FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Advanced)-2019

PAPER – 2

TEST DATE: 03-02-2019

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

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 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-D.**

1. ***Section-A (01 – 06, 19 – 24, 37 – 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *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, both of which are correct options.*
   *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 (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST-I*** *and* ***LIST-II****.* ***FOUR*** *options are given representing matching of elements from* ***LIST-I*** *and* ***LIST-II****.* ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

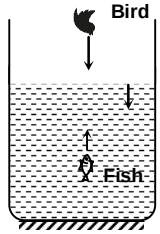
Physics

PART – I

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

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A bird is flying downward with constant velocity 6 cm/s towards a fixed container filled with a liquid of refractive index 4/3. A fish is moving upward with constant speed 4 cm/s towards the surface of liquid. Surface of liquid is also moving downward with constant velocity 2 cm/s as shown in the figure. The bottom of container is silvered. Then

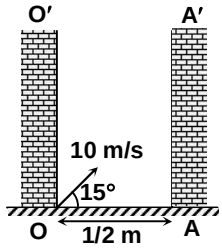


(A) Speed of fish as seen by bird only after refraction is 9 cm/sec
(B) Speed of fish as seen by bird only after refraction is 8.5 cm/sec
(C) Speed of fish as seen by bird after reflection and then refraction is 3 cm/sec
(D) Speed of fish as seen by bird after reflection and then refraction is 2.5 cm/sec

2. Two ideal gases A and B are kept in a closed container at room temperature. Consider collisions takes place between the molecules of A and B. Let K'_A and K'_B are the kinetic energies of molecule A and B respectively after collision and K_A and K_B are the kinetic energies of molecule A and B respectively before collision. Then choose the possible option(s)

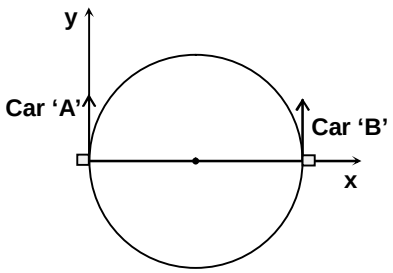
(A) $K_A > K_A', K_B > K_B'$
(B) $K_A < K_A', K_B < K_B'$
(C) $K_A > K_A', K_B < K_B'$
(D) $K_A < K_A', K_B > K_B'$

3. OO′ and AA′ are two vertical walls. A particle is projected from O with speed 10 m/s at an angle 15° from the horizontal. All collisions with each walls are perfectly elastic. Then choose the correct statement(s).



(A) The horizontal component of velocity will change after each collision.
(B) Particle will land on the ground between points O and A.
(C) The total number of collisions with walls is 9 till particle reaches ground again for the first time after projection.
(D) Time taken by particle to reach the ground is 2 sin 15° seconds.

4. Two cars 'A' and 'B' are moving along y-axis and in a circle of radius 30 m respectively. Initial co-ordinate of cars 'A' and 'B' are (0, 0) and (60, 0) respectively. Car 'A' starts from rest and moves with constant acceleration 20/3 m/s^2 and Car 'B' moves with constant speed. Time taken by car 'B' to complete the circle is 12 sec. Choose the correct option(s).



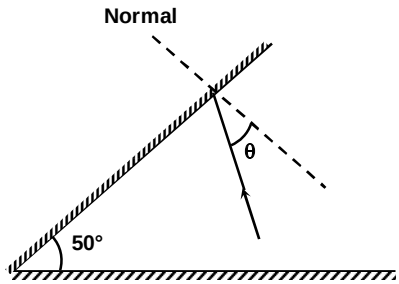
(A) The magnitude of average velocity of car 'A' with respect to car 'B' is 10 m/s in time interval 0 to 3 sec.

(B) The magnitude of average velocity of car 'A' with respect to car 'B' is 10 m/s in time interval 0 to 6 sec.

(C) The magnitude of average acceleration of car 'A' with respect to car 'B' is $\frac{5\pi+20}{3}$ m/s^2 in time interval 0 to 6 sec.

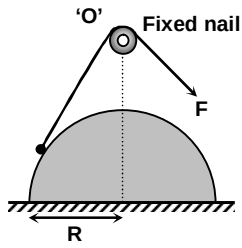
(D) The magnitude of average acceleration of car 'A' with respect to car 'B' is $\frac{5\pi}{3}$ m/s^2 in time interval 0 to 6 sec.

5. Two plane mirrors are placed in such a way that they make an angle 50° as shown in figure. A ray of light falls on one mirror and it reflects from each mirror once. For the given situation mark the correct statement(s).



(A) The value of θ must be less than 40°.
(B) θ can have any value ranging from 0° to 90°.
(C) Total deviation produced in light ray is independent of value 'θ'.
(D) Laws of reflection are valid for only plane and spherical mirrors.

6. A hemisphere of radius 'R' is kept fixed on a horizontal surface. A nail is also fixed at 'O' exactly above the centre of hemisphere at some height. A small ball of mass 'm' is slowly pulled by an external force F on the surface of hemisphere. String is massless and friction force between ball and hemisphere is negligible. Then

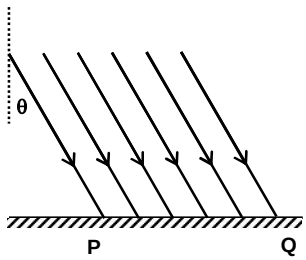


(A) As ball moves up tension in the string decreases.
(B) As ball moves up tension in the string increases.
(C) As ball moves up normal between ball and sphere decrease.
(D) As ball moves up normal between ball and sphere increase.

