FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2024
FULL TEST – VII
PAPER –1
TEST DATE: 28-04-2024

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 51 questions.
- Each subject (PCM) has 17 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 –03, 18 – 20, 35 – 37):* This section contains **NINE (9)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – A *(04 – 07, 21 – 24, 38 – 41)*: This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.

Section – A *(08 – 11, 25 – 28, 42 – 45):* This section contains **TWELVE (12)** Matching List Type Questions. Each question has **FOUR** statements in **List-I** entries (P), (Q), (R) and (S) and **FIVE** statements in **List-II** entries (1), (2), (3), (4) and (5). The codes for lists have choices (A), (B), (C), (D) out of which, **ONLY ONE** of these four options is correct answer.

Section – B *(12 – 17, 29 – 34, 46 – 51):* This section contains **EIGHTEEN (18)** numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.

MARKING SCHEME

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen;
Partial marks	:	+2	If three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–2	In all other cases.

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–1	In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If ONLY the correct numerical value is entered at the designated place;
Zero Marks	:	0	In all other cases.

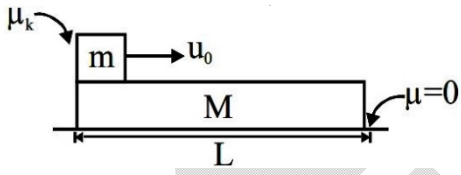
Physics

PART – I

SECTION – A
(One or More than one correct type)

*This section contains **THREE (03)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

1. A long plank mass M is initially at rest on frictionless surface. A small block with mass m [m = αM] and initial speed u_0 slides on the top of the larger plank. The coefficient of friction between the block and plank is μ.



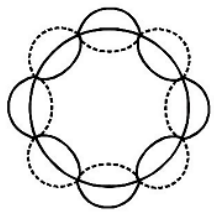
(A) At the time when the small block ceases to slide, displacement of smaller block with respect to ground is $\frac{u_0^2}{2\mu g}\left[1-\left(\frac{\alpha}{1+\alpha}\right)^2\right]$

(B) At the time when the small block ceases to slide, displacement of smaller block with respect to ground is $\frac{u_0^2}{2\mu g}\left(\frac{\alpha}{1+\alpha}\right)^2$

(C) Displacement of bigger plank till same instant is $\frac{u_0^2}{2\mu g}\frac{\alpha}{(1+\alpha)^2}$

(D) Displacement of bigger plank till same instant is $\frac{u_0^2}{2\mu g}\left(\frac{\alpha}{(1+\alpha)}\right)^2$

2. Figure shows stationary orbit of an hydrogen atom and upon the transition of electron form given excited state to ground state:



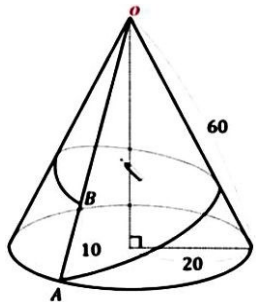
(A) Average change in angular momentum is $\frac{3h}{2\pi}$

(B) The ratio of de-Broglie wave lengths in final state to initial state is 4

(C) Energy of emitted photon is nearly 12.75 eV.

(D) Ratio of orbital time period between these two states is 4^3

3. The diagram illustrates a right circular cone-shaped hypothetical mountain, of apex 'O'. If you build a shortest distance track for a sightseeing train which goes exactly once around the mountain, in which the track starts at point A and ends at point B, the track will first go uphill, but then it will do downhill. A & B will lie on the same slant line from A to apex O such that distance between them along the slant line ABO, AB = 10 km, radius of cone = 20 km. Slant height of the cone = 60 km. the speed train (Consider it a particle) is set at a constant 20 kmph. Mark the **CORRECT** statement(s).



(A) At the instant of shortest distance form 'O' the angular velocity of train about 'O' is maximum

(B) The journey time of the train is $\frac{\sqrt{91}}{2}$hr

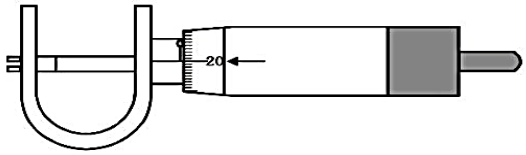
(C) The length of the downhill part of the journey is $\frac{200}{\sqrt{91}}$km

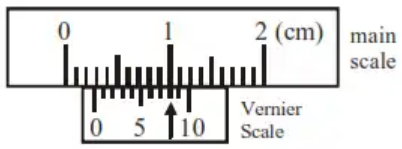
(D) The velocity of the train is always perpendicular to the line joining 'O' to the train

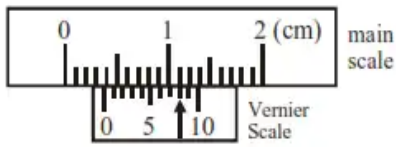
SECTION – A
(One Options Correct Type)

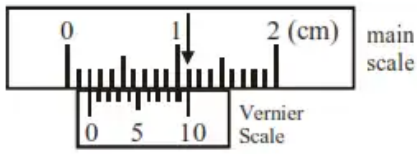
*This section contains **FOUR (04)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

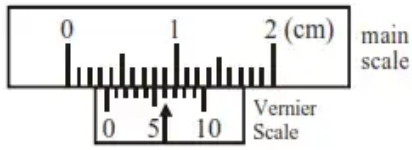
4. When a piece of wire is held diametrically in a screw gauge [pitch = 1mm, number of divisions on circular scale = 100]. The readings obtained are as shown: Now if we measure the same with help of vernier callipers [1 MSD = 1mm, 10 divisions of vernier coinciding with 9 divisions of main scale] having a negative zero error of 0.5 mm, then find which of the following figures correctly represents the reading



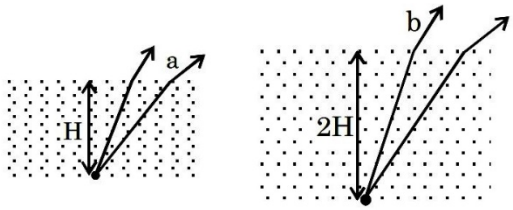
(A)


(B)


(C)


(D)


