

JEE ADVANCED TEST SERIES



NARAYANA
IIT ACADEMY
INDIA

Sec: Incoming.JR_*CO-SC
Time: 3 Hrs

Date: 24-05-20
Max. Marks:180

Name of the Student: _____

H.T. NO:

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17-05-20_JR. STAR CO-SUPER CHAINA _Jee-Main_WAT-2_SYLLABUS

PHYSICS: **PRESENT WEEK(80%):** Lenses and combination of lenses + experiments involving concave mirror, convex lens, concave lens (including optical bench) (Reference : CUMMULATIVE MAINS TEST syllabus)

PREVIOUS WEEK(20%): Prism, Refraction at curved surface (exclude problems involving relative motion and differential and integral calculus)

CHEMISTRY: **PRESENT WEEK(80%):** VSEPR Theory & shapes of simple molecules, VBT, hybridisation, Bond parameters Dipole moment

(Excluding bent's rule and drago's rule, back bonding and bridge bonding, MOT, Metallic Bonding, Vander Waals forces, Hydrogen bonding)

PREVIOUS WEEK(20%): **Chemical Bonding and Molecular Structure-I:** Kossel – Lewis approach to chemical bond formation, concept of ionic and covalent bonds, Lewis structures, Formal Charge, Ionic Bonding: Formation of ionic bonds, factors affecting the formation of ionic bonds; calculation of lattice enthalpy, Fajan's rules, Applications of Fajan's rules- solubility, thermal stability, melting points

MATHEMATICS: **PRESENT WEEK(80%):** Graphs of Trigonometric Functions, Periodicity and extreme values

PREVIOUS WEEK(20%): Conditional Identities, Miscellaneous problems on Transformation values, T-Ratio of some special angles, Transformation formulae (Except Summation)

PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec- I(Q.N: 01 – 10)	Questions with Single Correct Choice	3	-1	10	30
Sec- II(Q.N: 11 – 16)	Questions with Comprehension Type (3 Comprehensions – 2 +2+2 = 6Q)	3	-1	6	18
Sec- III(Q.N: 17 – 20)	Matrix Matching Type	3	-1	4	12
Total				20	60

CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 21 – 30)	Questions with Single Correct Choice	3	-1	10	30
Sec – II(Q.N : 31 – 36)	Questions with Comprehension Type (3 Comprehensions – 2 +2+2 = 6Q)	3	-1	6	18
Sec – III(Q.N : 37 – 40)	Matrix Matching Type	3	-1	4	12
Total				20	60

MATHEMATICS:

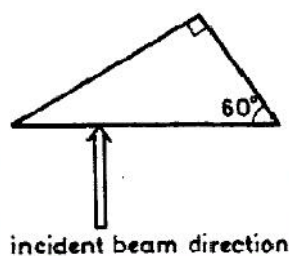
Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 41 – 50)	Questions with Single Correct Choice	3	-1	10	30
Sec – II(Q.N: 51 – 56)	Questions with Comprehension Type (3 Comprehensions – 2 +2+2 = 6Q)	3	-1	6	18
Sec – III(Q.N : 57 – 60)	Matrix Matching Type	3	-1	4	12
Total				20	60

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

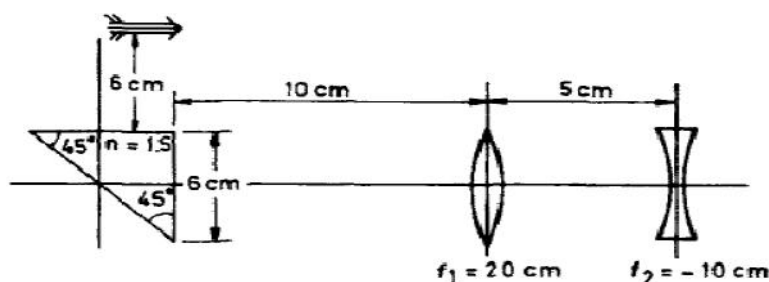
This section contains 10 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

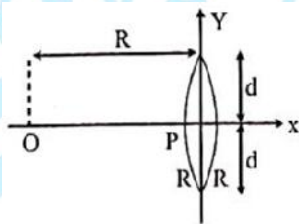
1. A narrow beam of light is incident on a $30^\circ - 60^\circ - 90^\circ$ prism as shown in figure. The index refraction of the prism $n=2.1$. Show that the entire beam emerges either from the right-hand face, or back along the incident path.



