising field (H) and Magnetic susceptibility (χ) vs temperature (T) graph:



Which of the following combination will be represented by a diamagnetic material?

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

Q7. Four particles each of mass M, move along a circle of radius R under the action of their mutual gravitational attraction as shown in figure. The speed of each particle is:



(A) $\frac{1}{2}\sqrt{\frac{GM}{R(2\sqrt{2}+1)}}$

(B) $\frac{1}{2}\sqrt{\frac{GM}{R}(2\sqrt{2}-1)}$

(C) $\frac{1}{2}\sqrt{\frac{GM}{R}(2\sqrt{2}+1)}$

(D) $\sqrt{\frac{GM}{R}}$

Q8. The temperature of an ideal gas in 3-dimensions is 300 K. The corresponding de-Broglie wavelength of the electron approximately at 300 K, is:

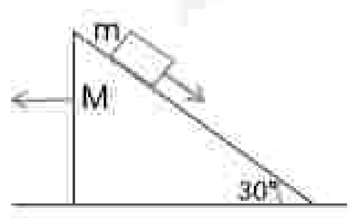
[m_e = mass of electron = 9×10^{-31} kg

h = Planck constant = 6.6×10^{-34} Js

k_B = Boltzmann constant = 1.38×10^{-23} JK^{-1}]

(A) 3.25 nm (B) 6.26 nm
(C) 2.26 nm (D) 8.46 nm

Q9. A block of mass m slides on the wooden wedge, which in turn slides backward on the horizontal surface. The acceleration of the block with respect to the wedge is: Given m = 8 kg, M = 16 kg Assume all the surfaces shown in the figure to be frictionless.



(A) $\frac{6}{5}g$ (B) $\frac{3}{5}g$

(C) $\frac{2}{3}g$ (D) $\frac{4}{3}g$

Q10. Due to cold weather a 1 m water pipe of cross-sectional area 1 cm^2 is filled with ice at -10°C. Resistive heating is used to melt the ice. Current of 0.5 A is passed through 4 kΩ resistance. Assuming that all the heat produced is used for melting, what is the minimum time required?

(Given latent heat of fusion for water/ice = 3.33×10^5 J kg^{-1}, specific heat of ice = 2×10^3 J kg^{-1} and density of ice = 10^3 kg / m^3)

(A) 3.53 s
(B) 0.353 s
(C) 35.3 s
(D) 70.6 s

Q11. A body of mass 'm' dropped from a height 'h' reaches the ground with a sped of $0.8\sqrt{gh}$. The value of work done by the air-friction is:

(A) –0.68 mgh
(B) 0.64 mgh
(C) mgh
(D) 1.64 mgh

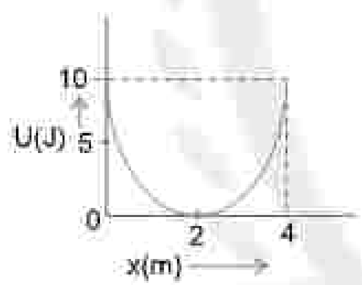
Q12. Electric field of a plane electromagnetic wave propagating through a non-magnetic medium is given by $E = 20\cos\left(2 \times 10^{10} t - 200x\right) V/m$. The dielectric constant of the medium is equal to: (Take $\mu_r = 1$)

(A) $\frac{1}{3}$
(B) 3
(C) 2
(D) 9

Q13. The ranges and heights for two projectiles projected with the same initial velocity at angles 42° and 48° with the horizontal are R_1, R_2 and H_1, H_2 respectively. Choose the correct option:

(A) $R_1 < R_2$ and $H_1 < H_2$
(B) $R_1 > R_2$ and $H_1 = H_2$
(C) $R_1 = R_2$ and $H_1 = H_2$
(D) $R_1 = R_2$ and $H_1 < H_2$

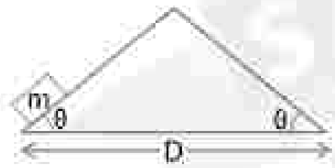
Q14. A mass of 5 kg is connected to a spring. The potential energy curve of the simple harmonic motion executed by the system is shown in the figure. A simple pendulum of length 4 m has the same period of oscillation as the spring system. What is the value of acceleration due to gravity on the planet where these experiments are performed?



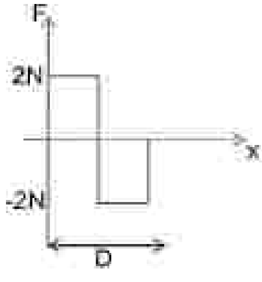
(A) 9.8 m/s^2
(B) 10 m/s^2
(C) 5 m/s^2
(D) 4 m/s^2

Q15. An object of mass 'm' is being moved with a constant velocity under the action of an applied force of 2N along a frictionless surface with following surface profile.

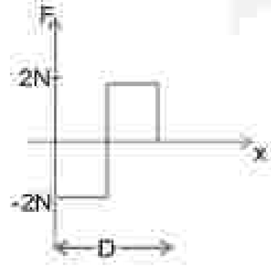
The correct applied force vs distance graph will be



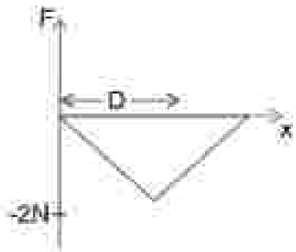
(A)



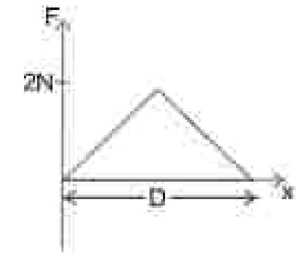
(B)



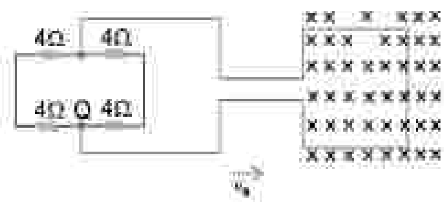
(C)



(D)

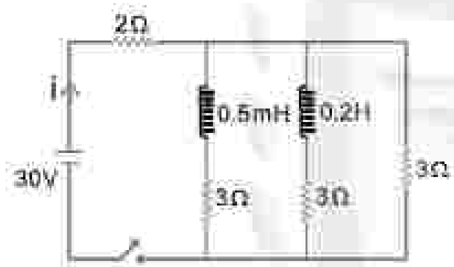


Q16. A square loop of side 20 cm and resistance 1Ω is moved towards right with a constant speed v_0.The right arm of the loop is in a uniform magnetic field of 5T. The field is perpendicular to the plane of the loop and is going into it. The loop is connected to a network of resistors each of value 4. What should be the value of v_0 so that a steady current of 2 mA flows in the loop



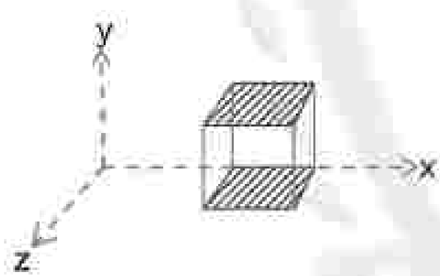
(A) 1 m/s
(B) 10^2 m/s
(C) 10^{-2} cm/s
(D) 1 cm/s

Q17. For the given circuit the current i through the battery when the key in closed and the steady state has been reached is ___________



(A) 25 A
(B) 0 A
(C) 6 A
(D) 10 A

Q18. A cube is placed inside an electric field, $\vec{E} = 150y^2\hat{j}$. The side of the cube is 0.5m and is placed in the field as shown in the given figure. The charge inside the cube is:



(A) 8.3×10^{-11}C
(B) 8.3×10^{-12}C
(C) 3.8×10^{-12}C
(D) 3.8×10^{-11}C

Q19. A student determined Young's Modulus of elasticity using the formula $Y = \frac{MgL^3}{4bd^3\delta}$. The value of g is taken to be 9.8 m/s^2, without any significant error, his observation are as follows:

Physical Quantity	Least count of the Equipment used for measurement	Observed value
Mass (M)	1 g	2 kg
Length of bar (L)	1 mm	1 m
Breadth of bar (b)	0.1 mm	4 cm
Thickness of bar (d)	0.01 mm	0.4 cm
Depression (δ)	0.01 mm	5 mm

Then the fractional error in the measurement of Y is:
(A) 0.083
(B) 0.0155
(C) 0.0083
(D) 0.155

Q20. Two resistors $R_1 = (4 \pm 0.8)\Omega$ and $R_2 = (4 \pm 0.4)\Omega$ are connected in parallel. The equivalent resistance of their parallel combination will be:

(A) $(4 \pm 0.4)\ \Omega$
(B) $(2 \pm 0.3)\ \Omega$
(C) $(4 \pm 0.3)\ \Omega$
(D) $(2 \pm 0.4)\ \Omega$

SECTION - B

(Numerical Answer Type)

This section contains **10** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**).

Q1. The width of one of the two slits in a Young's double slit experiment is three times the other slit. If the amplitude of light coming from a slit is proportional to the slit-width, the ratio of minimum to maximum intensity in the interference pattern is x : 4 where x is ______.

Q2. A steel rod with $y = 2.0 \times 10^{11}\ Nm^{-2}$ and $\alpha = 10^{-5}\ °C^{-1}$ of length 4 m and area of cross-section 10 cm^2 is heated from 0°C to 400°C without being allowed to extend. The tension produced in the rod is $x \times 10^5$ N where the value of x is __________.

Q3. A uniform heating wire of resistance 36 Ω is connected across a potential difference of 240V. The wire is then cut into half and a potential difference of 240 V is applied across each half separately. The ratio of power dissipation in first case to the total power dissipation in the second case would be 1 : x, where x is ________.

Q4. The temperature of 3.00 mol of an ideal diatomic gas is increased by 40.0°C without changing the pressure of the gas. The molecules in the gas rotate but do not oscillate. If the ratio of change in internal energy of the gas to the amount of work done by the gas is $\frac{x}{10}$. Then the value of x (round off to the nearest integer) is ________.
(Given $R = 8.31\ J\ mol^{-1}\ K^{-1}$)

Q5. The average translational kinetic energy of N_2 gas molecules at _________°C becomes equal to the K.E. of an electron accelerated from rest through a potential difference of 0.1 volt. (Given $k_B = 1.38 \times 10^{-23}$ J/K) (Fill the nearest integer).