5. When a point source is inside at a depth H in water (refractive index $\frac{4}{3}$), the fraction of light coming out of the water is 'a'. When source is placed at depth '2H', fraction of light escaped from water is 'b'. Then



(A) $b = \frac{a}{2}$

(B) a = b

(C) $b = \frac{a}{4}$

(D) $b = \frac{a}{\pi}$

6. A half cylinder of radius R and length L >> R is formed by cutting a cylindrical pipe made of an insulating material along a plane containing its axis. The rectangular base of the half cylindrical is closed by a dielectric plate of length L and width 2R. A Charge Q on the half cylinder and a charge q on the dielectric plate are uniformly sprinkled. Electro-static force between the plate and the half cylinder is closet to:

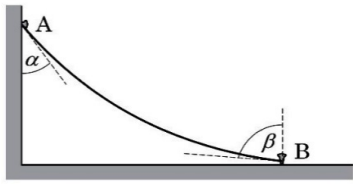
(A) $\frac{qQ}{2\varepsilon_0 RL}$

(B) $\frac{qQ}{2\pi\varepsilon_0 RL}$

(C) $\frac{4Q}{4\varepsilon_0 RL}$

(D) $\frac{qQ}{8\varepsilon_0 RL}$

7. A uniform rope is tied between a nail A on the wall and a nail B on the ground. The rope without touching the ground anywhere assumes a curved shape known as "catenary". Tangents at the ends A and B of this catenary make angles α and β with the vertical respectively. Which of the following conclusions can NOT be made?

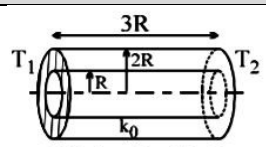
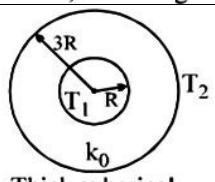
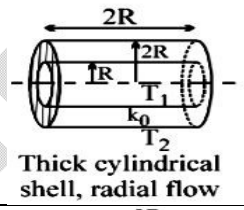
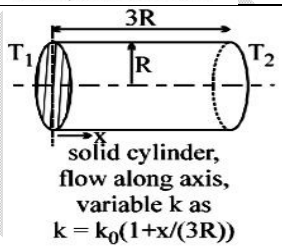


(A) Horizontal component of the tensile force in the rope is uniform.
(B) Vertical component of the tensile force increases with the height.
(C) Angle α can be greater the angle β
(D) Angle α cannot assume a value of 0^o

SECTION – A
(Matching List Type)

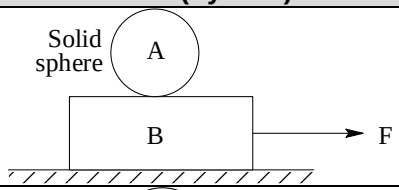
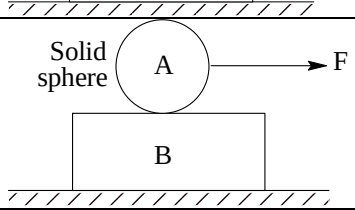
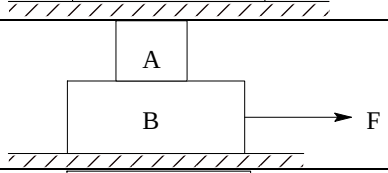
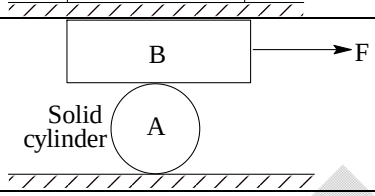
*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (P), (Q), (R) and (S) and FIVE statements in **List-II** entries (1), (2), (3), (4) and (5). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

8. Entries in list I consist of diagrams of thermal conductors. The type of conductors & direction of heat are listed below. Entries in list II consist of the magnitude of rate of the heat flow belonging to any of the entries in list I. If the temperature difference in all the cases is $(T_1 - T_2)$ the match list.

List – I		List – II	
(P)	 Thick cylindrical shell, flow along axis	(1)	$6\pi k_0 R(T_1 - T_2)$
(Q)	 Thick spherical shell, radial flow	(2)	$\frac{\pi k_0 R}{3\ell n2}(T_1 - T_2)$
(R)	 Thick cylindrical shell, radial flow	(3)	$\pi k_0 R(T_1 - T_2)$
(S)	 solid cylinder, flow along axis, variable k as $k = k_0(1+x/(3R))$	(4)	$\frac{4\pi k_0 R}{\ell n2}(T_1 - T_2)$
		(5)	None of these

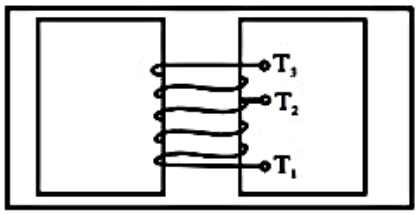
(A) (P) → (3), (Q) → (1), (R) → (1), (S) → (4)
(B) (P) → (2), (Q) → (3), (R) → (4), (S) → (1)
(C) (P) → (1), (Q) → (3), (R) → (2), (S) → (4)
(D) (P) → (3), (Q) → (1), (R) → (4), (S) → (2)

9. There is a sufficient friction between object A & B (of same mass) to avoid any sipping between them and ground is smooth

List – I (System)		List – II (Net force on object A)	
(P)		(1)	$\frac{2}{9}F$
(Q)		(2)	$\frac{7}{9}F$
(R)		(3)	$\frac{F}{2}$
(S)		(4)	$\frac{F}{4}$
		(5)	$\frac{3F}{4}$

(A) (P) → (3), (Q) → (1), (R) → (1), (S) → (4)
(B) (P) → (2), (Q) → (3), (R) → (4), (S) → (1)
(C) (P) → (1), (Q) → (2), (R) → (3), (S) → (4)
(D) (P) → (4), (Q) → (1), (R) → (2), (S) → (3)

10. An autotransformer consists of a single coil with a ferromagnetic core. Three connections are provided. Between connections T_1 and T_2 there are 200 turns and between T_2 and T_3 there are 800 turns. Any two connections can be used as primary and any two can be used as secondary.