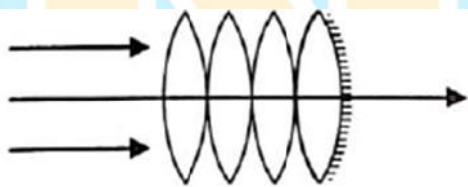
- A) Entire beam emerges from right hand face with adjacent angle 60°
 B) Entire beam emerges from right hand face with adjacent angle 30°
 C) Entire beam emerges from right hand face with adjacent angle 60° or reflected back from bottom surface
 D) Entire beam emerges from right hand face with adjacent angle 30° or reflected back from bottom surface
2. The index of refraction of glass can be increased by diffusing in impurities. It is then possible to make a lens of constant thickness. Given a disk of radius a and thickness d , find the radial variation of the index of refraction $n(r)$ which will produce a lens with focal length F . You may assume a thin lens ($d < a$). Index of refraction at centre of disk is taken as $n(r)=n_0$ (approximately expressed as)
- A) $n(r) = n_0 - \frac{r^2}{2dF}$ B) $n(r) = n_0 - \frac{r^2}{dF}$
 C) $n(r) = n_0 - \frac{2r^2}{dF}$ D) $n(r) = \frac{n_0}{2} - \frac{r^2}{dF}$
3. For the combination of one prism and 2 lenses shown, find the location and size of the final image when the object, length 1 cm, is located as shown in the figure.



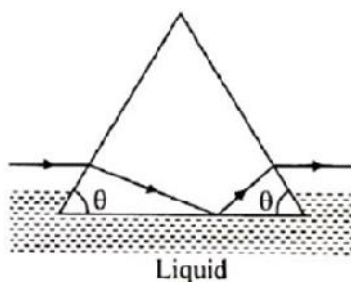
- A) 5 cm from the left of the first lens, 0.5 cm
 B) 10 cm from the right of the second lens, 0.5 cm
 C) 10 cm from the left of the second lens, 1.5 cm
 D) 10 cm from the left of the first lens, 0.5 cm
4. A biconvex lens of radius of curvature R is made up of variable refractive index $m = 2\left(1 + \frac{|y|}{d}\right)$. Assumed very small aperture $2d \ll R$. A point object O is placed at a distance $R = 7.5\text{m}$ on the principal axis from the lens (as shown). Due to variable refractive index of lens, there is infinite number of image on the principal axis. These images are spread over the length l . Find the value of l (in m)



- A) 5 B) 3 C) 6 D) 4
5. Four identical lenses are kept one beside the other on the same optical axis shown in the figure. The right surface of rightmost lens is silvered. Focal length of each lens is 20 cm and radius of silvered surface is 20 cm. The focal length of the combined system is

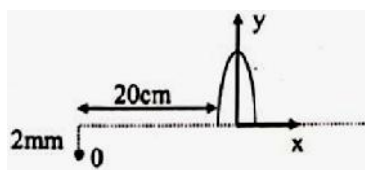


- A) 2cm B) -2cm C) 5 cm D) -5 cm
6. An iso-scale glass prism stands with its (horizontal) base in water as shown in the figure. An incident ray of light above and parallel to the liquid surface and perpendicular to the prism's axis, is internally reflected at the glass-liquid interface and subsequently re-emerges into the air. Refractive index of glass is m_g and liquid is m_l then which relation holds good

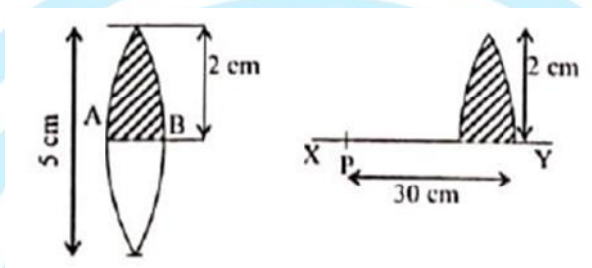


- A) $m_g^2 - m_l^2 \geq \cos^2 \theta (m_g^2 + 1 - 2m_l)$ B) $m_g = m_l \cos \theta$
 C) $m_g^2 = m_l^2 \cos \theta$ D) $m_g^2 - m_l^2 < \cos^2 \theta (m_g^2 + 1 - 2m_l)$

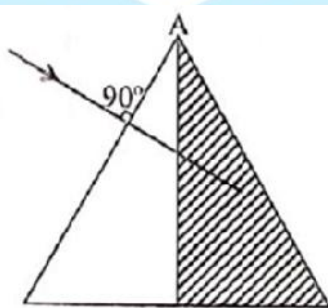
7. If an object is placed 20 cm in front of a half thin convex lens of focal length 10 cm, as shown in figure, then co-ordinate of image taking object position as origin



- A) [20 cm, 0.2 cm] B) [40 cm, 0.4 cm]
 C) [40 cm, -0.2 cm] D) [20 cm, 0.4 cm]
8. A converging lens of focal length 20 cm and diameter 5 cm is cut along the line AB. The part of the lens shown shaded in the diagram is now used to form an image of a point P placed 30 cm away from it on the line XY. Which is perpendicular to the plane to the lens. The image of P will be formed