Q6. The satellites revolve around a planet in coplanar circular orbits in anticlockwise direction. Their period of revolutions are 1 hour and 8 hours respectively. The radius of the orbit of nearer satellite is 2×10^3 km. The angular speed of the farther satellite as observed from the nearer satellite at the instant when both the satellites are closest is $\frac{\pi}{x}$ rad h^{-1} where x is ___________.

Q7. When a body slides down from rest along a smooth inclined plane making an angle of 30° with the horizontal, it takes time T. When the same body slides down from the rest along a rough inclined plane making the same angle and through the same distance, it takes time αT, where α is a constant greater than 1. The co-efficient of friction between the body and the rough plane is $\frac{1}{\sqrt{x}}\left(\frac{\alpha^2-1}{\alpha^2}\right)$ where x = _________.

Q8. A 2 kg steel rod of length 0.6 m is clamped on a table vertically at its lower end and is free to rotate in vertical plane. The upper end is pushed so that the rod falls under gravity. Ignoring the friction due to clamping at its lower end, the speed of the free end of rod when it passes through its lowest position is _________ ms^{-1}.

Q9. An engine is attached to a wagon through a shock absorber of length 1.5 m. The system with a total mass of 40,000 kg is moving with a speed of 72 kmh^{-1} when the brakes are applied to bring it to rest. In the process of the system being brought to rest, the spring of the shock absorber gets compressed by 1.0 m. If 90% of energy of the wagon is lost due to friction, the spring constant is ________ $\times 10^5$ N/m.

Q10. A carrier wave with amplitude of 250 V is amplitude modulated by a sinusoidal base band signal of amplitude 150 V. The ratio of minimum amplitude to maximum amplitude for the amplitude modulated wave is 50 : x, then 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. Number of paramagnetic oxides among the following given oxides is ________.
Li_2O, CaO, Na_2O_2, KO_2, MgO and K_2O
(A) 0 (B) 1 (C) 2 (D) 3

Q2. In the following sequence of reactions,
$$C_3H_6 \xrightarrow{H^+/H_2O} A \xrightarrow[\text{dil KOH}]{KIO} B + C$$
The compounds **B** and **C** respectively are:
(A) Cl_3COOK, HCOOH
(B) Cl_3COOK, CH_3I
(C) CH_3I, HCOOK
(D) CHI_3, CH_3COOK

Q3. The Crystal Field Stabilization Energy (CFSE) and magnetic moment (spin-only) of an octahedral aqua complex of a metal ion (M^{Z+}) are $-0.8\,\Delta_0$ and 3.87 BM, respectively. Identify (M^{Z+}):
(A) Cr^{3+}
(B) Mn^{4+}
(C) V^{3+}
(D) Co^{2+}

Q4. Water sample is called cleanest on the basis of which one of the BOD values given below:
(A) 3 ppm (B) 21 ppm (C) 11 ppm (D) 15 ppm

Q5. The oxide without nitrogen-nitrogen bond is:
(A) N_2O (B) N_2O_4 (C) N_2O_5 (D) N_2O_3

Q6. Given below are **two** statements:
Statement I : The nucleophilic addition of sodium hydrogen sulphite to an aldehyde or a ketone involves proton transfer to form a stable ion.
Statement II : The nucleophilic addition of hydrogen cyanide to an aldehyde or a ketone yields amine as final product.
In the light of the above statements, choose the **most appropriate** answer from the options given below:
(A) **Statement I** is true but **Statement II** is false.
(B) Both **Statement I** and **Statement II** are true.
(C) Both **Statement I** and **Statement II** are false.
(D) **Statement I** is false but **Statement II** is true.

Q7. The potassium ferrocyanide solution gives a Prussian blue colour, when added to:
(A) $CoCl_3$ (B) $FeCl_3$ (C) $FeCl_2$ (D) $CoCl_2$

Q8. Identify the element for which electronic configuration in +3 oxidation state is $[Ar]3d^5$:
(A) Ru (B) Mn (C) Fe (D) Co

Q9. Calamine and Malachite, respectively, are the ores of:
(A) Copper and Iron
(B) Aluminium and Zinc
(C) Nickel and Aluminium
(D) Zinc and copper

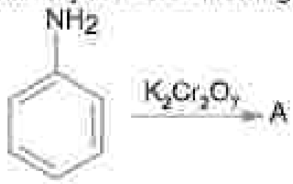
Q10. Match List-I with List-II

	List – I (Colloid Preparation method)		List – II (Chemical Reaction)
(a)	Hydrolysis	(i)	$2AuCl_3 + 3HCHO + 3H_2O \rightarrow 2Au(sol) + 3HCOOH + 6HCl$
(b)	Reduction	(ii)	$As_2O_3 + 3H_2S \rightarrow As_2S_3(sol) + 3H_2O$
(c)	Oxidation	(iii)	$SO_2 + 2H_2S \rightarrow 3S(sol) + 2H_2O$
(d)	Double Decomposition	(iv)	$FeCl_3 + 3H_2O \rightarrow Fe(OH)_3(sol) + 3HCl$

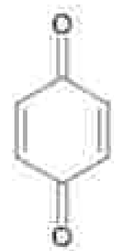
Choose the most appropriate answer from the options given below:

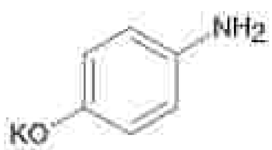
(A) (a)–(i), (b)–(ii), (c)–(iv), (d)–(iii)
(B) (a)–(iv), (b)–(ii), (c)–(iii), (d)–(i)
(C) (a)–(iv), (b)–(i), (c)–(iii), (d)–(ii)
(D) (a)–(i), (b)–(iii), (c)–(ii), (d)–(iv)

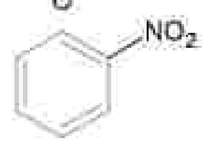
Q11. Identify A in the following reaction.



(A) 

(B) 

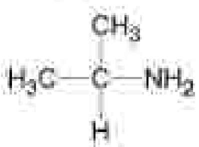
(C) 

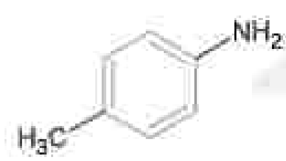
(D) 

Q12. Which one of the following gives the most stable Diazonium salt?

(A) 

(B) $CH_3 - CH_2 - CH_2 - NH_2$

(C) 

(D) 

Q13. In the following sequence of reactions a compound **A**, (molecular formula $C_6H_{12}O_2$) with a straight chain structure gives a C4 carboxylic acid. **A** is

$$A \xrightarrow[H_3O^+]{LiAlH_4} B \xrightarrow{\text{Oxidation}} C_4 \text{ - carboxylic acid}$$

(A) $CH_3-CH_2-CH_2-O-CH=CH-CH_2-OH$

(B) $CH_3-CH_2-CH(OH)-CH_2-O-CH=CH_2$

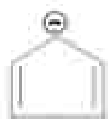
(C) $CH_3-CH_2-CH_2-COO-CH_2-CH_3$

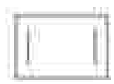
(D) $CH_3-CH_2-COO-CH_2-CH_2-CH_3$

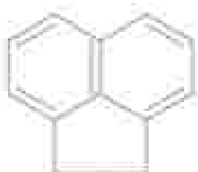
Q14. Hydrogen peroxide reacts with iodine in basic medium to give:

(A) IO^-
(B) I^-
(C) IO_4^-
(D) IO_3^-

Q15. Which one of the following compounds is aromatic in nature?

(A) 

(B) 

(C) 

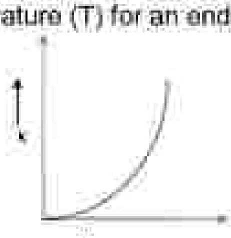
(D) 

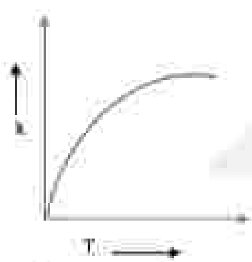
Q16. In the given chemical reaction, colors of the Fe^{2+} and Fe^{3+} ions, are respectively:

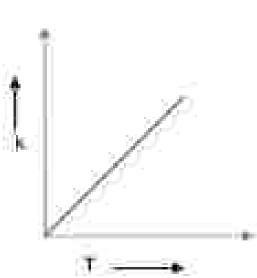
$5Fe^{2+} + MnO_4^- + 8H^+ \longrightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$

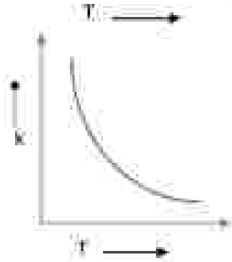
(A) Yellow, Green
(B) Green, Yellow
(C) Green, Orange
(D) Yellow, Orange

Q17. Which one of the following given graphs represents the variation of rate constant (k) with temperature (T) for an endothermic reaction?

(A) 

(B) 

(C) 

(D) 

Q18. Monomer units of Dacron polymer are:
(A) glycerol and terephthalic acid
(B) ethylene glycol and terephthalic acid
(C) glycerol and phthalic acid
(D) ethylene glycol and phthalic acid

Q19. Experimentally reducing a functional group cannot be done by which one of the following reagents?
(A) Na/H_2
(B) $Pt-C/H_2$
(C) $Pd-C/H_2$
(D) Zn/H_2O

Q20. The stereoisomers that are formed by electrophilic addition of bromine to *trans-but-2-ene* is/are
(A) 2 enantiomers and 2 mesomers
(B) 2 enantiomers
(C) 1 racemic and 2 enantiomers
(D) 2 identical mesomers

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SECTION - B

(Numerical Answer Type)

This section contains **10** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**).

Q1. An empty LPG cylinder weighs 14.8 kg. When full, it weighs 29.0 kg and shows a pressure of 3.47 atm. In the course of use at ambient temperature, the mass of the cylinder is reduced to 23.0 kg. The final pressure inside of the cylinder is ______ atm. (Nearest integer)
(Assume LPG to be an ideal gas)

Q2. The sum of oxidation states of two silver ions in $[Ag(NH_3)_2][Ag(CN)_2]$ complex is _____.

