

Preface

The idea of the book entitled “**Organic Chemistry: SET PYQ’s**” was born because of the lack of any comprehensive book covering previous year questions with detailed explanation for all states SET examination.

This book covers all PYQ’s with topic wise sorted question and solution:

1. Nomenclature,
2. General organic chemistry,
3. Stereochemistry,
4. Reaction Mechanism,
5. Name reaction,
6. Reagent,
7. Pericyclic reactions,
8. Photochemistry,
9. Spectroscopy,
10. Heterocyclic chemistry,
11. Natural Products.

The ultimate purpose of this book is to equip the reader with brainstorming challenges and solution for organic chemistry and applied aspect examinations. It contains predigested information on the entire academic subject of organic chemistry for good understanding, assimilation, self-evaluation, and reproducibility. Although we have made every effort to make the book error free, we are under no illusion. We welcome comments, criticism and suggestions from the readers to evolve the contents.

Acknowledgement

First of all I would like to thank our entire students at Institute for advanced Studies (IFAS), who have helped us to learn and practice both the art and science of chemistry. We would like to thank Er. Radheshyam Choudhary, Founding CEO, IfAS Edutech Pvt. Ltd. for being a continuous source of inspiration through his positive strokes.

We also want to thank Dr. Kailash Choudhary, Director at IFAS Publications, for his valuable support and critical suggestion for completion of the work.

Our special thanks Mr. Rajiv Abhyankar to motivating us.

We would not forget to thank all the IfAS team where we were able to further continue our teaching, training, and especially learning the many facets of the process of building these creative questions in books.

This book is a team effort, and producing it would be impossible without outstanding people of IFAS publication. It was pleasure to work with many others dedicated and creative people of IFAS during the production of this book. Special thanks for Vikendra Metha who crafted our ideas to wonderful design of cover page and Kuldeep Singh Rathore for formatting and type setting.

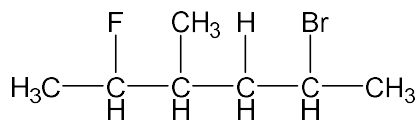
And finally, our humble greetings to all who put their significant efforts and are unmentioned.

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MH-SET

(2020)

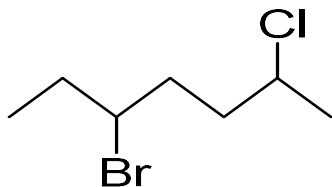
1. The correct IUPAC name of the following compound is:



- (1) 2-fluoro-5-bromo-3-methylhexane
(2) 5-bromo-2-fluoro-3-methylhexane
(3) 2-bromo-5-fluoro-4-methylhexane
(4) 5-fluoro-2-bromo-5-methylhexane

(2018)

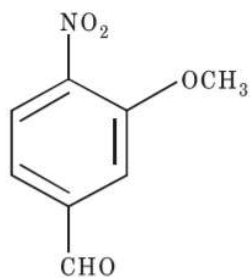
2. The correct IUPAC nomenclature of the following compound is



- (1) 5-Bromo-2-chloroheptane
(2) 2-chloro-5-bromoheptane
(3) 3-Bromo-6-chloroheptane
(4) 6-chloro-3-bromoheptane

(2018)

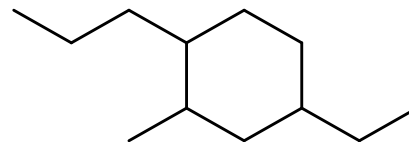
3. The correct IUPAC nomenclature of the following compound is:



- (1) 2-Nitro-5-carbaldehydo anisole
(2) 2-Methoxy-4-carbaldehydo nitrobenzene
(3) 4-Nitro-5-methoxy benzaldehyde
(4) 3-Methoxy-4-nitro benzaldehyde

(2017)

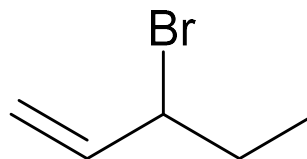
4. The correct IUPAC nomenclature of the following compound is:



- (1) 4-Ethyl-2-methyl-1-propylcyclohexane
(2) 1-Ethyl-3-methyl-4-propylcyclohexane
(3) 5-Ethyl-1-methyl-2-propylcyclohexane
(4) 3-Ethyl-1-methyl-6-propylcyclohexane

(2017)

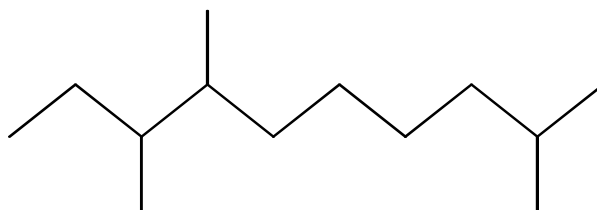
5. The correct IUPAC nomenclature of the following compound is



- (1) 3-Bromopent-4-ene
(2) 3-Bromopent-1-ene
(3) 1-Bromo-1-ethylprop-2-ene
(4) Ethyl vinyl bromomethane

(2016)

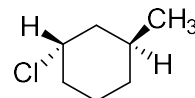
6. The correct IUPAC nomenclature of the following compound is:



- (1) 3, 4, 9-trimethyl decane
(2) 2, 7, 8-trimethydecane
(3) isotetradecane
(4) 7-methyl-2-(1-methylpropyl) octane

(2015)

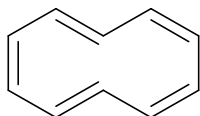
7. The correct IUPAC name of the following compound is



- (1) (1R, 3R)-1-chloro-3-methylcyclohexane
(2) (1R, 3S)-1-chloro-3-methylcyclohexane
(3) (1S, 3S)-1-chloro-3-methylcyclohexane
(4) (1S, 3R)-1-chloro-3-methylcyclohexane

(2015)

8. The correct IUPAC nomenclature for the following compound is:



- (1) 10-[5]-annulene (2) 10-[10]-annulene
(3) 10-[18]-annulene (4) 10-[20]-annulene

(2015)

9. The correct IUPAC nomenclature for the following compound is:



- (1) (E) Pent-2-en-4-yne (2) (E) Pent-1-yne-3-ene
(3) (E) Pent-4-yne-2-ene (4) (E) Pent-3-en-1-yne

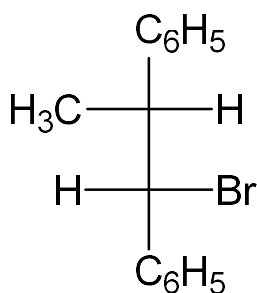
(2015)

10. The chemical abbreviation of DDT is one of the following:

- (1) p -dichlorodiphenyl trichloroethane
(2) p -dichlorodiphenyl tetrachloroethane
(3) p -dichlorodiphenyl trichloropropane
(4) p -dichlorodiphenyl Tetrachlorobutane

(2013)

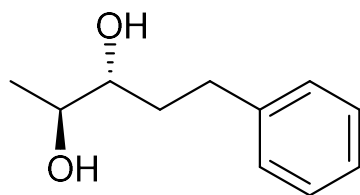
11. The IUPAC name of the following compound is:



- (1) Threo-2-bromo-1, 2-diphenylpropane
(2) Erythro-1-bromo-1,2-diphenylpropane
(3) Threo-1-bromo-1, 2-diphenylpropane
(4) Erythro-2-bromo-1,2-diphenylpropane

(2013)

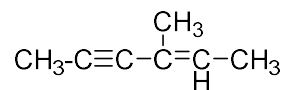
12. The correct IUPAC nomenclature of the following compound is :



- (1) (2S, 3R)—5—Phenylpentane-2, 3-diol
(2) (3S, 4R)—1—Phenylpentane-3, 4-diol
(3) (2R, 3S)—5—Phenylpentane-2, 3-diol
(4) (3R, 4S)—1—Phenylpentane-3, 4-diol

(2021)

13. The correct IUPAC name of the following compound is:



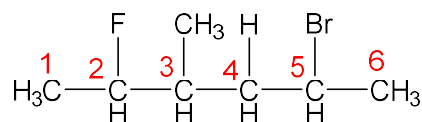
- (1) 4-Methyl-4-hexen-2-yne
(2) 4-Methyl-2-hexen-4-yne
(3) 3-Methyl-4-hexen-2-yne
(4) 3-methylhex-2-en-4-yne

Answer Key

1	2	3	4	5	6	7	8	9	10
2	2	4	1	2	2	3	2	4	1
11	12	13							
3	1	4							

:: MH-SET: Solutions ::

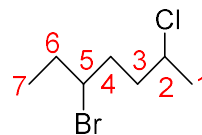
1. Solution:



Numbering give from this side where attachment of substituent should be nearest (CH₃ at 3) and naming of substituent gives alphabetically

Correct Answer is 5-bromo-2-fluoro-3-methylhexane

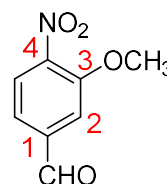
2. Solution:



Numbering give from this side where attachment of substituent should be nearest and priority of substituent through alphabetically

Correct Answer is 5-Bromo-2-chloroheptane

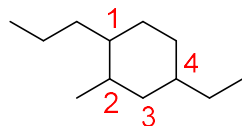
3. Solution:



In this example 1st numbering goes to aldehyde and then goes to nearest substituent and naming of substituent through alphabetically

Correct Answer is 3-Methoxy-4-nitro benzaldehyde

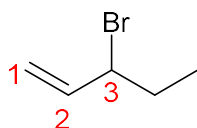
4. Solution:



Numbering has been given from that side where substituent are near and numbering of substituent through alphabetically

Correct Answer is 4-Ethyl-2-methyl-1-propylcyclohexane

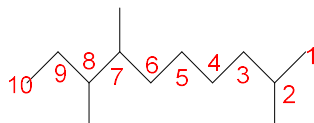
5. Solution:



1st priority goes to alkene functional group and numbering gives through alphabetically

Correct Answer is 3-Bromopent-1-ene

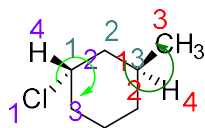
6. Solution:



First select long chain then numbering give from nearest substituent and numbering give alphabetically

Correct Answer is 2, 7, 8-trimethyldecane

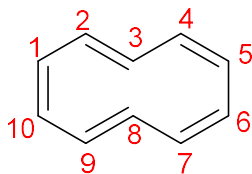
7. Solution:



1st number goes to halogenated carbon. And according to CIP rule 1st priority goes to highest atomic number atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane)

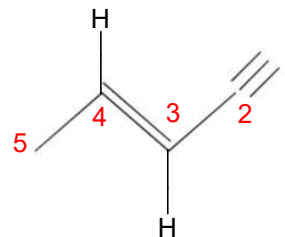
Correct Answer is (1S, 3S)-1-chloro-3-methylcyclohexane

8. Solution:



10 carbo and 10 electron so correct answer is 10-[10]-annulene

9. Solution:

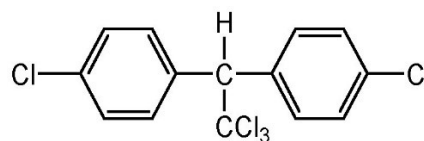


If two same group are opposite side then we can say trans(E) and numbering has been given to alkene first

Correct Answer is (E) Pent-3-en-1-yne

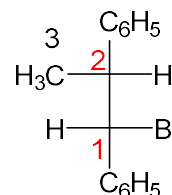
10. Solution:

DDT means



p-Dichlorodiphenyl trichloroethane with IUPAC name 4,4'-(2,2,2-trichloroethane-1,1-diyl)bis(chlorobenzene)

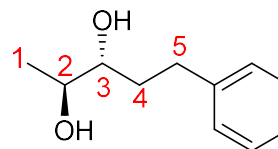
11. Solution:



1st no. goes to halogenated carbon and If the same atom are opposite side then we called threo isomer

Correct Answer is Threo-1-bromo-1, 2-diphenylpropane

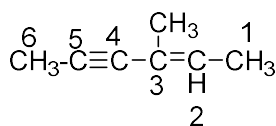
12. Solution:



Numbering has been given from nearest substituent side and R,S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane)

Correct Answer is (2S, 3R)—5—Phenylpentane-2, 3-diol

13. Solution:



Priority of alkene is more than alkyne.

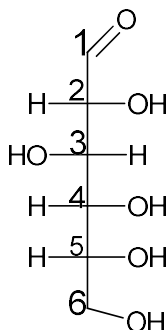
3-methylhex-2-en-4-yne

Correct Answer is D

Kerala-SET

(2019)

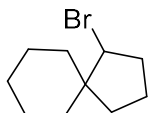
1. Using the following Fischer projection formula of D(+) glucose the R and S designations of the chiral centres can be assigned as



- (1) 2R, 3S, 4R, 5R (2) 2S, 3R, 4S, 5R
(3) 2R, 3R, 4S, 5S (4) 2S, 3S, 4R, 5S

(2018)

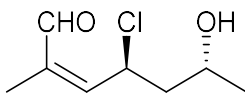
2. Give the IUPAC name of the following compound.



- (1) 1-bromospiro [5, 4] decane
(2) 1-bromospiro [4, 5]decane
(3) 2-bromospiro [4, 5]decane
(4) 2-bromospiro [5, 4]decane

(2017)

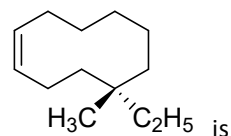
3. The IUPAC name of the following compound is



- (1) (2Z, 4R,6R)- 4-Chloro-6-hydroxy-2-methylhept-2-enal
(2) (2E, 4S,6R)- 4-Chloro-6-hydroxy-2-methylhept-2-enal
(3) (2E, 4R,6S)- 4-Chloro-6-hydroxy-2-methylhept-2-enal
(4) (2Z, 4S,6R)- 4-Chloro-6-hydroxy-2-methylhept-2-enal

(2016)

4. The IUPAC name of the compound



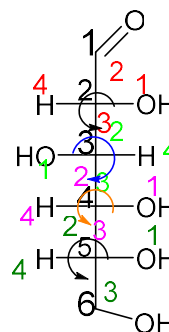
- (1) (1E, 5R) 5-ethyl-5-methylclodec-1-ene
(2) (1Z, 5S) 5-ethyl-5-methylclodec-1-ene
(3) (1E, 5S) 5-ethyl-5-methylclodec-1-ene
(4) (4E, 1S) 1-ethyl-1-methylcycloclodec-4-ene

Answer Key

1	2	3	4
1	2	4	2

:: Solution ::

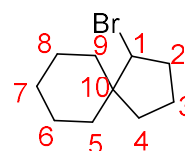
1. Solution:



In fisher projection all horizontal atom are in above the plane and R,S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane)

Correct Answer Is 2R, 3S, 4R, 5R

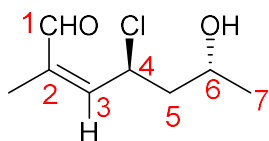
2. Solution:



Number starting from those carbon where substituent attached. In spiro compounds have one atom common to both rings. In spiro compound numbering starting from less membered ring to more membered ring

Correct Answer is 1-bromo spiro [4, 5] decane

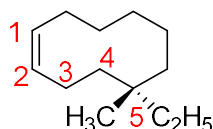
3. Solution:



1st priority goes to aldehyde, if two priority group on same side means Z isomer and R,S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane)

Correct Answer is (2Z, 4S, 6R)- 4-Chloro-6-hydroxy-2-methylhept-2-enal

4. Solution:



1st no. goes to alkene and numbering has been given from that side where nearest substituent will come and R,S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane)

Correct Answer is (1Z, 5S) 5-ethyl-5-methylclodec-1-ene

K-SET

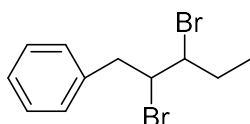
(2020)

1. The IUPAC name of camphor is

- (1) 6-oxo-1, 2, 2-Trimethylbicyclo[2,2,1] heptane
- (2) 1, 7, 7-Trimethylbicyclo[2,2,1] heptane-2-one
- (3) 1, 5, 5-Trimethylbicyclo[2,2,1] heptane-2-one
- (4) 1, 7, 7-Trimethylbicyclo[2,1,2] heptane-2-one

(2020)

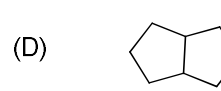
2. The IUPAC name of the following compound is:



- (1) 2,3-Dibromo pentyl benzene
- (2) 5-phenyl-3,4-dibromopentane
- (3) 2,3-Dibromo-1-phenylpentane
- (4) 1-phenyl-2,3-dibromopentane

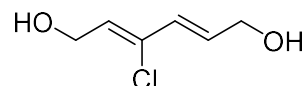
(2020)

3. Identify the correct structure of bicyclo [2,2,2] octane



(2018)

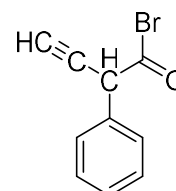
4. The IUPAC name of the following compound is



- (1) 2E,4E-3-chlorohex- 2, 4 - diene - 1, 6 - diol
- (2) 2Z,4E-3-chlorohex- 2, 4 - diene - 1, 6 - diol
- (3) 2Z,4Z-4-chlorohex- 2, 4 - diene - 1, 6 - diol
- (4) 2E,4Z-4-chlorohex- 2, 4 - diene - 1, 6 - diol

(2017)

5. The IUPAC name of the following compound is:-

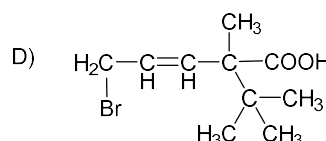
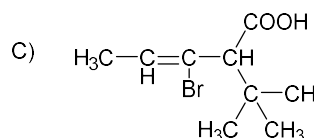
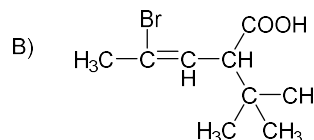
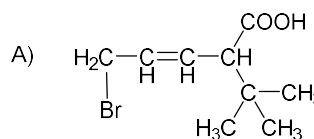


- (1) 2-(4-Pyridyl) but - 3ynoyl bromide
- (2) 1-(4-Pyridyl) but-1-yn-4-oyl bromide
- (3) 2-(4-Pyridyl) but-2-oyl bromide
- (4) 3-(4-Pyridyl) but-3-oyl bromide

(2017)

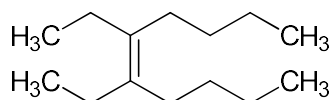
6. Choose the correct structure for the following Nomenclature.

5-bromo-2-(tert-butyl)pent-3-enoic acid



(2015)

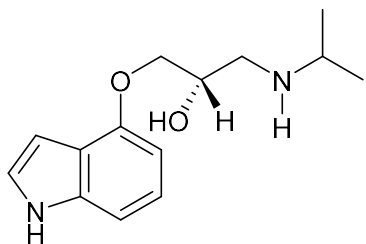
7. The IUPAC name of:-



- (1) 5, 6-diethyldeca -5-ene
 (2) 3,4-dibutyl hex - 3 - ene
 (3) 3-butyl - 4 - ethyl- oct-3-ene
 (4) 6-butyl-5-ethyl- oct-5-ene

(2015)

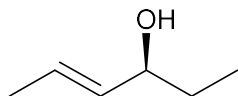
8. The IUPAC name of the compound having following structure is:-



- (1) (S)-1-((1H-indol-4-yl)oxy)-3-(isopropylamino)propan-2-ol
 (2) R-1-((1H-indol-4-yl)oxy)-3-(isopropylamino)propan-2-ol
 (3) S-3-((1H-indol-4-yl)oxy)-1-(isopropylamino)propan-2-ol
 (4) R-3-((1H-indol-4-yl)oxy)-1-(isopropylamino)propan-2-ol

(2014)

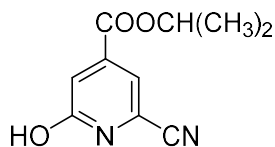
9. IUPAC name of the following compound is:-



- (1) (E, 4S) - Hept - 5 - en - 4 - ol
 (2) (E, 4S)-hex-4-en-3-ol
 (3) (E, 4R) - Hept - 5 - en - 4 - ol
 (4) (E, 4R) - Hept - 2 - en - 4 - ol

(2014)

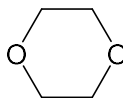
10. The IUPAC name of the compound is



- (1) Isopropyl 2-cyano-6-hydroxypyridine-4-carboxylate
 (2) Isopropyl 6-cyano-2-hydroxypyridine-4-carboxylate
 (3) Isopropyl 3-cyano-5-hydroxypyridine carboxylate
 (4) Isopropyl-3-hydroxy-5-cyanopyridine carboxylate

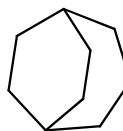
(2013)

11. The IUPAC name of the following compound is:-



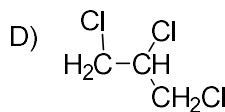
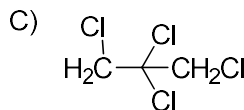
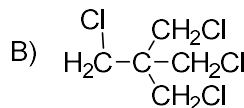
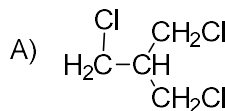
- (1) Dioxane
 (2) 1,4-Dioxane
 (3) Diethylene-1, 4-dioxane
 (4) 1,4-dioxacyclohexane

12. The IUPAC name of the following molecule is:-



- (1) Bicyclo [2.2.2] octane
 (2) Bicyclo [2.2.3] octane
 (3) Bicyclo [3.2.1] heptane
 (4) Bicyclo [3.2.2] nonane

13. The structure of the compound 1,3-dichloro-2, 2-bis(chloromethyl) propane

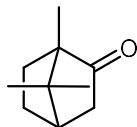


Answer Key

1	2	3	4	5	6	7	8	9	10
B	A	A	B	A	A	A	A	B	A
11	12	13							
B	D	B							

Solution

1. Solution:

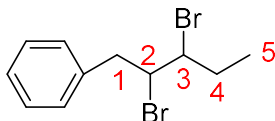


Numbering starting from near to ketone where substituent attach

Correct Answer is

1,7,7-Trimethylbicyclo[2,2,1]heptane-2-one

2. Solution:

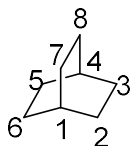


Numbering starting from those carbon where benzene group attached

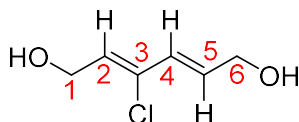
Correct Answer is 2, 3-Dibromo pentyl benzene

3. Solution:

Structure of bicyclo [2, 2, 2] octane is



4. Solution:

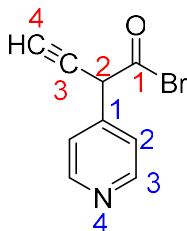


Numbering starting from those carbon where chlorine should near and for E, Z nomenclature if same priority group on same side, then we can say Z isomer and if same priority group on opposite side, then we can say E isomer and priority of the atom given on the basis of atomic number

Correct Answer is

2Z,4E-3-chlorohex-2,4-diene-1,6-diol

5. Solution:



1st number goes to carbonyl carbon

Correct Answer is

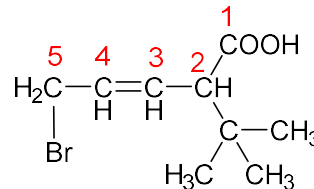
2-(4-Pyridyl) but - 3ynoyl bromide

6. Solution:

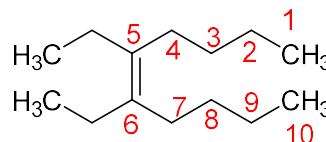
Correct structure for the following Nomenclature

5-bromo-2-(tert-butyl)pent-3-enoic acid

So, **Correct Answer is**



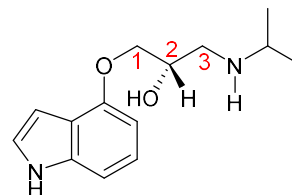
7. Solution:



1st select the long carbon chain then give numbering accordingly

Correct Answer is 5, 6-diethyldeca -5-ene

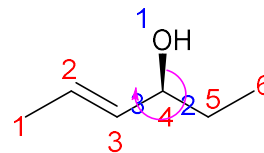
8. Solution:



1st number goes to those carbon where oxygen attach compare to nitrogen and R,S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane)

Correct Answer is (S)-1-((1H-indol-4-yl)oxy)-3-(isopropylamino)propan-2-ol

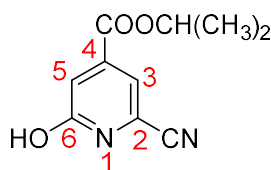
9. Solution:



1st number goes to those carbon where alkene attached and R,S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane) and for E,Z nomenclature if same priority group on opposite side then E isomer

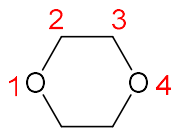
Correct Answer is (E, 4S)-hex-4-en-3-ol

10. Solution:



Correct Answer is Isopropyl 2-cyano-6-hydroxypyridine-4-carboxylate

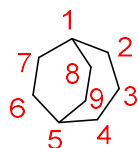
11. Solution:



1st number goes to oxygen

Correct Answer is 1, 4-Dioxane

12. Solution:

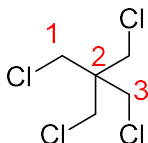


1st number goes to tertiary carbon and in bicyclic compound number starting from more membered ring to less numbered ring

Correct Answer is Bicyclo [3.2.2] nonane

13. Solution:

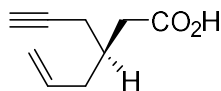
Structure of the compound 1, 3-dichloro-2, 2-bis(chloromethyl) propane is



Tel-SET

(2018)

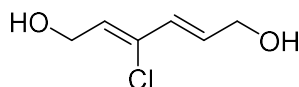
1. The IUPAC name of the following compound is



- (1) (R)-3-(prop-2-enyl) hex-5-ynoic acid
- (2) (R)-3-(prop-2-enyl) hex-5-enoic acid
- (3) (S)-3-(prop-2-enyl) hex-5-enoic acid
- (4) (S)-3-(prop-2-enyl) hex-5-ynoic acid

(2018)

2. The IUPAC nomenclature of the following compound is



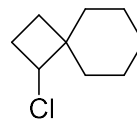
- (1) (2E, 4E)-3-chlorohexa-2, 4-diene-1, 6-diol
- (2) (2Z, 4E)-3-chlorohexa-2, 4-diene-1, 6-diol

(3) (2Z, 4Z)-3-chlorohexa-2, 4-diene-1, 6-diol

(4) (2E, 4Z)-3-chlorohexa-2, 4-diene-1, 6-diol

(2017)

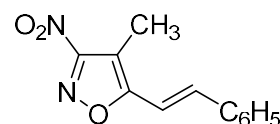
3. The correct name of the following compound is:



- (1) 1-chloro spiro- [3, 5] – nonane
- (2) 3-chloro spiro- [5, 3] – nonane
- (3) 6-chloro spiro- [5, 3] – nonane
- (4) 4-chloro spiro- [5, 3] – nonane

(2017)

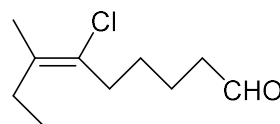
4. The correct nomenclature of the following compound is:



- (1) 3-Nitro-4-Methyl-5-Styryl oxazole
- (2) 4-methyl-3-nitro-5-styrylisoxazole
- (3) 3-Nitro-4-Methyl-5-Styryl pyrazole
- (4) 4-Styryl-2-Nitro-3-Methyl isoxazole

(2014)

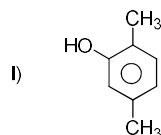
5. The correct name of the following compound is



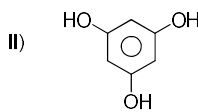
- (1) 6-Chloro-7-methylnonanol
- (2) 6-chloro-7-methylnon-6-enal
- (3) 6-Chloro-7-methylnonenol
- (4) 6-Chloro-7-methylnonanal

(2014)

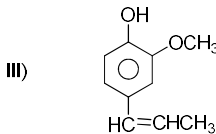
6. Match the following:



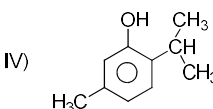
1. Phloroglucinol



2. PXylenol



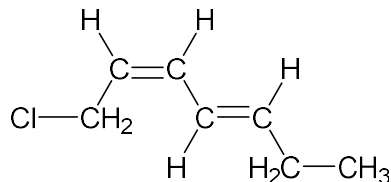
3. Thymol



4. Isoeugenol

	I	II	III	IV
(1)	1	3	2	4
(2)	2	1	4	3
(3)	3	4	2	1
(4)	1	4	3	2

7. Give the IUPAC name for the given structure

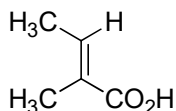


- (1) 1-Chloro – 2Z,4Z – heptadiene
 (2) 1-Chloro – 2Z,4E – 2,4 – heptadiene
 (3) 7-Chloro – 2Z,4E – heptadiene
 (4) 1-Chloro – 2E,4Z – 2,4 – heptadiene

8. Match the following:

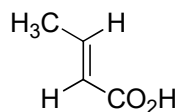
I) Maleic acid

1.