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

7. A parallel beam of light is incident on a fixed surface PQ at an angle 'θ' with the vertical as shown in the figure. The intensity of light is I and area of surface PQ is A. In List –I nature of reflection are given and in List-II force and generated radiation pressure are given. Then match List-I with suitable option List-II. (Given that I = 500 W/m^2, A = 1.5 m^2, θ = 37°)

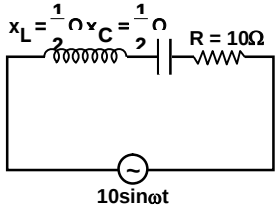
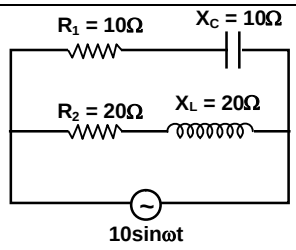
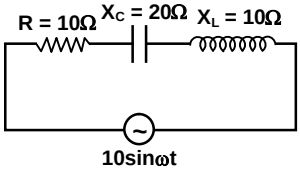
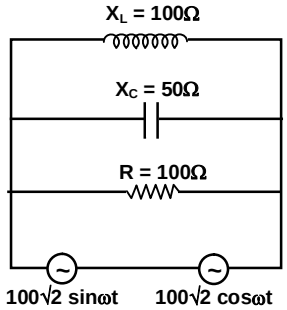


	LIST–I		LIST–II
P.	If all the incident energy is absorbed by surface PQ then force on the surface and radiation pressure generated are respectively.	1.	3.2×10^{-6} N, 2.13×10^{-6} N/m^2

Q.	If all the incident energy is reflected by surface PQ then force on the surface and radiation pressure generated are respectively.	2.	2.24×10^{-6} N, 1.38×10^{-6} N/m^2
R.	If 30% incident energy is reflected by the surface then force on the surface and pressure generated are respectively.	3.	2.74×10^{-6} N, 1.81×10^{-6} N/m^2
S.	If 70% incident energy is reflected back then force on the surface and radiation pressure are respectively.	4.	2×10^{-6} N, 1.06×10^{-6} N/m^2
		5.	4.2×10^{-6} N, 3.13×10^{-6} N/m^2

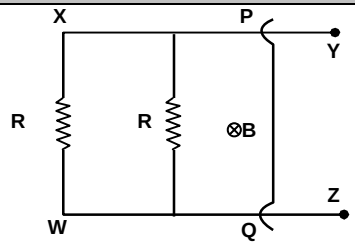
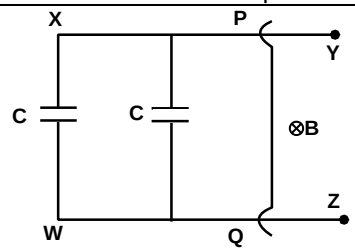
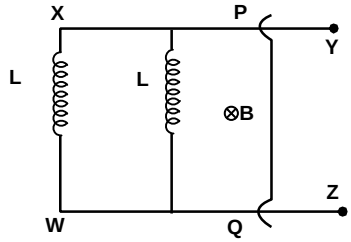
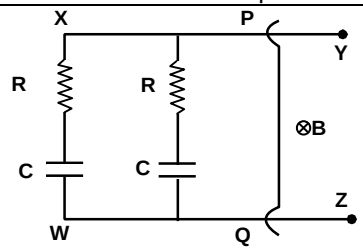
(A) P → 4; Q → 1; R → 3; S → 2
(B) P → 3; Q → 2; R → 1; S → 4
(C) P → 3; Q → 5; R → 4; S → 2
(D) P → 4; Q → 1; R → 2; S → 3

8. Some electric circuits with an A.C. source is given in List-I. In List-II instantaneous current and average power delivered by A.C. source are given. Then Match List-I with List-II.

LIST–I		LIST–II	
P.		1.	$I = \frac{\sqrt{10}}{4}\sin\left[\omega t + \frac{\pi}{4} - \tan^{-1}\left(\frac{1}{2}\right)\right]$, $P = \frac{15}{4}$ watt
Q.		2.	$I = 2\sqrt{2}\cos\omega t$, P = 200 watt
R.		3.	I = sin ωt, P = 5 watt
S.		4.	$I = \frac{1}{\sqrt{2}}\sin\left(\omega t + \frac{\pi}{4}\right)$, $P = \frac{5}{2}$ watt
		5.	$I = \frac{\sqrt{10}}{4}\sin\left(\omega t + \frac{\pi}{4} - \tan^{-1}(2)\right)$, $P = \frac{7}{2}$ watt

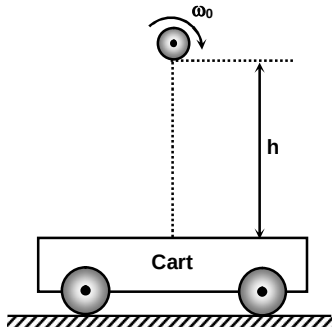
(A) P → 4; Q → 4; R → 1; S → 4
(B) P → 3; Q → 3; R → 1; S → 3
(C) P → 3; Q → 1; R → 4; S → 2
(D) P → 4; Q → 3; R → 4; S → 1

9. In List -I electrical circuits are given. In each circuit perpendicular inward magnetic field (B) exist and an initial velocity v_0 is imparted to the rod (PQ towards right. Rod is conducting and has negligible resistance. 'm' is the mass of rod and ℓ is the length of rod. Both rails xy and wz are frictionless and has negligible resistance also. In List -2, velocity of rod and current in the circuit are given. Match the circuit in List – I to the velocity and current in List – II.