Q3. The molar solubility of $Zn(OH)_2$ in 0.1 M NaOH solution is $x \times 10^{-18}$ M. The value of x is _____. (Nearest integer)
(Given : The solubility product of $Zn(OH)_2$ is 2×10^{-20})

Q4. If 80 g of copper sulphate $CuSO_4 \cdot 5H_2O$ is dissolved in deionised water to make 5 L of solution. The concentration of the copper sulphate solution is $x \times 10^{-3}$ mol L^{-1}. The value of x is _______.
[Atomic masses Cu : 63.54 u, S : 32 u, O : 16 u, H : 1 u]

Q5. A 50 watt bulb emits monochromatic red light of wavelength of 795 nm. The number of photons emitted per second by the bulb is $x \times 10^{20}$. The value of x is _________.
[Given: $h = 6.63 \times 10^{-34}$ Js and $c = 3.0 \times 10^{8}$ ms^{-1}]

Q6. A peptide synthesized by the reactions of one molecule each of Glycine, Leucine, Aspartic acid and Histidine will have ________ peptide linkages.

Q7. For the reaction $2NO_2(g) \rightleftharpoons N_2O_4(g)$, when $\Delta S = -176.0$ JK^{-1} and $\Delta H = -57.8$ kJ mol^{-1}, the magnitude of ΔG at 298 K for the reaction is _____ kJ mol^{-1}. (Nearest integer)

Q8. The spin-only magnetic moment value of species is ________ $\times 10^{-2}$ BM. (Nearest integer)
[Given: $\sqrt{3} = 1.73$]

Q9. The number of atoms in 8 g of sodium is $x \times 10^{23}$. The value of x is ________. (Nearest integer)
[Given: $N_A = 6.02 \times 10^{23}$ mol^{-1}, Atomic mass of Na = 23.0 u]

Q10. If the conductivity of mercury at 0°C is 1.07×10^{6} S m^{-1} and the resistance of a cell containing mercury is 0.243 Ω, then the cell constant of the cell is $x \times 10^{4}$ m^{-1}. The value of x is ___. (Nearest integer)

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. If n is the number of solutions of the equation $2\cos x\left(4\sin\left(\frac{\pi}{4}+x\right)\sin\left(\frac{\pi}{4}-x\right)-1\right)=1,\ x\in[0,\pi]$ and S is the sum of all these solutions, then the order pair (n, S) is:

(A) $(3, 5\pi/3)$
(B) $(2, 8\pi/9)$
(C) $(3, 13\pi/9)$
(D) $(2, 2\pi/3)$

Q2. The distance of line $3y - 2z - 1 = 0 = 3x - z + 4$ from the point $(2, -1, 6)$ is:

(A) $2\sqrt{6}$
(B) $\sqrt{26}$
(C) $2\sqrt{5}$
(D) $4\sqrt{2}$

Q3. $\cos^{-1}(\cos(-5)) + \sin^{-1}(\sin(6)) - \tan^{-1}(\tan(12))$ is equal to:
(The inverse trigonometric functions take the principal values)

(A) $3\pi - 11$
(B) $3\pi + 1$
(C) $4\pi - 11$
(D) $4\pi - 9$

Q4. If $y = y(x)$ is the solution curve of the differential equation $x^2dy+\left(y-\frac{1}{x}\right)dx=0$; $x > 0$, and $y(1) = 1$, then $y\left(\frac{1}{2}\right)$ is equal to:

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

Q5. Let $a_1, a_2, \ldots\ldots, a_{21}$ be an AP such that $\sum_{n=1}^{20}\frac{1}{a_na_{n+1}}=\frac{4}{9}$. If the sum of this AP is 189, then a_6a_{16} is equal to:

(A) 57
(B) 36
(C) 48
(D) 72

Q6. Let θ be the acute angle between the tangents to the ellipse $\frac{x^2}{9}+\frac{y^2}{1}=1$ and the circle $x^2 + y^2 = 3$ at their point of intersection in the first quadrant. The $\tan\theta$ is equal to:

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

Q7. The range of the function

$$f(x)=\log_{\sqrt{5}}\left(3+\cos\left(\frac{3\pi}{4}+x\right)+\cos\left(\frac{\pi}{4}+x\right)+\cos\left(\frac{\pi}{4}-x\right)-\cos\left(\frac{3\pi}{4}-x\right)\right)$$ is:

(A) $[-2, 2]$
(B) $\left[\frac{1}{\sqrt{5}}, \sqrt{5}\right]$
(C) $(0, \sqrt{5})$
(D) $[0, 2]$

Q8. Consider the system of linear equations
$-x + y + 2z = 0$
$3x - ay + 5z = 1$
$2x - 2y - az = 7$
Let S_1 be the set of all $a \in R$ for which the system is inconsistent and S_2 be the set of all $a \in R$ for which the system has infinitely many solutions. If $n(S_1)$ and $n(S_2)$ denote the number of elements in S_1 and S_2 respectively, then
(A) $n(S_1) = 1, n(S_2) = 0$
(B) $n(S_1) = 0, n(S_2) = 2$
(C) $n(S_1) = 2, n(S_2) = 0$
(D) $n(S_1) = 2, n(S_2) = 2$

Q9. The area, enclosed by the curves $y = \sin x + \cos x$ and $y = |\cos x - \sin x|$ and the lines $x = 0$, $x = \frac{\pi}{2}$, is:
(A) $2\sqrt{2}(\sqrt{2}+1)$
(B) $2\sqrt{2}(\sqrt{2}-1)$
(C) $2(\sqrt{2}+1)$
(D) $4(\sqrt{2}-1)$

Q10. Let $f: R \to R$ be a continuous function. The $\lim\limits_{x\to\pi/4}\dfrac{\frac{\pi}{4}\int_{2}^{\sec^2 x} f(x)dx}{x^2-\frac{\pi^2}{16}}$ is equal to:
(A) $2f(2)$
(B) $f(2)$
(C) $4f(2)$
(D) $2f(\sqrt{2})$

Q11. Let $P_1, P_2, \ldots, P_{15}$ be 15 points on a circle. The number of distinct triangles formed by points P_i, P_j, P_k such that $i + j + k \neq 15$, is:
(A) 455
(B) 443
(C) 12
(D) 419

Q12. Let the acute angle bisector of the two planes $x - 2y - 2z + 1 = 0$ and $2x - 3y - 6z + 1 = 0$ be the plane P. Then which of the following points lies on P?
(A) $(0, 2, -4)$
(B) $(4, 0, -2)$
(C) $(-2, 0, -\frac{1}{2})$
(D) $(3, 1, -\frac{1}{2})$

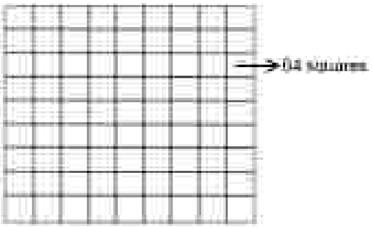
Q13. Let $J_{n,m}=\int_0^{1/2}\frac{x^n}{x^m-1}dx$, $\forall n > m$ and $n, m \in N$. Consider a matrix $A=[a_{ij}]_{3\times 3}$ where $a_{ij}=\begin{cases}J_{6+i,3}-J_{i+3,3}, & i\le j\\ 0, & i>j\end{cases}$. Then $|\text{adj } A^{-1}|$ is:
(A) $(15)^2 \times 2^{34}$
(B) $(15)^2 \times 2^{42}$
(C) $(105)^2 \times 2^{38}$
(D) $(105)^2 \times 2^{36}$

Q14. Let $S_n = 1\cdot(n-1) + 2\cdot(n-2) + 3\cdot(n-3) + \ldots + (n-1)\cdot 1,\ n \geq 4$. The sum $\sum_{n=4}^{\infty}\left(\frac{2S_n}{n!} - \frac{1}{(n-2)!}\right)$ is equal to:

(A) $\frac{e-2}{6}$ (B) $\frac{e}{3}$

(C) $\frac{e-1}{3}$ (D) $\frac{e}{6}$

Q15. Two squares are chosen at random on a chessboard (see figure). The probability they have a side in common is:



(A) $\frac{1}{18}$ (B) $\frac{1}{7}$

(C) $\frac{2}{7}$ (D) $\frac{1}{9}$

Q16. The function f(x), that satisfies the condition $f(x) = x + \int_0^{\pi/2} \sin x \cdot \cos y\, f(y)\, dy$ is:

(A) $x + \frac{2}{3}(\pi - 2)\sin x$ (B) $x + (\pi + 2)\sin x$

(C) $x + \frac{\pi}{2}\sin x$ (D) $x + (\pi - 2)\sin x$

Q17. The function $f(x) = x^3 - 6x^2 + ax + b$ is such that $f(2) = f(4) = 0$.

Consider two statements.

(S1) there exists $x_1, x_2 \in (2,4), x_1 < x_2$, such that $f'(x_1) = -1$ and $f'(x_2) = 0$.

(S2) there exists $x_3, x_4 \in (2,4), x_3 < x_4$, such that f is decreasing in $(2, x_4)$, increasing in $(x_4, 4)$ and $2f'(x_3) = \sqrt{3}f(x_4)$.

(A) both (S1) and (S2) are true (B) (S1) is true and (S2) is false

(C) (S1) is false and (S2) is true (D) both (S1) and (S2) are false

Q18. Consider the parabola with vertex $\left(\frac{1}{2}, \frac{3}{4}\right)$ and the directrix $y = \frac{1}{2}$. Let P be the point where the parabola meets the line $x = -\frac{1}{2}$. If the normal to the parabola at P intersects the parabola again at the point Q, then $(PQ)^2$ is equal to:

(A) $\frac{15}{2}$ (B) $\frac{25}{2}$ (C) $\frac{125}{16}$ (D) $\frac{75}{8}$

Q19. The number of pairs (a, b) of real numbers, such that whenever α is a root of the equation $x^2 + ax + b = 0$, $\alpha^2 - 2$ is also a root of this equation, is:

(A) 6 (B) 4 (C) 8 (D) 2

Q20. Which of the following is equivalent to the Boolean expression $p \wedge \sim q$?