- A) 0.5 cm above XY B) 1 cm below XY
 C) on XY D) 1.5 cm below XY
9. A ray of light is incident normally on the first reflecting face of the isosceles prism of refracting angle A. The ray of light comes out at grazing emergence. If one half of the prism (shaded position) is knocked off, the same ray will



- A) emerge at an angle of emergence $\sin^{-1}\left(\frac{1}{2}\sec A/2\right)$
 B) not emerge out of the prism
 C) emerge at an angle of emergence $\sin^{-1}\left(\frac{1}{2}\sec A/4\right)$
 D) None of these

10. Three right angled prisms of refractive indices are fitted together so that the faces of the middle prisms are in contact with one of the outside prisms. If the ray passes through the composite block and emerges without any deviation then
- A) $\mu_1^2 + \mu_3^2 + \mu_2^2 = 1$ B) $\mu_1^2 + \mu_3^2 - \mu_2^2 = 1$
 C) $\mu_1^2 - \mu_3^2 + \mu_2^2 = 1$ D) $\mu_1 + \mu_2 - \mu_3 = 1$

SECTION - II

(PARAGRAPH TYPE)

This section contains **3 Paragraph of questions**. Each paragraph has 2 multiple choice questions based on a paragraph. Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE IS** correct.
Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

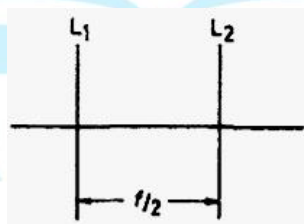
Paragraph for Question Nos. 11 & 12

If a student named Narayana described a combination of two converging lenses which produces an inverted, virtual image at the position of the object and of the same size.

11. The possible ratio of focal lengths to make above set up of student named narayana as possible one is
- A) $\frac{f_1}{f_2} = 9$ B) $\frac{f_1}{f_2} = \frac{1}{9}$ C) $\frac{f_1}{f_2} = 0.101$ D) $\frac{f_1}{f_2} = \frac{8}{9}$
12. The ratio between the distances from object to objective lens and object to eye lens or far away lens in the above mentioned system of two lenses is
- A) 3 B) 2 C) 4 D) 2.5

Paragraph for Question Nos. 13 & 14

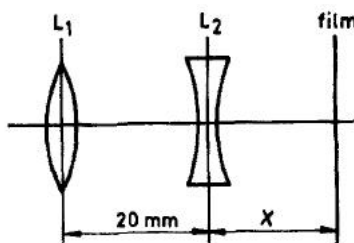
Two positive thin lenses L_1 and L_2 of equal focal length are separated by a distance of half their focal length (fig)



13. Locate the image position for an object placed at distance $4f$ to the left of L_1 .
- A) $\frac{5f}{11}$ B) $\frac{7f}{11}$ C) $\frac{f}{3}$ D) $\frac{5f}{6}$
14. Locate the focal points of this lens combination treated as a single thick lens
- A) $-\frac{f}{3}$ and $\frac{5f}{6}$ from L_1 B) $-\frac{f}{3}$ and $\frac{5f}{6}$ from L_2
 C) $\frac{f}{3}$ and $-\frac{5f}{6}$ from L_1 D) $\frac{f}{3}$ and $\frac{5f}{6}$ from L_2

Paragraph for Question Nos. 15 & 16

A 35mm camera lens (convex) of focal length 50 mm is made into a telephoto lens (concave) between it and the film, as shown. L_1 = camera lens, $f_1 = 50\text{mm}$, L_2 = negative lens, $f_2 = -100\text{mm}$.



15. What is the distance x if the system is focused at an object 50 cm in front of L_1 ?
 A) 5.52 mm B) 55.2 mm C) 50.2 mm D) 58.2 mm
16. What is the magnification produced by the lens combination?
 A) 0.17 B) 0.20 C) 0.11 D) 0.05

SECTION - III
(Matching List Type)

This section contains four questions, each having two matching lists (List-I & List-II). The options for the correct match are provided as (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

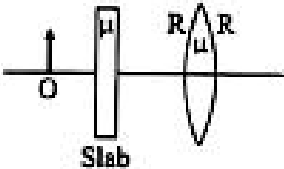
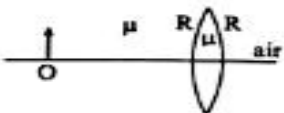
17. Column matching type questions

Column-I	Column-II
A)	P) At surface AC, TIR will take place
B)	Q) At surface AC, light will be refracted
C)	R) Ray refracted at AB will be parallel to base BC
D)	S) Ray refracted at AB will be not be parallel to base BC
	T) Light will graze the surface AC