LIST–I		LIST–II	
P.	 Two resistors 'R' in parallel	1.	Minimum magnitude of velocity of rod PQ is $\frac{mv_0}{m+2B^2\ell^2C}$.
Q.	 Two capacitor 'C' in parallel	2.	Maximum magnitude of velocity of rod is v_0.
R.	 Two inductors 'L' in parallel	3.	Velocity of rod oscillates with maximum magnitude of velocity v_0.
S.		4.	Minimum magnitude of velocity of rod is zero.
		5.	Current oscillates in the circuit.

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

10. A solid sphere of mass m = 80 kg and radius r = 0.2 m is released from height h = 5/4 meter. Sphere is initially rotating about horizontal axis passing through its centre of mass. It hits with a stationary cart of mass M = 200 kg exactly at the centre of cart. The cart can move smoothly on the horizontal surface. The collision between sphere and cart occurs in such a way that sphere reaches at same vertical displacement after collision and falls back onto it again. It is found that sphere starts pure rolling at the end of first collision. The coefficient of friction between sphere and cart is $\mu = 0.1$. Match the statement given in **List-I** to the values given in **List-II**.



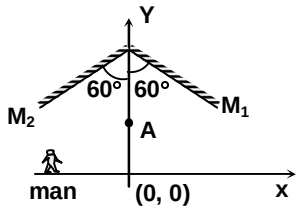
	LIST–I		LIST–II
P.	The minimum length (in meter) of cart to occur second collision with the sphere	1.	172
Q.	Initial angular velocity 'ω_0' (in rad/sec) of sphere for minimum length of cart.	2.	2.8
R.	Magnitude of work done (in Joule) by sphere on the cart during the process.	3.	156
S.	Magnitude of work done (in Joule) by cart on the sphere during the process	4.	19.5
		5.	16

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

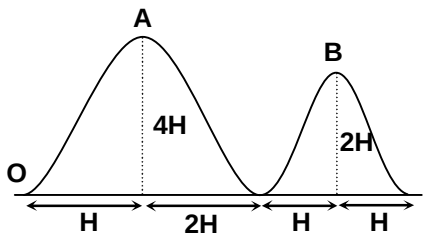
SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** 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**; e.g. xxxxx.xx).

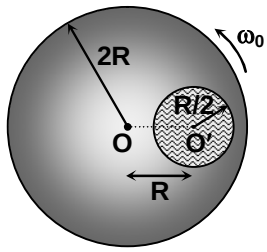
11. Two large plane mirrors M_1 and M_2 are kept at an angle of 120° as shown in figure. The co-ordinate of intersection of plane mirror is (0, 2 meter). A man moves along x-axis. Find the length (in meter) on x-axis for which man can see both the images of point A formed by mirrors simultaneously. (take $\sqrt{3} = 1.73$ and height of man is negligible)



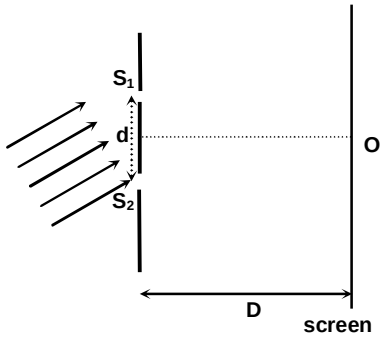
12. A small block of mass m = 200gm is projected from point 'O' on a rough curved surface. The coefficient of friction between particle and surface is 0.4. Assume particle is always in contact with the surface. A and B are local peaks of curved surface. Find the minimum kinetic energy (in Joule) given to the small block to reach at B. (Given H = 4 meter)



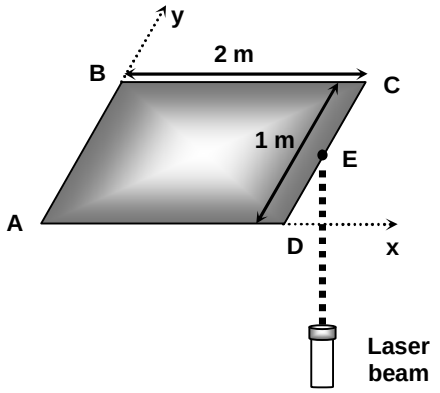
13. A disc of mass m and radius 2R has another disc of mass 2m and radius R/2 kept on it at O′. The system is given an angular velocity ω_0 about a vertical axis passing through O′. The friction between discs is negligible and smaller disc is free to rotate about O′. Find the angular momentum (in M.K.S unit) of system at t = $\frac{\pi}{\omega_0}$ about a vertical axis passing through O.
(Given that m = 300 gm, ω_0 = 8 rad/s and R = 1/2 m)



14. A monochromatic light of wavelength λ_0 and intensity I_0 is incident on YDSE experiment. The distance between slits S_1S_2 is 'd' (d<<D). The angle made by parallel beam light with the normal to the plane of slits is $\text{Sin}^{-1}\left(\frac{3\lambda}{2d}\right)$. Now, if a transparent glass slab of thickness $\frac{3\lambda}{2(\mu-1)}$ is kept infront of one of the slits, where 'μ' is refractive index of glass slab. Find the intensity (in W/m^2) at the geometrical centre 'O' of the screen. (Given, d = 1 mm, D = 2 m, μ = 4/3, λ = 4000Å and I_0 = 4.16 W/m^2)

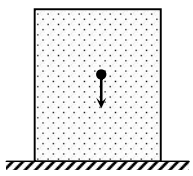


15. A perfectly reflecting rectangular plate ABCD is kept in horizontal (x–y) plane. The dimension of rectangular plane is (2 × 1)m^2 as shown. Rectangular plate can rotate about y–axis and gravity due to earth is along negative Z direction. An impulsive laser is kept below the point E which emits the pulses periodically. A laser beam of diameter 0.2 microns is directly incident at E. The time interval between two pulse is 0.01 ms, and has a total energy of 20 Jules. If the metallic plate ABCD remain in equilibrium then find the mass of plate in gram.