(A) $\sim p \rightarrow \sim q$ (B) $\sim(q \rightarrow p)$

(C) $\sim(p \rightarrow q)$ (D) $\sim(p \rightarrow \sim q)$

SECTION - B

(Numerical Answer Type)

This section contains **10** questions. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**).

Q1. Let X be a random variable with distribution.

x	–2	–1	3	4	6
P(X = x)	$\frac{1}{5}$	a	$\frac{1}{3}$	$\frac{1}{5}$	b

If the mean of X is 2.3 and variance of X is σ^2, then 100 σ^2 is equal to:

Q2. If for the complex numbers z satisfying $|z - 2 - 2i| \le 1$, the maximum value of $|3iz + 6|$ is attained at a + ib, then a + b is equal to ______________.

Q3. Let the points of intersections of the lines $x - y + 1 = 0$, $x - 2y + 3 = 0$ and $2x - 5y + 11 = 0$ are the mid points of the sides of a triangle ABC. Then the area of the triangle ABC is _____.

Q4. Let $f(x) = x^6 + 2x^4 + x^3 + 2x + 3$, $x \in R$. Then the natural number n for which $\lim_{x \to 1} \frac{x^n f(1) - f(x)}{x - 1} = 44$ is ________.

Q5. Let $\vec{a} = 2\hat{i} - \hat{j} + 2\hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} - \hat{k}$. Let a vector $\vec{v}$ be in the plane containing $\vec{a}$ and $\vec{b}$. If $\vec{v}$ is perpendicular to the vector $3\hat{i} + 2\hat{j} - \hat{k}$ and its projection on $\vec{a}$ is 19 units, then $|2\vec{v}|^2$ is equal to _________.

Q6. Let [t] denote the greatest integer $\le$ t. The number of points where the function $f(x) = [x]|x^2 - 1| + \sin\left(\frac{\pi}{[x] + 3}\right) - [x + 1]$, $x \in (-2, 2)$ is not continuous is __________.

Q7. All the arrangements, with or without meaning, of the word FARMER are written excluding any word that has two R appearing together. The arrangements are listed serially in the alphabetic order as in the English dictionary. Then the serial number of the word FARMER in this list is __________.

Q8. Let f(x) be a polynomial of degree 3 such that $f(k) = -\frac{2}{k}$ for k = 2, 3, 4, 5. Then the value of 52 – 10 f(10) is equal to _________.

Q9. A man starts walking from the point P(–3, 4), touches the x-axis at R, and then turns to reach at the point Q(0, 2). The man is walking at a constant speed. If the man reaches the point Q in the minimum time, then $50(PR)^2 + (RQ)^2$ is equal to ___________.

Q10. If the sum of the coefficients in the expansion of $(x + y)^n$ is 4096, then the greatest coefficient in the expansion is _______.

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PART – A (PHYSICS)

SECTION - A

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

SECTION - B

1.	1	2.	8	3.	4	4.	25.00
5.	500	6.	3	7.	3	8.	6
9.	16	10.	200				

PART – B (CHEMISTRY)

SECTION - A

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

SECTION - B

1.	2	2.	2	3.	2	4.	64
5.	2	6.	3	7.	5	8.	173
9.	2	10.	26				

PART – C (MATHEMATICS)

SECTION - A

1.	C	2.	A	3.	C	4.	D
5.	D	6.	C	7.	D	8.	C
9.	B	10.	A	11.	B	12.	C
13.	C	14.	C	15.	A	16.	D
17.	A	18.	C	19.	None	20.	C

SECTION – B

1.	781	2.	5	3.	6	4.	7
5.	1494	6.	2	7.	77	8.	26
9.	1250	10.	924				

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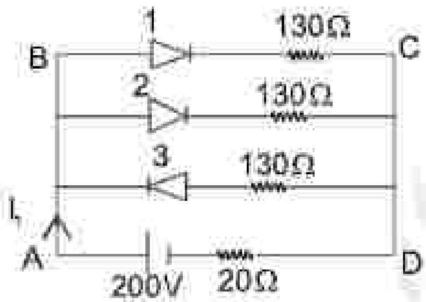
Solutions to JEE (Main) - 2021

PART – A (PHYSICS)

SECTION – A

Sol1. In give diagram Diode 1 and 2 are in forward bias with $R = 30\Omega$ and Diode 3 is reverse bias with R = infinite

I_1 current is flowing through 20Ω



So $\frac{I_1}{2}$ and $\frac{I_1}{2}$ current will flow through Diode 1 and 2. As resistance is same applying KCL in ABCD Loop

$$-\frac{I_1}{2}\times 130-\frac{I_1}{2}\times 130-I_1\times 20+200=0$$

$$-100I_1+200=0$$

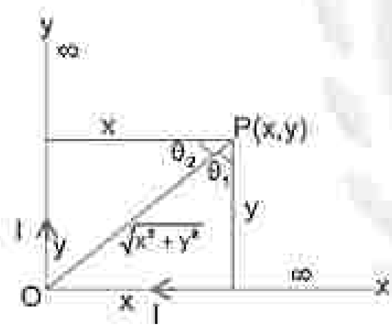
$$I_1=2$$

Sol2. B due to OX wire

$$B_1=\frac{\mu_0 I}{4\pi y}\left[\sin\theta_1+\sin 90^\circ\right] \text{——— (i)}$$

B due to OY wire

$$B_2=\frac{\mu_0 I}{4\pi x}\left[\sin\theta_2+\sin 90^\circ\right]$$



As in the diagram direction of B_1 and B_2 are in downward direction

So $B = B_1 + B_2$

$$B=\frac{\mu_0 I}{4\pi y}(\sin\theta_1+1)+\frac{\mu_0 I}{4\pi x}(\sin\theta_2+1)$$

$$\sin\theta_1=\frac{x}{\sqrt{x^2+y^2}} \text{ and } \sin\theta_2=\frac{y}{\sqrt{x^2+y^2}}$$

$$B=\frac{\mu_0 I}{4\pi}\left[\frac{1}{y}\left(1+\frac{x}{\sqrt{x^2+y^2}}\right)+\frac{1}{x}\left(1+\frac{y}{\sqrt{x^2+y^2}}\right)\right]$$

$$B=\frac{\mu_0 I}{4\pi}\left[\frac{1}{y}+\frac{1}{x}+\frac{x}{y\sqrt{x^2+y^2}}+\frac{y}{x\sqrt{x^2+y^2}}\right]$$

$$B=\frac{\mu_0 I}{4\pi}\left[\frac{x+y}{xy}+\frac{x^2+y^2}{xy\sqrt{x^2+y^2}}\right]$$

$$B=\frac{\mu_0 I}{4\pi xy}\left[(x+y)+\sqrt{x^2+y^2}\right]$$

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Sol3. $\left(t_{1/2}\right)_x = \left(t_{mean}\right)_y$

$\frac{\ell n2}{\lambda_x} = \frac{1}{\lambda_y}$

$\lambda_x = (\ell n2)\lambda_y$

$\lambda_x = 0.693\lambda_y$

Given $N_x = N_y = N_0$

So Activity $A = \lambda N$

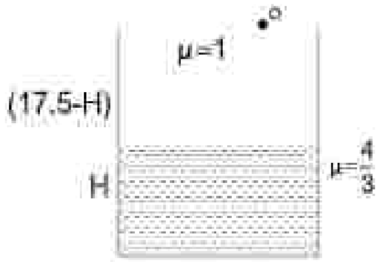
As $\lambda_x < \lambda_y \Rightarrow A_x < A_y$

So y will decay faster than x.

Sol4. As observer is at O So height of water observed by observer

$\Rightarrow \frac{H}{\mu_w} = \frac{H}{(4/3)} = \frac{3H}{4}$

Given diagram (17.5 – H) is height of observer



So $\frac{3H}{4} = 17.5 - H$

$\frac{7H}{4} = 17.5$

$7H = 70$

$H = 10$

Sol5. $V = 10\left(1 - e^{-t/RC}\right)$

$2 = 20\left(1 - e^{-t/RC}\right)$

$\frac{1}{10} = 1 - e^{-t/RC}$

$e^{t/RC} = \frac{10}{9}$

$\frac{t}{RC} = \ln\left(\frac{10}{9}\right) = 0.105$

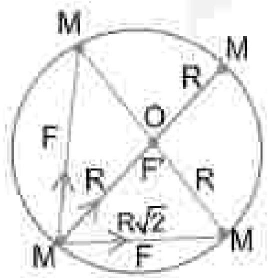
$C = \frac{t}{R \times 0.105} = \frac{10^{-6}}{10 \times 0.105} = 0.95\mu F$

Sol6. Magnetization (M) is directly proportional to magnetising field and magnetic susceptibility does not depend on temperature so option **3** is correct.