- A) A-P,S;B-Q, R;C-Q, S; D-P,S B) A-Q,S;B-Q,S;C-T,S;D-P,S
 C) A-P,Q;B-P,R;C-T,S;D-P,S,R D) A-Q,S;B-Q,R;C-Q,S;D-P,S,R

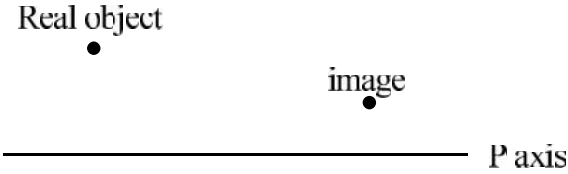
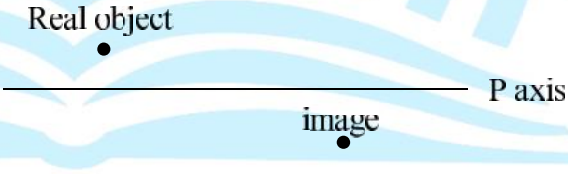
18. An object O (real) is placed at focus of an equal-bioconvex lens as shown in figure. The refractive index of lens of $\mu = 1.5$ and the radius of curvature of either surface of lens is R. The lens is surrounded by air. In each statement of List – I some changes are made to situation given above and information regarding final image formed as a result is given in list II. The distance between lens and object is unchanged in all statements of List – I. Match the statement in list – I with resulting image in list – II



LIST – I		LIST – II	
A)	If the refractive index of the lens is doubled (that is made 2μ) then	P)	Final image is real
B)	If the radius of curvature is doubled (that is, made $2R$) then	Q)	Final image is virtual
C)	If a glass slab of refractive index $\mu = 1.5$ is introduced between the object and lens as shown, then 	R)	Final image becomes smaller in size in comparison to size of image before the change was made
D)	If the left side of lens is filled with a medium of refractive index $\mu = 1.5$ as shown, then 	S)	Final image is of same size of Object

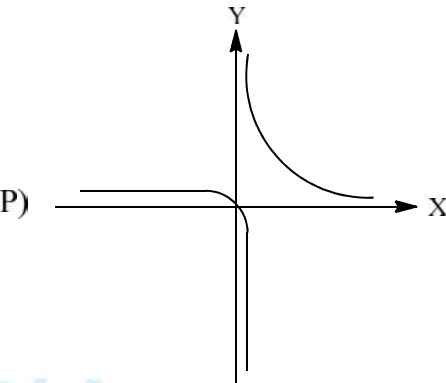
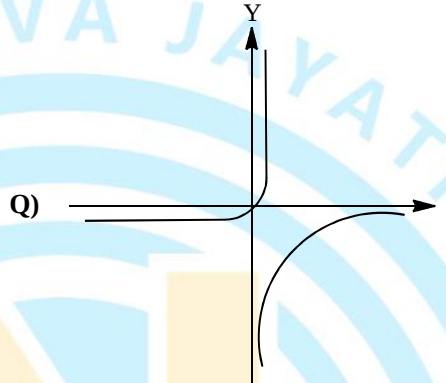
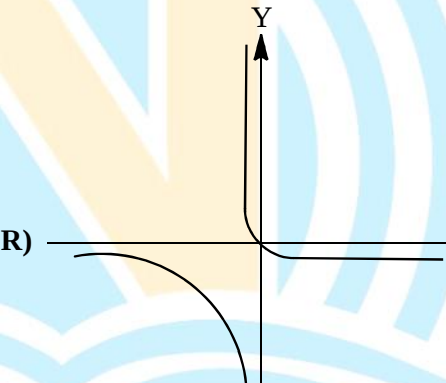
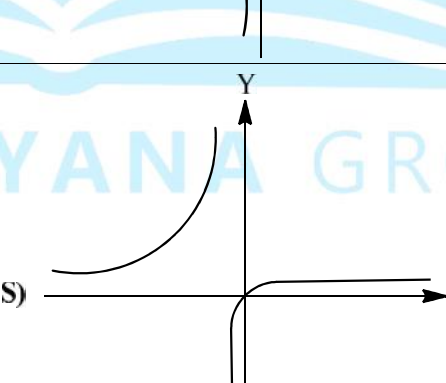
- A) A-P; B-Q,S ; C- Q,R; D- R B) A- P,Q; B-Q,R; C- Q,R;D- Q,R
 C) A-P, Q; B-Q, S; C-Q; D-R D) A-P, R; B-P, R; C-Q, R; D-P, R

19. In the I column optical system are given. Match the optical system with the image and object combination possible. The nature of image is not known and optical system can be at any position

COLUMN-I		COLUMN-II	
A)	Convex mirror	P)	
B)	Concave mirror	Q)	
C)	Converging lens	R)	
D)	Diverging lens	S)	

- A) A-P,Q; B-Q,S; C-Q,S; D-P,Q B) A-P,S; B-P,S; C-Q,S; D-P,R
 C) A-P,R; B-Q,S; C-Q,S; D-P,R D) A-Q,R; B-R,S; C-Q,R; D-P,S