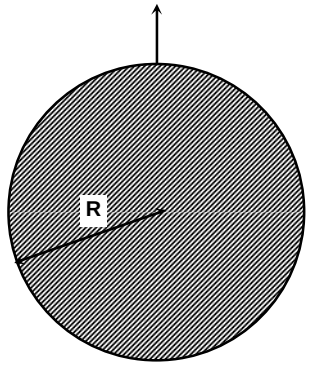


16. A screw gauge is used to measure the thickness of a thin sheet of copper. The pitch of screw gauge is 0.2 mm and total number of division on circular scale is 200. When two jaws are brought in contact then 160th division of circular scale is exactly coincide with the main scale line, and that the zero of main scale is barely visible. When thickness of sheet is measured with screw gauge then main scale reading is 0.6 mm and 100th division coincide with the main scale line. Find the thickness of copper sheet in mm.

17. A dense liquid is completely filled in a closed large container and kept at rest on a horizontal surface. A steel ball is moving downward with a constant speed of 0.5 cm/sec. Find the momentum of dense liquid in C.G.S unit, if its density is 3 gm/cm^3. Given that volume is steel ball of 1.5 cm^3.



18. A small body of mass 'm' is projected from the surface of a given planet as shown in the figure. If small body has velocity which is just sufficient to get out from the gravity of planet then time taken by small body to reach at height of 3R from the surface of planet is $K\sqrt{\frac{2R^3}{GM}}$. Find the value of K.



Planet of mass M and radius R

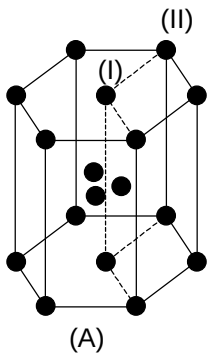
Chemistry

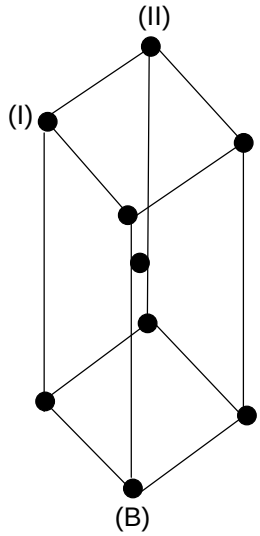
PART – II

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

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Consider a hexagonal unit cell as shown in figure (A). It can be considered to consist of three identical unit cells with a rhombus base as shown in figure (B).





Now, identify the correct statement(s) regarding (B):

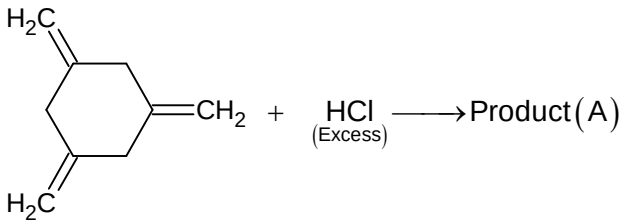
(A) contribution of lattice point (I) per unit cell is $\frac{1}{6}$.

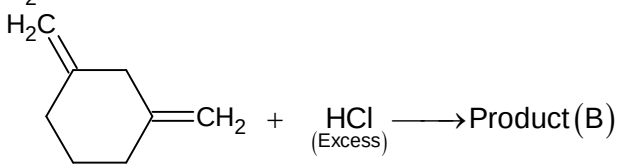
(B) contribution of lattice point (I) per unit cell is $\frac{1}{3}$.

(C) contribution of lattice point (II) per unit cell is $\frac{1}{12}$.

(D) contribution of lattice point (II) per unit cell is $\frac{1}{4}$.

20. Identify the correct statement(s) about the product "A and B" formed in the following reactions: (Assume carbocations do not rearrange)

(i) 

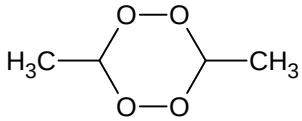
(ii) 

(A) In reaction (i), two geometrical isomers of (A) are possible.
(B) In reaction (i), two optical isomers of (A) are possible.
(C) In reaction (ii), two geometrical isomers of (B) are possible.
(D) In reaction (ii), three stereoisomers of (B) are possible.

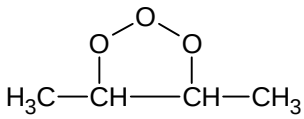
21. Hoope's process of purification of aluminium involves formation of layers during electrolysis. It involves:
(A) The 3 layers have same densities but different materials.
(B) The 3 layers have different densities.
(C) The upper layer is of pure aluminium which acts as cathode.
(D) The bottom layer is of impure aluminium which acts as an anode and middle layer consist of cryolite and fluorspar.