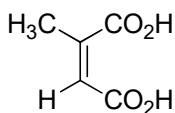
II) Citraconic acid

2.



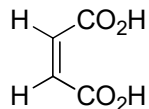
III) Crotonic acid

3.

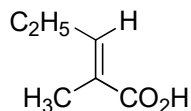


IV) Tiglic acid

4.

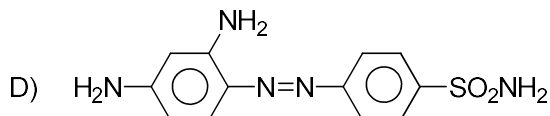
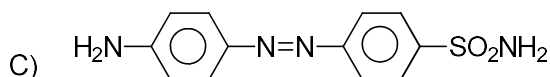
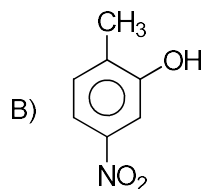
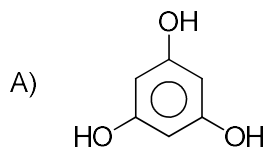


5.

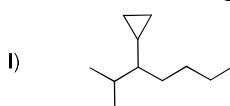


	I	II	III	IV
(1)	1	4	2	3
(2)	4	3	2	1
(3)	3	1	5	2
(4)	2	3	1	5

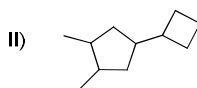
9. Identify prontosil from the following



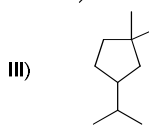
10. Match the following:



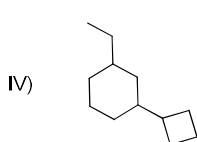
1. 1,1-Dimethyl-3- isopropyl cyclopentane



2. 1-Cyclobutyl-3- ethylcyclo-hexane



3. 1,1,2,3- Tetramethylcyclobutane



4. 3-cyclopropyl-2- methyl-heptane

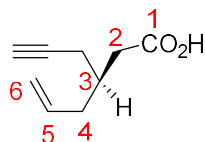
	I	II	III	IV
(1)	1	3	2	4
(2)	4	1	2	3
(3)	5	2	3	4
(4)	4	5	1	2

Answer Key

1	2	3	4	5	6	7	8	9	10
3	2	1	2	2	2	2	2	4	4

:: Solution ::

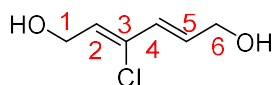
1. Solution:



1st number goes to carboxylic acid and R,S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane)

Correct Answer is (S)-3-(prop-2-ynyl) hex-5-enoic acid

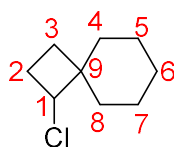
2. Solution:



1st number goes to that carbon where nearest substituent will come and E, Z nomenclature if same priority group on same side, then we can say Z isomer and if same priority group on opposite side, then we can say E isomer and priority of the atom given on the basis of atomic number

Correct Answer is (2Z, 4E)-3-chlorohexa-2, 4-diene-1, 6-diol

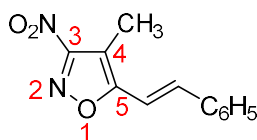
3. Solution:



1st number goes to these carbon where chlorine attached and in spiro compound numbering start from less membered ring to more membered ring

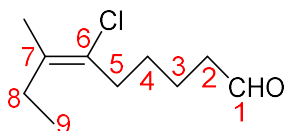
Correct Answer is 1-chloro spiro- [3, 5] – nonane

4. Solution:



Correct Answer is 4-methyl-3-nitro-5-styrylisoxazole

5. Solution:



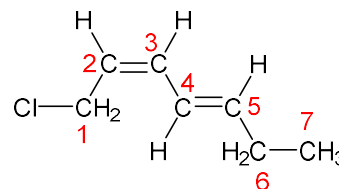
1st number goes to aldehyde and naming of substituent according to alphabetically order

Correct Answer is 6-chloro-7-methylnon-6-enal

6. Solution:

Correct Answer is (B) 2 1 4 3

7. Solution:



1st number goes to those carbon where substituent attached and for E,Z nomenclature if same priority group on same side, then we can say Z isomer and if same priority group on opposite side, then we can say E isomer and priority of the atom given on the basis of atomic number

Correct Answer is 1-Chloro – 2Z,4E – 2,4 – heptadiene

8. Solution:

Correct Answer is (B) 4 3 2 1

9. Solution:

Correct Answer is D

10. Solution:

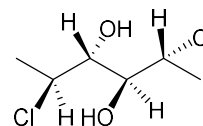
- I) 1. 1,1-Dimethyl-3- isopropyl cyclopentane
- II) 2. 1-Cyclobutyl-3- ethylcyclo- hexane
- III) 3. 1,1,2,3- Tetramethylcyclobutane
- IV) 4. 3-cyclopropyl-2- methyl-heptane
5. 4-cyclobutyl-1,2-dimethylcyclopentane

Correct Answer is (D) 4 5 1 2

WB-SET

(2020)

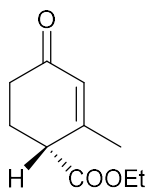
1. The IUPAC name of the following compound is



- (1) (2S, 3R, 4S, 5R)–2, 5–dichlorohexane – 3, 4–diol
 (2) (2S, 3S, 4S, 5R)–2, 5–dichlorohexane – 3, 4–diol
 (3) (2R, 3S, 4R, 5S)–2,5–dichlorohexane-3,4–diol
 (4) (2S, 3R, 4R, 5S)–2, 5–dichlorohexane – 3, 4–diol

(2018)

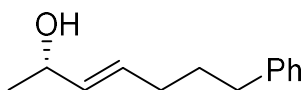
2. The IUPAC name of the following compound is



- (1) ethyl (S)-2-methyl-4-oxocyclohex-2-enecarboxylate
 (2) ethyl (R)-2-methyl-4-oxocyclohex-2-enecarboxylate
 (3) (R)-4-ethoxycarbonyl-3-methylcyclohex-2-enone
 (4) (S)-4-ethoxycarbonyl-3-methylcyclohex-2-enone

(2017)

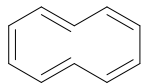
3. The IUPAC name for the compound given below is:



- (1) (2R,3Z)-7-phenylhept-3-en-2-ol
 (2) (2S,3Z)-7-phenylhept-3-en-2-ol
 (3) (2R,3E)-7-phenylhept-3-en-2-ol
 (4) (2S,3E)-7-phenylhept-3-en-2-ol

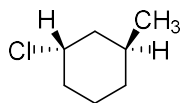
(2015)

4. The correct IUPAC nomenclature for the following compound is



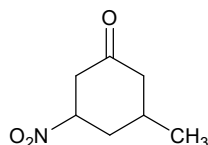
- (1) 10-[5]-annulene (2) 10-[10]-annulene
 (3) 10-[18]-annulene (4) 10-[20]-annulene

5. The correct IUPAC name of the following compound is



- (1) (1R, 3R)-1-chloro-3-methylcyclohexane
 (2) (1R, 3S)-1-chloro-3-methylcyclohexane
 (3) (1S, 3R)-1-chloro-3-methylcyclohexane
 (4) (1S, 3S)-1-chloro-3-methylcyclohexane.

6. The IUPAC name of the following compound is



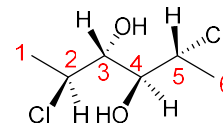
- (1) 3-methyl-5-nitrocyclohexan-1-one
 (2) 5-methyl-3-nitrocyclohexanone
 (3) 3-methyl-5-nitro-1-oxocyclohexane
 (4) 5-methyl-3-nitro-1-oxocyclohexane

Answer Key

1	2	3	4	5	6
3	2	4	2	4	1

:: Solution ::

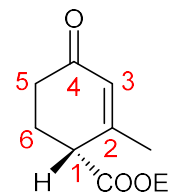
1. Solutions:



R, S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane)

Correct Answer is (2R, 3S, 4R, 5S)-2,5-dichlorohexane-3,4-diol

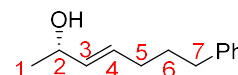
2. Solutions:



R, S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane) and numbering start from near to substituent

Correct Answer is ethyl (R)-2-methyl-4-oxocyclohex-2-enecarboxylate

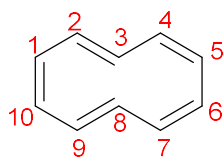
3. Solutions:



Numbering starting from these carbon where substituent should near and R,S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane) and for E,Z nomenclature if same priority group on opposite side then we can say E isomer

Correct Answer is (2S,3E)-7-phenylhept-3-en-2-ol

4. Solutions:



10 carbo and 10 electron

Correct Answer is 10 - [10]-annulene

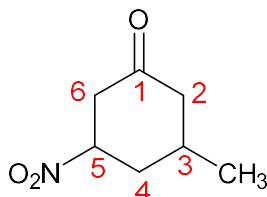
5. Solutions:



R, S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane)

Correct Answer is (1S, 3S)-1-chloro-3-methylcyclohexane

6. Solutions:



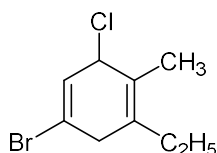
1st number goes to carbonyl group

Correct Answer is 3-methyl-5-nitrocyclohexan-1-one

AP-SET

(2019)

1. IUPAC name of



(1) 5-Bromo-3-chloro-1-ethyl-2-methylcyclohex-1,4-diene

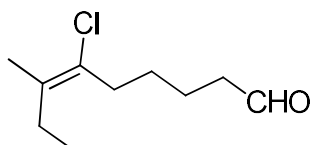
(2) 4-Bromo-6-chloro-2-ethyl-1-methylcyclohex-1-ene

(3) 1-Bromo-5-chloro-3-ethyl-4-methylcyclohex-3-ene

(4) 5-Bromo-4-chloro-3-ethyl-2-methylcyclohex-2-ene

(2014)

2. The correct name of the following compound is



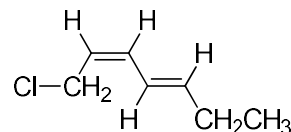
(1) 6-Chloro-7-methylnonanol

(2) 6-chloro-7-methylnon-6-enal

(3) 6-Chloro-7-methylnonenol

(4) 6-Chloro-7-methylnonanal

3. Give the IUPAC name for the given structure



(1) 1-Chloro - 2Z,4Z - heptadiene

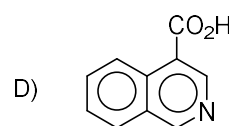
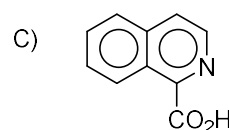
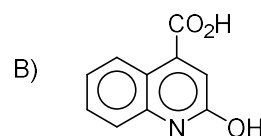
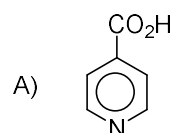
(2) 1-Chloro - 2Z,4E - 2,4 - heptadiene

(3) 7-Chloro - 2Z,4E - heptadiene

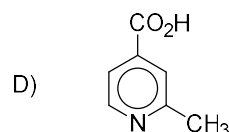
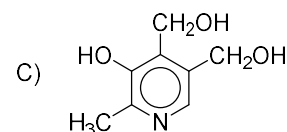
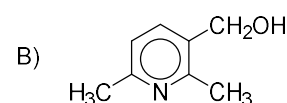
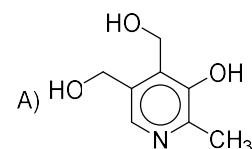
(4) 1-Chloro - 2E,4Z - 2,4 - heptadiene

(2013)

4. Identify cinchoninic acid from the following structures



5. Identify pyridoxin from the following structures

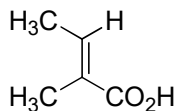


(2012)

6. Match the following: (Nomenclature)

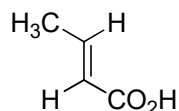
I) Maleic acid

1.



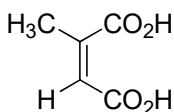
II) Citraconic acid

2.



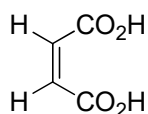
III) Crotonic acid

3.

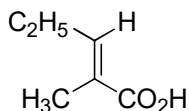


IV) Tiglic acid

4.

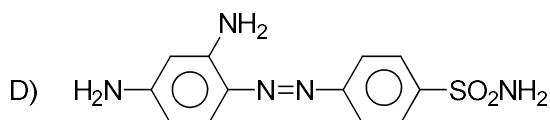
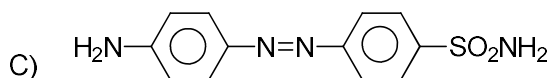
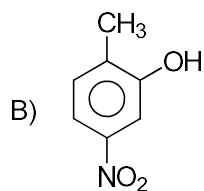
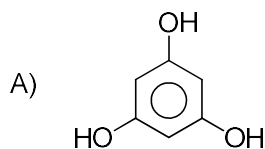


5.



	I	II	III	IV
(1)	1	4	2	3
(2)	4	3	2	1
(3)	3	1	5	2
(4)	2	3	1	5

7. Identify prontosil from the following (Nomenclature)



8. Match the following: (Nomenclature)

I) 1. 1,1-Dimethyl-3-isopropylcyclopentane

II) 2. 1-Cyclobutyl-3-ethylcyclohexane

III) 3. 4-cyclobutyl-1,2-dimethylcyclopentane

IV) 4. 3-cyclopropyl-2-methylheptane

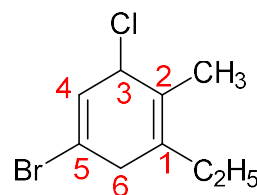
	I	II	III	IV
(1)	1	3	2	4
(2)	4	1	2	3
(3)	5	2	3	4
(4)	4	3	1	2

Answer Key

1	2	3	4	5	6	7	8
1	2	2	2	3	2	4	4

:: Solutions ::

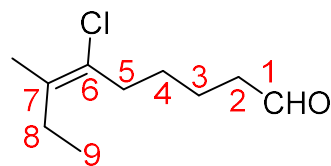
1. Solution:



1st number gives to those carbon where ethyl and alkene attached

Correct Answer is 5-Bromo-3-chloro-1-ethyl-2-methylcyclohex-1,4-diene

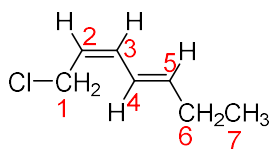
2. Solution:



1st priority goes to aldehyde

Correct Answer is 6-Chloro-7-methylnonanal

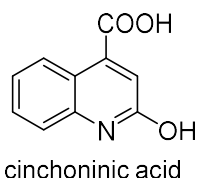
3. Solution:



1st number goes to those carbon where substituent attached and for E,Z nomenclature if same priority group on same side, then we can say Z isomer and if same priority group on opposite side, then we can say E isomer and priority of the atom given on the basis of atomic number

Correct Answer is 1-Chloro – 2Z, 4E – 2,4 – heptadiene

4. Solution:



Correct Answer is 1

5. Solution:

Correct Answer is **Ans C**

6. Solution:

Correct Answer is (B) 4 3 2 1

7. Solution:

Correct Answer is **Ans D**

8. Solution:

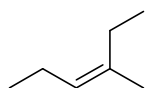
- I) 1. 1,1-Dimethyl-3- isopropyl cyclopentane
- II) 2. 1-Cyclobutyl-3- ethylcyclo-hexane
- III) 3. 1,1,2,3- Tetramethylcyclobutane
- IV) 4. 3-cyclopropyl-2- methyl-heptane
- 5) 4-cyclobutyl-1,2-dimethylcyclopentane

Correct Answer is (D) 4 5 1 2

GJ-SET

(2019)

1. The correct IUPAC name of the following compound is:



- (1) 4-Ethylpent-3-ene (2) 2-Ethylpent-2-ene
(3) 3-Methylhex-3-ene (4) 4-Methylhex-3-ene

(2019)

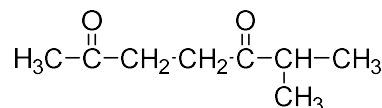
2. The structure of the following compound is:

(z)-2-(chloromethyl) but-2-enoic acid

- (A) (B)
(C) (D)

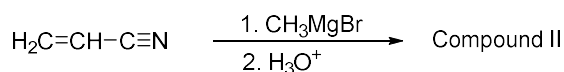
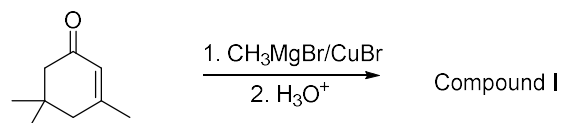
(2018)

3. The IUPAC name of the following compound is:



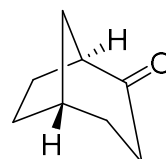
- (1) 6-Methylheptane-2, 5-dione
(2) 2-Methylheptane-3, 6-dione
(3) 6-Methyl-2, 5-dioxoheptane
(4) 2-Methyl-3, 6-dioxoheptane

4. Predict the products in the following reactions:



- (A) and $\text{H}_3\text{C}-\text{CH}_2-\text{CH}_2-\text{COCH}_3$
(B) and $\text{H}_3\text{C}-\text{CH}_2-\text{CH}_2-\text{C}\equiv\text{N}$
(C) and $\text{CH}_3-\text{CH}_2-\text{C}(=\text{O})-\text{CH}_3$
(D) and $\text{CH}_3-\text{CH}_2-\text{C}(=\text{O})-\text{CH}_3$

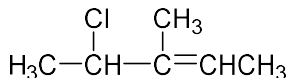
5. Propose correct IUPAC name for the following compound:



- (1) 1S, 5S-Bicyclo [3.2.1] octa-2-one
 (2) 1S, 5R-Bicyclo [3.2.1] octa-2-one
 (3) 1R, 5S-Bicyclo [3.2.1] octa-5-one
 (4) 1S, 5S-Bicyclo [3.2.1] octa-5-one

(2017)

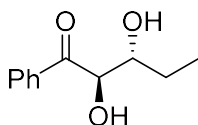
6. Which is the correct IUPAC name of the following compound?



- (1) 2-chloro-3-methylpent-3-ene
 (2) 4-chloro-3-methylpent-2-ene
 (3) 3-methyl-4-chloropent-2-ene
 (4) 3-methyl-2-chloropent-3-ene

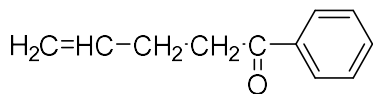
(2016)

7. The IUPAC name of the following molecule is:



- (1) (2S, 3R)-1-Phenyl-pentan-1-one
 (2) (2R, 3R)-2,3-dihydroxy-1-phenylpentan-1-one
 (3) (2S, 3S)-1-Phenyl-pentan-1-one
 (4) (2R, 3R)-1-Phenyl-pentan-1-one

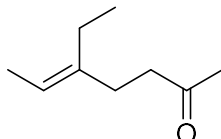
8. The IUPAC name of the following molecule is



- (1) Phenylbutenylketone
 (2) 5-phenyl-5-oxo-1-pentene
 (3) 1-phenylpenta-4-en-1-one
 (4) 1-phenyl-2-oxo-4-pentene

(2014)

9. The IUPAC name of the following compound is:

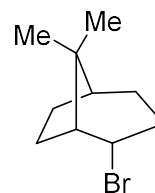


- (1) (Z)-3-Ethylhept-2-en-6-one
 (2) (E)-3-Ethylhept-2-en-6-one
 (3) (Z)-5-Ethylhept-5-en-2-one
 (4) (E)-5-Ethylhept-5-en-2-one

10. The IUPAC name of $\text{Li}[\text{AlH}_4]$ is:

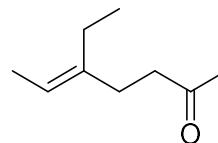
- (1) Lithium tetrahydridoaluminate (III)
 (2) Lithium tetrahydridoaluminium (III)
 (3) Lithium tetrahydridoaluminium
 (4) Lithium tetrahydroaluminate (III)

11. The IUPAC name of the following molecule is:



- (1) 2-bromo-6, 6-dimethylbicyclo [3.2.1] octane
 (2) 1, 1-dimethyl-3-bromobicyclo [1.2.3] octane
 (3) 2-bromo-8, 8-dimethylbicyclo [3.2.1] octane
 (4) 5-bromo-8, 8-dimethylbicyclo [3.2.1] octane

12. The IUPAC name of the following compound is:



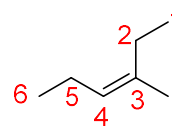
- (1) (Z)-3-Ethylhept-2-en-6-one
 (2) (E)-3-Ethylhept-2-en-6-one
 (3) (Z)-5-Ethylhept-5-en-2-one
 (4) (E)-5-Ethylhept-5-en-2-one

Answer Key

1	2	3	4	5	6	7	8	9	10
3	2	1	1	1	2	2	3	4	1
11	12								
3	4								

:: Solution ::

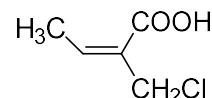
1. Solution:



Numbering starting from those carbon where methyl and double bond should near

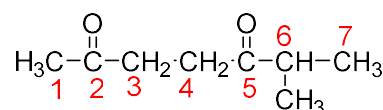
Correct Answer is 3-Methylhex-3-ene

2. Solution:



Correct Answer is B

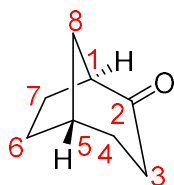
3. Solution:



Number starting from near to carbonyl carbon

Correct Answer is 6-Methylheptane-2, 5-dione

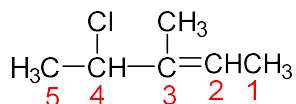
5. Solution:



Number starting from near to carbonyl carbon. R, S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane) numbering start from near to functional group

Correct Answer is 1S, 5S-Bicyclo [3.2.1] octa-2-one

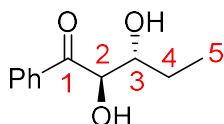
6. Solution:



Numbering starting from near to alkene carbon

Correct Answer is 4-chloro-3-methylpent-2-ene

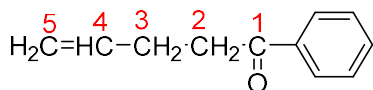
7. Solution:



Numbering starting from carbonyl carbon. If the same atom are opposite side then we called threo isomer.