20. Match the correct u - v graph with optical system using Cartesian sign conventions

Column I	Column II
A) Convex mirror	P) 
B) Concave mirror	Q) 
C) Converging lens	R) 
D) Diverging lens	S) 

A) A – Q; B – R; C – S; D – P

B) A – P; B – S; C – R; D – Q

C) A – Q; B – S; C – R; D – P

D) A – P; B – S; C – Q; D – R

CHEMISTRY

Max Marks: 60

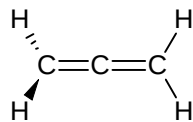
SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains 10 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

21. Which of the following d orbital(s) is (are) involved in hybridisation of SF_6 ?
- A) d_{z^2} only B) d_{xy}, d_{yz} C) $d_{z^2}, d_{x^2-y^2}$ D) d_{z^2}, d_{xy}
22. Which of the following represents correct order of π -bond strength?
- A) $2p-2p > 3p-3p > 2p-3d$ B) $2p-2p > 2p-3d > 3p-3p$
C) $2p-3d > 2p-2p > 3p-3p$ D) $3p-3p > 2p-2p > 2p-3d$
23. In which of the following case both the molecules contains equatorial bond longer than axial bond?
- A) SF_4, IF_7 B) $\text{BrF}_3, \text{BrF}_5$ C) $\text{BrF}_5, \text{IF}_7$ D) None
24. Which of the following pair of species contains same shape but different number of lone pairs on central atom?
- A) $\text{ClF}_3, \text{BF}_3$ B) $\text{CO}_2, \text{SnCl}_2$ C) $\text{XeF}_2, \text{I}_3^-$ D) $\text{XeF}_2, \text{CO}_2$
25. Correct order regarding bond angle in the following is:
- A) $\text{NH}_4^+ > \text{NH}_2^- > \text{NH}_3$ B) $\text{PCl}_3 < \text{AsCl}_3 < \text{SbCl}_3$
C) $\text{NO}_2^- > \text{NO}_3^- > \text{NO}_2^+$ D) $\text{BCl}_3 > \text{NCl}_3 > \text{PCl}_3$
26. Sum of $d_\pi - p_\pi$ bonds in SO_2 and SO_3 are:
- A) 0 B) 2 C) 3 D) 5
27. The correct order of dipole moments of $\text{H}_2\text{O}, \text{NH}_3$ and HF is:
- A) $\text{HF} > \text{H}_2\text{O} > \text{NH}_3$ B) $\text{NH}_3 > \text{H}_2\text{O} > \text{HF}$ C) $\text{H}_2\text{O} > \text{HF} > \text{NH}_3$ D) $\text{NH}_3 > \text{HF} > \text{H}_2\text{O}$
28. Least melting point is shown by the compound:
- A) PbCl_2 B) SnCl_4 C) AlCl_3 D) MgCl_2

29. Number of pure orbitals involved in bonding of following molecule is:



- A) 0 B) 4 C) 6 D) 8

30. Which of the following statement is **correct** for BrF_5 ?

- A) Br is sp^3d hybridized
 B) All fluorine atoms are in same plane
 C) All F-Br-F bond angles equal to 90°
 D) Four fluorine atoms are in same plane

SECTION - II (PARAGRAPH TYPE)

This section contains **3 Paragraph of questions**. Each paragraph has 2 multiple choice questions based on a paragraph. Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE IS** correct.
Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

Paragraph for Question Nos. 31 & 32

As a result of polarity, a covalent molecule possesses the dipole moment which can be defined as the product of the magnitude of the charge and the distance between the centres of positive and negative charge. Mathematically, it is expressed as follows:

Dipole moment (μ) = charge (Q) $\times$ distance of separation (r)

Dipole moment is usually expressed in Debye units (D). The conversion factor is

1 D = $3.33564 \times 10^{-30} \text{ C m}$ where C is coulomb and m is meter.

31. Each of the following options contains a set of four molecules. Identify the options where all four molecules possess permanent dipole moment at room temperature

- A) $\text{BeCl}_2, \text{CO}_2, \text{BCl}_3, \text{CHCl}_3$ B) $\text{NO}_2, \text{NH}_3, \text{POCl}_3, \text{CH}_3\text{Cl}$
 C) $\text{BF}_3, \text{O}_3, \text{SF}_6, \text{XeF}_6$ D) $\text{SO}_2, \text{C}_6\text{H}_5\text{Cl}, \text{H}_2\text{Se}, \text{PCl}_5$