22. Suppose your weight is 80 kg and you want to fly in the sky with the help of balloons each containing 50 moles of H_2 gas at 0.5 atm and 27^oC. How many balloons do you need to attach with yourself to fly. Given density of air = 1.25 g/L and it remains constant throughout (Neglect the weight of balloon).
(A) 25
(B) 27
(C) 30
(D) 20

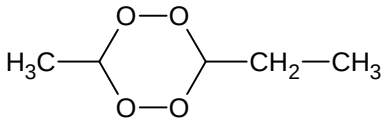
23. Identify the correct statement(s) regarding the reductive ozonolysis of 2-pentene.
(A) A maximum of 10 ozonides can be formed.
(B) One of the intermediate that can be formed is



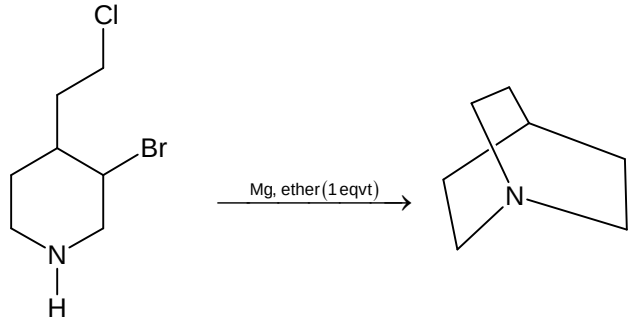
(C) One of the intermediate that can be formed is



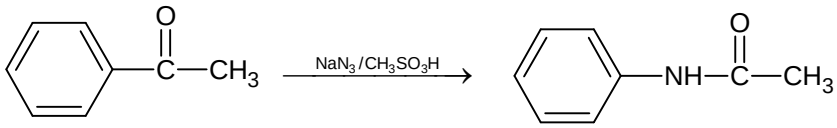
(D) One of the intermediate that can be formed is



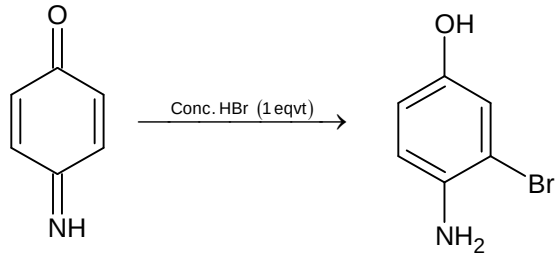
24. Identify the reaction(s) with correct major product?
(A)



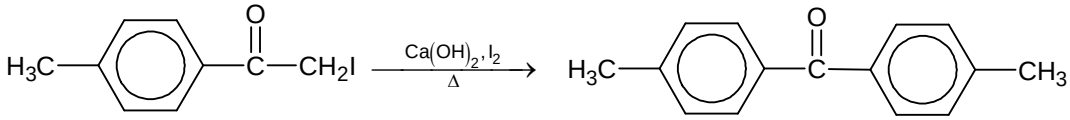
(B)



(C)



(D)



(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

25. Match the polymers in List-I with their characteristic in List-II and choose the correct option from the codes given below:

List-I		List-II	
(P)	Bakelite	(1)	Natural polymer
(Q)	Natural rubber	(2)	Addition polymer
(R)	Buna-N	(3)	Linear polymer
(S)	Cellulose	(4)	Co-polymer
		(5)	Thermosetting plastic

Codes:

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

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

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

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

26. Match the solids in List-I with their corresponding characteristics in List-II and choose the correct option from the codes given below: (where 'a' is the edge length of unit cell)

List-I		List-II	
(P)	NaCl type solid	(1)	Distance of an atom/ion from 6^{th} nearest neighbour is 1.22a
(Q)	CsCl type solid	(2)	Distance of an atom or ion from 4^{th} nearest neighbour is 1.65a
(R)	FCC type of metallic solid	(3)	4^{th} nearest neighbour of an atom or ion is 24
(S)	BCC type of metallic solid	(4)	6^{th} nearest neighbour of an atom or ion is 24
		(5)	2^{nd} nearest neighbours of an atom or ion are 6
		(6)	3^{rd} nearest distance between the neighbour is 1.22a

Codes:

(A) P $\rightarrow$ 1, 4, 5, Q $\rightarrow$ 2, 3, 4; R $\rightarrow$ 5, 6; S $\rightarrow$ 2, 3, 5

(B) P $\rightarrow$ 4, 5; Q $\rightarrow$ 2, 3; R $\rightarrow$ 4, 6; S $\rightarrow$ 2, 4, 5

(C) P $\rightarrow$ 1, 4; Q $\rightarrow$ 2, 3, 5; R $\rightarrow$ 5, 6; S $\rightarrow$ 2, 3, 5

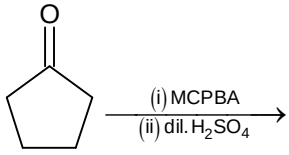
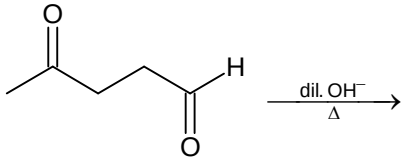
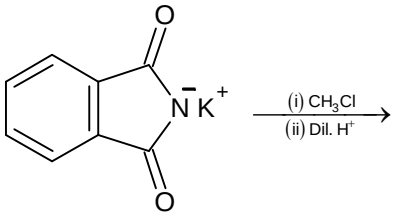
(D) P $\rightarrow$ 1, 4; Q $\rightarrow$ 2, 3, 5; R $\rightarrow$ 4, 5; S $\rightarrow$ 2, 3, 5

27. Match the inequality given in List-I with corresponding property in List-II and choose the correct option from the codes given below:

List-I			List-II
(P)	C > N	(1)	Order of first electron affinity
(Q)	O > F	(2)	Order of first ionisation energy
(R)	Mg > Na	(3)	Order of atomic radii
(S)	F > Cl	(4)	Order of second ionisation energy
		(5)	Order of number of valence electrons