Sol7. For circular motion $F_{net} = \frac{MV^2}{R}$

$\sqrt{2}F + F' = \frac{MV^2}{R}$

$\sqrt{2}\frac{GMM}{\left(\sqrt{2}R\right)^2} + \frac{GMM}{(2R)^2} = \frac{MV^2}{R}$



$$\frac{GM}{R}\left[\frac{1}{\sqrt{2}}+\frac{1}{4}\right]=V^2$$

$$V=\frac{1}{2}\sqrt{\frac{GM}{R}\left(2\sqrt{2}+1\right)}$$

Sol8. De Broglie wavelength

$$\lambda=\frac{h}{mV}=\frac{h}{\sqrt{2mE}} \qquad E\rightarrow K.E.$$

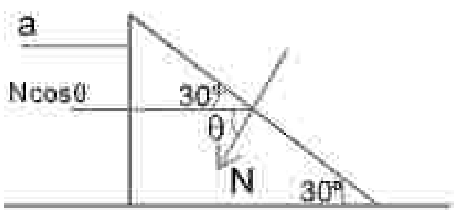
$E=\frac{3}{2}KT$ for gas

So $\lambda=\frac{h}{\sqrt{3mKT}}=\frac{6.6\times10^{-34}}{\sqrt{3\times9\times10^{-31}\times1.38\times10^{-23}\times300}}$

$\lambda=6.26\times10^{-9}m$

$\lambda=6.26nm$

Sol9. Suppose acceleration of wedge is a and acceleration of block w. r. t wedge is a_1 then



$N\cos60^\circ=Ma=16a\Rightarrow N=32a$

For block w.r.t. wedge

$N+8a\sin30^\circ=8g\cos30^\circ$

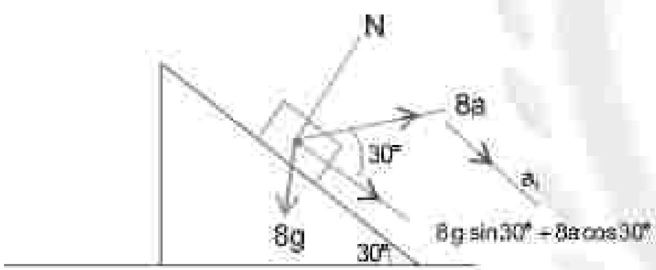
$N=8g\cos30^\circ-8a\sin30^\circ$

$\Rightarrow32a=8g\cos30^\circ-8a\sin30^\circ$

$\Rightarrow32a=4\sqrt{3}g-4a$

$\Rightarrow36a=4\sqrt{3}g$

$\Rightarrow a=\frac{\sqrt{3}}{9}g$



Now for 8 kg,

$8g\sin30^\circ+8a\cos30^\circ=ma_1$

$a_1=g\times\frac{1}{2}+\frac{\sqrt{3}}{9}g\times\frac{\sqrt{3}}{2}$

$=\frac{g}{2}+\frac{3}{18}g$

$=\frac{2}{3}g$

Sol10. Energy required to melt

$Q=MS\Delta T+ML$

$\Rightarrow10^{-1}\times2\times10^{3}\times10+10^{-1}\times3.33\times10^{5}$

$\Rightarrow3.53\times10^{4}J$

Heat Produce in wire

$H=I^2Rt$

$Q=3.53\times10^{4}=\left(\frac{1}{2}\right)^2\times\left(4\times10^{3}\right)\times t$

$t = \frac{3.53 \times 10^4 \times 4}{4 \times 10^3} = 35.3\,sec$

Sol11. Work done is equal to change in K.E.

So $W_1 + W_2 = \frac{1}{2}M\left(0.8\sqrt{gh}\right)^2 - 0$ $\quad W_1 \rightarrow$ work done by mg

$mgh + W_2 = \frac{1}{2}m \times 0.64gh$ $\quad W_2 \rightarrow$ work done by air friction

$W_2 = 0.32mgh - mgh = -0.68mgh$

$W_2 = -0.68mgh$

Sol12. Comparing $E = 20\cos\left(2 \times 10^{10}t - 200x\right)V/m$ to

$E = E_0\cos\left(\omega t - kx\right)v/m$

$\omega = 2 \times 10^{10}, K = 200$

Speed $= \frac{2 \times 10^{10}}{200} = 10^8\,m/s$

R.I. $= \frac{C}{speed} = \frac{3 \times 10^8}{10^8} = 3$

Now R.I. $= \sqrt{\varepsilon_r \mu_r}$

$3 = \sqrt{\varepsilon_r \times 1}$

$\varepsilon_r = 9$

Sol13. Range $R = \frac{u^2 \sin 2\theta}{g}$

For 42° and 48° Range will be same

H_{max} α maximum θ

So maximum height will be for 48°

Sol14. Maximum energy $= 10\,J$

$\frac{1}{2}Kx^2 = 10$

$K = 5$

Given $T_{pendulum} = T_{spring}$

$2\pi\sqrt{\frac{\ell}{g}} = 2\pi\sqrt{\frac{m}{K}}$

$\sqrt{\frac{4}{g}} = \sqrt{\frac{5}{5}}$

$g = 4\,m/s^2$

Sol15. object is moving in upward direction with constant velocity so in upward motion(+2N) and for downward motion (-2N) So option (1) is correct representation.

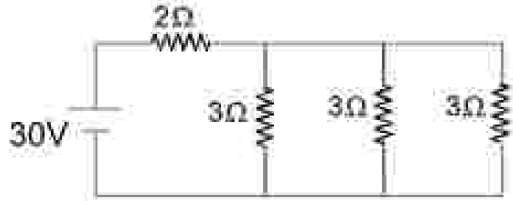
Sol16. $I = \frac{V_0 B\ell}{R} = \frac{V_0 \times 5 \times 20 \times 10^{-2}}{4+1}$

$2 \times 10^{-3} = V_0 \times 20 \times 10^{-2}$

$$V_0=\frac{2\times10^{-3}}{20\times10^{-2}}=\frac{2}{2}\times10^{-2}=1\times10^{-2}\,m/s$$

$$V_0=1\,cm/s$$

Sol17. In given circuit inductor behave as a simple wire so resultant circuit will be



$R_{el}=2+1=3\Omega$

$V=IR$

$I=\frac{30}{3}=10A$

Sol18. Direction of E in the direction of y axes so flux is only due to top and bottom surface for bottom surface $y=0$ $E=0$

and for top surface $y=0.5m$ So

$$E=150\times(0.5)^2=\frac{150}{4}$$

flux flowing $\phi=EA=\frac{150}{4}\times(0.5)^2$

$$=\frac{150}{16}$$

Gausses law $\phi=\frac{q}{\varepsilon_0}$

$$\frac{150}{16}=\frac{q}{\varepsilon_0}$$

$$q=\frac{150}{16}\times8.85\times10^{-12}$$

$$=8.3\times10^{-11}C$$

Sol19. $Y=\frac{MgL^3}{4bd^3\delta}$

For significant error in Y

$$=\frac{\Delta M}{M}+\frac{3\Delta L}{L}+\frac{\Delta b}{b}+3\frac{\Delta d}{d}+\frac{\Delta\delta}{\delta}$$

$$=\frac{1\times10^{-2}}{2}+\frac{3\times10^{-2}}{1}+\frac{10^{-2}}{4}+3\times\frac{0.01\times10^{-1}}{0.4}+\frac{10^{-2}}{5}$$

$$=10^{-2}\left[\frac{1}{2}+3+\frac{1}{0.4}+\frac{3}{0.4}+\frac{1}{0.5}\right]$$

$$=0.0156$$

Sol20. $\frac{1}{R_{eq}}=\frac{1}{R_1}+\frac{1}{R_2}=\frac{1}{4}+\frac{1}{4}$

$R_{eq}=2$

$$\frac{\Delta R_{eq}}{R_{eq}^2}=\frac{\Delta R_1}{R_1^2}+\frac{\Delta R_2}{R_2^2}$$

$$\frac{\Delta R_{eq}}{4}=\frac{0.8}{16}+\frac{0.4}{16}=\frac{1.2}{16}$$

$R_{eq}=0.3$

SECTION - B

Sol1. Amp. α slit with

Intensity $\alpha(\text{Amp})^2\,\alpha(\text{slit width})^2$

$$\frac{I_1}{I_2}=\left(\frac{3}{1}\right)^2=\frac{9}{1}\Rightarrow I_1=9I_2$$

$$\frac{I_{min}}{I_{max}}=\frac{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}=\frac{(3-1)^2}{(3+1)^2}$$

$$\Rightarrow\frac{1}{4}=\frac{x}{4}$$

$x=1.00$

Sol2. Force $=Ay\alpha\Delta T$

Force $=\left(10\times10^{-4}\right)\times\left(2\times10^{11}\right)\times10^{-5}\times400$

$F=8\times10^{5}N$

$x\times10^{5}=8\times10^{5}$

$x=8$

Sol3. In first condition $R_1=36\Omega$

In second condition $R_2=18\Omega$

$$P_1=\frac{V^2}{R_1}=\frac{(240)^2}{36}$$

$$P_2=\frac{V^2}{R_2}+\frac{V^2}{R_2}=\frac{(240)^2}{18}+\frac{(240)^2}{18}$$

$$P_2=\frac{(240)^2}{9}$$

$$\text{So }\frac{P_1}{P_2}=\frac{(240)^2/36}{(240)^2/9}=\frac{1}{4}$$

$x=4$

Sol4. Since process is isochoric

So $\Delta U=nC_V\Delta T$

$$\Delta U=n\left(\frac{5}{2}R\right)\Delta T\quad\text{--(i)}\qquad\left[C_V=\frac{5}{2}R\right]$$

And external work

$\Delta W=nR\Delta T$ --(ii)

$$\frac{\Delta U}{\Delta W}=\frac{\frac{5}{2}nR\Delta T}{nR\Delta T}=\frac{5}{2}$$

$\frac{5}{2}=\frac{x}{10}\Rightarrow x=25.00$

Sol5. K . E. energy of electron = eV

Translational K.E. of $N_2=\frac{3}{2}KT$

So $eV=\frac{3}{2}KT$

$1.6\times10^{-19}\times0.1=\frac{3}{2}\times1.38\times10^{-23}\times T$

$T=\frac{1.6\times10^{-19}\times0.1}{\frac{3}{2}\times1.38\times10^{-23}}=773K$

$T=773-273=500^{\circ}C$

Sol6. for A satellite T_1 = 1hour

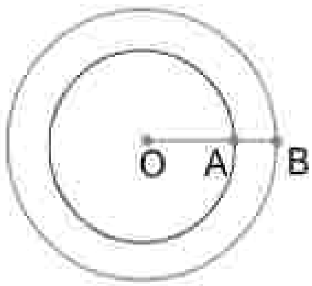
So $\omega_1=2\pi$ red/hour

for B satellite T_2 = 8hour

$\omega_2=\frac{\pi}{4}$ rad/hour

given $R_1=2\times10^3$Km

So $T^2\,\alpha\,R^3$



$\left(\frac{R_1}{R_2}\right)^3=\left(\frac{T_1}{T_2}\right)^2=\left(\frac{1}{8}\right)^2$