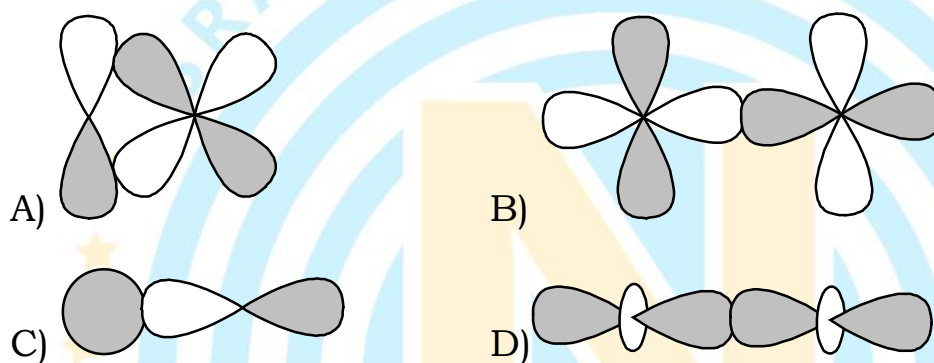
32. If bond length and dipole moment of H-X, respectively, are $2\text{\AA}$ and 1.2 D. Then the percentage of ionic character in H-X is:

- A) 25% B) 50% C) 12.5% D) 100%

Paragraph for Question Nos. 33 & 34

When orbitals of two atoms come close to form bond, their overlap may be positive, negative or zero depending upon the sign (phase) and direction of orientation of amplitude of orbital wave function in space. Positive and negative sign on boundary surface show the sign (phase) of orbital wave function and are not related to charge. Orbitals forming bond should have same sign (phase) and orientation in space. This is called positive overlap.

33. Which of the following represents positive overlap for sigma bond formation?



34. Assuming inter nuclear axis as z-axis which of the following result in π -bond formation?

**Paragraph for Question Nos. 35 & 36**

Polarisation induces covalent character in ionic compounds. The polarization depends on various factors like charge on ions, size of ions and electronic configuration of cation. Polarisation affects many properties of compounds like solubility, thermal stability and melting points etc.

Solubility of the compounds also depends on lattice energy, hydration energy apart from polarization.

35. Which of the following represents correct order of solubility in water?

- A) $\text{ZnCl}_2 < \text{CdCl}_2 < \text{HgCl}_2$ B) $\text{HgI}_2 > \text{HgBr}_2 > \text{HgCl}_2$
 C) $\text{AgCl} > \text{AgBr} > \text{AgI}$ D) $\text{PbCl}_2 < \text{PbBr}_2 < \text{PbI}_2$

36. In which of the following first compound is more soluble in water than second?

- A) $\text{MgCO}_3, \text{BeCO}_3$ B) LiF, NaF C) $\text{BeF}_2, \text{MgF}_2$ D) AlF_3, NaF

SECTION - III (Matching List Type)

This section contains four questions, each having two matching lists (List-I & List-II). The options for the correct match are provided as (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

37. Match the molecules/ions given in **List-I** with their characteristic property given in **List-II** and select the correct code.

List-I		List-II	
P)	NO_3^-	1)	Planar
Q)	ClO_4^-	2)	Polar
R)	SO_2	3)	$d_\pi - p_\pi$ bond
S)	XeOF_2	4)	Lone pair on central atom

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

38. Match the species given in List-I with their total number of lone pairs given in List-II and select the correct code.

List-I		List-II	
P)	XeF_6	1)	9
Q)	SNF_3	2)	12
R)	XeO_3F_2	3)	10
S)	ICl_2^-	4)	19

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

39. Match the orders given in List-I with the related property given in List-II and select a

List-I		List-II	
P)	$\text{LiCl} > \text{NaCl}$	1)	Thermal stability
Q)	$\text{Li}_2\text{CO}_3 < \text{Na}_2\text{CO}_3$	2)	Solubility in ether
R)	$\text{SnCl}_2 < \text{SnCl}_4$	3)	Solubility in water
S)	$\text{BeSO}_4 > \text{MgSO}_4$	4)	Covalent character

A) P-2; Q-1; R-3; S-4

B) P-2; Q-1; R-4; S-3

C) P-4; Q-3; R-1; S-2

D) P-4; Q-3; R-2; S-1

40. Match the molecules given in List-I with their characteristic properties given in List-II and select the correct code.

List-I		List-II	
P)	PCl_5	1)	Obeys octet rule
Q)	BF_3	2)	Hypervalent
R)	NO_2	3)	Hypovalent
S)	CO_2	4)	odd electron molecule

A) P-3; Q-2; R-4; S-1

B) P-3; Q-2; R-1; S-4

C) P-2; Q-3; R-1; S-4

D) P-2; Q-3; R-4; S-1

MATHEMATICS

Max Marks: 60

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains 10 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** option can be correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