Codes:
(A) P → 2, 3; Q → 3; R → 2, 5; S → 4
(B) P → 1; Q → 3; R → 4; S → 5
(C) P → 1, 3; Q → 3, 4; R → 2, 5; S → 2, 4
(D) P → 1, 3; Q → 3, 4; R → 4; S → 1, 4

28. Match the reaction product(s) in List-I with corresponding test which they give positively in List-II and choose the correct option from the codes given below:

List-I			List-II
(P)	 (where MCPBA is m-chloroperoxy benzoic acid)	(1)	Carbylamine test
(Q)		(2)	$NaHCO_3$ test
(R)		(3)	Product with Hinsberg's reagent is insoluble in aq. KOH solution
(S)	$CH_3NC \xrightarrow{Na/C_2H_5OH}$	(4)	Bromine water test
		(5)	Gives ceric ammonium nitrate test
		(6)	Gives a yellow liquid with CS_2 which do not give a black colour with $HgCl_2$.

Codes:
(A) P → 2, 5; Q → 4; R → 1, 2; S → 3, 6
(B) P → 1, 5; Q → 2, 4; R → 1, 2; S → 3, 6
(C) P → 2, 5; Q → 4; R → 1, 2; S → 2, 6
(D) P → 1, 4; Q → 2, 5; R → 1, 3; S → 3, 6

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** 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**; e.g. xxxxx.xx).

29. If volume occupied by CO_2 molecules is negligible and 'P' is the pressure exerted by one mole of CO_2 gas at 300 K, then find the value of $\frac{P}{16}$ in atm.
(R = 0.08 ℓ atm mol^{-1} K^{-1}, a = 3.6 atm ℓ^2 mol^{-2})

30. If the wave function 'ψ' is studied in one dimension that is along X-axis only then 'ψ' can be written as $\psi_{(x)} = A\sin\left(\frac{2\pi x}{\lambda}\right)$, here 'A' and '$\lambda$' are constants. If the following equation can be written as Schrodinger's wave equation for the above mentioned wave function (ψ):
$\frac{d^n\psi_{(x)}}{dx^n} - \frac{m\pi^p}{\lambda^q}\psi_{(x)} = 0$, where n, m, p and q are some constants. (Where n cannot have its value greater than 2). Find the value of $\frac{n+m+p+q}{m+4p}$

31. Sum of the spin only magnetic moment (in the units of B.M.) of the following complexes:
$\left[Cu(NH_3)_4\right]^{2+}; \left[Fe(CN)_6\right]^{3-}; [NiCl_4]^{2-}; [CoF_6]^{3-}; \left[Fe(H_2O)_5(NO)\right]SO_4$
[Given $\sqrt{2}=1.41, \sqrt{3}=1.73; \sqrt{5}=2.24; \sqrt{7}=2.64; \sqrt{15}=3.87; \sqrt{24}=4.90$

32. Let's assume some statements:
    (i) The rate constants of two parallel reactions are 10^{-2} sec^{-1} and 3×10^{-2} sec^{-1}. If their respective activation energy (Ea) values are 15 and 25 kJ mol^{-1}, then let the Ea of the overall reaction be 'x' kJ mol^{-1}.

    (ii) Rate constant of a first order reaction is 0.0693 min^{-1}. If initial concentration of the reactant is 20 M, then in y minutes, its concentration is reduced to 2.5 M.

    (iii) Half-lives of a first order and zero order reactions are same. Assuming initial concentration to be same in both. Let 'z' times of 0.693 be the ratio of their initial rates (initial rate of 1^{st} order to that of zero order).
    Now, calculate the value of (x + y + z).

33. Both gold and silver are extracted by cyanide process. Gold in nature is frequently alloyed with silver, which is also oxidized by aerated NaCN solution, similar to gold. 500 L of a solution of 0.002 M $[Au(CN)]^-$ and 0.003 M $[Ag(CN)_2]^-$ was evaporated to half of the original volume and treated with 78 g zinc (atomic mass = 65).
Assume that elevation from standard conditions is unimportant and that the redox reactions go to completion. Given:
$\left[Zn(CN)_4\right]^{2-} + 2e^- \longrightarrow Zn(s) + 4CN^-; \qquad E^o = -1.26\ V$

$\left[Au(CN)_2\right]^- + e^- \longrightarrow Au(s) + 2CN^-; \qquad E^o = -0.60\ V$

$\left[Ag(CN)_2\right]^- + e^- \longrightarrow Ag(s) + 2CN^-; \qquad E^o = -0.31\ V$

If the concentration of $[Au(CN)_2]^-$ in the solution after addition of zinc in it, be x mole l^{-1}, and let, the concentration of cyanide ion solution to keep 90% mole of the gold in solution in the form of cyanide complex be 'y' mol/litre? (Given: formation constant K_f of $[Au(CN)_2]^- = 4 \times 10^{28}$)

So, if $\frac{x}{y} = A \times 10^{-11}$, then find the value of 'A':

34. Pure oxygen is manufactured by the following sequential reactions, where MnO_2 is acting as a catalyst. The yield in each step of reaction is 50%.

(i) $MnO_2(s) + 2KClO_3(s) \longrightarrow K_2MnO_4(s) + Cl_2(g) + 2O_2(g)$;

(ii) $K_2MnO_4(s) + Cl_2(g) \longrightarrow 2KCl(s) + MnO_2(s) + O_2(g)$;

How much mass of $KClO_3$ in gms is required to liberate 60 g of O_2 gas at STP?
(Atomic mass : K = 39, Cl = 35.5, O = 16)

35. A 0.001 molal solution of $Pt(NH_3)_4Cl_4$ in water had a freezing point depression of 0.00558°C. If 'x' be the number of moles of ionisable Cl^- ions per mole of the complex, then find the value of $\frac{2x}{5}$.
(Given : K_f of water = 1.86 K kg $mol^{-1,}$ and complex is assumed to be 100% ionized).