Correct Answer is threo-1-phenyl-2, 3-dihydroxypentanone

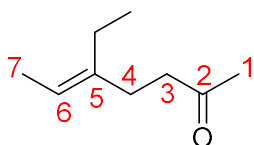
8. Solution:



Numbering starting from carbonyl carbon

Correct Answer is 1-phenylpenta-4-en-1-one

9. Solution:



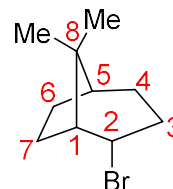
Numbering starting from near to carbonyl carbon

Correct Answer is (E)-5-Ethylhept-5-en-2-one

10. Solution:

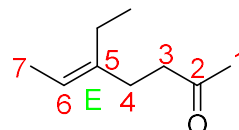
Correct Answer is Lithium tetrahydridoaluminate (III)

11. Solution:



Correct Answer is 2-bromo-8, 8-dimethylbicyclo [3.2.1] octane

12. Solution:

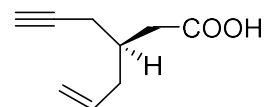


(E)-5-Ethylhept-5-en-2-one

HP-SET

(2018)

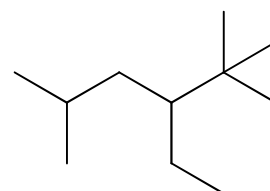
1. The IUPAC name of the following compound is:



- (1) (R)-3-(prop-2-enyl)hex-5-ynoic acid
- (2) (S)-3-(prop-2-enyl)hex-5-ynoic acid
- (3) (R)-3-(prop-2-enyl)hex-5-enoic acid
- (4) (S)-3-(prop-2-yn-1-yl)hex-5-enoic acid

(2017)

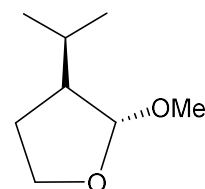
2. IUPAC name of the following compound is:-



- (1) 3-Ethyl-2, 2, 5-trimethyl hexane
- (2) 3-tert-butyl-5-methyl hexane
- (3) 4-Ethyl-2, 5, 5-trimethyl hexane
- (4) 2, 2, 5-trimethyl-4-Ethyl hexane

(2014)

3. IUPAC name of the following compound is:-

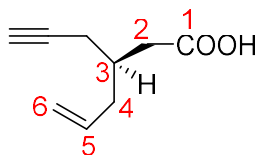


- (1) (3R)-isopropyl-(2S)-methoxy-tetrahydrofuran
- (2) (2R,3R)-3-isopropyl-2-methoxytetrahydrofuran
- (3) (3R)-isopropyl-(2R)-methoxy-tetrahydrofuran
- (4) (3S)-isopropyl-(2S)-methoxy-tetrahydrofuran

Answer Key		
1	2	3
4	1	2

:: Solutions ::

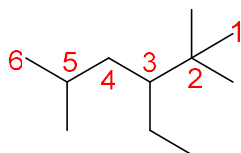
1. Solution:



1st number goes to carboxylic acid group and R, S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane)

Correct Answer is (S)-3-(prop-2-yn-1-yl)hex-5-enoic acid

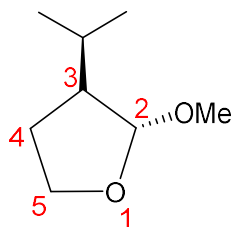
2. Solution:



1st select the long chain and numbering start from that side where substituent should near

Correct Answer is 3-Ethyl-2, 2, 5-trimethyl hexane

3. Solution:



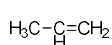
R, S nomenclature according to CIP rule 1st priority goes to highest atomic no. atom and then accordingly then for clockwise direction gives R (for that lowest priority group should be below the plane) and for anticlockwise direction give S (for that lowest priority group should be below the plane) and numbering start from oxygen

Correct Answer is (2R, 3R)-3-isopropyl-2-methoxytetrahydrofuran

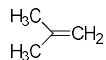
MH-SET

(2020)

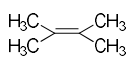
1. The correct order of stability of the following alkenes is:



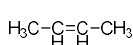
I



II



III



IV

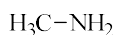
- (1) IV < II < III < I
(2) III < IV < II < I
(3) IV < III < I < II
(4) I < II < IV < III

(2020)

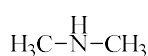
2. The correct order of basicity of the following compounds is:



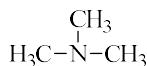
I



II



III

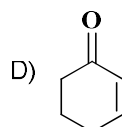
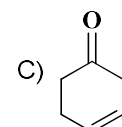
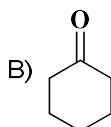
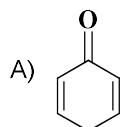


IV

- (1) III < II < IV < I
(2) IV < III < II < I
(3) I < IV < II < III
(4) II < IV < III < I

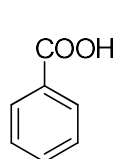
(2020)

3. Which of the following compounds undergo fastest tautomerization?

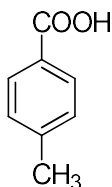


(2019)

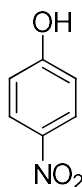
4. The correct order of acidity of the following molecules is



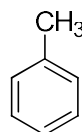
I



II



III

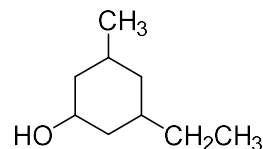


IV

- (1) (IV) < (III) < (II) < (I)
(2) (III) < (IV) < (II) < (I)
(3) (IV) < (II) < (I) < (III)
(4) (IV) < (I) < (III) < (II)

(2019)

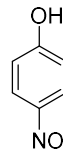
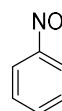
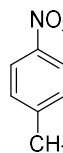
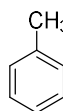
5. The correct IUPAC name of the following compound is



- (1) 3-ethyl-5-hydroxy-1-methyl cyclohexane
(2) 5-ethyl-3-methyl cyclohexanol
(3) 1-ethyl-3-methyl-5-hydroxy-cyclohexane
(4) 3-ethyl-5-methyl cyclohexanol

(2019)

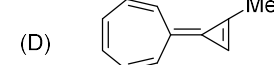
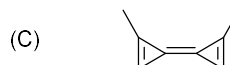
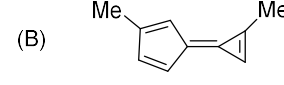
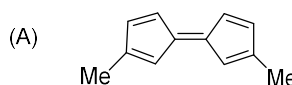
6. The correct order of dipole moment for the following compounds is



- (1) (III) < (I) < (IV) < (II)
(2) (III) < (II) < (I) < (IV)
(3) (I) < (IV) < (III) < (II)
(4) (I) < (II) < (III) < (IV)

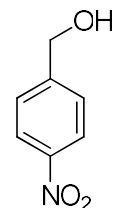
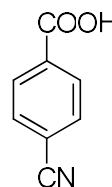
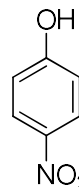
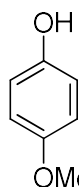
(2018)

7. Amongst the following the rate of cis-trans isomerisation is expected to be highest in:



(2018)

8. The correct order of acidity for the following compounds is:



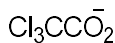
- (1) III > I > II > IV
(2) II > III > I > IV
(3) IV > II > I > III
(4) III > II > I > IV

(2017)

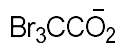
9. The correct order of basicity of the following species is:



I



II



III

(1) I > III > II

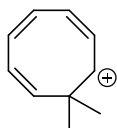
(2) II > I > III

(3) III > II > I

(4) III > I > II

(2016)

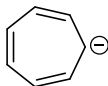
10.



[A]



[B]



[C]

Among the three ions [A], [B], [C], given:

(1) A is aromatic, B is homoaromatic and C is antiaromatic

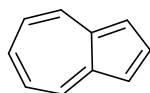
(2) A is homoaromatic, B is aromatic and C is antiaromatic

(3) A is aromatic, B is antiaromatic and C is homoaromatic

(4) A is homoaromatic, B is antiaromatic and C is aromatic

(2016)

11.



[X]

The most correct statement about compound [X] is:

(1) It is aromatic

(2) It is aromatic and has high dipole moment than expected

(3) It is aromatic but has no dipole moment

(4) It is antiaromatic

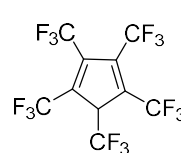
(2016)

12. The carbonyl compounds exhibit electrophilic functionality because they have:

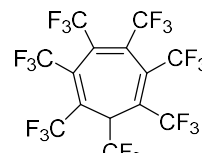
(1) A Low Energy LUMO σ^* orbital(2) A Low Energy HOMO π^* orbital(3) A Low Energy LUMO π^* orbital(4) A Low Energy HOMO σ^* orbital

(2015)

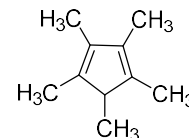
13. The correct order of acidity of the following compounds is



I



II



III

(1) II > III > I

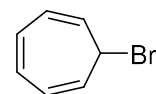
(2) I > III > II

(3) I > II > III

(4) III > I > II

(2015)

14. Cycloheptatrienyl bromide has structure:



This compound is to:

(1) behave like covalent compound and dissolves in non-polar solvents

(2) behave like ionic compound and dissolves in polar solvents like water

(3) behave like coordination compounds

(4) behave like ionic compound but dissolves in non-polar solvent

(2015)

15. Which of the following statements is not correct for Benzene?

(1) It is a $(4n + 2) = 6\pi$ -electron Annulene

(2) It doesn't represent by a real cyclic structure

(3) It doesn't show resonance phenomenon

(4) It is entirely different than Annulene skeleton

(2015)

16. The organic reaction occurs when the HOMO of nucleophile overlaps with the LUMO of electrophile to form:

(1) A new σ -bond(2) A new π -bond

(3) A new coordinate covalent bond

(4) A new lone pair/non-bonding electron pair

(2013)

17. Which of the following compounds is not aromatic in nature?

(1) Cyclopentadienyl anion (2) Pyrrole

(3) Fullerene C_{60} (4) Azulene

(2013)

18. Which of the following is not a criteria for

(1) Presence of $(4n + 2)$ delocalizable electrons

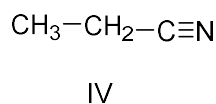
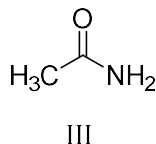
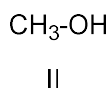
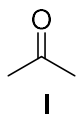
(2) Diamagnetic character

(3) Strong shielding-de-shielding pattern as a result of induced ring current

(4) Paramagnetic character

(2021)

19. The correct order of polarity of the following functional group is:



(1) I < II < III < IV

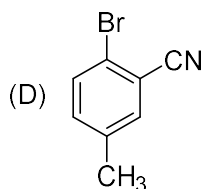
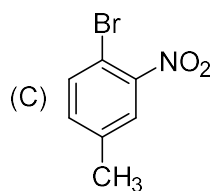
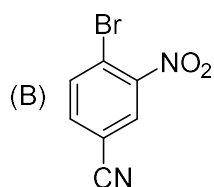
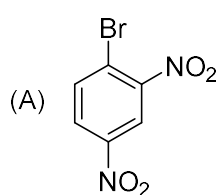
(2) I < IV < III < II

(3) IV < III < I < II

(4) III < IV < II < I

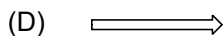
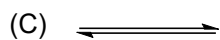
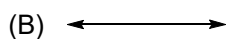
(2021)

20. Which of the following reacts fastest with NaOMe?



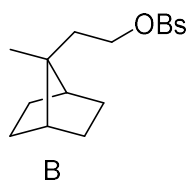
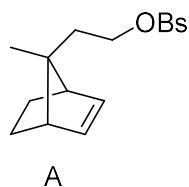
(2021)

21. Which one among the following arrows is the correct representation of resonance?



(2021)

22. Compound A at 25°C undergoes acetolysis 140000 times faster than compound B. Select the reason for this behavior:



- (1) Anchimeric assistance
(2) Inductive Effect
(3) Field effect
(4) Resonance effect

Answer Key

1	2	3	4	5	6	7	8	9	10
4	3	1	1	4	3	2	4	3	2
11	12	13	14	5	16	17	18	19	20
2	3	2	2	3	1	3	4	2	1
21	22								
2	1								

:: Solutions ::

1. Solution: (4)

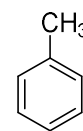
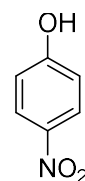
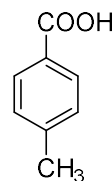
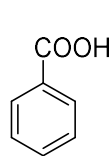
More substituted double bond is more stable.

2. Solution: (3)

3. Solution: (1)

In compounds first undergo fastest tautomerization because after tautomerization it becomes aromatic.

4. Solution: (1)



I

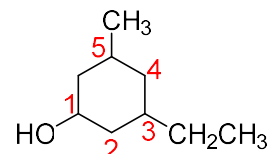
II

III

IV

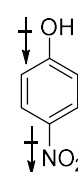
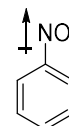
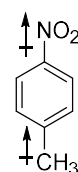
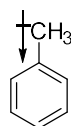
Because first one is more acidic; second compound is less acidic than first because +I effect of methyl group destabilise the carboxylate anion then third one and fourth.

5. Solution: (4)



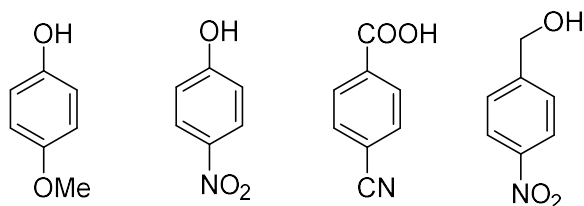
Correct Answer is 3-ethyl-5-methyl cyclohexanol

6. Solution: (3)



Because the more dipole moment presents in second compound compared to fourth compound because in compound four OH group have +M and -I effect but in compound second methyl group have only +I effect.

7. Solution: (2)

8. Solution: (4)

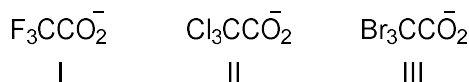
I

II

III

IV

Because, third one is more acidic because acid group present then second because -I effect of NO_2 group stabilise the negative charge then first and four respectively.

9. Solution: (3)

I

II

III

Third one is more basic because less electronegative Bromine atom and first one is less basic because more electronegative Fluorine atom withdraw electron density itself.

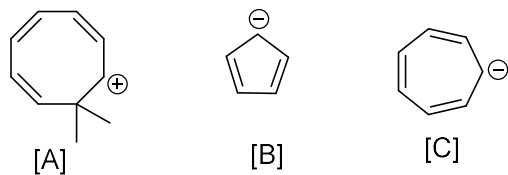
10. Solution: (2)

Rule for Aromaticity:-

If compound obey: $-4n+2\pi e$, Planar, Cyclic & cyclic Conjugation then this compound are aromatic.

If compound obey: $-4n\pi e$, Planar, Cyclic & cyclic Conjugation then this compound are Anti-aromatic.

If compound doesn't have (Planar, Cyclic, Conjugation) one of these three then this compound are non-aromatic.

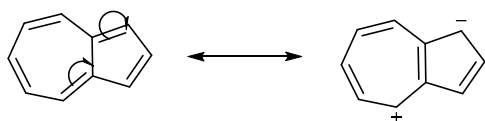


[A]

[B]

[C]

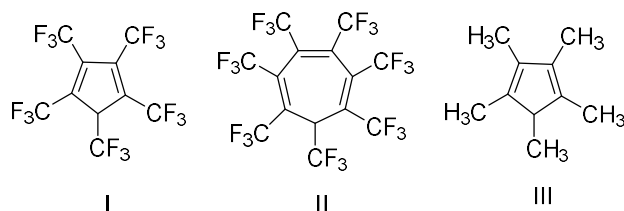
Correct Answer is A is homoaromatic, B is aromatic and C is antiaromatic. A is homoaromatic because it contains one SP^3 carbon and B is aromatic because it follows $4n+2\pi$ electron rule it is planar, conjugated and cyclic and C is antiaromatic because it follows $4n\pi$ electron.

11. Solution: (2)

Correct Answer is It is aromatic and has high dipole moment than expected

12. Solution: (1)

Correct Answer is A Low Energy LUMO π^* orbital because carbonyl carbon has SP^2 hybridized. Hence, they have low energy Lowest Unoccupied molecular Orbital (LUMO) π^* .

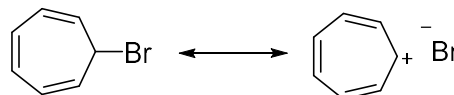
13. Solution: (2)

I

II

III

Correct Answer is $\text{I} > \text{III} > \text{II}$ I compound has more acidic proton because CF_3 group have -I effect and after removing proton it becomes aromatic II compound is less acidic because after removing proton it becomes Non-aromatic and III compound is more acidic than second because after removing proton it becomes aromatic compounds.

14. Solution: (2)

Correct Answer is behaved like ionic compound and dissolves in polar solvents like water. It is behaved like ionic compound because after ionisation it becomes aromatic and ionised compound are dissolve in polar solvent.

15. Solution: (3)

Correct Answer is It doesn't show resonance phenomenon

Benzene ring has resonating structure. Hence it always shows resonance phenomenon.

16. Solution: (1)

When HOMO of nucleophile (electron rich moiety) and LUMO of electrophile (electron deficient moiety) overlapped then formation of σ bond.

Correct Answer is A new σ -bond

17. Solution: (3)

Cyclopentadienyl anion, Pyrrole, and Azulene are aromatic compounds because they follow $4n+2\pi$ electron rule and they are planar, cyclic and they have conjugation.

Correct Answer is Fullerene C_{60}

18. Solution: (4)

Aromatic compound is: -

Obey $4n+2$ e rule.

Aromatic compound has diamagnetic character and anti-compound have paramagnetic character.

Aromatic compound shows strong induced ring current.

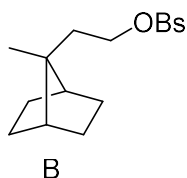
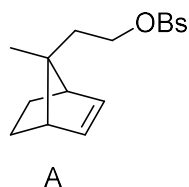
19. Solution: (2)

20. Solution: (1)

21. Solution: (2)

22. Solution: (1)

The interaction of an electron pair (either lone pair or PI bond) with an adjacent reaction center reaction is called as neighboring group participation also termed as Anchimeric assistance.



In Compound A pi-bond bond present hence Anchimeric assistance(neighboring group participation) presence while in Compound B no Anchimeric assistance(neighboring group participation).

Hence Rate of acetolysis (solvolysis) of Compound A is faster than compound B.

Kerla-SET

(2019)

1. Which of the following statement is true?

- (1) An aromatic compound is less stable than an analogous cyclic compound
- (2) An antiaromatic compound is less stable than an analogous cyclic compound
- (3) An antiaromatic compound is more stable than an analogous aromatic compound
- (4) An antiaromatic compound must be a planar cyclic compound with an interrupted ring of p-orbital bearing atoms and the π cloud must contain an odd number of pairs of π electrons.

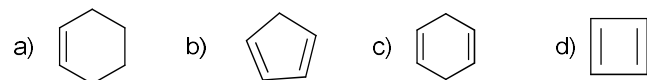
(2018)

2. Which among the following is aromatic?

- (1) Cyclopropene
- (2) Cyclopropenyl cation
- (3) Cyclopropenyl anion
- (4) Cyclopropane

(2018)

3. Which is more acidic?



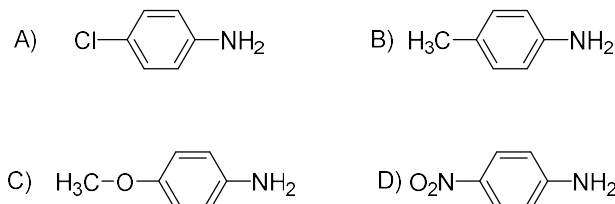
(2018)

4. Which one of the following shows highest dipole moment?

- (1) 1,3-dichlorobenzene
- (2) 1,3,5-trichlorobenzene
- (3) 1,4-dichlorobenzene
- (4) 1,2-dichlorobenzene

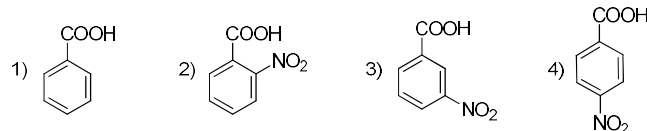
(2018)

5. Which is the weakest base among the following?



(2017)

6. Arrange the following in the increasing order of acidity.



- (1) (i) < (ii) < (iv) < (iii)
- (2) (i) < (iv) < (iii) < (ii)
- (3) (i) < (iii) < (iv) < (ii)
- (4) (iii) < (ii) < (iv) < (i)

(2017)

7. Which of the following statements is wrong?

- (1) Benzene, and [6] annulene is aromatic
- (2) Cyclobutadiene, and [4] annulene is antiaromatic
- (3) Cyclooctatetraene, and [8] annulene is nonaromatic
- (4) Cyclodecapentaene, and [10] annulene is aromatic

(2017)

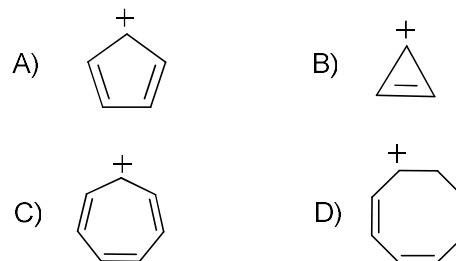
8. The increasing order of stability of the following free radicals is

- i) CH_3 ii) CF_3 iii) CH_2F iv) CHF_2

- (1) i < iii < iv < ii
- (2) i < ii < iii < iv
- (3) i < iii < ii < iv
- (4) ii < i < iii < iv

(2017)

9. Which among the following ion is homo aromatic?



10. The hapticity of cyclopentadienyl is/are

- (1) 1
- (2) 3
- (3) 5
- (4) 1, 3 and 5

Preface

The idea of the book entitled **“Inorganic Chemistry: SET PYQ’s”** was born because of the lack of any comprehensive book covering all the aspects of various entry level chemistry competitive examinations in particular conducted by CSIR, GATE, TIFR State and National Eligibility Test, but not limited to.

This book covers all PYQ’s with topic wise sorted question and solution

1. Chemical Periodicity
2. Chemical Bonding
3. Main Group Element
4. Coordination Chemistry
5. Inner Transition Element
6. Organometallic Chemistry
7. Bioinorganic Chemistry
8. EPR Spectroscopy
9. Nuclear Chemistry
10. Chemistry of Acid and Base
11. Analytical Chemistry
12. General Chemistry.

The ultimate purpose of this book is to equip the reader with brainstorming challenges and solution for inorganic chemistry and applied aspect examinations. It contains predigested information on the entire academic subject of inorganic chemistry for good understanding, assimilation, self-evaluation, and reproducibility. Although we have made every effort to make the book error free, we are under no illusion. We welcome comments, criticism and suggestions from the readers to evolve the contents.

Acknowledgement

First of all I would like to thank our entire students at Institute for advanced Studies (IFAS), who have helped us to learn and practice both the art and science of chemistry. We would like to thank **Er. Radheshyam Choudhary**, Founding CEO, IfAS Edutech Pvt. Ltd. for being a continuous source of inspiration through his positive strokes.

We also want to thank **Dr. Kailash Choudhary**, Director at IFAS Publications, for his valuable support and critical suggestion for completion of the work.

We would not forget to thank all the IfAS team where we were able to further continue our teaching, training, and especially learning the many facets of the process of building these creative questions in books.

This book is a team effort, and producing it would be impossible without outstanding people of IFAS publication. It was pleasure to work with many others dedicated and creative people of IFAS during the production of this book. Special thanks for Vikendra Metha who crafted our ideas to wonderful design of cover page and Kuldeep Singh Rathore for formatting and type setting.

And finally, our humble greetings to all who put their significant efforts and are unmentioned.