41. The range of $\frac{1}{4\cos x + 3\sin x + 2}$ is
- A) $\left[-\frac{1}{3}, \frac{1}{7}\right]$ B) $\left(-\infty, -\frac{1}{3}\right] \cup \left[\frac{1}{7}, \infty\right)$
- C) $[-3, 7]$ D) $\left[-\frac{1}{3}, 0\right] \cup \left[\frac{1}{7}, \infty\right)$
42. Range of $f(x) = \sin^6 x + \cos^6 x$ is
- A) $[0, 1]$ B) $[0, \sqrt{2}]$ C) $\left[\frac{1}{\sqrt{2}}, \frac{3}{4}\right]$ D) $\left[\frac{1}{4}, 1\right]$
43. In a triangle ABC if $\tan A < 0$ then:
- A) $\tan B \cdot \tan C > 1$ B) $\tan B \cdot \tan C < 1$
- C) $\tan B \cdot \tan C = 1$ D) None of the above
44. Consider the following four statements:
- I) The sum of two periodic functions is always periodic
- II) If $f(x)$ is periodic with fundamental period T , then $|f(x)|$ may have fundamental period Less than T
- III) If $f(2x)$ is periodic with fundamental period T , then the fundamental period of $f(x)$ must be $T/2$
- IV) If LCM of fundamental periods of $f(x)$ and $g(x)$ is T , then the fundamental period of $f(x)g(x)$ may be $T/5$
- Then the number of correct statements out of these four is
- A) 1 B) 2 C) 3 D) 4
45. Which of the following DOES NOT have $\frac{\pi}{2}$ as fundamental period?
- A) $|\sin x| + |\cos x|$ B) $\sin^2 x + \cos^2 x$ C) $\sin^4 x + \cos^4 x$ D) $\sec^2 2x - \tan^2 2x$

46. If $\sin x + \cos(x + \theta) + \cos(x - \theta) = 2$, has a real solution for x , then the minimum value of $\sin \theta$ is
- A) -1 B) $\frac{1}{2}$ C) 0 D) $-\frac{1}{2}$
47. If $\sec A \tan B + \tan A \sec B = 28$, then the value of $\sec A \sec B + \tan A \tan B$ is
- A) 785 B) $\pm\sqrt{783}$ C) 783 D) $\pm\sqrt{785}$
48. If A, B, C are angles of a triangle, then $2\sin\frac{A}{2}\operatorname{cosec}\frac{B}{2}\sin\frac{C}{2} - \sin A \cot\frac{B}{2} - \cos A$ is
- A) independent of A, B, C B) non constant function of A
C) non constant function of B D) non constant function of C
49. If A, B, C, D are acute angles such that $\cot A \cot B = \tan C \tan D$, then the maximum value of $\cos A \cos B \cos C \cos D$ is
- A) 1 B) $\frac{1}{2}$ C) $\frac{1}{4}$ D) $\frac{1}{16}$
50. The ratio of greatest value of $2 - \cos x + \sin^2 x$ to its least value is $\frac{k}{4}$, then $k =$
- A) 13 B) 4 C) 2 D) 5

SECTION - II
(PARAGRAPH TYPE)

This section contains **3 Paragraph of questions**. Each paragraph has 2 multiple choice questions based on a paragraph. Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE IS** correct.
Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

Paragraph for Question Nos. 51 & 52

Minimum and maximum values of $a\cos\theta + b\sin\theta + c$ are $c - \sqrt{a^2 + b^2}$ and $c + \sqrt{a^2 + b^2}$ respectively

51. If $x^2 + y^2 = x^2y^2$ then the range of is $\frac{5x+12y+7xy}{xy}$
- A) $[3, 20]$ B) $[-6, 20]$ C) $[-6, 3]$ D) $[7, 20]$
52. The range of $3\cos(\theta + 30^\circ) + 3\sin\theta + 2$ is
- A) $[-1, 4]$ B) $[3, 5]$ C) $[-1, 5]$ D) $[1, 3]$

Paragraph for Question Nos. 53 & 54

If $f(x)$ and $g(x)$ are two periodic functions with fundamental period T_1 and T_2 respectively, then the fundamental period of $f(x) \pm g(x)$, $f(x)g(x)$, $\frac{f(x)}{g(x)}$ may be the LCM of T_1 and T_2 or the submultiple of the LCM or does not exist.

53. The fundamental period of the function $\sin\left(\frac{\pi x}{3}\right) + \cos^2\left(\frac{\pi x}{4}\right)$ is

- A) 12π B) 24 C) 24π D) 12

54. How many of the following functions periodic?

- I) $\sin(x) + \cos(\sqrt{2}x)$ II) $\sin\left(\left(\sqrt{2}+1\right)x\right) + \cos\left(\sqrt{\frac{3}{4} + \frac{1}{\sqrt{2}}}x\right)$
III) $\sin\left(\frac{22}{7}x\right) + \cos(\pi x)$ IV) $\sin\left(\frac{1+\sqrt{3}}{1-\sqrt{2}}x\right) + \cos\left(\left(1+\sqrt{2}+\sqrt{3}+\sqrt{6}\right)x\right)$
A) 0 B) 1 C) 2 D) 3

Paragraph for Question Nos. 55 & 56

The maximum value of addition of two functions can be obtained by adding their respective maximums if both occur for the same value of the input.