$\frac{R_1}{R_2}=\left(\frac{1}{8}\right)^{2/3}=\left(\frac{1}{2}\right)^2$

Then $R_2=R_1\times2^2=2\times10^3\times4$

$R_2=8\times10^3$Km

$V_1=\omega_1R_1=4\pi\times10^3$Km / h

$V_2=\omega_2R_2=2\pi\times10^3$Km / h

Relative $\omega=\frac{V_1-V_2}{R_2-R_1}=\frac{2\pi\times10^3}{6\times10^3}$

$\Rightarrow\frac{\pi}{3}$ rad / hour

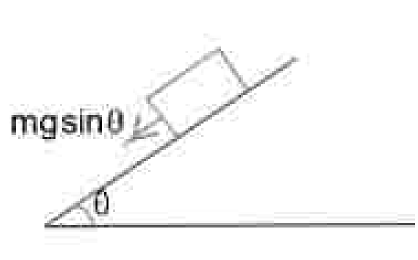
x = 3

Sol7. for smooth surface

$a=g\sin30^{\circ}=\frac{g}{2}$

$S_1=ut+\frac{1}{2}at^2$

$S_1=\frac{1}{2}\frac{g}{2}t^2=\frac{g}{4}t^2$ ....(i)

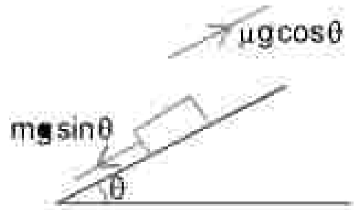


for rough Surface

$a = \frac{mg\sin\theta - \mu mg\cos\theta}{m}$

$a = g\sin\theta - \mu g\cos\theta$

$a = \left(\frac{g}{2} - \mu g \times \frac{\sqrt{3}}{2}\right) = \frac{g}{2}\left(1 - \mu\sqrt{3}\right)$



Now

$S = \frac{1}{2}a(\alpha t)^2$

$S = \frac{1}{2}\frac{g}{2}\left(1-\mu\sqrt{3}\right)\alpha^2 t^2$ ......(ii)

By (i) and (ii)

$\frac{g}{4}t^2 = \frac{g}{4}\left(1-\mu\sqrt{3}\right)\alpha^2 t^2$

$1 = \left(1-\mu\sqrt{3}\right)\alpha^2$

$\mu = \frac{1}{\sqrt{3}}\left(\frac{\alpha^2 - 1}{\alpha^2}\right) \quad x = \sqrt{3}$

Sol8. $I = \frac{m\ell^2}{3}$

Energy conservation Low

$mg\ell = \frac{1}{2}I\omega^2$

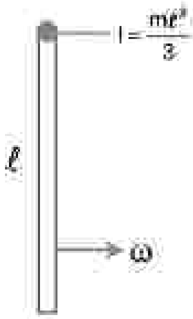
$mg\ell = \frac{1}{2}\frac{m\ell^2}{3}\omega^2$ ...(i)

And speed $V = \omega r = \omega\ell$

By equation (I) $\omega = \sqrt{\frac{6g}{\ell}}$

then $V = \sqrt{6g\ell} = \sqrt{6\times 10\times .6}$

$\Rightarrow 6 m/s$



Sol9. By work energy theorem

Work done = change in K.E.

Work done by friction work done by spring

$= 0 - \frac{1}{2}mV^2$

As 90% of K.E. is losed by friction so that

$-\frac{90}{100}\left(\frac{1}{2}mV^2\right) - \frac{1}{2}Kx^2 = -\frac{1}{2}mV^2$

$-\frac{1}{2}kx^2 = \left(\frac{90}{100} - 1\right)\frac{1}{2}mV^2 = \frac{-10}{100}\frac{1}{2}mV^2$.

$-Kx^2 = -\frac{1}{10}mV^2$

$-K = -\frac{1}{10}\times\frac{40000\times 20^2}{1} = 4000\times 400$

$-K \Rightarrow -16\times 10^5$

$K = 16\times 10^5$

Sol10. $A_{max} = A_c + A_m$

$A_{min} = A_c - A_m$

$$\frac{A_{min}}{A_{max}} = \frac{A_c - A_m}{A_c + A_m} = \frac{250-150}{250+150}$$

$$\Rightarrow \frac{100}{400} = \frac{50}{200}$$

PART – B (CHEMISTRY)

SECTION - A

Sol1. Given are the oxide of alkali and alkaline earth metals which are ionic in nature.
Simple oxide are Li_2O, CaO, MgO and K_2O.
Peroxide is Na_2O_2 and superoxide is KO_2.
All simple oxides are diamagnetic as it has no unpaired electron.
For peroxide;

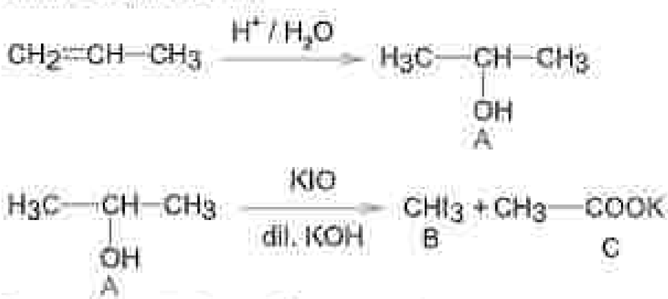
$O_2^{2-} \rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 \pi 2p_y^2 \pi^* 2p_x^2 \pi^* 2p_y^2$

It is diamagnetic as it has no unpaired electron.
For superoxide;

$O_2^{-} \rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 \pi 2p_y^2 \pi^* 2p_x^2 \pi^* 2p_y^1$

It is paramagnetic due to unpaired electron.
Here, only superoxide are paramagnetic which is KO_2.
Out of given oxides only 1 is paramagnetic, i.e., KO_2.

Sol2. Here, C_3H_6 is propene



Second reaction is Iodoform reaction.

Sol3. Spin only moment ; $\mu = 3.87 BM$

$\mu = \sqrt{n(n+2)} B.M$

$3.87 = \sqrt{n(n+2)} BM$

So; number of unpaired electrons; n = 3

In ;

$Cr^{3+} - 4s^0 3d^3; n = 3$

$Mn^{4+} - 4s^0 3d^3; n = 3$

$V^{3+} - 4s^0 3d^2; n = 2$

$Co^{2+} - 4s^0 3d^7; n = 3$

So; M^{x+} can not be V^{3+}

Now ;

CFSE for octahedral complex $= -0.4n_1\Delta_0 + 0.6n_2\Delta_0$

$= (-0.4n_1 + 0.6n_2)\Delta_0$

Where ; n_1 = number of electrons in t_{2g}

n_2 = number of electrons in eg

For Cr^{3+} ;

$4s^0 3d^3 = t_{2g}^3 eg^0$

$CFSE = (-0.4 \times 3 + 0.6 \times 0)\Delta_0$

$= -1.2\Delta_0$

For Mn^{4+},

$4s^0 3d^3 = t_{2g}^3 eg^0$

$CFSE = (-0.4 \times 3 + 0.6 \times 0)\Delta_0$

$= -1.2\Delta_0$

For Co^{2+},

$4s^0 3d^7$

In aqua complex; H_2O is weak field ligand.

So; $t_{2g}^5 eg^2$

$CFSE = (-0.4 \times 5 + 0.6 \times 2)\Delta_0$

$= -0.8\Delta_0$

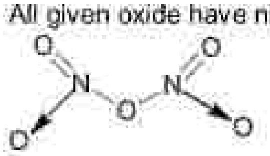
Hence ; M^{2+} is Co^{2+}

Sol4. BOD is biological oxygen demand which represents the amount of oxygen required to degrade organic matter in water.

Higher the BOD more polluted the water is

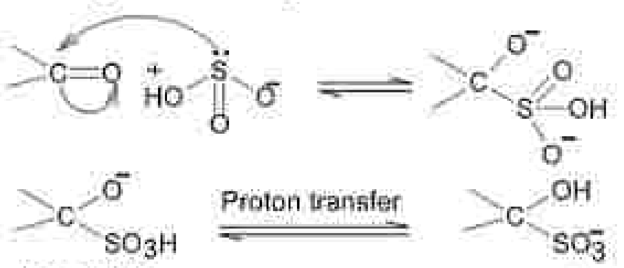
So; here water sample with BOD = 3 ppm is cleanest.

Sol5. All given oxide have nitrogen- nitrogen bond except N_2O_5 as;



Sol6. Nucleophilic addition of sodium hydrogen sulphite to aldhyde or ketone is as:

$NaHSO_3 \rightleftharpoons Na^+ + HSO_3^-$



Less stable
or
more acidic

more stable or less acidic

So; nucleophilic addition of sodium hydrogen sulphite to an aldehyde or a ketone involves proton transfer to form a stable ion.

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Addition of hydrogen cyanide;

Final product is cyanohydrin.

Sol7. $FeCl_3$ gives prussion blue colour on reacting with potassium ferrocynaide solution as

$$4FeCl_3 + 3K_4\left[Fe(CN)_6\right] \longrightarrow Fe_4\left[Fe(CN)_6\right]_3 + 12KCl$$

Potassium ferrocyanide — Ferric ferrocyanide (Prussion blue)

Sol8. Electronic configuration of Fe is [Ar] $4s^2 3d^6$ and in +3 oxidation state it has [Ar] $4s^0 3d^5$ configuration.

Sol9. Calamine is the ore of zinc i.e $ZnCO_3$.

Malachite is the ore of copper i.e $CuCO_3 \cdot Cu(OH)_2$.

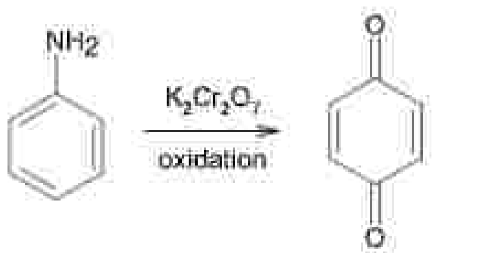
Sol10. $FeCl_3 + 3H_2O \longrightarrow Fe(OH)_3\,(Sol) + 3HCl \rightarrow$ Hydrolysis

$2AuCl_3 + 3HCHO + 3H_2O \rightarrow 2Au(Sol) + 3HCOOH + 6HCl \rightarrow$ Reduction

$SO_2 + 2H_2S \longrightarrow 3S(Sol) + 2H_2O \rightarrow$ Oxidation

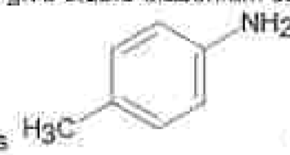
$As_2O_3 + 3H_2S \longrightarrow As_2S_3\,(Sol) + 3H_2O \rightarrow$ Double decomposition

Sol11.