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CHEMICAL PERIODICITY

MH SET

(MH-SET 25 Nov. 2011)

1. The number of nodes in a 3s orbital is:

(A) 0 (B) 1
(C) 2 (D) 3

(MH-SET 25 Nov. 2011)

2. The three unpaired electrons on the nitrogen atom is ascribed to :

(A) Pauli's exclusion principle
(B) Aufbau principle
(C) Hund's rule
(D) Uncertainty principle

(MH-SET 25 Nov. 2011)

3. Which of the following specie have distorted octahedral structures?

(A) SF₆ (B) [PF₆]⁻
(C) SbF₅ (D) XeF₆

(MH-SET 25 Nov. 2011)

4. Which one of the following compounds readily forms dimers?

(A) AsCl₃ (B) AlCl₃
(C) PCl₃ (D) BCl₃

(MH-SET 2015)

5. The strength of hydrogen bonds follow the order:

(A) ClH Cl > NH N > OH O > FH F
(B) ClH Cl < NH N < OH O < FH F
(C) ClH Cl < NH N > OH O > FH F
(D) ClH Cl < NH N < OH O > FH F

(MH-SET 2015)

6. First and second ionization energies of Mg are 7.646 and 15.035 eV respectively. The amount of energy in kJ needed to convert all the atoms of magnesium into Mg
- ²⁺
- ions present in 12 mg of magnesium vapors is:

(A) 1.5 (B) 2.0
(C) 1.1 (D) 0.5

(MH-SET 2015)

7. Which of the following is the correct order of 1
- st
- Ionization Potential:

(A) Ca > Sr > Ba > Mg (B) Ba > Mg > Ca > Sr
(C) Sr > Ca > Mg > Ba (D) Mg > Ca > Sr > Ba

(MH-SET 2015)

8. The correct order of the basicity of the following oxides:

(A) NO₂ < CO₂ < Na₂O < Al₂O₃ (B) CO₂ < NO₂ < Al₂O₃ < Na₂O
(C) NO₂ < CO₂ < Al₂O₃ < Na₂O (D) Al₂O₃ < Na₂O < NO₂ < CO₂

(MH-SET 2018)

9. The correct order of First Ionization energy of group 13 elements is:

(A) B > Tl > Ga > Al > In (B) B > Tl > Al > Ga > In
(C) B > Al > Ga > In > Tl (D) B > Ga > Tl > In > Al

(MH-SET 2018)

10. The ionophore valinomycin is highly selective for:

(A) K⁺ (B) Na⁺
(C) Mg²⁺ (D) Ca²⁺

(MH -SET 2019)

11. Size of the d orbitals for Si, P, S and Cl follow the order:

(A) Si > P > S > Cl (B) Cl > P > S > Si
(C) Cl > S > P > Si (D) P > S > Si > Cl

(MH - SET 2020)

12. The hydrogen bond strength in

(i) O—H.....O
(ii) O—H.....Cl
(iii) O—H.....N will follow the order:

(A) (i) > (iii) > (ii) (B) (ii) > (i) > (iii)
(C) (i) = (ii) > (iii) (D) (i) > (ii) > (iii)

(MH - SET 2020)

13. The strength of hardness of the isoelectronic ions F
- ⁻
- , OH
- ⁻
- , NH
- ₂
- ⁻
- and CH
- ₃
- ⁻
- follows the order:

(A) CH₃⁻ > OH⁻ > NH₂⁻ > F⁻ (B) CH₃⁻ > F⁻ > OH⁻ > NH₂⁻
(C) F⁻ > OH⁻ > NH₂⁻ > CH₃⁻ (D) CH₃⁻ > NH₂⁻ > OH⁻ > F⁻

GUJARAT SET

[GUJARAT SET 2014]

14. Which SET of quantum numbers is possible for an element?

(A) n = 1, l = 1, m = 0, s = -1/2
(B) n = 2, l = 1, m = 0, s = +1/2
(C) n = 2, l = 0, m = -2, s = +1/2
(D) n = 1, l = 0, m = 1, s = -1/2

(GJ-SET 2014)

15. The strongest van der Waals interaction is present in:

- (A) F_2 (B) Cl_2
(C) Br_2 (D) I_2

(GJ-SET 2014)

16. Greater the number of lone pairs on a central atom, the contraction caused in the bond angle will be:

- (A) Less (B) More
(C) no effect (D) Balance the angle

(GJ-SET 2014)

17. Comparing structure and properties of:

(I) $Na^+(CH_2C_6H_5)^-$ and (II) $Na^+(C_6H_5)^-$

Which of the following statements is not correct?

- (A) Both (I) and (II) belongs to the class of ionic organometallic compounds
(B) The nucleophilic character of (I) is less than (II)
(C) (I) is stabilized by resonance while (II) is not
(D) Reactivity of (I) > (II)

(GJ-SET 2014)

18. The correct order of second ionization potential of C, N, O and F is:

- (A) $C > N > O > F$ (B) $O > N > F > C$
(C) $O > F > N > C$ (D) $F > O > N > C$

(GJ-SET 2014)

19. Fluorine has the highest electronegativity amongst ns^2np^5 group but electron affinity of F is less than that of Cl because:

- (A) The atomic number of F is less than that of Cl
(B) F behaves in unusual manner
(C) Cl can accommodate an electron better than F by utilizing its vacant 3d orbital
(D) High electron density makes an addition of an electron less favorable than Cl.

(GJ-SET 2014)

20. Most substances expand when heated in all temperature ranges. Water exhibits anomalous behavior. It contracts when heated between 0° and $4^\circ C$. Which of the following statements is the appropriate to this behavior?

- (A) Ice has an open cage like structure
(B) In ice, water molecules are both covalently as well as hydrogen bonded
(C) When ice melts, density increases as water molecules come closer together to filling up empty spaces in the cage structure
(D) In ice, water molecules are tetrahedrally oriented with respect to each other.

(GJ-SET 2017)

21. Which of the following species has the largest dissociation energy?

- (A) CN (B) BN
(C) CN^- (D) NO

(GJ-SET 2018)

22. The van der Waals radii of O, N, Cl, F and Ne increase in the order:

- (A) F, O, N, Ne, Cl (B) N, O, F, Ne, Cl
(C) Ne, F, O, N, Cl (D) F, Cl, O, N, Ne

(GJ-SET 2019)

23. The radial part of an atomic orbital wave function depends upon:

- (A) l only (B) n only
(C) n, l and m (D) m only

(GJ-SET 2019)

24. The values of electronegativity of atoms M and N are 2.5 and 1.05, respectively. The % ionic character of M-N bond is:

- (A) 28.80% (B) 34.20%
(C) 38.50% (D) 45%

HP SET

[HPSET 2014]

25. In which of the following pairs do the two species resemble each other most closely in chemical properties?

- (A) 1_1H and ${}^1_1H^+$ (B) ${}^{14}_7N$ and ${}^{14}_7N^{3-}$
(C) ${}^{12}_6C$ and ${}^{13}_6C$ (D) All of the above

(HP-SET 2019)

26. An atomic orbital has two angular nodes and one radial node. It is a:

- (A) 2p orbital (B) 3p orbital
(C) 3d orbital (D) 4d orbital

KARNATAKA SET

(KA-SET 2020)

27. The filling of molecular orbitals takes place according to:

- (A) The Aufbau principle
(B) Pauli Exclusion principle
(C) Hund's rule of maximum multiplicity
(D) All of the mentioned above

AP SET

(AP-SET 2012)

28. The correct increasing order of second ionization energy of elements X, Y, Z with respective atomic numbers 19, 20, 38 is

(A) X, Y, Z (B) X, Z, Y
(C) Z, Y, X (D) Z, X, Y

(AP-SET 2014)

29. The correct decreasing order of the first ionization energy of the elements P, S, Cl is:

(A) Cl, S, P (B) Cl, P, S
(C) P, Cl, S (D) S, Cl, P

(AP-SET 2014)

30. The number of radial nodes for a 3s orbital is:

(A) 0 (B) 1
(C) 2 (D) 3

(AP-SET 2014)

31. Which of the following has the highest Pauling's electronegativity value?

(A) Be (B) Mg
(C) Ca (D) Ba

(AP-SET 2014)

32. Match the following

List – I	List – II
I. Orbital angular momentum quantum number	1. M_l
II. Magnetic quantum number	2. l
III. Spin quantum number	3. J
IV. Total angular momentum quantum number	4. S

1	2	3	4
(A) I	II	III	IV
(B) I	III	II	IV
(C) II	I	IV	III
(D) III	IV	I	II

(AP-SET 2014)

33. Among the halogens from Cl to I, decreasing trend is observed with respect to:

I. Ionization energy
II. Electro positivity
III. Electronegativity
IV. Metallic character the correct combination is

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

(AP-SET 2018)

34. A 3d atomic orbital has:

(A) one radial node and one angular node
(B) Two angular nodes
(C) Two radial nodes
(D) No nodes

JAMMU KASHMIR SET

(J & K-SET 2011)

35. The second ionization energies of Li, Be, B and C are in the order:

(A) $Li > C > B > Be$ (B) $Li > B > C > Be$
(C) $B > C > Be > Li$ (D) $Be > C > B > Li$

(J & K-SET 2011)

36. All Cu (II) halides are known except the iodide. The reason for is that:

(A) iodide is a bulky ion
(B) Cu^{2+} oxidizes iodide to iodine
(C) Cu^{2+} (aq) has much more negative hydration enthalpy
(D) Cu^{2+} ion has smaller size

(J&K SET 2011)

37. Maximum number of electrons in a shell with principal quantum number 'n' is given by:

(A) n (B) $2n$
(C) n^2 (D) $2n^2$

(J&K SET 2012)

38. The correct order of electron gain enthalpy with negative sign of F, Cl, Br, and I having atomic number 9, 17, 35, and 53 respectively is:

(A) $F < Cl < Br < I$ (B) $Cl < F < Br < I$
(C) $I < Br < F < Cl$ (D) $Cl < Br < I < F$

(J&K SET 2012)

39. Properties of elements are periodic function of number of _____ present in the nucleus:

(A) Protons (B) Electrons
(C) Neutrons (D) Mesons

(J&K SET 2012)

40. Which of the following elements has the highest value of electron affinity?

(A) O (B) S
(C) Se (D) Te

(J & K-SET 2016)

41. Electronegativities of _____ atoms changes _____ rapidly when crossing d block than while crossing the p block elements.

(A) less (B) more
(C) very less (D) huge

(J & K-SET 2016)

42. Which of the following pair of reagents will not react to form product?

- (A) $\text{PF}_5 + \text{CsF}$ (B) $\text{XeF}_6 + \text{BF}_3$
(C) $\text{RbBr} + \text{BaBr}_2$ (D) $\text{NaF} + \text{AlF}_3$

(J & K-SET 2018)

43. The number of radial nodes for a 3s orbital is

- (A) 0 (B) 1
(C) 2 (D) 3

(J & K-SET 2018)

44. The correct decreasing order of the first ionization energy of the elements P, S, Cl is

- (A) Cl, S, P (B) Cl, P, S
(C) P, Cl, S (D) S, Cl, P

(J & K - SET 2018)

45. Match the following

List – I	List – II
I. Orbital angular momentum	1. M_l quantum number
II. Magnetic quantum	2. l number
III. Spin quantum	3. j number
IV. Total angular momentum	4. s quantum number

- | | | | |
|---------|-----|-----|-----|
| 1 | 2 | 3 | 4 |
| (A) I | II | III | IV |
| (B) I | III | II | IV |
| (C) II | I | IV | III |
| (D) III | IV | I | II |

(J & K-SET 2018)

46. Among the halogens from Cl to I, a decreasing trend is observed with respect to

- I. Ionization energy
II. Electropositivity
III. Electronegativity
IV. Metallic character

The correct combination is

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

(J & K-SET 2018)

47. Assertion (A): The radius of Fe^{3+} is less than that of Fe^{2+} .
Reason (R): Fe^{3+} has a lower effective nuclear charge than Fe^{2+} .

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

(J & K-SET 2018)

48. The correct ground state configuration for Chromium is:

- (A) $[\text{Ar}] 3d^4 4s^2$ (B) $[\text{Ar}] 3d^5 4s^1$
(C) $[\text{Ne}] 3d^5 4s^1$ (D) $[\text{Ne}] 3d^4 4s^2$

KA SET

(KA –SET 2014)

49. Which one of the following is incorrect with respect to the property indicated?

- (A) Electronegativity: $\text{F}_2 > \text{Cl}_2 > \text{Br}_2$
(B) Electron affinity: $\text{Cl}_2 > \text{F}_2 > \text{Br}_2$
(C) Oxidizing power: $\text{F}_2 > \text{Cl}_2 > \text{Br}_2$
(D) Bond energy: $\text{F}_2 > \text{Cl}_2 > \text{Br}_2$

(KA –SET 2014)

50. Which one of the following SETs indicate the correct variation in electro negativities?

- (A) $\text{F} > \text{N} < \text{O} > \text{C}$ (B) $\text{F} > \text{N} > \text{O} > \text{C}$
(C) $\text{F} < \text{N} < \text{O} < \text{C}$ (D) $\text{F} < \text{O} > \text{N} > \text{C}$

(KA-SET 2015)

51. The reduced ionization energy within a given family of non-transition elements is due to:

- (A) increase in size
(B) increase in shielding
(C) combined effect of increased size and shielding
(D) combined effect of increased size and decreased shielding

(KA-SET 2015)

52. Which of the following pair of elements form covalent compounds:

- (1) C and S (B) 1 and 3
(2) Na and Cl
(3) S and O
(4) Ca and H
(A) 1 and 2 (D) 2 and 3
(C) 2 and 4

53. The electronegativity difference is the highest for the pair:

- (A) Na, F (B) Li, F
(C) Li, Cl (D) K, F

54. The correct order of decreasing electronegativity and ionic size is as follows

- (A) $\text{Al} > \text{Ca} > \text{S} > \text{As}; \text{K}^+ > \text{Cl}^- > \text{Ca}^{2+} > \text{S}^{2-}$
(B) $\text{S} > \text{As} > \text{Al} > \text{Ca}; \text{S}^{2-} > \text{Cl}^- > \text{K}^+ > \text{Ca}^{2+}$
(C) $\text{S} > \text{As} > \text{Ca} > \text{Al}; \text{S}^{2-} > \text{Cl}^- > \text{K}^+ > \text{Ca}^{2+}$
(D) $\text{As} > \text{Al} > \text{Ca} > \text{S}; \text{K}^+ > \text{Ca}^{2+} > \text{S}^{2-} > \text{Cl}^-$

(KA-SET 2016)

55. Which of the following pairs has the highest difference in their first ionization energy?
- (A) Xe, Cs (B) Ne, Na
(C) Kr, Rb (D) Ar, K

(KA-SET 2017)

56. The atom with the highest ionization potential is:
- (A) Boron (B) Carbon
(C) Nitrogen (D) Oxygen

(KA-SET 2017)

57. H_2S gas is passed through an acidic solution containing Pb^{2+} , Zn^{2+} , Cu^{2+} and Ni^{+2} ions. The precipitate will consist of:
- (A) ZnS and PbS (B) PbS and NiS
(C) NiS and CuS (D) CuS and PbS

(KA-SET 2017)

58. Which of the following can be acceptable electronic configuration of xenon atom in the first excited state?
- (A) $5s^25p^6$ (B) $5s^25p^45d^2$
(C) $5s^25p^55d^1$ (D) $5s^25p^35d^3$

KL SET

(KL-SET 2012)

59. The number of radial nodes for the 3s orbital of hydrogen atom is:
- (A) 0 (B) 1
(C) 2 (D) 3

(KL-SET 2013)

60. Which of the following is the salt of an organic acid?
- (A) Rochelle salt (B) Microcosmic salt
(C) Mohr's salt (D) Zeise's salt

(KL -SET 2013)

61. The electronic configuration of the element X is $[\text{Ar}] 4s^2d^{10}$. Which one of the following is the most suitable formula for its oxide?
- (A) X_2O (B) X_2O_3
(C) XO (D) X_2O_5

(KL -SET 2013)

62. Atomic nuclei having same neutron number, N and hence different Z and A values are called:
- (A) Isobars (B) Isotones
(C) Isotopes (D) Isomers

63. Which of the following is not a greenhouse gas?
- (A) O_3 (B) CH_4
(C) N_2 (D) CO_2

(KL-SET JUNE 2015)

64. Which one of the following indicates the correct order of variation in atomic size?
- (A) $\text{B} > \text{Be} > \text{C} > \text{N}$ (B) $\text{Be} > \text{C} > \text{N} > \text{B}$
(C) $\text{Be} > \text{B} > \text{C} > \text{N}$ (D) $\text{N} > \text{C} > \text{B} > \text{Be}$

(KL-SET JUNE 2015)

65. Which of the following elements is metalloid?
- (A) C (B) P
(C) Pb (D) As

(KL-SET JUNE 2015)

66. The second ionization energy of C, N, O and F is of the order
- (A) $\text{C} < \text{N} < \text{O} < \text{F}$ (B) $\text{C} < \text{N} < \text{F} < \text{O}$
(C) $\text{O} < \text{N} < \text{C} < \text{F}$ (D) $\text{C} < \text{F} < \text{O} < \text{N}$

(KL-SET JUNE 2015)

67. The binding energy per nucleon of ^{16}O and ^{17}O are 7.98 MeV and 7.76 MeV respectively then the energy required in MeV to remove a neutron from ^{17}O is
- (A) 3.58 (B) 7.76
(C) 4.24 (D) 7.98

(KL-SET JUNE 2015)

68. Total number of nodes (planar and spherical) present in the 5f-orbital is:
- (A) One (B) Two
(C) Three (D) Four

(KL-SET JUNE 2015)

69. The effective nuclear charge at the periphery of nitrogen atom when an extra electron is added in the formation of anion
- (A) 3.9 (B) 2.8
(C) 2.6 (D) 3.5

(KL-SET DEC 2015)

70. Which of the following elements has the highest third ionization energy?
- (A) Mg (B) Al
(C) Si (D) P

(KL-SET DEC 2015)

71. Lowest IP will be shown by the element having the configuration:
- (A) $[\text{He}] 2s^2$ (B) $[\text{He}] 2s^2 2p^2$
(C) $1s^2$ (D) $[\text{He}] 2s^2 2p^3$

(KL-SET 2016)

72. Which one of the following indicates the correct order of variation in atomic size?
- (A) $\text{Be} > \text{C} > \text{F} > \text{Ne}$ (B) $\text{Be} > \text{C} > \text{F} < \text{Ne}$
(C) $\text{Be} < \text{C} < \text{F} < \text{Ne}$ (D) $\text{F} > \text{Ne} > \text{B} > \text{C}$

(KL-SET JUNE 2017)

73. The number of radial and angular nodes in a 4f orbital are respectively
 (A) 3,3 (B) 2,2
 (C) 0,3 (D) 0,2

(KL-SET JULY 2017)

74. The increasing order of electron affinity values among the elements C, N, O & F is
 (A) $N < C < O < F$ (B) $C < N < O < F$
 (C) $N < O < C < F$ (D) $C < O < N < F$

(KL SET 2018)

75. The electron gain enthalpy of halogens are in the order
 (A) $F > Cl > Br > I$ (B) $F > Br > Cl > I$
 (C) $Cl > F > Br > I$ (D) $Cl > Br > F > I$

(KL SET 2018)

76. Which is the smallest cation among the following?
 (A) Na^{2+} (B) Al^{3+}
 (C) Ba^{+} (D) Mg^{2+}

RAJ SET

(RAJ-SET 2012)

77. Which of the following has the highest Ionization potential:
 (A) Na (B) Al
 (C) Mg (D) K

(RAJ-SET 2012)

78. The screening effect is maximum for electron in:
 (A) s – orbital (B) p – orbital
 (C) d – orbital (D) f – orbital

(RAJ-SET 2012)

79. The inert pair effect is maximum in:
 (A) N (B) P
 (C) As (D) Bi

(RAJ-SET 2012)

80. Select the correct sequence of first ionization energy:
 (A) $Be < B < N < O$ (B) $Be < B < O < N$
 (C) $B < Be < O < N$ (D) $B < Be < N < O$

(RAJ-SET 2013)

81. Which order are correct?
 (I) Thermal stability: $BeSO_4 < MgSO_4 < CaSO_4 < SrSO_4 < BaSO_4$
 (II) Basic nature: $ZnO > BeO > MgO > CaO$
 (III) Solubility in water: $LiOH > NaOH > KOH > RbOH > CsOH$
 (IV) Melting point: $NaCl > KCl > RbCl > CsCl > LiCl$
 (A) (I) and (IV) (B) (II) and (III)
 (C) (I) and (III) (D) (II) and (IV)

(RAJ-SET 2013)

82. Which of the following possesses lowest value of first ionization energy?
 (A) Al (B) Ga
 (C) In (D) Tl

(RAJ-SET 2013)

83. The atomic number of Cr and Cu is 24, 29 and its electronic configuration is:
 (A) $3d^5 4s^1$ and $3d^{10} 4s^1$ (B) $3d^4 4s^2$ and $3d^{10} 4s^1$
 (C) $3d^5 4s^1$ and $3d^9 4s^2$ (D) $3d^4 4s^2$ and $3d^9 4s^2$

WB SET

(WB -SET)

84. The difference in the electronegativity scale between the two atom is 1.9, the nature of the bond is
 (A) 75% ionic (B) 50% ionic
 (C) 25% ionic (D) 100% ionic

(AP -SET 2013)

85. The correct statements among the following:
 (1) Na^{+} and Ne are isoelectronic but ionization energy of Na^{+} is more than Ne
 (2) Na^{+} and Ne are isoelectronic but ionization energy of Ne is more than Na^{+}
 (3) O^{2-} and F^{-} are isoelectronic but F^{-} has higher radius than O^{2-}
 (4) O^{2-} and F^{-} are isoelectronic but O^{2-} has higher radius than F^{-}
 (A) 1, 2, 3, 4 are correct (B) 1 and 3 are correct
 (C) 1 and 4 are correct (D) 2 and 4 are correct

(AP -SET 2013)

86. The correct order of ionic radii of given ions:
 (A) $K^{+} > Ca^{2+} > Cl^{-} > S^{2-}$ (B) $S^{2-} > Cl^{-} > K^{+} > Ca^{2+}$
 (C) $Ca^{2+} > Cl^{-} > S^{2-} > K^{+}$ (D) $K^{+} > Ca^{2+} > S^{2-} > Cl^{-}$

(J & K-SET 2011)

87. The second ionization energies of Li, Be, B and C are in the order:
 (A) $Li > C > B > Be$ (B) $Li > B > C > Be$
 (C) $B > C > Be > Li$ (D) $Be > C > B > Li$

(J & K-SET 2011)

88. Which of the following is the largest in size?
 (A) Cl^{-} (B) S^{2-}
 (C) Na^{+} (D) F^{-}

(J & K-SET 2011)

89. The correct order of reducing character of alkali metals is:
 (A) $Rb < K < Na < Li$ (B) $Li < Na < K < Rb$
 (C) $Na < K < Rb < Li$ (D) $Rb < Na < K < Li$

(J & K-SET 2018)

90. Which of the following has the highest Pauling's electronegativity value?

- (A) Be (B) Mg
(C) Ca (D) Ba

(WB SET 2015)

91. The correct order of stability in water is :

- (A) $\text{LiI} < \text{NaI} < \text{KI} < \text{CsI}$ (B) $\text{LiI} < \text{NaI} < \text{KI} < \text{CsI}$
(C) $\text{CsI} > \text{LiI} > \text{NaI} > \text{KI}$ (D) $\text{LiI} < \text{NaI} < \text{KI} < \text{CsI}$

(WB SET 2015)

92. Which of the following is the correct order of 1st ionization potential:

- (A) $\text{Ca} > \text{Sr} > \text{Be} > \text{Mg}$ (B) $\text{Be} > \text{Mg} > \text{Ca} > \text{Sr}$
(C) $\text{Sr} > \text{Ca} > \text{Mg} > \text{Be}$ (D) $\text{Mg} > \text{Be} > \text{Sr} > \text{Ca}$

(WB SET 2017)

93. For the molecule OCF_2 the correct statement is:

- (A) Both $\angle \text{FCF}$ and $\angle \text{FCO}$ are 120°
(B) $\angle \text{FCF} > 120$ but $\angle \text{FCO} < 120$
(C) $\angle \text{FCF} < 120$ but $\angle \text{FCO} > 120$
(d) $\angle \text{FCF}$ and $\angle \text{FCO} > 120$

(WB SET 2017)

94. An element has valence shell configurations $5d^5 6s^1$. Which group and period does it belong to?

- (A) 1st Group and 6th period
(B) 6th group and 5th period
(C) 6th group and 6th period
(D) 5th group and 6th period

(GJ SET 2003)

95. The ionic radii are:

- (A) directly proportional to effective nuclear charge
(B) directly proportional to square of effective nuclear charge
(C) inversely proportional to effective nuclear charge
(D) inversely proportional to square of effective nuclear charge

(GJ SET 2004)

96. The correct order of IP of B, C, N, O are

- (A) $\text{N} > \text{O} > \text{B} > \text{C}$ (B) $\text{O} > \text{N} > \text{B} > \text{C}$
(C) $\text{N} > \text{O} > \text{C} > \text{B}$ (D) $\text{O} > \text{N} > \text{C} > \text{B}$

(GJ – SET 2022)

97. Which of the following order is correct with respect to first ionization energies (in KJ mol^{-1}) ?

- (A) $\text{Li} < \text{K} < \text{Mg} < \text{Al}$ (B) $\text{K} < \text{Li} < \text{Al} < \text{Mg}$
(C) $\text{Al} < \text{Li} < \text{Mg} < \text{K}$ (D) $\text{Li} < \text{Al} < \text{Mg} < \text{K}$

ANSWER KEY

1	2	3	4	5	6	7	8	9	10
C	C	D	B	B	C	D	B	A	A
11	12	13	14	15	16	17	18	19	20
A	D	C	B	D	B	D	C	D	C
21	22	23	24	25	26	27	28	29	30
C	D	B	A	C	D	D	C	B	C
31	32	33	34	35	36	37	38	39	40
A	C	B	B	B	B	D	C	A	A
41	42	43	44	45	46	47	48	49	50
A	C	C	B	C	B	C	B	D	A
51	52	53	54	55	56	57	58	59	60
C	B	A	B	B	C	D	B	C	A
61	62	63	64	65	66	67	68	69	70
C	B	C	C	D	B	C	D	D	A
71	72	73	74	75	76	77	78	79	80
B	B	C	A	C	B	C	A	D	C
81	82	83	84	85	86	87	88	89	90
A	D	A	B	C	B	B	B	B	A
91	92	93	94	95	96	97			
D	B	C	C	C	C	B			

:: SOLUTIONS ::

MH SET

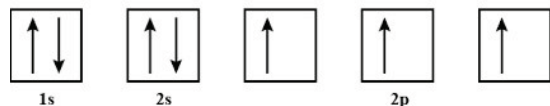
1. **Solution: (C)**

Total number of nodes for any orbital can be given by = $n - 1$ where n is the principal quantum number. For 3s orbital value of n is 3 so total number of orbitals is = $n - 1 = 2$

Hence, option C is correct.