55. The maximum value of $4\sin x + \frac{13 - 3\sin^2 x - 3\sec x}{\cos x}$ is

- A) $1 + 2\sqrt{30}$ B) $\frac{40}{3}$ C) 11 D) None of the above

56. The minimum value of $9\sec^2 x - 25\sin^2 x - 30\cos x - 24\tan x$ is

- A) 41 B) -21 C) -70 D) -41

SECTION - III

(Matching List Type)

This section contains four questions, each having two matching lists (List-I & List-II). The options for the correct match are provided as (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

57. Match the following.

Column – I		Column – II	
A)	$\cos^2 52^\circ \frac{1}{2} - \sin^2 22^\circ \frac{1}{2}$	P)	1
B)	$\cos^2 \frac{3p}{5} + \cos^2 \frac{4p}{5}$	Q)	$\frac{3-\sqrt{3}}{4\sqrt{2}}$
C)	$\sin 24^\circ + \cos 6^\circ$	R)	$3/4$
D)	$\sin^2 50^\circ + \cos^2 130^\circ$	S)	$\frac{\sqrt{15}+\sqrt{3}}{4}$

A) $A \rightarrow R, B \rightarrow Q, C \rightarrow P, D \rightarrow S$

B) $A \rightarrow S, B \rightarrow R, C \rightarrow Q, D \rightarrow P$

C) $A \rightarrow Q, B \rightarrow R, C \rightarrow S, D \rightarrow P$

D) $A \rightarrow Q, B \rightarrow P, C \rightarrow S, D \rightarrow R$

58. Match the following.

Column – I		Column – II	
A)	The maximum value of $\cos(2A+q) + \cos(2B+q)$ ($q \in R$ and A, B are constants)	P)	$2\sin(A+B)$
B)	Maximum value of $\cos 2A + \cos 2B$ ($A, B \in \left(0, \frac{p}{2}\right)$, $A+B$ is constant)	Q)	$2\sec(A+B)$
C)	Minimum value of $\sec 2A + \sec 2B$ ($A, B \in \left(0, \frac{p}{4}\right)$, $A+B$ is constant)	R)	$2\cos(A+B)$
D)	Minimum value of $\sqrt{\tan^2 q + \cot^2 q - 2\cos(2A+2B)}$ ($q \in R$, A, B are constants and $A, B \in \left(0, \frac{p}{2}\right)$)	S)	$2\cos(A-B)$

A) $A \rightarrow Q, B \rightarrow R, C \rightarrow P, D \rightarrow S$

B) $A \rightarrow S, B \rightarrow R, C \rightarrow Q, D \rightarrow P$

C) $A \rightarrow S, B \rightarrow P, C \rightarrow Q, D \rightarrow R$

D) $A \rightarrow Q, B \rightarrow R, C \rightarrow S, D \rightarrow P$

59. Match the fundamental period of the functions in column I to column II

Column – I		Column – II	
A)	$\cos(\cos x)$	P)	p
B)	$\cos(\cos x) + \cos(\sin x)$	Q)	$2p$
C)	$(1 - 2 \cos 2x) \cos x$	R)	$\frac{p}{2}$
D)	$\sin(\sin x)$	S)	$\frac{2p}{3}$

A) $A \rightarrow R, B \rightarrow R, C \rightarrow S, D \rightarrow Q$

B) $A \rightarrow P, B \rightarrow R, C \rightarrow Q, D \rightarrow S$

C) $A \rightarrow P, B \rightarrow R, C \rightarrow S, D \rightarrow Q$

D) $A \rightarrow P, B \rightarrow S, C \rightarrow R, D \rightarrow Q$

60. Match the columns

Column – I		Column – II	
A)	Maximum value of $4 \sin^2 x + 3 \cos^2 x + \sin \frac{x}{2} + \cos \frac{x}{2} - \sqrt{2}$	P)	4
B)	Minimum of $\cos 2q + \cos q + \frac{9}{8}$	Q)	0
C)	Maximum of $ 3 \sin x + 4 \cos x - 5 $	R)	10
D)	If $A, B > 0, A + B = \frac{p}{3}$ then maximum value of $3 \tan A \tan B$ is	S)	1

A) $A \rightarrow P, B \rightarrow Q, C \rightarrow R, D \rightarrow S$

B) $A \rightarrow P, B \rightarrow Q, C \rightarrow S, D \rightarrow R$

C) $A \rightarrow R, B \rightarrow Q, C \rightarrow P, D \rightarrow S$

D) $A \rightarrow P, B \rightarrow S, C \rightarrow R, D \rightarrow Q$