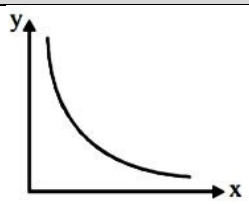
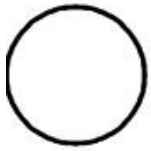
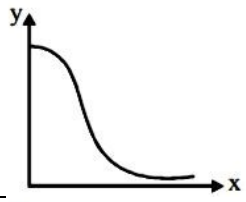
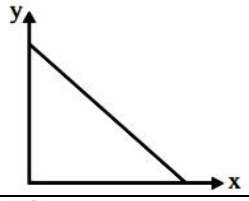
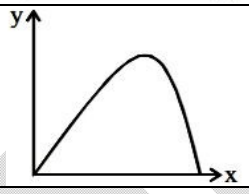
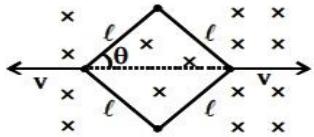


List – I		List – II	
(P)	For setup transformer maximum value of $\frac{V_{secondary}}{V_{primary}}$	(1)	0.8
(Q)	For stepdown transformer maximum value of $\frac{V_{secondary}}{V_{primary}}$	(2)	0.2
(R)	For step up transformer minimum value of $\frac{V_{secondary}}{V_{primary}}$	(3)	1.25

(S)	For stepdown transformer minimum value of $\frac{V_{secondary}}{V_{primary}}$	(4)	5
		(5)	2.5

(A) (P) → (3), (Q) → (1), (R) → (1), (S) → (4)
(B) (P) → (2), (Q) → (3), (R) → (4), (S) → (1)
(C) (P) → (1), (Q) → (2), (R) → (3), (S) → (4)
(D) (P) → (4), (Q) → (1), (R) → (3), (S) → (2)

11. In a List-I certain graph(s) are shown which depict the situation shown in List II

List – I		List – II	
(P)		(1)	uniformly charged sphere, distance from centre = x, potential = y 
(Q)		(2)	Graph between charge on capacitor and current in RC charging.
(R)		(3)	Object distance and image distance from focus in concave mirror.
(S)		(4)	$\theta = 90^\circ$ at t = 0, flux as a function time 
		(5)	kinentic energy (y) vs angular speed (x) for a rod in pure rotation.

(A) (P) → (3), (Q) → (1), (R) → (2), (S) → (4)
(B) (P) → (2), (Q) → (3), (R) → (4), (S) → (1)
(C) (P) → (1), (Q) → (2), (R) → (3), (S) → (4)
(D) (P) → (4), (Q) → (1), (R) → (3), (S) → (2)

SECTION – B

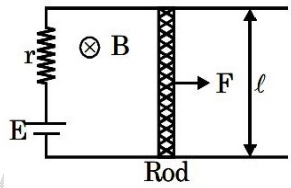
(Numerical Answer Type)

*This section contains **SIX (06)** Numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.*

12. Electromagnetic radiation whose electric component varies with time as $E = C_1 (C_2 + C_3 \cos \omega t) \cos \omega_0 t$, here C_1, C_2 and C_3 are constants, is incident on lithium and liberates photoelectrons. If the kinetic energy of most energetic electrons is 2.6 eV, the work function of lithium is (in eV). [Take: $\omega_0 = 2.4 \pi \times 10^{15}$ rad/sec and $\omega = 8\pi \times 10^{14}$ rad/sec planks constant $h = 6.6 \times 10^{-34}$ MKS].

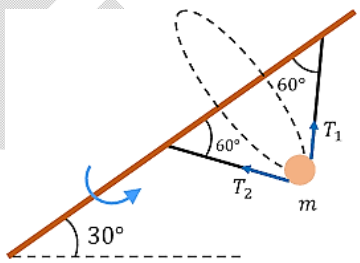
13. Bacteria can be knocked out in the presence of radiation from green kryptonite, which has a very long half-life. If 150 g of it can knock out the bacteria in just 1.5 minutes, how long can the bacteria withstand the radiation if there is 4.5 kg of slab of green kryptonite? Assume that kryptonite obeys radioactive obeys radioactive decay law. Express your answer in power of 10^{-2} minutes.

14. Two parallel conducting rails are connected to a source of emf E and internal resistance r. Another conducting rod of length ℓ having negligible resistance lies at rest and can slide without friction over the rails. At t = 0, the rod is pulled along the rails by applying a force F. The velocity of the rod is observed to be $v = v_0 \cos(\omega t)$ then find the power (in watt) spent by the forcer over 1 cycle. (Given B = 2 Tesla, r = 2 x 10^{-4} Ω, v_0 = 2 ms^{-1}, ℓ = 1cm)

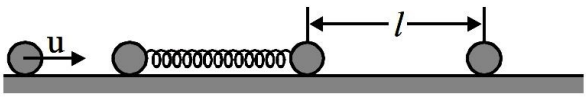


15. In a pipe open at two ends a diatomic gas is oscillating in 1st harmonic. The length of the tube is π m and the maximum pressure variation is 1.4 Pa. The maximum displacement of gas particles which are a distance of $\frac{\pi}{3}$ m from one end is *x* x 10^{-6}m. The value of x is: (Take 1 atm = 10^5Pa)

16. Figure shows a massless rod arranged at an angle of 30° from the horizontal. Two massless strings are attached to rod and a mass 'm' as shown in figure, the rod is rotated maintaining its direction in space, so that m travels in a circular path. The strings are of equal length and make angle of 60° with the rod as shown. Calculate the minimum value of the tangential speed at topmost point (m/sec) of the mass such that the string with Tension T_2 does not become slack when the mass is directly above rod. Take length of string ℓ = 2.4m



17. Two identical metal balls connected at the ends of a light spring of force constant k from a dumbbell like structure. The dumbbell rests on a frictionless horizontal floor and the third identical ball is placed at distance l from the right ball of the dumbbell. All the three balls are in a line A fourth identical ball moving with velocity u collides with left ball of the dumbbell. If all collisions are elastic and the rightmost ball acquires a velocity u. The minimum value of l is $\pi u\sqrt{\frac{m}{xk}}$. Find x____.