(Benzoquinone)

Sol12. Only 1° aromatic amines give stable diazonium salt on reaction with nitrous acid

Here 1° aromatic amine is 

which gives most stable diazonium salt

Sol13. Here A is $CH_3 - CH_2 - CH_2 - COO - CH_2 - CH_3$

The given sequence of reaction is:

$$CH_3 - CH_2 - CH_2 - COO - CH_2 \xrightarrow[H_3O^+]{LiAlH_4} CH_3 - CH_2 - CH_2 - CH_2 - OH + CH_3 - CH_2 - OH$$

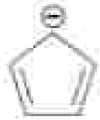
Here B is $CH_3 - CH_2 - CH_2 - CH_2 - OH$ as it gives C4- carboxylic acid on oxidation as,

$$\underset{B}{CH_3 - CH_2 - CH_2 - CH_2 - OH} \xrightarrow{oxidation} CH_3 - CH_2 - CH_2 - COOH$$

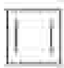
Sol14. Hydrogen peroxide reduces iodine to iodide ion is basic medium as;

$H_2O_2 + 2OH^- + I_2 \rightarrow O_2 + 2I^- + 2H_2O$

Sol15.



- Aromatic



- Anti-aromatic

- Non- aromatic

-Anti-aromatic

Sol16. In reaction;

$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$

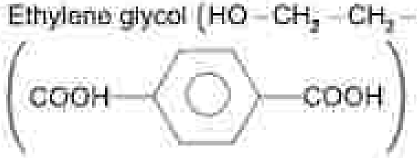
Color of Fe^{2+} is green and that of Fe^{3+} is yellow

Sol17. Rate constant depends on temperature as

$K = Ae^{-Ea/RT}$

Here; as T increases rate constant increases exponentially.

Sol18. Ethylene glycol $(HO-CH_2-CH_2-OH)$ and terephthalic acid

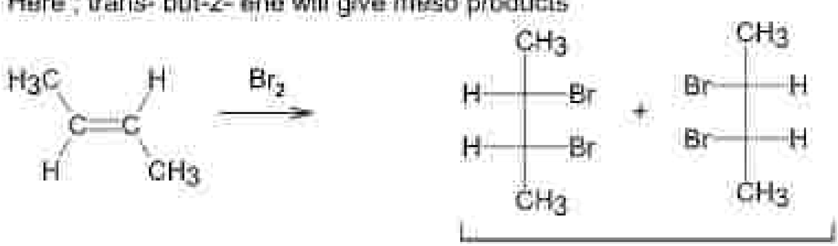


are monomers of dacron polymer.

Sol19. Na / H_2 can not reduce a functional group as Na does not behaves as catalyst here.

Sol20. Electrophilic addition of bromine to an alkene is anti- addition, in which cis- alkene gives two enantiomers and trans- alkene gives meso form

Here ; trans- but-2- ene will give meso products



Both are identical

SECTION – B

Sol1. Mass of empty cylinder = 14.8 kg
Mass of cylinder when full = 29 kg
Mass of gas in cylinder when filled ; $W_1 = 29 - 14.8 = 14.2$ kg
Mass of gas in cylinder after using ; $W_2 = 23 - 14.8 = 8.2$ kg
Initial pressure ; $P_1 = 3.47$ atm
Final pressure ; $P_2 = ?$
Using

$$PV = \frac{W}{M}RT$$

$$P_1V = \frac{W_1}{M}RT \text{ ....(I)}$$

$$P_2V = \frac{W_2}{M}RT \text{ ....(II)}$$

$$\frac{P_1}{P_2} = \frac{W_1}{W_2}$$

$$\frac{3.47}{P_2} = \frac{14.2}{8.2}$$

$P_2 = 2$atm

Sol2. $[Ag(NH_3)_2][Ag(CN)_2]$ contains $[Ag(NH_3)_2]^+$ and $[Ag(CN)_2]^-$
In $[Ag(NH_3)_2]^+$, oxidation state of Ag = +1
In $[Ag(CN)_2]^-$, oxidation state Ag = +1
Hence ; sum of oxidation state = 2

Sol3. $Zn(OH)_2 \rightleftharpoons Zn^{2+} + 2OH^-$

S	–	–
–	S	2S

$NaOH \rightarrow Na^+ + OH^-$

0.1M	–	–
–	0.1M	0.1M

$[Zn^{2+}] = S$

$[OH^-] = 2S + 0.1 \approx 0.1$

As; $S << 1$

$K_{sp} = [Zn^{2+}][OH^-]^2$

Here ; $2 \times 10^{-20} = S(0.1)^2$

So; $S = 2 \times 10^{-18}$M

Sol4. Mass of $CuSO_4 . 5H_2O$ = 80g
Volume of solution = 5L
Molar mass of $CuSO_4 . 5H_2O$ = 249.54 g/ ml

Moles of $CuSO_4.5H_2O = \frac{80}{249.54}$ mol = 0.32 mol

Concentration = $\frac{\text{moles}}{\text{volume of solution}}$.

$= \frac{0.32}{5} = 0.064M$

$= 64 \times 10^{-3} M$

Sol5. Power = 50 watt = 50 J / sec
Energy emitted per second = 50 J
Wavelength ; $\lambda = 795 nm$

Energy of one photon = $\frac{hc}{\lambda}$

$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{795 \times 10^{-9}} J$

$= 0.025 \times 10^{-17} J$

Number of photons emitted per second $= \frac{50}{0.025 \times 10^{-17}}$

$= 2 \times 10^{20}$

Sol6. Peptide contains four amino acid i.e glycine, aspartic acid and histidine, so it will have three peptide linkage

Sol7. $2NO_2(g) \rightleftharpoons N_2O_4(g)$
$\Delta S = -176 JK^{-1} = -0.176 kJK^{-1}$

$\Delta H = -57.8 KJmol^{-1}$

T = 298K

Using, $\Delta G = \Delta H - T\Delta S$

$= -57.8 + (298 \times 0.176) KJmol^{-1}$

$= -57.8 + 52.5 KJmol^{-1}$

$= -5.3 KJmol^{-1}$

Hence, magnitude of ΔG in $kJmol^{-1}$ is 5 (nreaest integers)

Sol8. $B_2^+ \rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^1$
Here, number of unpaired electrons, n= 1

Spin only moment ; $\mu = \sqrt{n(n+2)}$ B.M

$\mu = \sqrt{1(1+2)} = \sqrt{3}$B.M

$\mu = 1.73$B.M

$= 173 \times 10^{-2}$ B.M

Sol9. Moles of sodium = $\frac{8}{23}$ mol

Number of atoms = $\frac{8}{23} \times 6.02 \times 10^{23}$

$= 2.09 \times 10^{23}$

$= 2 \times 10^{23}$

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Sol10. Conductivity: $\kappa = 1.07 \times 10^6 Sm^{-1}$
Resistance ; $R = 0.243\Omega$
cellconstant; $G^* = ?$
Using;
$\kappa = \frac{G^*}{R}$
$G^* = \kappa \times R$
$= 1.07 \times 10^6 \times 0.243 m^{-1}$
$= 26 \times 10^4 m^{-1}$

PART – C (MATHEMATICS)

SECTION – A

Sol1. $2\cos x\left(4\sin\left(\frac{\pi}{4}+x\right)\sin\left(\frac{\pi}{4}-x\right)-1\right)=1$

$\Rightarrow 2\cos x(2\cos 2x-1)=1$

$\Rightarrow \cos 3x=\frac{1}{2}$. For $0 \le x \le \pi$, $x=\frac{\pi}{9},\frac{5\pi}{9},\frac{7\pi}{9}$

Sol2. line : $3y-2z-1=0, 3x-z+4=0$

$\Rightarrow$ a point $P\left(\frac{t-4}{3},\frac{2t+1}{3},t\right)$ on the line, $Q(2,-1,6)$

$PQ^2=\frac{2}{9}(7t^2-56t+220)$

$\ge \frac{2}{9}(112-224+220)$

$(PQ)_{min.}=2\sqrt{6}$

Sol3. Given expression
$= 2\pi-5+6-2\pi-(12-4\pi)=4\pi-11$

Sol4. DE : $\frac{dy}{dx}+\frac{y}{x^2}=\frac{1}{x^3}$

$IF = e^{-\frac{1}{x}}$

Solution : $ye^{-\frac{1}{x}}=\int e^{-\frac{1}{x}}.\frac{1}{x^3}dx=\frac{1}{x}e^{-\frac{1}{x}}+e^{-\frac{1}{x}}+C$

Point $(1,1) \Rightarrow C=-\frac{1}{e}$

$x=\frac{1}{2} \Rightarrow y=3-e$

Sol5. $S_{20}=\sum_{n=1}^{20}\frac{1}{d}\left(\frac{1}{a_n}-\frac{1}{a_{n+1}}\right)$

$$=\frac{1}{d}\left(\frac{1}{a_1}-\frac{1}{a_{21}}\right)$$

$$=\frac{20}{a_1a_{21}}=\frac{4}{9}\Rightarrow a_1a_{21}=45$$

$$\Rightarrow a(a+20d)=45 \ldots\ldots(i)$$

$$a_6a_{16}=(a+5d)(a+15d)$$

$$=a^2+20ad+75d^2$$

$$=45+75d^2$$

Also, $\frac{21}{2}[2a+20d]=189$

$$\Rightarrow a+10d=9 \ldots\ldots(ii)$$

(i) & (ii) $\Rightarrow d^2=\frac{36}{100}$

$$\Rightarrow a_6a_{16}=72$$

Sol6. Point of intersection of

$\frac{x^2}{9}+y^2=1$ and $x^2+y^2=3$ in the 1st quadrant is $\left(\frac{3}{2},\frac{\sqrt{3}}{2}\right)$

$$m_1=-\frac{1}{3\sqrt{3}},\ m_2=-\sqrt{3}$$

$$\tan\theta=\left|\frac{m_1-m_2}{1+m_1m_2}\right|=\frac{2}{\sqrt{3}}$$

Sol7. $f(x)=\log_{\sqrt{5}}\left(3+\sqrt{2}(\cos x-\sin x)\right)$

$$-\sqrt{2}\le\cos x-\sin x\le\sqrt{2}$$

$$\Rightarrow 0\le f(x)\le 2$$

Sol8. $\Delta=0\Rightarrow a=3,4$

For a = 3, no solution

For a = 4, no solution

$n(S_1)=2,\ n(S_2)=0.$

Sol9. Required area

$$A=2\int_0^{\pi/4}\left((\sin x+\cos x)-(\cos x-\sin x)\right)dx$$

$$=2\int_0^{\pi/4}\sin x\,dx$$

$$=2\sqrt{2}\left(\sqrt{2}-1\right)$$

Sol10. $\lim\limits_{x\to\frac{\pi}{4}}\frac{\frac{\pi}{4}.f(\sec^2 x)2\sec^2 x\tan x}{2x}=2f(2)$