36. If the total number of geometrical isomers formed by the square planar complex $[M_{abcd}]$ are 'x', the total number of geometrical isomers formed by the complex $[M_{abcdef}]$ are 'y' and the total number of isomers of $K_4[Fe(CN)_6]$ are 'z', then find the value of $\left(\frac{xy}{z}\right)$

Mathematics

PART – III

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

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. A and B are two $n \times n$ matrices such that $\det(A) \neq 0$, $A + B = (AB)^2$ and $BAB = A + I$. Choose the **correct** option(s).
(A) $A^{-1} = (A^4 - I)$
(B) $B^5 - A^5 = A + B$
(C) $A^9 = A^4 + A + I$
(D) $A^2B^2 = BA^2B$

38. Let f(x) be a differentiable function such that $f'(x) > 0$, $\int_0^1 f(x)\,dx = 2$, $\int_0^1 |f(x)|\,dx = 4$. Choose the **correct** option(s).
(A) $f(x) = 0$ has exactly one root in (0, 1).
(B) $f(x) = 0$ has no root in (0, 1).
(C) $\int_0^1 f(x).\left(\int_0^x |f(t)|\,dt\right)dx = 1$
(D) $\int_0^1 f(x).\left(\int_0^x |f(t)|\,dt\right)dx = 7$

39. Points A and B lie on the auxiliary circle of ellipse $\frac{x^2}{4} + y^2 = 1$. P and Q are the corresponding points on the ellipse for the points A and B respectively (O is the origin). Choose the **correct** option(s).
(A) The maximum value of angle AOP is $\tan^{-1} 2\sqrt{2}$.
(B) The maximum value of angle AOP is $\tan^{-1} \frac{1}{2\sqrt{2}}$.
(C) If $OA \perp OB$ and Q′ is reflection of Q in origin, then minimum value of angle POQ′ is $\tan^{-1} \frac{4}{3}$.
(D) If $OA \perp OB$ and Q′ is reflection of Q in origin, then minimum value of angle POQ′ is $\tan^{-1}\left(\frac{3}{4}\right)$.

40. From the set of n number {1, 3, 5, ..., 2n–1} five consecutive numbers are removed and the mean of remaining numbers is $\frac{393}{5}$. Choose the **correct** option(s).
(A) The value of n is 80.
(B) The value of n is 75.
(C) The mean of removed number is 101.
(D) The mean of removed number is 99.

41. If $\lim\limits_{x\to 0}\dfrac{\sqrt{1+x^2}\tan\sin\tan^{-1}x+2\sqrt{1-x^2}\sin\tan\sin^{-1}x-3x}{x^p}$ exists finitely, then choose the **correct** option(s).

(A) The value of p is 3

(B) The value of p is 5

(C) The value of limit is $\dfrac{-31}{60}$

(D) The value of limit is $\dfrac{-8}{15}$

42. A is 3×3 matrix whose every entry is 1 or –1. Choose the **correct** option(s).

(A) The maximum value of determinant of A is 4.

(B) Total number of different values of determinant of A can take is 3.

(C) Total number of different values of determinant of A can take is 5.

(D) Total number of different matrices A, such that determinant of A is positive, is 96.

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

43. Let A and B are points on the line L_1, L_2 respectively such that d = OA + OB + AB is minimum (O being the origin), match the following List-I with List-II

LIST - I		LIST - II	
P.	$L_1: x-1=y-1=\dfrac{z+1}{0}$, $L_2: x+2=4-y=\dfrac{z+1}{0}$	1.	$d=4\sqrt{2}$
Q.	$L_1:\dfrac{x-1}{2}=1-y=1-z$, $L_2: x-2=y-2=\dfrac{2-z}{2}$	2.	$d=2\sqrt{3}$
R.	$L_1: x=y=z-\sqrt{2}$, $L_2: x=y=z+\sqrt{2}$	3.	$d=6\sqrt{2}$
S.	$L_1: 2x-3=6-y=\dfrac{z}{0}$, $L_2: x+3=2y=\dfrac{z}{0}$	4.	$d=4\sqrt{3}$

The correct option is:

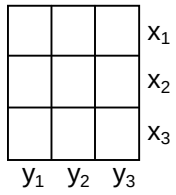
(A) P → 1; Q → 4; R → 2; S → 3

(B) P → 2; Q → 4; R → 1; S → 3

(C) P → 2; Q → 4; R → 3; S → 1

(D) P → 4; Q → 1; R → 2; S → 3

44. Let every cell of adjoining 3×3 array is filled by natural number such that $x_1x_2x_3 = y_1y_2y_3 = 2^3\cdot3^4\cdot5^7$ where x_i, y_j are product of numbers filled in three cells of i^{th} row and j^{th} column respectively i, j ∈ {1, 2, 3}, match the following List-I with List-II



LIST – I (Condition on x_i, y_i)		LIST – II (Number of filling the array)	
P.	If x_i as well as y_j are divisible by 2 for every i, j ∈ {1, 2, 3}	1.	$3\cdot{}^{11}C_3({}^9C_2\cdot{}^9C_5+{}^{12}C_5\cdot{}^6C_2-2\cdot{}^9C_2\cdot{}^6C_2)$