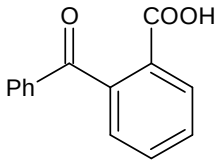
Chemistry

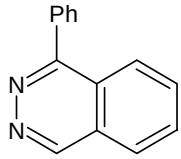
PART – II

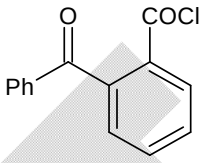
SECTION – A
(One or More than one correct type)

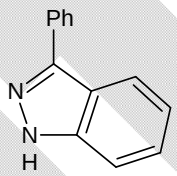
*This section contains **THREE (03)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

18. An aromatic dibasic acid anhydride on reaction with benzene in presence of anhydrous $AlCl_3$ gives a compound A. The compound A on treatment with PCl_5 followed by reaction with H_2 and Rosenmund catalyst gives compound B. Compound B reacts with hydrazine in slightly acidic conditions to give a cyclized product C, ($C_{14}H_{10}N_2$). Which of the following is/are correct statement(s)?

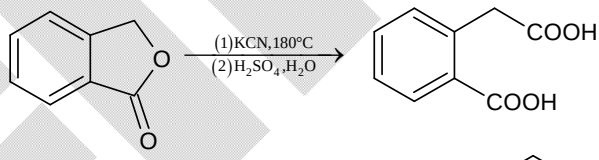
(A) The compound 'A' is 

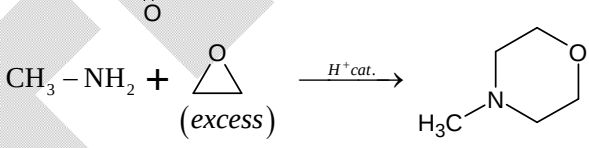
(B) The compound 'C' is 

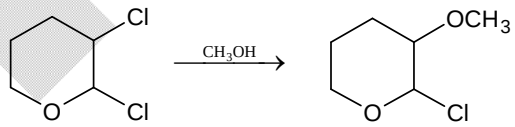
(C) The compound 'B' is 

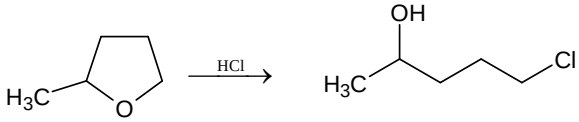
(D) The compound 'C' is 

19. Which of the following reactions correctly matched with major product?

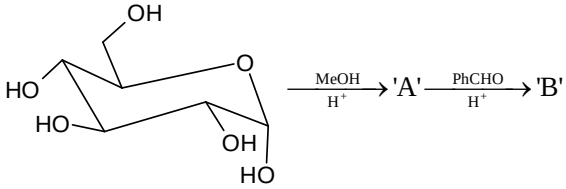
(A) 

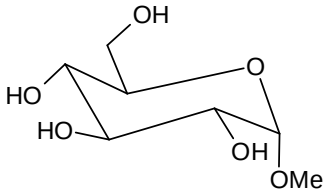
(B) 

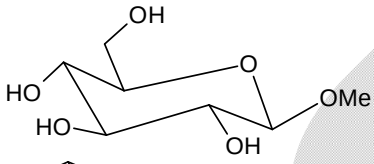
(C) 

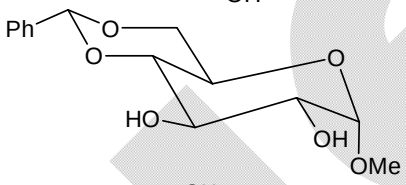
(D) 

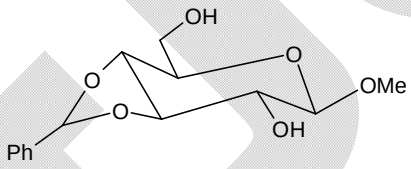
20. Which of the following is correct about below reaction sequence?



(A) The compound 'A' is 

(B) The compound 'A' is 

(C) The compound 'B' is 

(D) The compound 'B' is 

SECTION – A
(One Options Correct Type)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

21. Which statement is/are most likely to be correct about astatine, At?
(A) AgAt(s) reacts with excess of dilute aqueous ammonia to form a solution of a soluble complex.
(B) At_2 and KCl (aq.) react to form KAt (aq.) and Cl_2.
(C) KAt (aq.) and dil. H_2SO_4 react to form white fumes of HAt(g).
(D) NaAt(s) and conc. H_2SO_4 acid react to form At_2.

22. Two liquids X and Y form are ideal solution. At 300 K, vapour pressure of the solution containing 1 mole of X and 3 mole of Y is 550 mm Hg. At the same temperature, if 1 mole of Y is further added to this solution, vapour pressure of the solution increases by 10 mm Hg. Vapour pressure (in mm Hg) of X and Y in their pure states will be respectively.
(A) 200 and 300 (B) 300 and 400
(C) 400 and 600 (D) 500 and 600

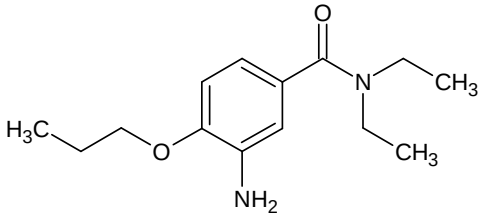
23. The number of species having symmetrical electron distribution in their HOMO and paramagnetic in nature are_
(A) $O_2, B_2, C_2^{2-}, N_2^{2-}$ (B) O_2, B_2, N_2^{2-}, He^+
(C) CN^-, He^+, C_2^+, NO (D) $C_2^{2-}, N_2^{2-}, CN^-, He^+$

24. Para – hydroxybenzoic acid $\xrightarrow{HNO_3}$ 'A' $\xrightarrow[n\text{-}PrCl]{base}$ 'B' $\xrightarrow{SOCl_2}$ 'C'

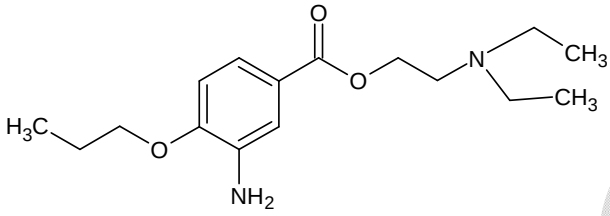
 $+Et_2NH \longrightarrow$ 'D' $\xrightarrow{+'C'}$ 'E' $\xrightarrow{H_2/Pd/C}$ 'F'