Sol11. Required number $={}^{16}C_3$ – number of solution of $x_1+x_2+x_3=15$, where $x_1<x_2<x_3$

${}^{15}C_3 = 455$,

For $x_2 = x_1 + a, a \geq 1$

$x_3 = x_2 + b, b \geq 1$

$x_1 + x_2 + x_3 = 15$

$\Rightarrow 3x_1 + 2a + b = 15$

Coefficient of x^{15} in

$\left(x^3 + x^6 + x^9 + x^{12} + x^{15}\right)$

$\left(x^2 + x^4 + x^6 + x^8 + x^{10} + x^{12}\right)$

$\left(x^1 + x^2 + x^3 + \ldots\ldots + x^{15}\right) = 12$

Required number = 455 – 12 = 443

Sol12. Angle bisectors are

$$\frac{x - 2y - 2z + 1}{3} = \pm\frac{2x - 3y - 6z + 1}{7}$$

$\Rightarrow x - 5y + 4z + 4 = 0$, (i)

$3x - 23y - 32z + 10 = 0$..........(ii)

As distance of a point $(-1, 0, 0)$ on $x - 2y - 2z + 1 = 0$

from (i) is greater than that from (ii)

(ii) is the acute angle bisector.

Sol13. $I_{n,m} = \int_0^{\frac{1}{2}} \frac{x^n}{x^m - 1} dx$, $m, n \in N$, $n > m$

$I_{6+i,3} - I_{3+i,3}$

$$= \int_0^{\frac{1}{2}} x^{3+i} dx = \frac{1}{(4+i)2^{4+i}}$$

$$A = \frac{1}{2^5}\begin{bmatrix} \frac{1}{5} & \frac{1}{5} & \frac{1}{5} \\ 0 & \frac{1}{12} & \frac{1}{12} \\ 0 & 0 & \frac{1}{28} \end{bmatrix} = \frac{B}{32}$$

$$|\text{adj}\, A^{-1}| = \frac{1}{|A|^2}$$

$$\det(B) = \frac{1}{16 \times 105}$$

$$|A| = \left(\frac{1}{32}\right)^3 |B| = \frac{1}{105.2^{19}}$$

Sol14. $S_n = \sum_{r=1}^{n-1} r(n - r)$

$= n\Sigma r - \Sigma r^2$

$$=n\frac{(n-1)n}{2}-\frac{(n-1)n(2n-1)}{6}=\frac{n^3-n}{6}$$

$$S=\sum_{n=4}^{\infty}\left(\frac{2}{6}\cdot\frac{n^3-n}{n!}-\frac{1}{(n-2)!}\right)=\frac{1}{3}\sum_{n=4}^{\infty}\frac{1}{(n-3)!}=\frac{e-1}{3}$$

Sol15. Required number $=\frac{4\times2+24\times3+36\times4}{2}=112$

Sol16. $f(x)=x+a\sin x$

where $a=\int_0^{\frac{\pi}{2}}\cos y f(y)dy$

$a=\int_0^{\frac{\pi}{2}}\cos y(y+a\sin y)dy$

$\Rightarrow a=\left[y\sin y+\cos y-\frac{a}{4}\cos 2y\right]_0^{\pi/2}$

$\Rightarrow a=\pi-2$

Sol17. $f(2)=f(4)=0$ and $f(x)=x^3-6x^2+ax+b$

$\Rightarrow f(x)=(x-2)(x-4)x=x^3-6x^2+8x$

$\Rightarrow a=8, b=0$

$f'(x)=0\Rightarrow x=2\pm\frac{2}{\sqrt{3}}$, $x_4=2+\frac{2}{\sqrt{3}}, f(x_4)=\frac{-16}{3\sqrt{3}}$

$f'(x_1)=-1, f(x_4)=0, f'(2)=-4, f'(4)=8$

$f'(x_2)=0,$

$f'(x_3)=\frac{\sqrt{3}}{2}f(x_4)=\frac{-8}{3}$

Sol18. The parabola : $\left(x-\frac{1}{2}\right)^2=y-\frac{3}{4}$

$\Rightarrow y=x^2-x+1$.......(i)

$P\left(-\frac{1}{2},\frac{7}{4}\right)$

$\left(\frac{dy}{dx}\right)_P=-2$

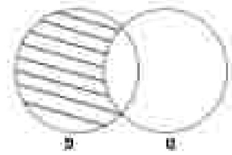
$N_P: y=\frac{x}{2}+2$ ....(ii)

(i) & (ii) $\Rightarrow Q(2,3)$

$PQ^2=\frac{125}{16}$

Sol19. For every α, there must be a α^2-2. So, there will be infinitely many pairs (a, b).

Sol20. $\sim(\sim p \vee q) = p \wedge \sim q$



SECTION - B

Sol1. $\overline{x} = \Sigma x \times p(x)$

$\Rightarrow \frac{23}{10} = \frac{-2}{5} - a + 1 + \frac{4}{5} + 6b$

$\Rightarrow 6b - a = \frac{9}{10}$ ....(i)

Also, $\frac{1}{5} + a + \frac{1}{3} + \frac{1}{5} + b = 1$

$\Rightarrow a + b = \frac{4}{15}$ ....(ii)

(i) & (ii) $\Rightarrow a = \frac{1}{10}, b = \frac{1}{6}$

$\sigma^2 = \overline{(x^2)} - (\overline{x})^2$

$= \Sigma x^2 p(x) - (\overline{x})^2$

$= \frac{4}{5} + \frac{1}{10} + 3 + \frac{16}{5} + 6 - \left(\frac{23}{10}\right)^2$

$\Rightarrow 100\sigma^2 = 781$

Sol2. $|3iz + 6| = 3|z - 2i|$

Also, $|z - 2 - 2i| \le 1$

$1 \ge |(z - 2i) - 2| \ge ||z - 2i| - 2|$

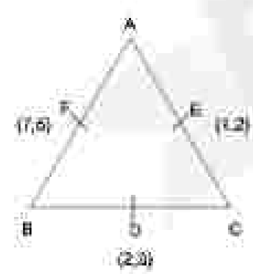
$\Rightarrow 1 \le |z - 2i| \le 3$

$\Rightarrow 3 \le 3|z - 2i| \le 9$

$|z - 2i| = 3$ for $z = 3 + 2i \Rightarrow a + b = 5$

Sol3. $ar(ABC) = 4ar(DEF)$

$= 4 \times \frac{1}{2} \times |2(2-5) + 1(5-3) + 7(3-2)| = 2|-6 + 2 + 7| = 6$



Sol4. $\lim_{x \to 1} \frac{x^n f(1) - f(x)}{x - 1}$

$= \lim_{x \to 1} \frac{9x^n - (x^8 + 2x^4 + x^3 + 2x + 3)}{x - 1}$

$= \lim_{x \to 1} 9nx^{n-1} - 8x^7 - 8x^3 - 3x^2 - 2$

$= 9n - 19 = 44 \Rightarrow n = 7$

Sol5. $\vec{v} = l\vec{a} + m\vec{b}$

$= (2l + m, -l + 2m, 2l - m)$

$\vec{v}.(3, 2, -1) = 0 \Rightarrow l = -4m$ ....(i)

$|\vec{v}.\hat{a}| = 19 \Rightarrow 9l - 2m = 57$ ......(ii)

(i) & (ii) $\Rightarrow l = 6, m = \frac{-3}{2}$

$\Rightarrow 2\vec{v} = (21, -18, 27)$

$|2\vec{v}|^2 = 1494$

Sol6. $f(x) = \begin{cases} -2x^2 + 3, & -2 < x < -1 \\ x^2, & -1 \le x < 0 \\ \frac{\sqrt{3}}{2} - 1, & 0 \le x < 1 \\ x^2 - 3 + \frac{1}{\sqrt{2}}, & 1 \le x < 2 \end{cases}$

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

$f(0^-) = 0, f(0^+) = \frac{\sqrt{3}}{2} - 1 = f(0)$

$f(1^-) = \frac{\sqrt{3}}{2} - 1$

$f(1^+) = f(1) = \frac{1}{\sqrt{2}} - 2$

Points of discontinuity

x = 0, 1

Sol7. A E F M R R

A						$\frac{5!}{2!} - 4! = 36$
E						$\frac{5!}{2!} - 4 = 36$
FAE						$\frac{3!}{2!} - 2! = 1$

MRR

FAM				$\frac{3!}{2!} - 2! = 1$

ERR

FARE			$2! = 2$

MR

F	A	R	M	E	R	1

Sol8. $xf(x) + 2 = \lambda(x-2)(x-3)(x-4)(x-5)$

$x = 0 \Rightarrow \lambda = \frac{1}{60}$

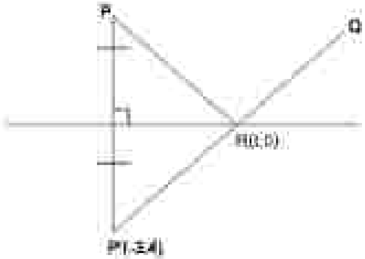
$x = 10 \Rightarrow 10f(10) = 26$

Sol9. $m_{P'Q} = m_{QR}$

$\Rightarrow \frac{6}{3} = \frac{2}{-t} \Rightarrow t = -1$

$\Rightarrow R(-1, 0)$

$PR^2 + RQ^2 = 20 + 5 = 25$



Sol10. $2^n = 4096 \Rightarrow n = 12$

$^{12}C_6 = 924$ (greatest coefficient)