2. **Solution: (C)**

The presence of three unpaired in Nitrogen can be explained by Hund's rule. According to this rule, *electron pairing in any orbital (s, p, d or f) cannot take place until each orbital of the same sublevel contains 1 electron*. The atomic number of nitrogen is 7, so its electronic configuration will be - $1s^2 2s^2 2p^3$. 2p orbital has 3 sub-levels each of which will contain one electron. Pairing will occur only if the fourth electron is added. The distribution of electrons on the nitrogen is shown as follows:



Hence, option C is correct.

3. **Solution: (D)**

$H = \frac{1}{2} [V + M - C + A]$ where,

H = Number of orbitals involved in hybridization.

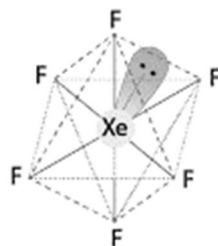
V = Valence electrons of a central atom.

M = Number of monovalent atoms linked to the central atom.

C = Charge of the cation.

A = Charge of the anion.

By applying the above formula, we get, the structure of XeF_6 is distorted one $[\text{sp}^3\text{d}^3]$. Others are perfect octahedral.

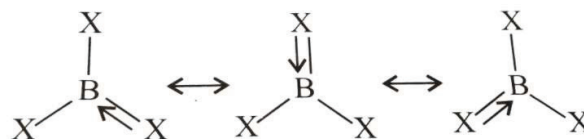


Hence, option D is correct.

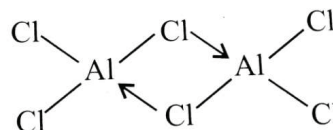
4. **Solution: (B)**

Boron atom being small in size is unable to accommodate four large-sized chlorine atoms around it. However, because of its large size, Al can easily

accommodate four large-sized Cl atoms around it. Since in both BCl_3 and AlCl_3 , there are only six electrons present in the valence shell of B and Al, both are electron deficient compound. BCl_3 compounds reduce their electron deficiency by accepting a pair of electrons from the filled np orbital of the halogen atom in the vacant 2p orbital of B, thus forming $\text{p}\pi\text{-p}\pi$ back bonding.



However, Al accepts a pair of electrons from 3p orbital of Cl (from another AlCl_3 molecule) in its vacant 3p orbital. As a result, AlCl_3 exist as a chlorine-bridged dimeric structure.



Hence, option B is correct.

5. **Solution: (B)**

A hydrogen bond is the electrostatic attraction between polar groups that occurs when a hydrogen (H) atom bound to a highly electronegative atom such as nitrogen (N), oxygen (O) or fluorine (F) experiences attraction to some other nearby highly electronegative atom. More electronegative the element, more is the hydrogen bonding.

Hence, the order is $\text{Cl} < \text{N} < \text{O} < \text{F}$

Hence, option B is correct.

6. **Solution: (C)**

The energy required to convert one Mg atom to Mg^{2+} ion is the sum of first and second ionization potentials = $7.646 + 15.035 = 22.681\text{eV} = 96.5 \times 22.681 = 2188.7\text{kJ/mol}$. The atomic mass of Mg is 24 g/mol and 12 mg of Mg corresponds to 0.5 millimoles.

The amount of energy required to convert 0.5 mmol of Mg atoms to Mg^{2+} ions = $0.5 \times 10^{-3} \times 2188.7 = 1.1\text{kJ}$

Hence, option C is correct.

7. **Solution: (D)**

As we go down group electropositive character increases because of increases in size and hence I.E. decreases. Ba is the most electropositive element in the group and Mg is least.

So, correct order is: $\text{Mg} > \text{Ca} > \text{Sr} > \text{Ba}$.

Hence, option D is correct.

8. **Solution: (B)**

There are certain rules that defines the acidity and the basicity of the oxides.

All metallic oxides are basic in nature hence, Na_2O is more basic in nature. Metal oxides which react with both acids as well as bases to produce salts and water are known as amphoteric oxides. Many metals (such as zinc, tin, lead, aluminum, and beryllium) form amphoteric oxides or hydroxides.

All nonmetallic oxides are acidic in nature hence, acidic oxides are NO_2 , CO_2 .

Deciding between CO_2 and NO_2 , we have carried out the hydrolysis reaction of both which produces H_2CO_3 [less acidic] and HNO_3 [more acidic] and hence correct order is $\text{CO}_2 < \text{NO}_2 < \text{Al}_2\text{O}_3 < \text{Na}_2\text{O}$

Hence, option B is correct.

9. **Solution: (A)**

On moving down the group, the ionization enthalpy decreases. This is true for B and Al. The ionization enthalpy of Ga is unexpectedly higher than that of Al. Ga contains 10 d electrons in inner shell which are less penetrating. Their shielding is less effective than that of s and p electrons. The outer electron is held fairly strongly by the nucleus. The ionization enthalpy increases slightly. A similar increase is observed from In to Tl due to presence of 14f electrons in the inner shell of Tl which have poor shielding effect. Hence the order is, $\text{B} > \text{Tl} > \text{Ga} > \text{Al} > \text{In}$

Hence, option A is correct.

10. **Solution: (A)**

Valinomycin is a naturally occurring compound in living beings used in the transport of potassium. It is highly selective for potassium ions over sodium ions within the cell membrane. It functions as a potassium-specific transporter and facilitates the movement of potassium ions through lipid membranes down the electrochemical potential gradient.

Hence, option A is correct.

11. **Solution: (A)**

From left to right, Atomic size decreases due to increase in effective nuclear charge and from top to bottom, atomic size increases due to increase in principal quantum number. Hence the order is given as: $\text{Si} > \text{P} > \text{S} > \text{Cl}$

Hence, option A is correct.

12. **Solution: (D)**

A hydrogen bond is the electrostatic attraction between polar groups that occurs when a hydrogen (H) atom bound to a highly electronegative atom such as nitrogen (N), oxygen (O) or fluorine (F) experiences attraction to some other nearby highly electronegative atom. *More electronegative the element, more is the hydrogen bonding.* Also, the chlorine atom is too large. Despite its electronegativity, the size of the atom is such that its electron density is too low to form hydrogen bonds. This is why Chlorine does not display hydrogen bonding while nitrogen does. The correct order of the electronegativity is $\text{Cl} < \text{N} < \text{O}$ and hence, (i) > (iii) > (ii) Hence, option D is correct.

13. **Solution: (C)**

Hardness of the compound depends upon the size [atomic and ionic radius]. *Smaller is the radius, smaller is the size and harder is the base which shows higher HOMO-LUMO gap.* In the given question, size follows the order as, $\text{CH}_3^- > \text{NH}_2^- > \text{OH}^- > \text{F}^-$ and hence, the correct order of the hardness is $\text{CH}_3^- < \text{NH}_2^- < \text{OH}^- < \text{F}^-$ Hence, option C is correct.

GUJARAT SET

14. **Solution: (B)**

There are total four quantum numbers. Their values can be given in the following manner:

Quantum Number	Symbol	Possible values
Principal quantum number	n	1,2,3,4.....
Azimuthal quantum number	l	0,1,2,3,4.....($n-1$)
Magnetic quantum number	m_l	- l ,.....,-1,0,1,.....+ l
Spin quantum number	m_s	+1/2, -1/2

All the SETs given above in the option, only $n = 2$, $l = 1$, $m = 0$, $s = +1/2$ matches with the above table

Hence, option B is correct.

15. **Solution: (D)**

Van der Waals forces include attraction and repulsions between atoms, molecules, and surfaces, as well as other intermolecular forces. The order of van der Waals interaction present in the halogens is given as $\text{F}_2 < \text{Cl}_2 < \text{Br}_2 < \text{I}_2$. This is the same order as that for the increase in the atomic size. Higher is the atomic size, higher will be the van der Waal's force.

Hence, option D is correct.

16. Solution: (B)

When one or more of the bonding pairs of electrons is replaced with a lone pair, the molecular geometry (actual shape) of the molecule is altered or contracted. The bond angle in the tetrahedral CH_4 molecule is 109.5° . Again, the replacement of one of the bonded electron pairs with a lone pair compresses the angle slightly. The H-N-H angle is approximately 107° . In the water molecule, two of the electron pairs are lone pairs rather than bonding pairs. The molecular geometry of the water molecule is bent. The H-O-H bond angle is 104.5° , which is smaller than the bond angle in NH_3 .

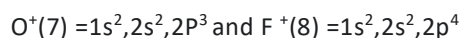
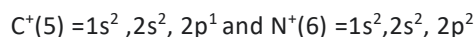
Hence, option B is correct.

17. Solution: (D)

I is stabilized by resonance while II is not. As I is stabilized by resonance it will have less nucleophile character than II. I will react slower than II.

18. Solution: (C)

Second ionization potential is the amount of energy required to remove an electron from the outer shell of unipositive ion and the electronic configuration of unipositive ions is as follows



In O^+ , half-filled p-orbital is present, so its second ionization potential is greater than that of F^+ . Thus, the correct is $\text{O} > \text{F} > \text{N} > \text{C}$.

Hence, option C is correct.

19. Solution: (C)

A valence-electron in a multi-electron atom is attracted by the nucleus and repelled by the electrons of inner-shells. The combined effect of this attractive and repulsive force acting on the valence-electron experiences less attraction from the nucleus. This is called shielding or screening effect. In Cl, there are empty d-orbitals where it can accommodate its electron and because of this, attraction forces increase and electron affinity also.

Hence, option C is correct.

20. Solution: (C)

In the structure of ice, due to Hydrogen bonding each molecule of H_2O is surrounded by three H_2O molecules in hexagonal honey comb manner. So due to large empty space voids are present in ice. When ice melts, density increases as water molecules come closer together to filling up empty spaces.

In the structure of ice each molecule of H_2O is surrounded by three H_2O molecules in hexagonal honey comb manner. Whereas in water, each molecule is surrounded by four neighboring molecules randomly which results in an open cage – like structure. As a result, there are a number of 'hole' or open spaces are present in ice. When ice melts a large number of hydrogen bonds are broken. The molecules of H_2O occupy the holds or open spaces and come closer to each other than they were in solid state. This results in sharp increase in the density. Therefore, ice has lower density than water at 4°C .

Hence, option C is correct.

21. Solution: (C)

The concept of dissociation energy depends upon the concept of bond order, bond strength and bond length. *Higher is the bond order, stronger is the bond strength, shorter is the bond length and largest is the bond dissociation energy.* From the options given above, bond order of CN^- is the largest (3) than BN (2), CN (2.5) and NO (2.5) and hence it has the largest dissociation energy.

Hence, option C is correct.

22. Solution: (D)

Generally, *As the Z_{eff} increase in a period for left to right direction so the radius decreases.* But in the case of Nobel gases, the van der Waal's radius is much larger than other elements. This is because of the more electron-electron repulsion. In a group radius increase down the group. So, the order is-



Hence, option D is correct.

23. Solution: (A), (B)

The radial part of wave function which relates to the position of an electron at a specific point depends on the principal quantum number and azimuthal quantum number.

Hence, option A and B both are correct.

24. Solution: (A)

Ionic character can be calculated by formula:

$$\% \text{ ionic character} = 16[\text{E}_\text{A} - \text{E}_\text{B}] + 3.5[\text{E}_\text{A} - \text{E}_\text{B}]^2 = 16[2.5 - 1.05] + 3.5[2.5 - 1.05]^2 = 28.80\%$$

Hence, option A is correct.

HP SET

25. **Solution: (C)**

All carbon atoms have six protons, and most have six neutrons as well. But some carbon atoms have seven or eight neutrons instead of the usual six. ... Different isotopes of an element generally have the same physical and chemical properties because they have the same numbers of protons and electrons.

Hence, option C is correct.

26. **Solution: (D)**

For 4d orbital,

Angular nodes= $l=2$ for d-orbital

Radial node= $n-l-1=4-2-1=1$

Hence, option D is correct.

KARNATAKA SET

27. **Solution: (D)**

The distribution of electrons in these molecular orbitals by filling the orbitals in the same way that we fill atomic orbitals.

Hence, option D is correct.

AP SET

28. **Solution: (C)**

Elements X, Y and Z with atomic numbers 19, 37, 55 lie in group 1 (alkali metals). Within a group, IE decreases from top to bottom. Therefore, IE of Y could be between those of X and Z.

Hence, option C is correct.

29. **Solution: (B)**

P has higher ionisation energy than S as P has a half-filled 3p subshell. Removal of an electron from P atom will break the stability of half-filled subshell.

Hence, option B is correct.

30. **Solution: (B)**

No of radial nodes in 3s

$$= n - l - 1 = 3 - 0 - 1 = 2$$

Hence, option B is correct.

31. **Solution: (A)**

Moving right in the periodic table results in an increase in electronegativity and a decrease in electronegativity if we move downwards

Be being on the top right expected to have a maximum value of electronegativity

Hence, option A is correct.

32. **Solution: (C)**

Orbital angular momentum is denoted by l while magnetic quantum no which defines the orbitals is denoted by m . Spin quantum no which is $\frac{1}{2}$ or $-\frac{1}{2}$ for an electron is denoted by s Total angular quantum no is denoted by J

Hence, option C is correct.

33. **Solution: (B)**

Decrease in electronegativity is observed if we move downwards. And greater the electronegativity greater would be the amount of energy required to remove an electron from the outermost shell and hence greater would be the ionization energy.

Hence, option B is correct.

34. **Solution: (B)**

3d atomic orbital,

Radial nodes $= n - l - 1 = 3 - 2 - 1 = 1$

Angular nodes $= l = 2$

Hence, option B is correct.

JAMMU KASHMIR SET

35. **Solution: (B)**

o know about the second ionization energy of the given atoms we are supposed to know the electronic configuration of the given atoms.

- The atomic number of lithium is 3 and the electronic configuration of the lithium is $1s^2 2s^1$
- The atomic number of beryllium is 4 and the electronic configuration of the beryllium is $1s^2 2s^2$
- The atomic number of boron is 5 and the electronic configuration of the boron is $1s^2 2s^1 2p^1$
- The atomic number of carbon is 6 and the electronic configuration of the carbon is $1s^2 2s^1 2p^2$

After removing one electron from the given elements the electronic configuration of the given elements will be as follows.

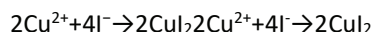
- Electronic configuration of the lithium (+1) is $1s^2 2s^0$.
- Electronic configuration of the beryllium (+1) is $1s^2 2s^1$.
- Electronic configuration of the boron (+1) is $1s^2 2s^2 2p^0$.
- Electronic configuration of the carbon (+1) is $1s^2 2s^2 2p^1$

Hence the order will be:

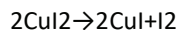
$$Li > B > C > Be$$

The second ionization energy for lithium is very high because the electronic configuration of Li (+1) resembles the electronic configuration of the stable noble gas. Boron also has filled 2s orbital after losing one electron. So, boron has high second ionization energy.

Hence, option B is correct.

36. Solution: (B)

The CuI_2 immediately decomposes to liberate I_2 and insoluble copper (I) iodide.



Hence, option B is correct.

37. Solution: (D)

In n th shell, the total number of orbitals are n^2 where each orbital can occupy a maximum of two electrons with opposite spin quantum number as $+1/2$ and $-1/2$. Hence max will be $2n^2$. Rest of the three quantum numbers in a given orbital will be same.

Thus it will follow Pauli's exclusion principle.

Hence, option D is correct.

38. Solution: (C)

The correct order of electron gain enthalpy with negative sign of F, Cl, Br, and I is $\text{Cl} > \text{F} > \text{Br} > \text{I}$. Actually halogens have maximum electron gain enthalpy in the corresponding periods and it becomes less negative down the group. However, the negative electron gain enthalpy of fluorine is less than that of chlorine.

Hence, C is the correct option.

39. Solution: (A)

Properties of elements are a periodic function of their atomic number. Let us recall that the atomic number gives us the number of protons in the nucleus of an atom and this number increases by one in going from one element to the next. Atomic no is given by the no of protons and electrons. Now in nucleus, protons are present so, the correct option is A

40. Solution: (A)

Highest electron affinity will be of oxygen because as we move down the group, the size increases and hence the attraction of nucleus for electron also decreases.

Hence, the correct option is A

41. Solution: (A)

Electronegativity of atoms change less rapidly when crossing the d-block of elements than when crossing the p-block. This is due to the higher screening effect of penultimate d electrons. Hence, the increase in the effective nuclear charge is more gradual for d block elements.

Hence the correct option is A

42. Solution: (C)

Since Rb belongs to the first group of the periodic table and Ba belongs to the second period, hence the reaction

between the two is not possible. The first metal has +1 valency while the period 2 metal while have +2 valency.

Hence the correct option is C

43. Solution: (C)

The no of radial nodes = $n - l - 1$

$$3s = 3 - 0 - 1 = 2$$

Hence the correct option is C

44. Solution: (B)

Generally, ionization energy increases with atomic number in a period as we move from left to right. But as P has the stability of half-filled 'p' orbital, it has greater ionization energy than S which has 4 electrons in 3p level and would readily lose the extra electron to acquire the stable half-filled 3p orbital.

Hence the correct option is B

45. Solution: (C)

Orbital angular momentum is denoted by l which defines the type of orbital present. $l = 0 - s$

$$l = 1 - p$$

$$l = 2 - d$$

Magnetic quantum no is denoted by m quantum no

Spin quantum no is denoted by s

Total angular momentum is denoted by J

Hence the correct option is C

46. Solution: (B)

While moving down the group, the electronegativity increases, with this increase the atoms try to keep their electrons to themselves and hence more ionization energy is required to remove the outermost electrons, hence an increase in I.E is observed.

Hence the correct option is B

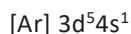
47. Solution: (C)

The radius of Fe^{3+} is lower than that of Fe^{2+} because the greater the charge, the greater would be the effective nuclear charge experienced and hence smaller radius.

Hence the correct option is C

48. Solution: (B)

To achieve the stable half-filled d orbital configuration, only 1 electron is occupied by s orbital and 5 electrons are occupied by d-orbital.



Hence the correct option is B

KA SET

49. Solution: (D)

A) E.N.: $\text{F} > \text{Cl} > \text{Br}$ - Electronegativity decreases down the group and F is the most electronegative element.

- B) E.A.: $\text{Cl} > \text{Br} < \text{F}$ - Electron affinity of fluorine is less than that of chlorine because of small size of F atom. As a result, there is strong interelectronic repulsion in the relatively small 2p orbitals of F and thus, the incoming electron does not experience much attraction.

Fluorine is stronger oxidising agent than chlorine because low bond dissociation energy of F-F bond and high hydration enthalpy of F^-

Bond energy $\text{F}_2 > \text{Cl}_2 > \text{Br}_2$ is wrong because low bond dissociation energy of F-F bond than Cl-Cl.

Hence the correct option is D

50. **Solution: (A)**

Electronegativity depends on the number of electrons required to get octet configuration. It increases from left to right in a period, hence correct order is $\text{F} > \text{O} > \text{N} > \text{C}$.

Hence the correct option is A

51. **Solution: (C)**

On moving down the group, in main group elements the ionization energy regularly decreases due to the following factors.

- (i) Atomic size: On moving down the group, as additional shells are added, the atomic size increases.
- (ii) Shielding effect: As the number of inner electrons increases, the shielding effect on the outermost electrons increases.
- (iii) Nuclear charge: On moving from top to down in a group, the nuclear charge increases. The effect of increase in the atomic size and the shielding effect is much more significant than the nuclear charge. The electron becomes less tightly held to the nucleus on moving down the group. Due to this, the ionization enthalpies gradually decrease on moving down the group. In non-transition elements.

Hence the correct option is C

52. **Solution: (B)**

Sodium and chlorine atoms come together to form sodium chloride (NaCl). NaCl is an ionic compound because of the strong electrostatic forces of attraction between positively charged Na metal cations and negatively charged Cl non-metal anions.

Carbon disulfide (CS_2) is made by the reaction of carbon and Sulphur. Since electronegativity of C and S is almost same so it is a covalent compound.

Sulphur reacts with oxygen to give Sulphur dioxide (SO_2). Sulfur dioxide bond is of covalent bonding since Sulphur and oxygen are both non-metals.

Calcium hydride (CaH_2) is an ionic compound that is formed when calcium metal reacts with hydrogen gas.

Hence the correct option is B

53. **Solution: (A)**

Electronegativity varies in a predictable way across the periodic table. Electronegativity increases from bottom to top in groups, and increases from left to right across periods. Thus, fluorine is the most electronegative element, while francium is one of the least electronegative.

Hence the correct option is A

54. **Solution: (B)**

55. **Solution: (B)**

Due to stable fully filled p-orbital the neon molecule does not want to lose electrons easily. Therefore, its first ionization potential is high. Also in sodium, the first ionization energy would be low as it would lead to stable inert gas configuration.

Hence option B is correct answer.

56. **Solution: (C)**

In nitrogen, the first ionization energy would be very high as the electron is to be removed from stable half-filled p-orbital.

Hence the correct option is C

57. **Solution: (D)**

ZnS is soluble in acidic solution. Hence, it cannot be precipitated from acidic solution. However, it can be precipitated from alkaline solution and to some extent from neutral solution. CuS and PbS can be precipitated from acidic solution.

Thus, the treatment of hydrogen sulfide with a solution containing ions of copper, zinc and lead will precipitate CuS and PbS .

Hence the correct option is D

58. **Solution: (B)**

The electronic configuration of xenon is-
 $[\text{Kr}] 4d^{10} 5s^2 5p^6$

In excited state, the two electrons in 5p are excited to higher energy 5d orbital.

Hence the correct option is B

KL SET

59. **Solution: (C)**

Radial nodes $= n - l - 1$

For $3s = 3 - 0 - 1 = 2$

60. **Solution: (A)**

Potassium sodium tartrate tetrahydrate, also known as Rochelle salt, is a double salt of tartaric acid, and hence an organic acid.

Hence the correct option is A

61. **Solution: (C)**

Electronic configuration is $[\text{Ar}] 4s^2 d^{10}$

It readily loses $4s^2$ electrons to form X^{2+}

. Hence formula of oxide is $X^{2+}O^{2-}=XO$.

We can see that the metal is Zn. ZnO reacts with acid as well as base. Hence the nature of oxide is amphoteric.

Hence the correct option is C

62. **Solution: (B)**

Two nuclides are isotones if they have the same neutron number N, but different proton number z. For example, Boron 12 and Carbon-13 nuclei both contain 7 neutrons and so are isotones

Hence the correct option is B

63. **Solution: (C)**

Oxygen and nitrogen are not greenhouse gases, because they are transparent to infrared light. These molecules are invisible because when you stretch one, it doesn't change the electric field.

Hence the correct option is C

64. **Solution: (C)**

The size of an element within a period decreases from left to right up to halogens because of the net increase in nuclear charge on the outermost electron. From halogen to noble gases the size increases as the last electron completes the octet and compensates for the increase in nuclear charge. Be is at the extreme left and hence will have larger size. Therefore, among B, C, N, Be, the size will follow the order:

$\text{Be} > \text{C} > \text{F} < \text{N}$

Hence the correct option is C

65. **Solution: (D)**

Arsenic is the third element in the fifteenth column of the periodic table. It is classified as a metalloid because it has some properties similar to a metal and others of a non-metal. Arsenic atoms have 33 electrons and 33 protons with 5 valence electrons in the outer shell.

Hence the correct option is D

66. **Solution: (A)**

Electronic configuration of,

$O_8 \rightarrow 1s^2 2s^2 2p^4$

$F_9 \rightarrow 1s^2 2s^2 2p^5$

$N_7 \rightarrow 1s^2 2s^2 2p^3$

$C_6 \rightarrow 1s^2 2s^2 2p^2$

2nd I.E. $\rightarrow$

$O^- \rightarrow 1s^2 2s^2 2p^3$

$F^- \rightarrow 1s^2 2s^2 2p^4$

$N^- \rightarrow 1s^2 2s^2 2p^2$

$C^- \rightarrow 1s^2 2s^2 2p^1$

Oxygen having half-filled configuration is most stable and will require high energy to remove an e^- followed by fluorine being the most electronegative element, then followed by N which is less electronegative than F but more than C.