The structure of compound 'F' is:

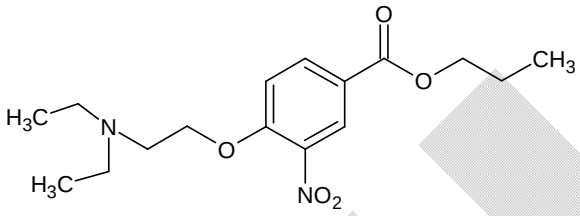
(A)



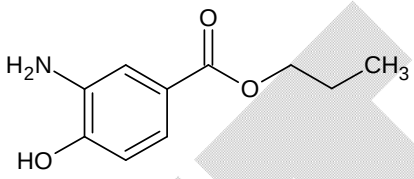
(B)



(C)



(D)



SECTION – A
(Matching List Type)

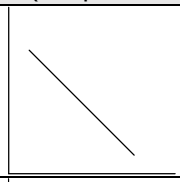
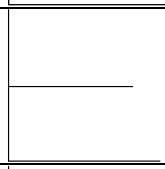
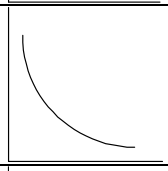
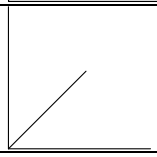
*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (P), (Q), (R) and (S) and FIVE statements in **List-II** entries (1), (2), (3), (4) and (5). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

25. **Matrix Match Type**

	List-I		List-II
(P)	H_2O (ℓ, 1 atm, 263 K) $\rightarrow$ H_2O (s, 1 atm, 263 K)	(1)	$\Delta_r G > 0$
(Q)	H_2O (ℓ, 1 atm, 363 K) $\rightarrow$ H_2O (g, 1 atm, 363 K)	(2)	$\Delta_r S > 0$
(R)	H_2O (ℓ, 1 atm, 373 K) $\rightarrow$ H_2O (g, 1 atm, 373 K)	(3)	$\Delta_r H < 0$
(S)	H_2O (s, 1 atm, 373 K) $\rightarrow$ H_2O (ℓ, 1 atm, 373 K)	(4)	$\Delta_r U > 0$
		(5)	$\Delta_r G < 0$

(A) (P) $\rightarrow$ (2), (5); (Q) $\rightarrow$ (1), (2); (R) $\rightarrow$ (3), (4); (S) $\rightarrow$ (4), (2)
(B) (P) $\rightarrow$ (1), (4); (Q) $\rightarrow$ (1), (2), (5); (R) $\rightarrow$ (2), (4); (S) $\rightarrow$ (2), (4), (1)
(C) (P) $\rightarrow$ (3), (5); (Q) $\rightarrow$ (1), (2) (4); (R) $\rightarrow$ (2), (4); (S) $\rightarrow$ (2), (4), (5)
(D) (P) $\rightarrow$ (3), (5); (Q) $\rightarrow$ (3), (4); (R) $\rightarrow$ (2), (3); (S) $\rightarrow$ (1), (2), (5)

26. **Matrix Match Type**

	List-I (Graphs for reaction: $A \rightarrow$ Products)		List-II (Co-ordinates, y-axis vs x-axis)
(P)		(1)	$\ln[A] vs\, t\,(order = 1)$
(Q)		(2)	$t_{1/2} vs [A_0] (order = 1)$
(R)		(3)	$rate\, of\ reaction\ vs\ t\,(order > 0)$
(S)		(4)	$rate\, of\ reaction\ vs\ t\,(order = 0)$
		(5)	$r\ vs\ [A] (order = 1)$

(A) (P) $\rightarrow$ (2); (Q) $\rightarrow$ (2), (4); (R) $\rightarrow$ (3), (4); (S) $\rightarrow$ (5)
(B) (P) $\rightarrow$ (1); (Q) $\rightarrow$ (2), (4); (R) $\rightarrow$ (3); (S) $\rightarrow$ (5)
(C) (P) $\rightarrow$ (1); (Q) $\rightarrow$ (2) (4); (R) $\rightarrow$ (1), (3); (S) $\rightarrow$ (1), (5)
(D) (P) $\rightarrow$ (3); (Q) $\rightarrow$ (4); (R) $\rightarrow$ (5), (3); (S) $\rightarrow$ (1), (2)

27. **Matrix Match Type**

	List-I		List-II
(P)	Ligands that cannot produce synergic bonding	(1)	NMe3
(Q)	Species, which can act as an ambidentate ligand	(2)	CN^-
(R)	Species, which have the ability to form synergic bonding due to vacant π^* M. O.	(3)	PR_3
(S)	Species, which can act as chelating ligand	(4)	Glycinate
		(5)	CO

(A) (P) $\rightarrow$ (3); (Q) $\rightarrow$ (1); (R) $\rightarrow$ (2), (5); (S) $\rightarrow$ (4)
(B) (P) $\rightarrow$ (1), (4); (Q) $\rightarrow$ (2); (R) $\rightarrow$ (2), (5); (S) $\rightarrow$ (4)
(C) (P) $\rightarrow$ (3), (1); (Q) $\rightarrow$ (4); (R) $\rightarrow$ (1); (S) $\rightarrow$ (5)
(D) (P) $\rightarrow$ (1), (4); (Q) $\rightarrow$ (2); (R) $\rightarrow$ (3); (S) $\rightarrow$ (2)

28. **Matrix Match Type**

	List-I		List-II
(P)	$S_2O_4^{2-}$ + dil acid or $H_2O \longrightarrow$	(1)	COS
(Q)	$S_2O_3^{2-}$ + dil HCl $\longrightarrow$	(2)	SO_2 or HSO^-_3
(R)	$S_2O_8^{2-}$ + dil acid $\longrightarrow$	(3)	Sulphur
(S)	SCN^- + H_2SO_4 (conc) $\xrightarrow{\Delta}$	(4)	SO_4^{2-}
		(5)	$S_2O_3^{2-}$