Q.	If none of y_i (i = 1, 2, 3) is divisible by 27	2.	$(3! \cdot {}^{12}C_4 \cdot {}^{15}C_8)$
R.	If none of x_i (i = 1, 2, 3) is divisible by 15	3.	$2 \cdot 3^5 \cdot {}^{11}C_3 \cdot {}^{15}C_7$
S.	If exactly two cells are assigned the value 1 and all other cells have number divisible by 5	4.	$({}^9C_6 \cdot {}^{10}C_6){}^9C_2$

The correct option is:
(A) P → 2; Q → 1; R → 3; S → 4
(B) P → 4; Q → 3; R → 1; S → 2
(C) P → 3; Q → 1; R → 4; S → 2
(D) P → 2; Q → 3; R → 1; S → 4

45. The equation $x^2 - a = \sqrt{x+a}$ has real or imaginary roots depending on values of a. List-I represents the nature of root and List-II represents the corresponding exhaustive values of a, match the following List-I with List-II

LIST–I		LIST–II	
P.	No real root	1.	$(0,1) \cup \left\{-\frac{1}{4}\right\}$
Q.	One real root	2.	$\left(-\infty, -\frac{1}{4}\right)$
R.	Exactly two real roots	3.	$\left(-\frac{1}{4}, 0\right] \cup [1, \infty)$
S.	Atleast two real roots	4.	$\left(0, \frac{3}{4}\right) \cup \left\{-\frac{1}{4}\right\}$
		5.	$\left(-\frac{1}{4}, 0\right] \cup \left[\frac{3}{4}, \infty\right)$

The correct option is:
(A) P → 2; Q → 1; R → 3; S → 3
(B) P → 2; Q → 1; R → 5; S → 4
(C) P → 1; Q → 4; R → 5; S → 5
(D) P → 2; Q → 4; R → 5; S → 5

46. For a given n sided regular polygon, its r vertices are chosen randomly. In List-I: the value of n and r as well as event E is defined. In List-II: P(E), probability of event (E), is given. Match the following List-I with List-II

LIST–I		LIST–II	
P.	n = 10; r = 3, circumcentre lies on the side of triangle itself	1.	P(E) = 1
Q.	n = 9; r = 3, orthocentre of triangle so formed lies inside it	2.	$P(E) = \frac{5}{14}$
R.	n = 10; r = 4, quadrilateral thus formed is regular	3.	P(E) = 0
S.	n = 9; r = 4, out of four selected points, feet of perpendiculars from one of the point to sides of triangle formed by remaining three points is collinear	4.	$P(E) = \frac{1}{3}$

The correct option is:
(A) P → 4; Q → 2; R → 3; S → 1
(B) P → 2; Q → 4; R → 3; S → 3
(C) P → 4; Q → 2; R → 3; S → 3
(D) P → 2; Q → 4; R → 1; S → 3

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** 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**; e.g. xxxxx.xx).

47. Given that $\begin{vmatrix} a & d & 1 \\ b & e & 1 \\ c & f & 1 \end{vmatrix} = -5$, $\begin{vmatrix} a & b & c \\ 1 & 2 & 3 \\ d & e & f \end{vmatrix} = -3$ find the value of $\begin{vmatrix} c & 3 & f \\ b & 1 & e \\ a & -1 & d \end{vmatrix}$.

48. Let $a_{n+1} \cdot a_n = a_n + 2a_{n+1}$, $n \in \mathbf{N}$. For $a_1 = a$ $(a \neq 0)$, sequence is periodic and when $a_1 = b$, a_n is undefined for every n such that $n \geq m$, $m \in \mathbf{N}$. Let maximum value of b is c and minimum value of b is d and $e = \lim_{n\to\infty} a_n$ (for the case when sequence is non-periodic and defined for all values of $n \in N$). Find the value of (a + c + d + e).

49. $f(x) = x^6 - 2x^3 - 8$ and $g(x) = x^2 + 2x + 4$. Let $\alpha_1, \alpha_2, ..., \alpha_6$ are the roots of equation f(x) = 0, find $g(\alpha_1) \cdot g(\alpha_2) ..... g(\alpha_6)$.

50. Find the remainder when $\sum_{r=0}^{2014} \sum_{k=0}^{r} (-1)^k (k+1)(k+2)\, {}^{2019}C_{r-k}$ is divided by 64.

51. The curve f(x, y) = 0 passing through (0, 2) satisfy the differential equation $\frac{dy}{dx} = \frac{y^3}{e^x + y^2}$. If the line x = ln 5 intersect it at points $y = \alpha$ and $y = \beta$, then find the value of $\alpha^2 + \beta^2 + \alpha\beta$.

52. P is a point on parabola $y^2 = 4x$ such that PS = 4 (S is the focus). Tangent is drawn at P to parabola which intersects tangent at vertex at T. A point R is taken on axis of parabola such that SR = 4 and R lies inside the parabola. The area of quadrilateral PRST is q. Find the value of $\sqrt{3}\,q$.

53. Find the maximum value of $\int_0^y \sqrt{x^4 + \left(y(3-y)\right)^2}\,dx$, where $0 \leq y \leq 3$.

54. In a triangle ABC given that a = 7, b = 3, c = 5. The value of
$$\frac{ab}{\left(\tan\frac{B}{2}+\tan\frac{C}{2}\right)\left(\tan\frac{A}{2}+\tan\frac{C}{2}\right)} + \frac{bc}{\left(\tan\frac{A}{2}+\tan\frac{C}{2}\right)\left(\tan\frac{A}{2}+\tan\frac{B}{2}\right)} + \frac{ac}{\left(\tan\frac{B}{2}+\tan\frac{C}{2}\right)\left(\tan\frac{A}{2}+\tan\frac{B}{2}\right)}$$
is _____