$\therefore$ Order of second ionization enthalpy is $O > F > N > C$

Hence the correct option is B

67. **Solution: (C)**

BE per nucleon $O^{16} = 7.97 \text{ MeV}$

BE per nucleon $O^{17} = 7.75 \text{ eV}$

$O^{17} \rightarrow n_0^1 + O^{16}$

energy required to remove neutron

$= 17 \times 7.75 - 16 \times 7.97 = 4.23 \text{ MeV}$

Hence the correct option is C

68. **Solution: (D)**

Total no of nodes = 5f orbital

Nodes = $n-1 = 5-1 = 4$

Hence the correct option is D

69. **Solution: (D)**

When an extra electron is added in nitrogen atom, added electron will be screened by five electrons in second orbit ($2s^2 2p^3$) and two electrons in first orbit ($1s^2$).

Now screening constant, $\sigma = 5 \times 0.35$ in nth orbit + 2×0.85 in $(n-1)$ th orbit = $1.75 + 1.70 = 3.45$

$\therefore$ Effective nuclear charge = $7 - 3.45 = 3.55$.

Hence the correct option is D

70. **Solution: (A)**

Electronic configuration of Mg is- $1s^2 2s^2 2p^6 3s^2$

Because the third ionization energy involves the removal of a 2p electron, from fully filled p-orbital that is more closely bound to the nuclear core, this electron should require more energy to remove.

Hence the correct option is A

71. **Solution: (B)**

In case of he, electron is to be removed from fully filled 2s orbital, similarly in $1s^2$ electron is to be removed from fully filled 1s while in the D option, e is to be removed from highly stable half-filled electronic configuration.

Hence the correct option is B

72. **Solution: (B)**

The size of an element within a period decreases from left to right up to halogens because of the net increase in nuclear charge on the outermost electron. From halogen to noble gases the size increases as the last electron completes the octet and compensates for the increase in nuclear charge. Therefore among B, C, F, Ne, the size will follow the order:

$B > C > F < Ne$

Hence the correct option is B

73. Solution: (C)

Radial nodes = $n - l - 1 = 4 - 3 - 1 = 0$

Angular nodes = $l = 3$

In 4f orbital

Hence the correct option is C

74. Solution: (A)

The correct sequence of the electron affinity of C, N, O and F is $C > N < O < F$. The electron affinity of C is greater than that of N. The electronic configurations of C and N are $1s^2 2s^2 2p^2$ and $1s^2 2s^2 2p^3$ respectively. In case of N, the 2p orbital is half filled and stable.

Hence the correct option is A

75. Solution: (C)

Electron gain enthalpy becomes less negative on moving down a group due to increase in atomic size. However, the electron gain enthalpy of F is less negative than that of Cl due to electron-electron repulsion in small-sized F atom. Thus, the correct order is $F < Cl > Br > I$.

F, Cl, Br and I have $\Delta_e H$ values (in kJ mol^{-1}) -328, -349, -325 and -295 respectively.

Hence the correct option is C

76. Solution: (B)

The cations Na^+ , Mg^{2+} , Al^{3+} have 10e each. Ca^{2+} has 18e and hence is larger than the three.

Al^{3+} will have the smallest size. This is because the effective nuclear charge is most in this case and hence the electrons are attracted closer to the nucleus.

Hence the correct option is B

RAJ SET

77. Solution: (C)

Mg has electronic configuration- $1s^2 2s^2 2p^6 3s^2$, since the electron is to be removed from fully filled 2s electronic configuration, hence will have highest ionization potential.

Hence the correct option is C

78. Solution: (A)

The shielding effect can be defined as a reduction in the effective nuclear charge on the electron cloud, which is due to a difference in the attraction forces on the electrons in the atom. The s orbital has the greatest effect to reduce the force of attraction between the outermost electron and nucleus due to its effective charge density followed by $p > d > f$. According to orbital order, S orbital

is closest to the nucleus followed by the P orbital, D orbital and finally the F orbital.

So, as per the screening effect, S orbital being close to the nucleus lacks screening from any other orbital as it is the first and the closest orbital.

Hence the correct option is A

79. Solution: (D)

The inert pair effect decreases down a group, Bi will experience the maximum because the inert pair effect is the tendency of two Electrons in the outermost atomic orbital to remain unshared. The Electrons present in the intervening d-(and f-) orbitals do not effectively shield the s-electrons of the violence shell down the group. As a result, the inert pair of s Electrons remains more tightly held by the nucleus and hence participates less in bond formation.

Hence the correct option is D

80. Solution: (C)

N will have the maximum ionization energy

$1s^2 2s^2 2p^3$ because it will require maximum energy to remove an e from stable half-filled electronic configuration.

B will have the lowest ionization energy, $1s^2 2s^2 2p^1$ because on removing the e from p orbital, stable fully filled configuration will be achieved.

Hence the correct option is C

81. Solution: (A)

Comparison of melting points of ionic compounds is generally done by considering the following two factors:
Charge of the cation/anion: More the charge of cation or anion, stronger will be the forces of attraction between the ions and higher will be the melting point.

Ionic radii: More the distance between ions, lesser will be the strength of the bond giving rise to lesser melting point. Going by the above rules, the order should have been: $LiCl > NaCl > KCl > RbCl$

(Since charges of the ions are same for each molecule and cationic radius increases down the group.)

But LiCl, due to excessive polarization (Fajans' rules), exhibits high covalent character and is placed last in the order. Hence, the new order would be:

$NaCl > KCl > RbCl > LiCl$

Hence the correct option is A

82. Solution: (D)

We know that the ionization energy decreases from top to bottom in a group. This is because as we move down the group, the atomic size increases and hence the force of attraction towards the valence electrons decreases.

In the above scenario, thallium has the least ionization energy compared to the other elements.

Hence the correct option is D

83. Solution: (A)

Cr acquires

$4s^1 3d^5$ configuration so as to achieve half filled d-configuration while Cu acquires

$4s^1 3d^{10}$ configuration so as to achieve fully filled d-configuration which is highly stable.

Hence the correct option is A

WB SET

84. Solution: (B)

If the electronegative difference is >1.7 then its nature is ionic and <1.7 then its nature is covalent and if its equal to 1.7 then nature of bond will be 50% ionic and 50% covalent.

Hence the correct option is B

85. Solution: (C)

Na^+ and Ne have the same electrons that is 10 but Na being positive ion will exhibit more effective nuclear charge and hence its radius will be low.

Similarly, O^{2-} and F- have same electrons that is 10 but $\text{O}^{(2-)}$ having more negative charge will have higher size because of more polarization.

Hence the correct option is C

86. Solution: (B)

These are isoelectronic species. They have same number of electrons (10 electrons in each ion). Ca^{2+} has max positive charge that is of 20 protons and hence will pull e more inside thus implying smaller radius.

Similarly, S^{2-} has lowest protons 16, hence will be less effectively pulled by nucleus.

Hence the correct option is B

87. Solution: (B)

The ionization energy is the energy required to remove an electron from the outermost shell of an isolated gaseous atom. When the first electron or the most loosely bound electron is removed, the amount of energy required is less than the energy required to remove the electron in the next successive shell. This ionisation energy goes on increasing with the number of electrons removed.

So the number of electrons removed from the successive no of shells and the energy involved is called successive ionization energy.

The second ionization energy is the energy required to remove an electron from a $1+$ cation in the gaseous state. Just like the first ionization energy, the second ionization energy is affected by size, effective nuclear charge, and electron configuration.

The order is $\text{Be} < \text{C} < \text{B} < \text{Li}$

Hence the correct option is B

88. Solution: (B)

These are isoelectronic species. They have same number of electrons. S^{2-} has lowest protons 16, hence will be less effectively pulled by nucleus and hence the largest size.

Hence the correct option is B

89. Solution: (B)

Li has the most negative E° value while E° values of other alkali metal become more and more negative as we, move down the group from Na to Rb.

Hence the correct option is B

90. Solution: (A)

Electronegativity increases across a period because of the number of charges on the nucleus increases. That attracts the bonding pair of electrons more strongly. It decreases along a group because the no of charges on nucleus is decreasing. Hence, Be will have maximum electronegativity.

Hence the correct option is A

91. Solution: (D)

Among alkaline earth metal hydroxides, the anion being common, the cationic radius will influence the lattice enthalpy. Since lattice enthalpy decreases much more than the hydration enthalpy with increasing ionic size, the solubility increases down the group ($\downarrow$). The size of anions being much larger as compared to cations, the lattice enthalpy will remain almost constant within a particular group. Since the hydration enthalpy decreases down the group, solubility will decrease as found for alkaline earth metal carbonates and sulphates.

Hence the correct option is D

92. Solution: (B)

As we move down the group, size increases. The smallest size Be will have maximum effective nuclear charge and hence the highest ionization enthalpy that is the energy required to remove an outermost electron.

Hence the correct option is B

93. Solution: (C)

S-character is directly proportional to Bond angle i.e.

S-character $\propto$ Bond Angle

Combination of S & P orbitals gives rise to Hybrid orbitals and more the s-character of a Hybrid molecule has, the greater the angle between their bond.

As F is more electronegative than O, so %s in C-F bond decreases hence $\angle FCF$ bond angle also decreases.

Hence, $\angle FCO > 120$ and $\angle FCF < 120$.

Hence the correct option is C

94. **Solution: (C)**

The last shell will indicate the period while n+1 of the previous shell will indicate the group of the element in periodic table.

Hence the correct option is C

95. **Solution: (C)**

The radius of the ion depends on the effective nuclear charge, more the charge, more heavily the electrons are attracted towards the center and lesser in the size. Hence the ionic radii are inversely proportional to effective nuclear charge.

Hence the correct option is C

96. **Solution: (C)**

The 1st Ionization Potential increases across a period as atomic size decrease. Given elements are Be, B, C, N, O.

1st Ionization Potential order is $B < C < O < N$.

Hence the correct option is C

97. **Solution: (B)**

Ionization energy decreases down the group but increases from left to right in a period. So $K < Na < Al < Mg$ is the correct order of ionization energy potassium is present in the fourth period. Sodium, aluminum & magnesium.

Hence the correct option is B.

CHEMICAL BONDING

MH SET

(MH-SET 2011)

1. The bond angles in
- H_2O
- are:

(A) $<109^\circ$ (B) 109°
(C) 120° (D) 180°

(MH-SET 2011)

2. Which one of the following compounds is practically insoluble in water?

(A) CaCl_2 (B) CaF_2
(C) MgI_2 (D) BaCl_2

(MH-SET 2011)

3. The H-A-H bond angle in the following hydrides with general formula
- AH_3
- follows the order:

(A) $\text{AsH}_3 > \text{PH}_3 > \text{NH}_3$ (B) $\text{PH}_3 > \text{AsH}_3 > \text{NH}_3$
(C) $\text{NH}_3 > \text{AsH}_3 > \text{PH}_3$ (D) $\text{NH}_3 > \text{PH}_3 > \text{AsH}_3$

(MH – SET 2013)

4. In which of the following bonds does H carry
- δ
- ve charge?

(A) F-H (B) O-H
(C) B-H (D) N-H

(MH – SET 2020)

5. Which of the following statements regarding solubility of
- LiF
- and
- LiI
- in water at room temperature is correct?

(A) Both are equally soluble
(B) Both are insoluble
(C) LiF is more soluble than LiI
(D) LiI is more soluble than LiF

GUJARAT SET

(GJ-SET 2014)

6. Amongst (I)
- NH_3
- ; (II)
- $\text{N}(\text{CH}_3)_3$
- and (III)
- $\text{N}(\text{SiH}_3)_3$
- Predict the order of basicity from the SETs mentioned below. (Hints: (I) and (II) have pyramidal and (III) is trigonal planar structure.)

(A) (II) $>$ (III) $>$ (I) (B) (II) $>$ (I) $>$ (III)
(C) (III) $>$ (II) $>$ (I) (D) (I) $>$ (II) $>$ (III)

7. What is bond angle in nitrogen trichloride?

(A) 120° (B) 190.5°
(C) 107.5° (D) 90°

(GJ-SET 2018)

8. The bond angle of
- Cl_2O
- is

(A) Smaller than that of F_2O
(B) Greater than that of H_2O
(C) Smaller than that of H_2O
(D) Same as that of H_2O

(GJ-SET 2019)

9. Identify the correct sequence which represents the increasing order of polarizing power of the cationic species:
- K^+
- ,
- Ca^{2+}
- ,
- Mg^{2+}
- ,
- Be^{2+}
- :

(A) $\text{K}^+ < \text{Mg}^{2+} < \text{Ca}^{2+} < \text{Be}^{2+}$ (B) $\text{K}^+ < \text{Ca}^{2+} < \text{Mg}^{2+} < \text{Be}^{2+}$
(C) $\text{Be}^{2+} < \text{K}^+ < \text{Ca}^{2+} < \text{Mg}^{2+}$ (D) $\text{Mg}^{2+} < \text{Be}^{2+} < \text{K}^+ < \text{Ca}^{2+}$

(GJ-SET 2002)

10. Which of the following have identical bond orders

(A) N_2 and O_2^- (B) N_2 and O_2
(C) N_2 and O_2^+ (D) NO and O_2^+

(GJ-SET 2003)

11. Which of the following d orbital involve in
- dsp^2
- hybridization:

(A) d_{xy} (B) d_{x^2}
(C) $d_{x^2-y^2}$ (D) d_{xy}

(GJ – SET 2022)

12. Identify the correct pair of having most basic and acidic nature, respectively.

(A) Cr_2O_3 , CrO_3 (B) CrO_3 , Cr_2O_3
(C) CrO , CrO_3 (D) CrO_3 , CrO

(GJ – SET 2022)

13. The enthalpies of hydration of
- Li
- ,
- Na
- ,
- K
- ,
- Rb
- ions follow the order as

(A) $\text{Li} < \text{Na} < \text{K} < \text{Rb}$ (B) $\text{Na} > \text{Li} < \text{K} > \text{Rb}$
(C) $\text{Li} > \text{Na} > \text{K} > \text{Rb}$ (D) $\text{Rb} < \text{Na} > \text{K} > \text{Li}$

HP SET

(HP-SET 2014)

14. Which of the following molecules or ions is not linear?

(A) BeCl_2 (B) ICl_2^-
(C) CS_2 (D) ICl_2^+

(HP-SET 2014)

15. The hybridization of atomic orbitals of N in NO_2^+ , NO_3^- and NH_4^+ are respectively: -
 (A) sp, sp^2 and sp^3 (B) sp , sp^3 and sp^2
 (C) sp^2 , sp and sp^3 (D) sp^2 , sp^3 and sp

(HP-SET 2014)

16. The strength of bonds by overlapping of atomic orbitals is in the order: -
 (A) s-s > s-p > p-p (B) s-s < p-p < s-p
 (C) s-p < s-s < p-p (D) p-p < s-s < s-p

(HP-SET 2014)

17. Which of the following is not stable?

(A) H_2^+ (B) H_2
 (C) He_2 (D) HHe

(HP-SET 2014)

18. Compound X is highly volatile and insoluble in H_2O . Bonding in X is:-

(A) Ionic (B) Covalent
 (C) Polar covalent (D) Coordinate

(HP-SET 2014)

19. The compound $NH_3 \cdot BF_3$ can be easily separated into its compound because: -

(A) BF_3 is highly reactive
 (B) NH_3 is highly reactive
 (C) BF_3 and NH_3 are unstable
 (D) BF_3 and NH_3 have their independent existence

(HP-SET 2014)

20. The hybrid orbital of the central atom in AlF_4^- is: -

(A) sp (B) sp^2
 (C) sp^3 (D) dsp^2

(HP-SET 2014)

21. Which one of the following is not an s-block element?

(A) $[Ar] 4s^2 3d^{10} 4p^6 5s^1$ (B) $1s^2 2s^2 2p^1$
 (C) $1s^2 2s^1 2p^1$ (D) $[Ar] 4s^1 4p^1$

(HP-SET 2014)

22. Which one of the following cannot be used to generate H_2 ?

(A) $Al + NaOH$ (B) $Zn + NaOH$
 (C) $Mg + NaOH$ (D) $LiH + H_2O$

(HP-SET 2019)

23. Arrange in order of increasing dipole moment BF_3 , H_2S , H_2O

(A) $BF_3 < H_2S < H_2O$ (B) $H_2S < H_2O < BF_3$
 (C) $H_2S < BF_3 < H_2O$ (D) $H_2O < H_2S < BF_3$

KARNATAKA SET

(KA-SET 2020)

24. The total number of electrons in a molecule of phosphoric acid are:
 (A) 50 (B) 48
 (C) 52 (D) 51

(KA-SET 2013)

25. The point group symmetry of $XeOF_4$ is:
 (A) D_{3h} (B) D_{4v}
 (C) C_{4v} (D) C_{3v}

(KA-SET 2014)

26. ^{19}F NMR spectrum of PF_5 gives
 (A) Two singlets
 (B) A doublet and a triplet
 (C) Two doublets and three singlets
 (D) A doublet

(KA-SET 2014)

27. Assertion (A): BeH_2 is linear and H_2O bent.
 Reason (R): The major difference between BeH_2 and H_2O is the number of valence electrons on central atom.
 (A) Both A and R are true, but R is not the correct explanation
 (B) Both A and R are true and R is the correct explanation
 (C) A is true but R is false
 (D) A is false but R is true

(KA-SET 2015)

28. Identify the non-planar species among
 (A) SO_3 (B) NO_3^-
 (C) CO_3^{2-} (D) SO_3^{2-}

29. Which among the following is the best fluorinating agent?

(A) XeF_2 (B) XeF_4
 (C) XeF_6 (D) XeO_2F_4

(KA-SET 2015)

30. XeF_6 is hydrolyzed to give

(A) $XeOF_4$ (B) XeO_2F_2
 (C) XeO_3 (D) XeO_2

(KA-SET 2016)

31. Assuming ClF_3 to be stereochemical rigid, its ^{19}F NMR spectrum (I for $^{19}F=1/2$) would be (ignore any NMR activity of Cl):

(A) A doublet and triplet for a T-shaped structure
 (B) A single for a trigonal planar structure
 (C) A double and a singlet for a T-shaped structure
 (D) Two singlets for a trigonal pyramid structure

(KA-SET 2016)

32. Numbers of geometric isomers of PBr_2Cl_3 molecule which have non-zero dipole moment are:
- (A) 2 (B) 1
(C) 0 (D) 3

(KA-SET 2017)

33. Molten iodine conducts electricity because of the formation of:
- (A) $\text{I}_2 + \text{I}_3^-$ (B) $\text{I}_3^+ + \text{I}_3^-$
(C) I_3^+ (D) I_3^-
34. Number of lone pairs of electrons present in SF_4 , CF_4 and XeF_4 are
- (A) 1, 0, 2 (B) 2, 0, 2
(C) 1, 0, 1 (D) 0, 0, 2

(KA-SET 2017)

AP SET

(AP-SET 2012)

35. The most stable among the following is
- (A) LiF (B) LiI
(C) HgF_2 (D) BeI_2

(AP-SET 2013)

36. Correct order of bond angles in given molecules
- (A) $\text{H}_2\text{S} > \text{H}_2\text{Se} > \text{H}_2\text{O}$ (B) $\text{H}_2\text{Se} > \text{H}_2\text{O} > \text{H}_2\text{S}$
(C) $\text{H}_2\text{O} > \text{H}_2\text{Se} > \text{H}_2\text{S}$ (D) $\text{H}_2\text{O} > \text{H}_2\text{S} > \text{H}_2\text{Se}$

(AP-SET 2013)

37. According to Bent's rule
- (1) More electronegative substituents prefer hybrid orbitals having more S character
 - (2) More electronegative substituents prefer hybrid orbitals having less S character
 - (3) More electropositive substituents prefer hybrid orbitals having more S character
 - (4) More electropositive substituents prefer hybrid orbitals having less S character
- (A) 1 and 2 are correct (B) 2 and 3 are correct
(C) 3 and 4 are correct (D) 1 and 4 are correct

(AP-SET 2014)

38. The correct order of the solubility of the following in water is
- (A) $\text{BeSO}_4 < \text{MgSO}_4 < \text{CaSO}_4 < \text{SrSO}_4$
(B) $\text{BeSO}_4 > \text{MgSO}_4 > \text{CaSO}_4 > \text{SrSO}_4$
(C) $\text{BeSO}_4 < \text{MgSO}_4 \sim \text{CaSO}_4 < \text{SrSO}_4$
(D) $\text{BeSO}_4 > \text{MgSO}_4 \sim \text{CaSO}_4 < \text{SrSO}_4$

(AP-SET 2014)

39. The correct statements among the following are:
- (1) Angular momenta of 1s, 2s and 3s orbitals are same
 - (2) Energies of 1s, 2s and 3s orbitals are same

- (3) Angular momenta of 1s, 2s and 3s orbitals are different
- (4) Energies of 1s, 2s and 3s orbitals are different
- (A) 1, 2 (B) 2, 3
(C) 3, 4 (D) 1, 4

(AP-SET 2014)

40. Assertion (A): The bond angle in NF_3 is less than that in NH_3 .
Reason (R): The high electronegativity of F pulls the bonding electrons in NF_3 further away from N and a greater distortion is caused.
- (A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is not the correct explanation of A
(C) A is true but R is false
(D) A is false but R is true

(AP-SET 2014)

41. Assertion (A): The radius of Fe^{3+} is less than that of Fe^{2+} .
Reason (R): Fe^{3+} has a lower effective nuclear charge than Fe^{2+} .
- (A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is not the correct explanation of A
(C) A is true but R is false
(D) A is false but R is true

(AP-SET 2018)

42. Arrange in order of increasing dipole moment BF_3 , H_2S , H_2O
- (A) $\text{BF}_3 < \text{H}_2\text{S} < \text{H}_2\text{O}$ (B) $\text{H}_2\text{S} < \text{H}_2\text{O} < \text{BF}_3$
(C) $\text{H}_2\text{S} < \text{BF}_3 < \text{H}_2\text{O}$ (D) $\text{H}_2\text{O} < \text{H}_2\text{S} < \text{BF}_3$

(AP-SET 2018)

43. The number of peroxide bonds in perxenate ion, $[\text{XeO}_6]^{4-}$ is:
- (A) 0 (B) 2
(C) 3 (D) 1

JAMMU KASHMIR SET

(J&K-SET 2011)

44. Which of the following is the largest in size?
- (A) Cl^- (B) S^{2-}
(C) Na^+ (D) F^-

(J&K-SET 2011)

45. The hybridization involved in PCl_5 is:
- (A) sp^3d (B) sp^3d^2
(C) d^2sp^2 (D) sp^3

(J&K -SET 2011)

46. Among the following which one is a linear molecule having zero dipole moment?
 (A) H_2O (B) HCl
 (C) CO_2 (D) H_2S

(J&K -SET 2011)

47. Among the following, the compound that is readily soluble in water is:
 (A) BeSO_4 (B) CaSO_4
 (C) SrSO_4 (D) BaSO_4

(J&K -SET 2012)

48. The hybridization of Carbon in molecular CO_2 is:
 (A) sp (B) sp^2
 (C) sp^3 (D) sp^3d

(J&K -SET 2018)

49. The correct order of the solubility of the following in water is
 (A) $\text{BeSO}_4 < \text{MgSO}_4 < \text{CaSO}_4 < \text{SrSO}_4$
 (B) $\text{BeSO}_4 > \text{MgSO}_4 > \text{CaSO}_4 > \text{SrSO}_4$
 (C) $\text{BeSO}_4 < \text{MgSO}_4 = \text{CaSO}_4 < \text{SrSO}_4$
 (D) $\text{BeSO}_4 > \text{MgSO}_4 = \text{CaSO}_4 < \text{SrSO}_4$

(J & K-SET 2018)

50. Assertion (A): The bond angle in NF_3 is less than that in NH_3 .
 Reason (R): The high electronegativity of F pulls the bonding electrons in NF_3 further away from N and a greater distortion is caused.
 (A) Both A and R are true and R is the correct explanation of A
 (B) Both A and R are true but R is not the correct explanation of A
 (C) A is true but R is false
 (D) A is false but R is true

KL SET

(KL-SET 2012)

51. does not exist
 (A) ClF_3 (B) BrF_3
 (C) IF_3 (D) ICl_2

(KL-SET 2012)

52. The angle between the three iodine atoms of I_3^- ion is.....
 (A) 60° (B) 90°
 (C) 120° (D) 180°

(KL-SET 2013)

53. Which of the following pentafluoride does not exist?
 (A) NF_5 (B) AsF_5
 (C) SbF_5 (D) AsF_5

(KL -SET 2013)

54. Valinomycin is an ionophore that specially binds with
 (A) Na^+ ion (B) K^+ ion
 (C) Na^+ and K^+ ion (D) Any alkali metal ion

(KL-SET JUNE 2017)

55. The type of molecular interactions in liquid nitrogen is:
 (A) Dipole – dipole
 (B) Dipole -induced dipole
 (C) Ion- dipole
 (D) Induced dipole – induced dipole

RAJ SET

(RAJ-SET 2013)

56. Which is the most soluble in water amongst the following?
 (A) LiF (B) LiCl
 (C) LiBr (D) LiI

WB SET

(WB-SET)

57. NaOH and HOCl both contains – OH groups but the former is base while the latter is acid in their aqueous solution, because
 (A) Na-O bond is more polar than O-H bond in NaOH
 (B) -O-H bond is more polar than Na-O bond in NaOH
 (C) H-O bond in HOCl is less polar
 (D) -O-Cl bond in HOCl is more polar

(WB SET 2017)

58. The structures of NF_3 and NH_3 are based on a tetrahedron with one corner occupied by a lone pair. Which one of the statements is true for both the molecules?
 (A) both are pyramidal with bond angles 107.5
 (B) both are pyramidal with bond angles 102.3 and 107.5 respectively.
 (C) both are pyramidal with bond angles 109.5
 (D) both are pyramidal with bond angles 105 and 107.5 respectively.