(A) (P) $\rightarrow$ (2), (5); (Q) $\rightarrow$ (3); (R) $\rightarrow$ (3); (S) $\rightarrow$ (4)
(B) (P) $\rightarrow$ (3), (5); (Q) $\rightarrow$ (4), (5); (R) $\rightarrow$ (2); (S) $\rightarrow$ (1), (3)
(C) (P) $\rightarrow$ (3), (4); (Q) $\rightarrow$ (2), (3); (R) $\rightarrow$ (4); (S) $\rightarrow$ (1), (5)
(D) (P) $\rightarrow$ (2), (5); (Q) $\rightarrow$ (2), (3); (R) $\rightarrow$ (4); (S) $\rightarrow$ (1), (4)

SECTION – B

(Numerical Answer Type)

*This section contains **SIX (06)** Numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.*

29. Calculate the number of chemical entities given below, in which central atom has $d_{x^2-y^2}$ orbital in hybridized state?
$\left[Cr\left(NH_3\right)_6\right]^{3+}$, XeF_5^-, $Ni\left(CO\right)_4$, $\left[Ni\left(CN\right)_4\right]^{2-}$, $Cr_2O_7^{2-}$, IF_5, $\left[Pt\left(Br\right)_2\left(en.\right)\right]$, SF_4, $\left[Ni\left(dmg\right)_2\right]$, $Fe\left(CO\right)_5$

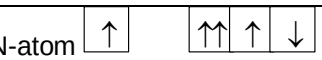
30. How many of the following metallurgical process are matched correctly:

(1)	Matte	$98\%\,Cu_2S + 2\%\,FeS$
(2)	Van Arkel method	Purification of metals like Ti and Zr.
(3)	Poling	Purification of metal containing impurity of oxide of same metal.
(4)	Leaching	Chemical method of concentration of ores like Au and Ag.
(5)	Froth floatation	Argentite, copper pyrite
(6)	Electro refining of aluminium	Electrolyte is molten alumina mixed with cryolite and $AlCl_3$
(7)	Blister copper	Purest form of copper
(8)	Electrolytic reduction for Mg	Electrolysis of mixture of 4:1 ratio of $MgCl_2$(aq.) & NaCl(aq.).
(9)	Blast furnace in extraction of Iron	Zone of heat absorption is at temperature around 1800K
(10)	Cyanide process	Extraction of silver ore to obtain crude Ag in absence of air.

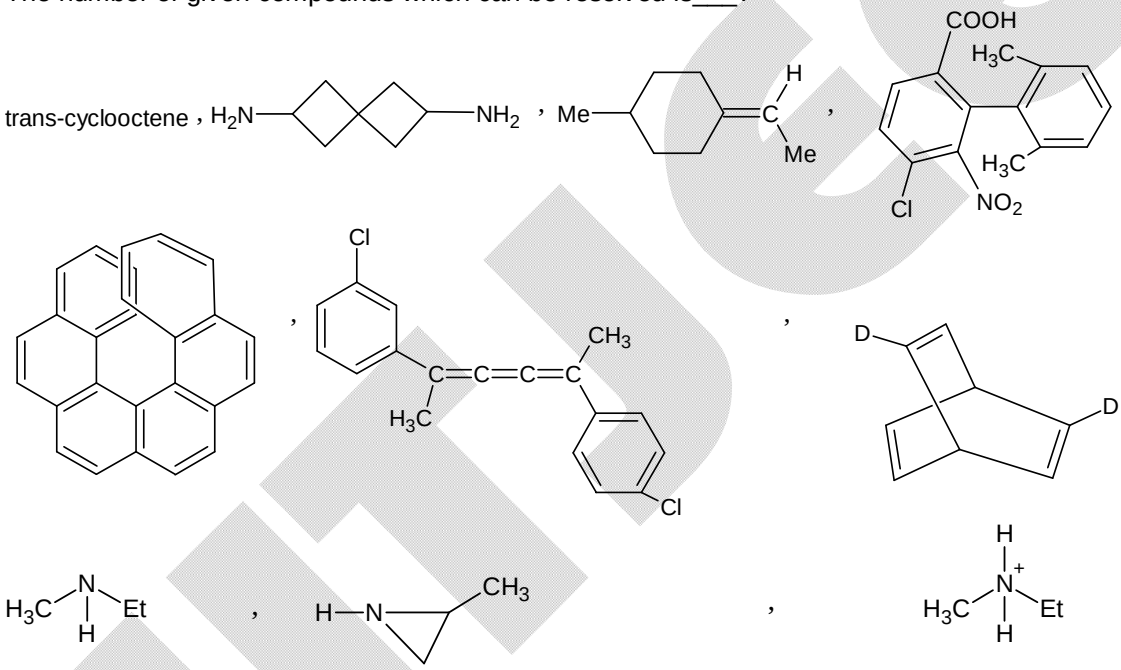
31. Fe_7S_8 is an iron sulphide containing iron as Fe^{2+} *and* Fe^{3+}. If the percentage of cation vacancies relative to Fe^{2+} ions present initially (as ideal crystal of FeS) is 'a'. Then the value of '2a' is___.

32. The solubility of SO_2 in water at 298K is 1.5 mol/ltr, when pressure of SO_2 over water is 1 atm. On a certain day the average concentration of SO_2 in the atmosphere is 10 ppm at an average temperature of 298K. the pKa of H_2SO_3 is 2, then the pH of rainwater on that day is 'x'. The value of $100x$ is____.
(Given: If α_1 is greater than 0.90, consider it 1 and ignore α_2 for H_2SO_3, log2 = 0.3, log 3 = 0.48)

33. How many of the following statements are correctly matched?

(1)	Orbitals having directional characters in a sub-shell	degenerate orbitals.
(2)	Orbitals with one spherical node	2s, 3p.
(3)	Probability density is maximum at nucleus	1s of H-atom.
(4)	Probability of finding an e^- is maximum at 0.2645Å	He^+ ion ground state.
(5)	Orbitals with equal energy	3p, 3d of H-atom
(6)	Orbitals having zero orbital angular momentum	2s, 2p of He^+ ion.
(7)	Valence e^- of N-atom 	Violation of Aufbau rule, Pauli exclusion principle and Hund's rule.
(8)	The radial node for 1s-orbital	at 0.529Å for H-atom

34. The number of given compounds which can be resolved is___?



Mathematics

PART – III

SECTION – A
(One or More than one correct type)

*This section contains **THREE (03)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

35. Let X be a square matrix of order 4 such that $16X^4 - 96X^3 + 216X^2 + 81I = O$ and det(X) = 16, then which of the following can be true?

(A) $\det\left(\text{adj}\left(2I-3X^{-1}\right)\right)=3^6$ (B) $\text{adj}\left(\text{adj}X\right)=2^8.X$

(C) $\text{adj}\left(\text{adj}\left(\text{adj}X\right)\right)=2^{28}.X^{-1}$ (D) $\det\left(\text{adj}\left(2I-3X^{-1}\right)\right)=2^{12}$

36. The position vectors of the vertices A, B and C of a tetrahedron ABCD are $\hat{i}+\hat{j}+\hat{k},\hat{i}\text{and}3\hat{i}$ respectively. The altitude form vertex D to the opposite face ABC meets the median line through A of the triangle ABC at a point E. If the length of edge AD is 4 units and volume of tetrahedron is $\frac{2\sqrt{2}}{3}$ units, then the possible position vectors (s) of point E is/are

(A) $-\hat{i}+3\hat{j}+3\hat{k}$ (B) $2\hat{j}+2\hat{k}$

(C) $3\hat{i}+\hat{j}+\hat{k}$ (D) $3\hat{i}-\hat{j}-\hat{k}$

37. The solution of the differential equation $xy\left(\frac{dy}{dx}\right)^2-\left(x^2-y^2\right)\frac{dy}{dx}-xy=0$ represents (C_1, C_2 are constant of integration)

(A) $\left(x^2+y^2-C_1\right)\left(2x^2+3y^2-C_2\right)=0$

(B) $\left(xy-C_1\right)\left(x^2-y^2-C_2\right)=0$

(C) A conic with eccentricity $\sqrt{2}$

(D) A circle and an ellipse

SECTION – A
(One Options Correct Type)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

38. Let $P = \frac{1}{2}\cos\theta-\frac{1}{4}\sin2\theta-\frac{1}{8}\cos3\theta+\frac{1}{16}\sin4\theta+\frac{1}{64}\sin6\theta-\frac{1}{128}\cos7\theta+...$

$Q = 1-\frac{1}{2}\sin\theta-\frac{1}{4}\cos2\theta+\frac{1}{8}\sin3\theta+\frac{1}{16}\cos4\theta-\frac{1}{32}\sin5\theta-\frac{1}{64}\sin6\theta+\frac{1}{128}\cos7\theta+...$ So that $\frac{P}{Q}=\frac{2\sqrt{2}}{7}$, then number of possible values of θ in interval $\left(-3\pi,3\pi\right)$ is equal to

(A) 4 (B) 6

(C) 12 (D) 18

39. The number of order pairs (a, b) of integers such that $\log_a b + 6\log_b a = 5$, $2\le a\le 2021$ and $2\le b\le 2021$, is equal to

(A) 43 (B) 47

(C) 54 (D) 57

40. If $k < \frac{n}{2}$ where k, $n \in N$; then ${}^{n}C_{2k}$ is equal to (assume ${}^{P}C_{q} = 0$ if p < q)

(A) $\sum_{r=0}^{n}(-1)^{r}.{}^{n}C_{r}.{}^{n}C_{2k}$ (B) $\sum_{r=0}^{n}(-1)^{r}.{}^{n}C_{r}.{}^{r}C_{2k}.3^{n-r}$

(C) $\sum_{r=0}^{n}{}^{n}C_{r}.{}^{r}C_{2k}.3^{n-r}.(-2)^{r-2k}$ (D) $\sum_{r=0}^{n}{}^{n}C_{r}.{}^{r}C_{3k}.(3)^{n-r}.(-1)^{r-3k}$

41. If the combined equation of sides of a triangle are $(x+y-12)(x^2-6xy+y^2)=0$, then

(A) The coordinate of incentre of the triangle is $(9-3\sqrt{3},9-3\sqrt{3})$

(B) Area of the incircle is $(24-12\sqrt{3})\pi$ sq. units

(C) Ratio of the circumradius and inradius is $\frac{3}{4}(\sqrt{3}-1)$ units

(D) Perimeter of the triangle is $22(\sqrt{3}+1)$ units

SECTION – A
(Matching List Type)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (P), (Q), (R) and (S) and FIVE statements in **List-II** entries (1), (2), (3), (4) and (5). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

42. Match the following:

	List-I		List-II
(P)	If z_1, z_2, z_3 are the vertices of an equilateral triangle with centroid z_0, the value of $\left(\frac{z_1^2+z_2^2+z_3^2}{z_0^2}\right)$ is	(1)	0
(Q)	If the complex number z satisfying the equation $(i-z)(1+2i)+(1-zi)(3-4i)=1+7i$, then $z+\bar{z}+z\bar{z}$ is equal to	(2)	7
(R)	If $\lvert z-i\rvert \le 2$ and $z_0 = 5 + 3i$, the maximum value of $\lvert iz+z_0\rvert$ is	(3)	3
(S)	If a complex z lies on a circle of radius $\frac{1}{2}$, then the complex number $(1-4z)$ lies on a circle radius	(4)	2
		(5)	1

(A) (P) $\to$ 4; (Q) $\to$ 5; (R) $\to$ 1; (S) $\to$ 5 (B) (P) $\to$ 3; (Q) $\to$ 1; (R) $\to$ 2; (S) $\to$ 4

(C) (P) $\to$ 4; (Q) $\to$ 1; (R) $\to$ 1; (S) $\to$ 5 (D) (P) $\to$ 3; (Q) $\to$ 5; (R) $\to$ 2; (S) $\to$ 4