(WB SET 2015)

59. The hybrid state of carbon in C-60
 (A) sp (B) sp^2
 (C) sp^3 (D) dsp^2

(WB-SET 2015)

60. The number of pairs of framework electrons in the closo borane $[\text{B}_n\text{H}_n]^{2-}$
 (A) $n+1$ (B) $n+2$
 (C) $n+3$ (D) $n+4$

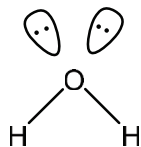
ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
A	B	D	C	D	B	C	B	B	D
11	12	13	14	15	16	17	18	19	20
C	C	C	D	A	A	C	B	D	C
21	22	23	24	25	26	27	28	29	30
B	C	A	A	C	D	B	D	C	C
31	32	33	34	35	36	37	38	39	40
A	A	B	A	A	D	B	B	D	A
41	42	43	44	45	46	47	48	49	50
C	A	A	B	A	C	A	A	B	A
51	52	53	54	55	56	57	58	59	60
D	D	A	B	B	A	A	B	B	A

:: SOLUTIONS ::

MH SET

1. **Solution: (A)**

Hybridization of central atom Oxygen in H_2O molecules is sp^3 with tetrahedral geometry with two lone pair of electrons and two bond pairs. lone pair – lone pair repulsion is more as compare to bond-pair-bond pair repulsion in a molecule creating deviation in bond angle from 109.5° to 104.5° .



Therefore, Option (A) is correct.

2. **Solution: (B)**

Solubility of compound depend on lattice energy and Hydration energy. decreasing lattice energy favours increasing solubility. AS CaF_2 molecule has extremely high lattice energy. Hence it is insoluble in water. Therefore, Option (B) is correct.

3. **Solution: (D)**

Electronegativity of central atom decrease, bond angle decrease. As we move down the group electronegativity of atom decreases in order of $N > P > As$ in periodic table. Hence increasing order of bond angle in H-A-H molecule is in order $NH_3 > PH_3 > AsH_3$

Therefore, Option (D) is correct.

4. **Solution: (C)**

If central atom is more electronegative than surrounding atoms then it attracts more negative charge toward itself.

In comparison with Boron and Hydrogen, electronegativity of H is 2.1 while that of B is 1.5. Therefore, Hydrogen carries negative charge in B-H bond. In case of F-H, O-H and N-H. Electronegativity of F, O and N is more as compare to H atom resp.

Therefore, Option (C) is correct.

5. **Solution: (D)**

In LiF, Fluoride ion have small size and lattice energy of LiF is higher than its hydration energy, therefore it is insoluble in water or other hands In LiI size of Iodide ion is much more larger than fluoride ion. Hence its lattice energy comparatively lower than LiF, therefore LiI is more soluble than LiF.

Therefore, Option (D) is correct.

GUJARAT SET

6. **Solution: (B)**

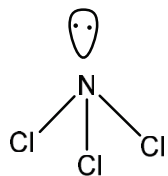
In $N(SiH_3)_3$, silicon atom have vacant d-orbital. Therefore, lone pair of nitrogen is resonating with the empty d orbital of silicon causing planar structure of $N(SiH_3)_3$ molecule and this lone pair on nitrogen is not available for donation resulting least basicity. In $N(CH_3)_3$ electron donating inductive effect (+I) of CH_3 make Nitrogen atom more electron rich to donate lone pair and passes highest basicity among all.

Therefore, Option (B) is correct.

7. **Solution: (C)**

In Nitrogen trichloride (NCl_3) hybridization of nitrogen atom is sp^3 which possesses tetrahedral geometry with one lone pair and three bond pairs. As lone pair-bond pair

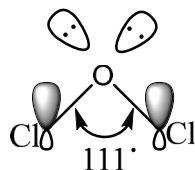
repulsion is more stronger as compare to bond pair-bond pair repulsion. Hence it decrease bond angle from 109.5° to 107.5°



Therefore, Option (C) is correct.

8. **Solution: (B)**

Geometry of Cl_2O molecule is Tetrahedral as same as H_2O but two chlorine atoms are much larger in size than hydrogen atom which creates steric Hindrance and bond angle increase to 111° .



Therefore, Option (B) is correct.

9. **Solution: (B)**

Polarizing power of charged species depend on charge-to-size ratio of ions. As charge to size ratio increases then polarizing power of ions also increases. In case of Ca^{+2} , Mg^{+2} and Be^{+2} . Charge is same but order of size is given as $Ca^{+2} > Mg^{+2} > Be^{+2}$. Therefore, increasing order of Charge to size ratio (charge density) is in order of $Be^{+2} > Mg^{+2} > Ca^{+2}$ and polarizing power also in order of $Be^{+2} > Mg^{+2} > Ca^{+2}$. Charge on K^+ is lowest and size is larger which give lowest charge density and polarizing power.

Therefore, Option (B) is correct.

10. **Solution: (C)**

According to molecular orbital theory (MOT), total numbers of electron in diatomic molecule and bond order relation given in following table,

Total No. of Electrons	8	9	10	11	12	13	14
Bond Order	0	0.5	1	1.5	2	2.5	3
Total No. of Electrons	15	16	17	18	19	20	
Bond Order	2.5	2	1.5	1	0.5	0	

Total no. of electrons in N_2 molecule = $7 + 7 = 14$,
bond order = 3

Total no. of electrons in O_2 molecule = $8 + 8 = 16$,
bond order = 2

Total no. of electrons in O_2^- molecule = $8 + 8 + 1 = 17$,
bond order = 1.5

Total no. of electrons in O_2^+ molecule = $8 + 8 - 1 = 15$,
bond order = 2.5

Total no. of electrons in NO molecule = $7 + 8 = 15$, bond order = 2.5

Hence, NO and O_2^+ molecule have identical bond orders
Therefore, Option (D) is correct.

11. **Solution: (C)**

Orbitals involve in dsp^2 hybridisation are, $dx^2 - y^2$, s , p_x and p_y .

Therefore, Option (C) is correct.

12. **Solution: (C)**

Oxidation state of central atom increases Acidity also increases.

Less oxidation state of central atom basicity increases

CrO CrO_3

+2 +6

More basic more acidic.

Therefore, Option (C) is correct.

13. **Solution: (C)**

If size increases hydration energy decreases

$\therefore$ small size has more hydration energy

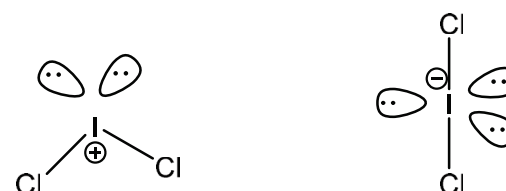
$\therefore Li > Na > K > Rb$

Therefore, Option (C) is correct.

HP SET

14. **Solution: (D)**

Hybridization of ICl_2^+ is sp^3 and passes tetrahedral geometry i.e. Bent shape, which is not linear. In case of $BeCl_2$ and CS_2 Hybridization is sp & having linear geometry while in ICl_2^- Hybridization is sp^3d and passes trigonal bipyramidal geometry i.e. linear shape.



Therefore, Option (D) is correct.

15. **Solution: (A)**

Hybridization of atomic orbitals of N in NO_2^+ , NO_3^- and NH_4^+ are

NO_2^+ : Number of lone pair = 0 and Number of Bond pair = 2

Total Electron pairs = 2

Hybridization of NO_2^+ is sp

NO_3^- : Number of lone pair = 0 and Number of Bond pairs = 3

Total electron pairs = 3

Hybridization of NO_3^- is sp^2

NH_4^+ : Number of Bond pairs = 4 and Number of lone pairs = 0

Total number of electron pairs = 4

Hybridization of NH_4^+ is sp^3

Therefore, Option (A) is correct.

16. **Solution: (A)**

Strength of Covalent bond depend on strenght of overlap between atomic orbitals. greater the overlap between atomic orbitals, more stable the bond. s-s orbital overlap is stronger as it is linear overlap of orbital of same kind. While P-P orbital overlap is weaker it is lateral overlap between p- orbitals. s-p overlap of orbital is of two different orbital overlap in linear fashion, Hence it weaker as compare to s-s overlap and stronger as compare to P-P overlap.

Therefore, Option (A) is correct.

17. **Solution: (C)**

In He_2 molecular orbital diagram contains two electron in σ_{1s} bonding MO and two electron in σ_{1s}^* antibonding MO. So, its bond order calculated from formula,

$$\text{Bond order} = \frac{\text{No. of e in } \sigma_{1s} - \text{No. of e in } \sigma_{1s}^*}{2} = \frac{2-2}{2} = 0$$

Molecule with bond order zero does not exist. Hence He_2 molecule is not stable

Therefore, Option (C) is correct.

18. **Solution: (B)**

Volatility of compound is ability of compound to change into gaseous phases. Ionic compound have strong bonds & they readily don't changes to gaseous phase, but covalent compound have weak attractive forces and easily converted to gaseous phase.

Water is polar compound. As per concept of like dissolve in like. Non-polar covalent compound not dissolve in polar water.

Therefore, Option (B) is correct.

19. **Solution: (D)**

The bonding between $NH_3 - BF_3$ is coordinate (dative) bonding. Which are just interactions between lone pair of Nitrogen of NH_3 and vacant orbital of Boron in BF_3 . These weak interactions make both NH_3 and BF_3 to remain in their independent existence.

Therefore, Option (D) is correct.

20. **Solution: (C)**

Hybridization atom calculated from sum of lone pair and bond pairs. In AlF_4^- molecule.

Number of lone pairs = 0

Number of Bond pairs = 4

Total electron pairs = 4

As AlF_4^- molecule has total four electron pairs, it posses sp^3 Hybridization.

Therefore, Option (C) is correct

21. **Solution: (B)**

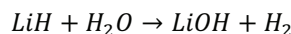
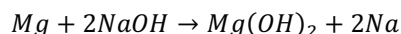
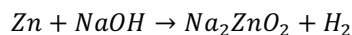
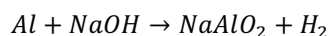
(A) $[Ar] 4s^2, 3d^{10}, 4p^6 5s^1 = Rb$ (Rubidium)

(B) $1s^2, 2s^1, 2p^1 = B$ (Boron)

(C) $1s^2, 2s^2, 2p^1 = Be$ (Beryllium)

(D) $[Ar] 4s^1, 4p^1 = Ca$ (Calcium)

Therefore, Option (B) is correct.

22. **Solution: (C)**

Only in the reaction of Mg with NaOH not production H_2 gas. Therefore, Option (C) is correct.

23. **Solution: (A)**

BF_3 is planar molecular with trigonal planar geometry and overall dipole moment of BF_3 is zero. In comparison of H_2O and H_2S , H_2O has more dipole moment as electronegativity difference between oxygen and hydrogen is more as compare to hydrogen and Sulphur. Overall order of dipole moment is $H_2O > H_2S > BF_3$

Therefore, Option (A) is correct.

KARNATAKA SET

24. **Solution: (A)**

Phosphoric acid (H_3PO_4) has total 50 electrons out of which 15 electrons from phosphorus, 8 electrons from each of four oxygen atom and one electron from each of three hydrogen atoms.

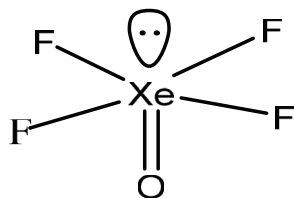
Therefore, Option (A) is correct.

25. Solution: (C)

Hybridization of $XeOF_4$ is Sp^3d^2 and geometry is octahedral.

Principle axis is C_4 where subsidiary axis is absent. Also vertical plane σ_v present

Therefore, point group is C_{4v} .



Therefore, Option (C) is correct.

26. Solution: (D)

Hybridization of PF_5 is SP^3d and geometry is trigonal bipyramidal. At room temperature PF_5 show fluctuational behavior and all Fluorine show only one signal. with $(2nI + 1) = 2 \times 1 \times 1/2 + 1 = 2$ (doublet) as I value for P is $\frac{1}{2}$.

Therefore, Option (D) is correct.

27. Solution: (B)

Hybridization of Be in BeH_2 is sp which show linear geometry and O in H_2O is Sp^3 which show tetrahedral geometry (bend shape). Hence both Assertion and reason are correct and R is correct explanation of A.

Therefore, Option (B) is correct.

28. Solution: (D)

Geometry of SO_3 Trigonal planar and Hybridization sp^2
 Geometry of NO_3^- Trigonal planar and Hybridization sp^2
 Geometry of CO_3^{2-} Trigonal planar and Hybridization sp^2
 Geometry of SO_3^{2-} Tetrahedral and Hybridization sp^3
 Only SO_3^{2-} is non-planar species among all.

Therefore, Option (D) is correct.

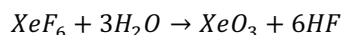
29. Solution: (C)

Fluorinating agent are the substances, where reaction active species are electron deficient species. XeF_6 is strongest fluorinating agent among all.

Therefore, Option (C) is correct.

30. Solution: (C)

Hydrolysis reaction of XeF_6 ,

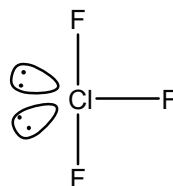


Therefore, Option (C) is correct.

31. Solution: (A)

Hybridization of ClF_3 is Sp^3d and geometry is trigonal bipyramidal (shape is T-shaped). As ClF_3 have rigid structure, so it have 2 types of fluorines (axial and equatorial). So ^{19}F NMR signal show two peak one is due

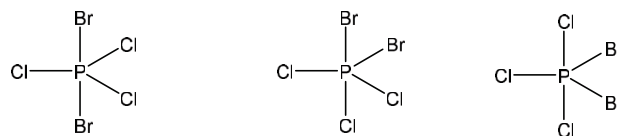
to of equatorial fluorine which show $(2nI + 1) = [2 \times 1 \times \frac{1}{2}] + 1 = 2$ (doublet) and other peak due to of two axial fluorine which show $(2nI + 1) = [2 \times 1 \times \frac{1}{2}] + 1 = 3$ (triplet).



Therefore, Option (A) is correct.

32. Solution: (A)

PBr_2Cl_3 possesses total three isomer out of which only one isomer have zero dipole moment while other two have non-zero dipole moments as follows,



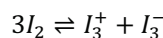
Dipole moment is zero.

Molecules with Non-zero Dipole moment

Therefore, Option (A) is correct.

33. Solution: (B)

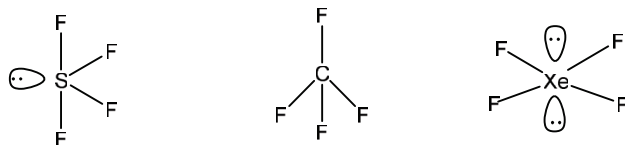
Electrical conductivity of molten iodine solution is because of self-ionization equilibrium reaction,



Therefore, Option (B) is correct.

34. Solution: (A)

Geometry SF_4 , CF_4 and XeF_4 are



Lone pair = 1

Lone pair = 0

Lone pair = 2

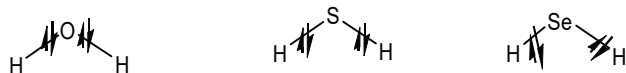
Therefore, Option (A) is correct.

AP SET**35. Solution: (A)**

Stability of compound depend on effective interaction between atoms bounded together. In LiF, Lithium and Fluorine has approximately same size and strong interaction present in between them make LiF most stable. In LiI Iodine is larger in size as compare to Lithium and weak interaction between them to form LiI molecule. same phenomenon observed in case of HgF_2 and BeI_2 . Therefore, Option (A) is correct.

36. **Solution: (D)**

Bond angle of molecule depend on electronegativity of central atom. As central atom is more electronegative it pull share pair of electron towards itself in bonds. these electron pair repell each other and increase bond angle.



Therefore, Option (D) is correct.

37. **Solution: (B)**

According to Bent's rule more electronegative substituent prefer hybrid orbital having less s - character and more electropositive substituents prefer hybrid orbital having more s - character.

Therefore, Option (B) is correct.

38. **Solution: (B)**

In case of sulphates of alkaline earth metal, size of compound almost same as sulphate ion are already large in size as compare to metal cation and small increase in size of metal cation does not affect overall size of compound. Hydration enthalpy decrease down the group as size of cation increase. Hence solubility of sulphates decreases down the group from Be^{+2} to Sr^{+2} .

Therefore, Option (B) is correct.

39. **Solution: (D)**

As value of angular quantum number (l) is same for each s-orbital, hence angular momentum of 1s, 2s and 3s orbital are same. While energy of 1s, 2s and 3s orbital are arranged in increasing order as follows $3s > 2s > 1s$

Therefore, Option (D) is correct.

40. **Solution: (A)**

Bond angle of F-N-F in NF_3 is 102.5° and H-N-H in NH_3 107.8° . Therefore, bond angle of NF_3 is less than NH_3 , this is due to high electronegativity of F pulls bonding electrons away from N and bond pair-bond pair repulsion decreases. And greater distortion in bond angle is caused. Hence Both Assertion (A) and Reason (R) are correct and R is correct explanation of A.

Therefore, Option (A) is correct.

41. **Solution: (C)**

Radius of Fe^{+3} is less than that of Fe^{+2} . As one more electron remove from Fe^{+2} to form Fe^{+3} which result larger nuclear charge on remaining electrons. This cause outer shell of Fe^{+3} to be pulled little more inward compare to Fe^{+2} . Hence its size smaller. Therefore Assertion (A) is true but Reason (R) is false.

Therefore, Option (C) is correct.

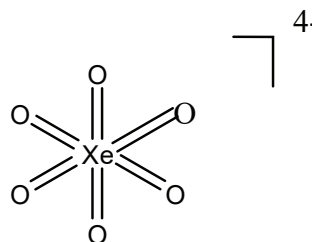
42. **Solution: (A)**

BF_3 is planar molecular with trigonal planar geometry and overall dipole moment of BF_3 is zero. In comparison of H_2O and H_2S , H_2O has more dipole moment as electronegativity difference between oxygen and hydrogen is more as compare to hydrogen and Sulphur. Overall order of dipole moment is $H_2O > H_2S > BF_3$

Therefore, Option (A) is correct.

43. **Solution: (A)**

Hybridization of $[XeO_6]^{-4}$ is Sp^3d^2 and have octahedral geometry with no presence of peroxobond



Therefore, Option (A) is correct.

JAMMU KASHMIR SET

44. **Solution: (B)**

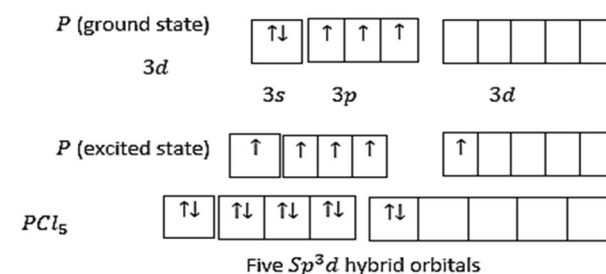
More the negative charge on an atom, more the inter electronic repulsion and ion have maximum size, similarly positive charge on ion increase effective nuclear charge hence size of ion decreases. Overall order of size is $S^{-2} > Cl^- > F^- > Na^+$

Therefore, Option (B) is correct.

45. **Solution: (B)**

Electronic configuration of phosphorus is

$$P = [Ne] 3S^2, 3P^3$$



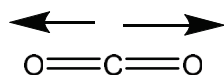
∴ Hybridization of PCl_5 is Sp^3d

Therefore, Option (A) is correct.

46. **Solution: (C)**

- (i) H_2O is bend molecular and it is polar
- (ii) HCl is polar molecule as chlorine is more electronegative than hydrogen and possesses non-zero dipole moment.
- (iii) Similar to H_2O , H_2S is bend molecule and possess non-zero dipole moment.

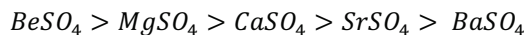
- (iv) CO_2 is linear molecule but having zero dipole moment as both dipoles are equal and opposite in direction.



Therefore, Option (C) is correct.

47. **Solution: (A)**

Solubility of sulphates of alkaline earth metals in water decrease on moving down the group as size of metal cation decreases and Hydration energy increases which result in decrease in solubility of metal sulphates. Overall order of solubility is



Therefore, Option (A) is correct.

48. **Solution: (A)**

In CO_2 molecule,

Number of lone pair on central $C = 0$

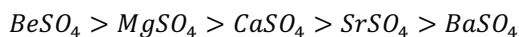
Number of bond pairs on central $C = 2$

Hybridization of CO_2 is sp

Therefore, Option (A) is correct.

49. **Solution: (B)**

Solubility of sulphates of alkaline earth metals in water decrease on moving down the group as size of metal cation increases and Hydration energy decreases which result in decrease in solubility of metal sulphates. Overall order of solubility is



Therefore, Option (B) is correct.

50. **Solution: (A)**

Bond angle of F-N-F in NF_3 is 102.5° and H-N-H in NH_3 is 107.8° . Bond angle of NF_3 is less than NH_3 , this is due to high electronegativity of F, F pulls bonding electrons away from N hence less bond pair-bond pair repulsion takes place. Hence in NF_3 lesser bond angle than NH_3 . Hence Both Assertion (A) and Reason (R) are correct and R is correct explanation of A.

Therefore, Option (A) is correct.

KL SET

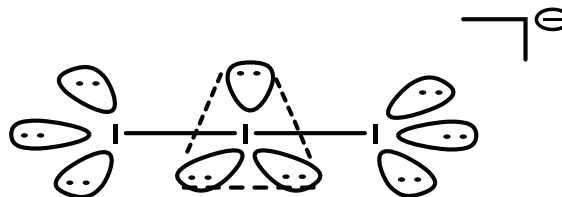
51. **Solution: (D)**

Interhalogen compound in the form of AB_2 , AB_4 does not exist, only AB , AB_3 , AB_5 , AB_7 exist. In AB_2 type of compound only one unpaired e^- left after Hybridization & bonding which is not possible in real case. Hence ICl_2 does not exist.

Therefore, Option (D) is correct.

52. **Solution: (D)**

Geometry of I_3^- is Trigonal bipyramidal and possesses sp^3d Hybridization But shape of I_3^- is linear and having 180°



Therefore, Option (D) is correct.

53. **Solution: (A)**

In case of Nitrogen due to absence of empty d-orbital it cannot expand its valency up to 5 and not form penta-coordinated compounds. Hence NF_5 does not exist.

Therefore, Option (A) is correct.

54. **Solution: (B)**

Valinomycin is a naturally occurring lipid molecule that binds with K^+ ions and facilitates transfer of it across a lipid bilayer which acts as an ionophore.

Therefore, Option (B) is correct.

55. **Solution: (B)**

In liquid Nitrogen gas partial charges are formed within one molecule of N_2 , inducing a partial charge on nearby molecules and all molecules around it show behavior like a polar molecule which holds all molecules together by weak forces called Dipole-Induced dipole interaction.

Therefore, Option (B) is correct.

RAJ SET

56. **Solution: (A)**

For lithium halides, the order of increasing size is given as $LiI > LiBr > LiCl > LiF$. As the size of the compound increases, hydration energy decreases which results in decreasing solubility, therefore LiF has the smallest size and highest solubility in water.

Therefore, Option (A) is correct.

WB SET

57. **Solution: (A)**

In $NaOH$, the $Na-O$ bond is more polar than the $O-H$ bond and it easily dissociates as Na^+ and OH^- which act as a base. But in $HOCl$, the $H-OCl$ bond is more polar than the $O-Cl$ bond and it dissociates as H^+ and OCl^- which act as an acid.

Therefore, Option (A) is correct.

Preface

The idea of the book entitled **“Physical Chemistry: SET PYQ’s”** was born because of the lack of any comprehensive book covering all the aspects of various entry level chemistry competitive examinations in particular conducted by CSIR, GATE, TIFR State and National Eligibility Test, but not limited to.

This book covers all PYQ’s with topic wise sorted question and solution

1. Quantum Chemistry,
2. Molecular Spectroscopy,
3. Group Theory,
4. Chemical Thermodynamics,
5. Statistical Thermodynamics,
6. Electrochemistry,
7. Chemical Kinetics,
8. Colloidal and Surface Chemistry,
9. Solid State,
10. Polymer Chemistry.

The ultimate purpose of this book is to equip the reader with brainstorming challenges and solution for organic chemistry and applied aspect examinations. It contains predigested information on the entire academic subject of organic chemistry for good understanding, assimilation, self-evaluation, and reproducibility. Although we have made every effort to make the book error free, we are under no illusion. We welcome comments, criticism and suggestions from the readers to evolve the contents.

Acknowledgement

First of all I would like to thank our entire students at Institute for advanced Studies (IFAS), who have helped us to learn and practice both the art and science of chemistry. We would like to thank Er. Radheshyam Choudhary, Founding CEO, IfAS Edutech Pvt. Ltd. for being a continuous source of inspiration through his positive strokes.

We also want to thank Dr. Kailash Choudhary, Director at IFAS Publications, for his valuable support and critical suggestion for completion of the work.

We would not forget to thank all the IfAS team where we were able to further continue our teaching, training, and especially learning the many facets of the process of building these creative questions in books.