43. Match the following:

	List-I		List-II
(P)	$\int_{-\pi}^{\pi} \frac{x^2}{1+\sin x+\sqrt{1+\sin^2 x}}dx$ is equal to	(1)	$\tan^{-1}\frac{2}{\pi}-\frac{\pi}{4}$
(Q)	$\int_{1/2}^{2} \frac{\tan^{-1}x}{x^2-x+1}dx$ is equal to	(2)	0
(R)	$\int_{0}^{\frac{\pi}{2}} \frac{x\cos x-\sin x}{x^2+\sin x}dx$ is equal to	(3)	$\tan^{-1}\frac{3}{\pi}-\frac{\pi}{4}$
(S)	$\int_{-1}^{1} \frac{\sqrt[3]{x}}{\sqrt[3]{1-x}+\sqrt[3]{1+x}}dx$ is less than or equal to	(4)	$\frac{\pi^2\sqrt{3}}{18}$
		(5)	$\frac{\pi^3}{3}$

(A) (P) $\rightarrow$ 4; (Q) $\rightarrow$ 4; (R) $\rightarrow$ 3; (S) $\rightarrow$ 4 (B) (P) $\rightarrow$ 4; (Q) $\rightarrow$ 2; (R) $\rightarrow$ 3; (S) $\rightarrow$ 2
(C) (P) $\rightarrow$ 5; (Q) $\rightarrow$ 2; (R) $\rightarrow$ 1; (S) $\rightarrow$ 4 (D) (P) $\rightarrow$ 5; (Q) $\rightarrow$ 4; (R) $\rightarrow$ 1; (S) $\rightarrow$ 2

44. Match the following:

	List-I		List-II
(P)	The number of the distinct real roots of the equation $(x + 1)^5 = 2(x^5 + 1)$ is	(1)	16
(Q)	The absolute maximum value of the function $f(x) = \frac{(x+1)^4}{x^4-x^3+x^2-x+1}$ is	(2)	3
(R)	Let $f(x) = ab \sin x + \sqrt{1-a^2}\cos x + c$, where $\lvert a\rvert, \lvert b\rvert < 1$, then the maximum difference of maximum and minimum value of f(x) is	(3)	1
(S)	If $u = \sqrt{4\cos^2\theta+\sin^2\theta}+\sqrt{4\sin^2\theta+\cos^2\theta}$, then the difference between maximum and minimum value of u^2 is	(4)	2
		(5)	0

(A) (P) $\rightarrow$ 2; (Q) $\rightarrow$ 1; (R) $\rightarrow$ 4; (S) $\rightarrow$ 3 (B) (P) $\rightarrow$ 3; (Q) $\rightarrow$ 5; (R) $\rightarrow$ 3; (S) $\rightarrow$ 4
(C) (P) $\rightarrow$ 2; (Q) $\rightarrow$ 5; (R) $\rightarrow$ 4; (S) $\rightarrow$ 3 (D) (P) $\rightarrow$ 3; (Q) $\rightarrow$ 1; (R) $\rightarrow$ 3; (S) $\rightarrow$ 4

45. Match the following:

	List-I		List-II
(P)	Area of region formed by points (x, y) satisfying $[x]^2 = [y]^2$ for $0 \le x \le 4$ is equal to (where [ ] denotes greatest integer function)	(1)	48
(Q)	The area of region formed by points (x, y) satisfying $x + y \le 6$, $x^2 + y^2 \le 6y$ and $y^2 \le 8x$ is $\frac{k\pi-2}{12}$, then k	(2)	27
(R)	The area in the first quadrant bounded by the curve $y = \sin x$ and the line	(3)	7

	$\frac{2y-1}{\sqrt{2}-1}=\frac{2}{\pi}(6x-\pi)$ is $\left[\frac{\sqrt{3}-\sqrt{2}}{2}-\frac{\left(\sqrt{2}+1\right)\pi}{k}\right]$ then k =		
(S)	If the area bounded by the graph of $y = xe^{-ax}$ (a > 0) and the abscissa axis is $\frac{1}{9}$ then the value of a is	(4)	4
		(5)	3

(A) (P) $\rightarrow$ 4; (Q) $\rightarrow$ 3; (R) $\rightarrow$ 4; (S) $\rightarrow$ 2 (B) (P) $\rightarrow$ 3; (Q) $\rightarrow$ 2; (R) $\rightarrow$ 1; (S) $\rightarrow$ 5

(C) (P) $\rightarrow$ 4; (Q) $\rightarrow$ 2; (R) $\rightarrow$ 4; (S) $\rightarrow$ 5 (D) (P) $\rightarrow$ 3; (Q) $\rightarrow$ 3; (R) $\rightarrow$ 1; (S) $\rightarrow$ 2

SECTION – B

(Numerical Answer Type)

*This section contains **SIX (06)** Numerical based questions. The answer to each question is a **NON-NEGATIVE INTEGER VALUE**.*

46. If there exist a chord a parabola $y = ax^2 + bx$, $a, b \in R, a \neq 0, b \neq 0$, such that the end points of the chord are (p, q) and (q, p) for some $p, q \in R$ and $p \neq q$ then the least possible positive integral value of b is

47. The number of solutions of the equation $x^3 - [x^3] = (x - [x])^3$ where [x] denotes the greatest integer less that than or equal to x, $\in [1, 10)$ is

48. If $S = \frac{\sum_{n=1}^{99}\sqrt{10+\sqrt{n}}}{\sum_{n=1}^{99}\sqrt{10-\sqrt{n}}}$ then the value of $\left(\frac{1}{S}-S\right)$ is

49. Let $a_n = \sum_{\gamma=1}^{n}\frac{\cos\left(2.3^{\gamma-1}.\alpha\right)}{\sin\left(3^{\gamma}\alpha\right)}$ where $\alpha = 18^o$ and $b_n = \sum_{\gamma=1}^{n}\frac{\cos\left(3.2^{\gamma-1}\beta\right)}{\cos\left(2^{\gamma}\beta\right)}$ where $\beta = 36^o$ then the value of $a_{2021} + b_{2020}$ is

50. The number of ordered quadruples of real numbers (a, b, c, d) such that
$a-\frac{1}{a}=2b, b-\frac{1}{b}=2c, c-\frac{1}{c}=2$ dand $d-\frac{1}{d}=2a$ is___

51. In a 8 x 8 chess board, let P be the probability of selecting two squares such that a white queen and a black knight can be placed there in non attacking position. The value of 36 P is (Note: Queen can attack in the same row, column and diagonally. A knight can attack by moving 2 squares horizontally and one square vertically and vice- verse in a single move)