This book is a team effort, and producing it would be impossible without outstanding people of IFAS publication. It was pleasure to work with many others dedicated and creative people of IFAS during the production of this book. Special thanks for Vikendra Metha who crafted our ideas to wonderful design of cover page and Kuldeep Singh Rathore for formatting and type setting.

And finally, our humble greetings to all who put their significant efforts and are unmentioned.

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QUANTUM CHEMISTRY

HP SET

[HP-SET 2014]

1. The wave function $\sin^{-1}$ is not acceptable, because it is:-
 (A) Not continuous
 (B) Not an eigen function of kinetic energy operator
 (C) Not differentiable
 (D) Not a single valued function

[HP-SET 2014]

2. The value of the commutator $[x, p_x^2]$, is given by:-
 (A) $2i$ (B) $2i\hbar$
 (C) $2i\hbar x$ (D) $2i\hbar p_x$

[HP-SET 2014]

3. The first order correction to energy for the ground state of a particle in a box due to perturbation λx is would be:-
 (A) $\lambda L/2$ (B) λL
 (C) $2\lambda L$ (D) 2

[HP-SET 2014]

4. The energy levels of cyclopropenyl cation are $\alpha + 2\beta$, $\alpha - \beta$ and $\alpha - \beta$. The delocalization energy of $C_3H_3^+$ is:-
 (A) 2β (B) 0
 (C) 3β (D) β

[HP-SET 2017]

5. The zero point energy of the harmonic oscillator is:-
 (A) $\hbar\omega$ (B) zero
 (C) $\frac{1}{2}\hbar\omega$ (D) $\frac{2}{3}\hbar\omega$

[HP-SET 2017]

6. The energy levels of the cyclobutadiene are $\alpha + 2\beta$, α , α , $\alpha - 2\beta$. The delocalization energy in this molecule is:-
 (A) 0 (B) -4β
 (C) -8β (D) 4α

[HP-SET 2017]

7. If Δy and Δp_y are the uncertainties in the y coordinate and the y component of the momentum of the particle respectively, then according to the uncertainty principle $\Delta y \Delta p_y$ is ($\hbar = \frac{h}{2\pi}$ and h is a Planck's constant):-
 (A) $\geq \hbar$ (B) $> \hbar/2$
 (C) $> \hbar$ (D) $\geq \hbar/2$

[HP-SET 2017]

8. When hydrogen atom is placed in an electric field along the y-axis, the orbital that mixes most with the ground state $1s$ orbital is:-
 (A) $2s$ (B) $2p_x$
 (C) $2p_y$ (D) $-2p_z$

[HP-SET 2018]

9. The separation between the adjacent energy levels of a particle in a one-dimensional box of length a is:
 (A) $n^2\hbar^2/8ma^2$ (B) $(a/2)^{1/2}$
 (C) $(2n+1)\hbar^2/8ma^2$ (D) $8ma^2/\hbar^2$

[HP-SET 2018]

10. The energy of photon associated with light of wavelength 200 nm is:
 (A) $99 \times 10^{-19} \text{ J}$ (B) $0.9 \times 10^{-19} \text{ J}$
 (C) $9.9 \times 10^{-19} \text{ J}$ (D) $9.0 \times 10^{-19} \text{ J}$

[HP-SET 2018]

11. If e^{ax} is an eigen function and d^n/dx^n is an operator, then the eigen value will be:
 (A) α^n (B) α
 (C) n (D) n^α

[HP-SET 2018]

12. A projectile of mass 1.0 g is known to within $1 \mu\text{m s}^{-1}$. Calculate the minimum uncertainty in its position:
 (A) $5 \times 10^{26} \text{ m s}^{-1}$ (B) $5 \times 10^{26} \text{ m}$
 (C) $5 \times 10^{-26} \text{ m s}^{-1}$ (D) $5 \times 10^{-26} \text{ m}$

KERALA SET

[KERALA-SET 2012]

13. According to de Broglie hypothesis, the wave length of a particle is -----
 (A) Directly proportional to its mass
 (B) Directly proportional to its energy
 (C) Directly proportional to its momentum
 (D) Inversely proportional to its momentum

[KERALA-SET 2012]

14. Which among the following will have maximum wave character if they move with identical speeds?
 (A) Electrons (B) Protons
 (C) Neutrons (D) Alpha particles

[KERALA-SET 2012]

15. The energy of a particle in a one-dimensional box is given by ----
 (A) $nh^2/8ma^2$ (B) $n^2h^2/8ma^2$
 (C) $n^2h^2/4ma^2$ (D) $nh^2/4ma^2$

[KERALA-SET 2012]

16. The number of radial nodes for the 3s orbital of hydrogen atom is ----
 (A) 0 (B) 1
 (C) 2 (D) 3

[KERALA-SET 2012]

17. _____ is not a fermion.
 (A) Electron (B) Proton
 (C) Neutron (D) 4He

[KERALA-SET 2012]

18. What is the energy of the photon having a wavelength $3.313 \text{ \AA}$?
 (A) $3 \times 10^{-16} \text{ J}$ (B) $13.254 \times 10^{-16} \text{ J}$
 (C) $6 \times 10^{-16} \text{ J}$ (D) $13.254 \times 10^{-18} \text{ J}$

[KERALA-SET 2013]

19. In units of $h^2/8ml^2$, the energy difference between levels corresponding to 3 and 2 node eigen functions for a particle of mass m in a one dimensional box of length l is
 (A) 1 (B) 3
 (C) 5 (D) 7

[KERALA-SET 2013]

20. The momentum of a photon of frequency $5 \times 10^{20} \text{ s}^{-1}$ is nearly
 (A) $1.1 \times 10^{-25} \text{ Kg m s}^{-1}$ (B) $1.1 \times 10^{-21} \text{ Kg m s}^{-1}$
 (C) $2.1 \times 10^{-21} \text{ Kg m s}^{-1}$ (D) $2.1 \times 10^{-22} \text{ Kg m s}^{-1}$

[KERALA-SET 2013]

21. The equation which forms the basis of photoelectric effect is
 (A) $h\nu = 1/2mv^2 - w$ (B) $1/2mv^2 = h\nu - w$
 (C) $W = h\nu + mv^2$ (D) $1/2 mv^2 = h\nu + w$

[KERALA-SET 2015]

22. The first emission line of Balmer series of He^+ spectrum has wave no. in cm^{-1} (R_H = Rydberg constant)
 (A) $\frac{3}{4} R_H$ (B) $\frac{5}{36} R_H$
 (C) $\frac{5}{9} R_H$ (D) $\frac{1}{4} R_H$

[KERALA-SET 2015]

23. Which of the following is an eigen function of the operator $\hat{P}_x$?
 (A) e^{ikx} (B) xe^{ikx}
 (C) $x^2 + 2x$ (D) $\cos 2x$

[KERALA-SET 2015]

24. The angular momentum of an electron in the 4d-orbital is
 (A) $\frac{2h}{\pi}$ (B) $\sqrt{2} \frac{h}{2\pi}$
 (C) $\sqrt{3} \frac{h}{2\pi}$ (D) $\sqrt{6} \frac{h}{2\pi}$

[KERALA-SET 2015]

25. The average radius of 1s orbital of H-atom is
 (A) a_0 (B) $2a_0$
 (C) $1.5a_0$ (D) $3a_0$

[KERALA-SET 2015]

26. The number of radial nodes present in 4f-orbitals is
 (A) Zero (B) One
 (C) Two (D) Three

[KERALA-SET 2015]

27. If a trial function is used to calculate the energy of a quantum mechanical system, the calculated energy is always greater than the true energy. This statement is related to
 (A) Perturbation theory
 (B) Variation principle
 (C) Born-Oppenheimer approximation
 (D) Heisenberg's uncertainty principle

[KERALA-SET 2015]

28. According to MO theory the ground state wave function including spin of H_2 molecule is represented as

$$\begin{aligned} \text{(A)} & \frac{1}{\sqrt{2}} \begin{vmatrix} \sigma_g 1s(1)\alpha(1) & \sigma_g 1s(1)\beta(1) \\ \sigma_g 1s(2)\alpha(2) & \sigma_g 1s(2)\beta(2) \end{vmatrix} \\ \text{(B)} & \frac{1}{\sqrt{2}} \begin{vmatrix} \sigma_u 1s(1)\alpha(1) & \sigma_u 1s(1)\beta(1) \\ \sigma_g 1s(2)\alpha(2) & \sigma_g 1s(2)\beta(2) \end{vmatrix} \\ \text{(C)} & \frac{1}{\sqrt{2}} \begin{vmatrix} \sigma_g 1s(1)\alpha(1) & \sigma_g 1s(1)\beta(1) \\ \sigma_g 1s(2)\beta(2) & \sigma_g 1s(2)\alpha(2) \end{vmatrix} \\ \text{(D)} & \frac{1}{\sqrt{2}} \begin{vmatrix} \sigma_g 1s(1)\alpha(1) & \sigma_u 1s(1)\beta(1) \\ \sigma_g 1s(2)\alpha(2) & \sigma_u 1s(2)\beta(2) \end{vmatrix} \end{aligned}$$

[KERALA-SET 2015]

29. The angle between the two hybrid orbitals ψ_1 and ψ_2 shown below is

$$\psi_1 = \frac{1}{\sqrt{3}} 2s - \frac{1}{\sqrt{6}} 2p_x + \frac{1}{\sqrt{2}} 2p_y$$

$$\psi_2 = \frac{1}{\sqrt{3}} 2s - \frac{1}{\sqrt{6}} 2p_x - \frac{1}{\sqrt{2}} 2p_y$$

- (A) 90° (B) 109.5°
 (C) 120° (D) 180°

[KERALA-SET 2016]

30. Which of the following is not a linear operator?
 (A) $\frac{d^2}{dx^2}$ (B) $\sqrt{\quad}$
 (C) $\hat{P}_x$ (D) $\hat{H}$

[KERALA-SET 2016]

31. The probability that a particle to be found in between 0 and $a/2$ in a one dimensional box of length 'a' is
- (A) $\frac{1}{2}$ (B) $\frac{1}{3}$
(C) $\frac{1}{4}$ (D) $\frac{3}{4}$

[KERALA-SET 2016]

32. The angular momentum of an electron in the f-orbital is
- (A) $\sqrt{2} \frac{h}{2\pi}$ (B) $\sqrt{6} \frac{h}{2\pi}$
(C) $\sqrt{3} \frac{h}{2\pi}$ (D) $\sqrt{12} \frac{h}{2\pi}$

[KERALA-SET 2016]

33. According to the Born-Oppenheimer approximation, which of the following relative motion may be neglected?
- (A) Electron to nucleus (B) Electron to electron
(C) Nucleus to nucleus (D) All of the above

[KERALA-SET 2016]

34. For hydrogen molecule in the excited state $\sigma_g^1 \sigma_u^1$, the spin part of the triplet state with $m_s = 0$ is proportional to
- (A) $\alpha(1)\beta(2)$ (B) $\alpha(1)\beta(2) + \beta(1)\alpha(2)$
(C) $\alpha(1)\alpha(2)$ (D) $\alpha(1)\beta(2) - \beta(1)\alpha(2)$

[KERALA-SET 2016]

35. The term symbol of a molecule with the electronic configuration $(1\sigma_g)^2(1\sigma_u)^2(2\sigma_g)^2(2\sigma_u)^2(1\pi_u)^2(1\pi_u)^2(3\sigma_g)^1$ is
- (A) $^1\Sigma_g^+$ (B) $^3\Sigma_g^+$
(C) $^2\Sigma_g^-$ (D) $^2\Sigma_g^+$

[KERALA-SET 2016]

36. According to Huckel MO treatment the four π -MO energies of butadiene are given by $\alpha \pm 1.62\beta$ and $\alpha \pm 0.62\beta$. The delocalization energy of butadiene is
- (A) 0.62β (B) 0.48β
(C) 1.62β (D) 1.48β

[KERALA-SET 2016]

37. Which of the following is a well-behaved function? (x lies between plus and minus infinity).
- (A) $y = \exp(ax^2)$ (B) $y = ax + b$
(C) $y = ax^2$ (D) $y = \exp(-ax^2)$

[KERALA-SET 2017]

38. The time dependent Schrodinger equation is

(A) $\hat{H}\Psi = E\Psi$
(B) $i\hbar \frac{\partial \Psi}{\partial t} = \hat{H}\Psi$
(C) $\nabla^2 \Psi + V\Psi = E\Psi$
(D) $-\frac{\hbar^2 \partial^2 \Psi}{2m \partial x^2} + V\Psi = E\Psi$

[KERALA-SET 2017]

39. If the energy of a particle in a cubical box of edge length L is $\frac{3h^2}{8mL^2}$ the energy required for the excitation of the particle into the next higher energy level is
- (A) $\frac{3h^2}{8mL^2}$ (B) $\frac{6h^2}{8mL^2}$
(C) $\frac{9h^2}{8mL^2}$ (D) $\frac{3h^2}{4mL^2}$

[KERALA-SET 2017]

40. The number of radial and angular nodes in a 4f orbital are respectively
- (A) 3, 3 (B) 2, 2
(C) 0, 3 (D) 0, 2

[KERALA-SET 2017]

41. Which of the following is an eigen function of the operator P_x ?
- (A) e^{ikx} (B) xe^{ikx}
(C) $x^2 + 2x$ (D) e^{ikx^2}

[KERALA-SET 2017]

42. The energy of a particle in a 3D cubic box of side length L is $14 h^2/8mL^2$. The degeneracy of the state is
- (A) 4 (B) 2
(C) 6 (D) 3

[KERALA-SET 2017]

43. According to variation principle, the energy E evaluated using a trial wave function will be related to the ground state energy
- (A) $E \leq E_0$ (B) $E = E_0$
(C) $E \geq E_0$ (D) $E \neq E_0$

[KERALA-SET 2017]

44. The third Hermite polynomial is
- (A) 1 (B) $4\xi^2$
(C) 2ξ (D) $4\xi^2 - 2$

[KERALA-SET 2017]

45. According to Huckel MO treatment the six π -MO energies of benzene are given by $\alpha \pm 2\beta$ and $\alpha \pm \beta$ twice. The delocalization energy of benzene is
- (A) -2β (B) 2β
(C) β (D) 4β

[KERALA-SET 2018]

46. The ground state energy of a particle in a 1D box of length $1\text{\AA}$ is $0.6032 \times 10^{-17} \text{ J}$. The energy gap between first and the second energy level is
- (A) $6.032 \times 10^{-17} \text{ J}$ (B) $1.8095 \times 10^{-17} \text{ J}$
(C) $0.2528 \times 10^{-17} \text{ J}$ (D) $0.6032 \times 10^{-17} \text{ J}$

[KERALA-SET 2018]

47. The commutator $[\hat{L}_x, \hat{L}_y]$ is equal to

- (A) $-i\hbar \hat{L}_z$ (B) $i\hbar \hat{L}_z$
(C) $-i\hbar \hat{L}_z$ (D) $-i\hbar \hat{L}_z$

[KERALA-SET 2018]

48. The value of the spherical harmonics $Y_{1,0}(\theta, \phi)$ is

- (A) $\sqrt{\frac{3}{4\pi}} \sin\theta$ (B) $\sqrt{\frac{3}{4\pi}} \cos\theta$
(C) $\sqrt{\frac{3}{4\pi}} \sin\theta \cos\phi$ (D) $\sqrt{\frac{3}{4\pi}} \sin\theta \sin\phi$

[KERALA-SET 2018]

49. The Huckel theory secular determinant equation for cyclobutadiene is

- (A) $\begin{vmatrix} x & 1 & 0 & 1 \\ 1 & x & 1 & 0 \\ 0 & 1 & x & 1 \\ 1 & 0 & 1 & x \end{vmatrix} = 0$ (B) $\begin{vmatrix} x & 0 & 1 & 1 \\ 1 & x & 0 & 1 \\ 1 & 0 & x & 1 \\ 1 & 1 & 0 & x \end{vmatrix} = 0$
(C) $\begin{vmatrix} x & 1 & 0 & 0 \\ 1 & x & 1 & 0 \\ 0 & 1 & x & 1 \\ 0 & 0 & 1 & x \end{vmatrix} = 0$ (D) $\begin{vmatrix} x & 0 & 0 & 1 \\ 1 & x & 1 & 0 \\ 0 & 1 & x & 1 \\ 1 & 0 & 0 & x \end{vmatrix} = 0$

[KERALA-SET 2018]

50. The delocalisation energy of benzene according to Huckel MO method is

- (A) 0.48β (B) 2.0β
(C) 4.0β (D) 4.472β

[KERALA-SET 2018]

51. If uncertainty in position and momentum are equal, then uncertainty in velocity is

- (A) $1/2m (h/\pi)^{1/2}$ (B) $1/m (h/2\pi)^{1/2}$
(C) $1/2m (h/4\pi)^{1/2}$ (D) $1/m (h/2\pi)^{1/2}$

[KERALA-SET 2018]

52. If two operations commute, then

- (A) They are Hermitian
(B) They are linear
(C) They have the same eigen functions
(D) They have the same eigen values

[KERALA-SET 2018]

53. Use Hückel theory to determine the energies of the π orbitals of the allyl radical system, C_3H_4 .

- (A) $\alpha + \beta, \alpha, \alpha - \beta$ (B) $\alpha + 2\beta, \alpha, \alpha - 2\beta$
(C) α, α, α (D) $\alpha + \sqrt{2}\beta, \alpha, \alpha - \sqrt{2}\beta$

[KERALA-SET 2019]

54. Which of the following observations of photoelectric effect could not be explained using classical mechanics?

- I. The proportionality of the intensity of photoelectric current to the intensity of radiation.

II. Existence of a threshold frequency characteristic of the metal

III. The variation of stopping potential of photoelectrons linearly with the frequency of the radiation

IV. The absence of a time lag between the fall of radiation on the metal surface and the ejection of electrons

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

[KERALA-SET 2019]

55. In Compton effect, the Compton wavelength is the $\Delta\lambda$ corresponding to the scattering angle θ equal to

- (A) 90° (B) 60°
(C) 45° (D) 180°

K SET

[KSET 2013]

56. The square of the wave function in quantum mechanics represents:-

- (A) A state of the system
(B) Shape of the system
(C) Probability of the system
(D) Energy of the system

[KSET 2014]

57. The zero point energy of an electron is equal to:-

- (A) $\frac{h^2}{2m^2}$ (B) $\frac{h^2}{4ma^2}$
(C) $\frac{h^2}{8ma^2}$ (D) $\frac{h^2}{16ma^2}$

[KSET 2014]

58. An acceptable wave function must be:-

- (A) Continuous, have a continuous first derivative, be single valued and be square integrable
(B) Discontinuous, have a discontinuous first derivative, be single valued and be square integrable
(C) Continuous, have a continuous first derivative, be of any value and no restrictions in square integrability
(D) Both (B) and (C)

[KSET 2015]

59. Ψ^2 measures

- (A) The energy of the electron in n^{th} orbit
(B) Uncertainty in the position and velocity of electron
(C) The probability of finding an electron in a given region
(D) The hybrid character of orbitals

[KSET 2015]

60. $\nabla^2 \text{ in } \nabla^2 \Psi + \frac{8\pi^2 m(E-V)}{h^2} \Psi = 0$ is known as
 (A) Laplacian operator (B) Hamiltonian operator
 (C) Angular momentum (D) Energy operator

[KSET 2016]

61. Hamiltonian operator (H) in $H\Psi = E\Psi$ is the operator for the ____ of the system.
 (A) Potential energy of the system
 (B) Kinetic energy of the system
 (C) Total energy of the system
 (D) Zero point energy of the system

[KSET 2017]

62. Match the following:-

List - I (Color)

- i) Green
 ii) Red
 iii) Orange
 iv) Violet

List –II

- a) 420
 b) 620
 c) 530
 d) 700

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

[KSET 2017]

63. The following data is given (p-probability):-

X p(x)

- 1 0.20
 3 0.25
 4 0.55

The average value of x is equal to

- (A) $\langle x \rangle = 3.15$ (B) $\langle x \rangle = 0.12$
 (C) $\langle x \rangle = 0.24$ (D) $\langle x \rangle = 0.31$

[KSET 2017]

64. Which of the following are linear operators?

$$\frac{d}{dx}, \frac{d^2}{dx^2}, \sqrt{\cdot}, x^2$$

- (A) $\frac{d}{dx}, \frac{d^2}{dx^2}$ and x^2 (B) $\sqrt{\cdot}$
 (C) $\sqrt{\cdot}$ and x^2 (D) $\frac{d}{dx}$ and $\sqrt{\cdot}$

[KSET 2013]

65. The radial and angular wave function gives:-

- (A) Shape, orientation and energy, size of the orbitals respectively
 (B) Energy, size and shape, orientation of the orbitals respectively
 (C) Energy and size of orbitals respectively
 (D) Shape and orientation of orbitals respectively

[KSET 2013]

66. According to the Schrodinger's wave equation the energy of a particle (E_n) in one dimensional box is:-

$$(A) E_n = \frac{n^2 h^2}{ma^2} \quad (B) E_n = \frac{n^2 h^2}{4ma^2}$$

$$(C) E_n = \frac{nh}{8ma^2} \quad (D) E_n = \frac{n^2 h^2}{8ma^2}$$

[KSET 2013]

67. Perturbation theory is a technique that gives _____

- (A) Approximate solution to Schrodinger wave equation
 (B) Correct solution to Schrodinger wave equation
 (C) Does not deal with Schrodinger wave equation
 (D) None of the above

[KSET 2014]

68. Which one of the following statements is not true?

- (A) S orbitals are spherically symmetric
 (B) A harmonic oscillator obeys Hooke's law
 (C) Spin quantum number, S, for an electron S = 1
 (D) An azeotrope is a mixture that boils without change of composition

[KSET 2014]

69. Pick out the fermions

- i) Electron
 ii) Proton
 iii) Neutron
 iv) Deuteron

- (A) iv is correct
 (B) i and iv are correct
 (C) iii and iv are correct
 (D) i, ii and iii are correct

[KSET 2014]

70. An even function is

- i) $f(-x) = f(x)$
 ii) Product of two even functions
 iii) Product of two odd functions
 iv) Product of an even and an odd function
 (A) i, ii and iii are correct (B) iv is correct
 (C) ii and iv are correct (D) i and iv are correct

[KSET 2014]

71. Linear momentum of photon of wavelength 350 nm is equal to

- (A) $0.189 \times 10^{-27} \text{ kgms}^{-1}$
 (B) $1.89 \times 10^{-27} \text{ kgms}^{-1}$
 (C) $1.89 \times 10^{-26} \text{ kgms}^{-1}$
 (D) $1.89 \times 10^{-28} \text{ kgms}^{-1}$

[KSET 2014]

72. Match the following:-

- i) Bohr frequency condition a) $\ominus = \frac{h\nu}{k}$
 ii) Debye temperature b) $\Delta E = h\nu$
 iii) Linear momentum c) $\Omega\Psi = w\Psi$
 iv) Eigen value equation d) h/λ

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

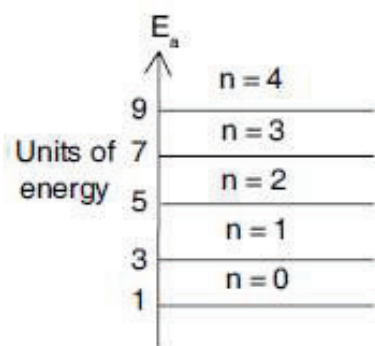
[KSET 2015]

73. For a particle in a one-dimensional box of length L, in the region $0 \leq x \leq \frac{1}{4}$, the probability of the state is given by $p = \frac{1}{4} - \frac{\sin(\frac{n\pi}{2})}{2\pi}$. Then the probability for the particle in the state $n = 2$ and $n = 1$ are respectively:-

- (A) 0.125 and 0.25 (B) 0.375 and 0.0908
 (C) 0.25 and 0.0908 (D) 0.75 and 0.25

[KSET 2015]

74. The figure shown in the energy level diagram corresponding to:-



- (A) Particle in a box (B) Particle tunneling
 (C) Harmonic oscillator (D) Hydrogen atom

[KSET 2015]

75. The selection rules for hydrogenic atom are:-

- (A) $\Delta l = \pm 1$ $\Delta m_l = 0, \pm 1$ (B) $\Delta l = \pm 1$ $\Delta m_l = \pm 1/2$
 (C) $\Delta l = 0$ $\Delta m_l = \pm 1/2$ (D) $\Delta l = \pm 1$ $\Delta m_l = -1/2$

[KSET 2015]

76. Choose the correct statement(s)

- i) Bosons are particles with half integral spin.
 ii) Symmetry number of NH_3 is 3.
 iii) The stiffer the bond, the greater is the force constant.
 iv) An aerosol is a dispersion of a liquid in a gas
 (A) ii, iii and iv are correct (B) i and ii are correct
 (C) i is correct (D) iii and iv are correct

[KSET 2016]

77. The simplest ground state VB wave function of a HCl molecule is given as

$$\Psi = \Psi_H(1s, 1) \Psi_{Cl}(3p_z, 2) + B$$

where B represents

- (A) $\Psi_{Cl}(1s, 1) \Psi_H(3p_z, 3)$ (B) $\Psi_H(3p_z, 3) \Psi_{Cl}(1s, 3)$
 (C) $\Psi_{Cl}(2s, 2) \Psi_H(1s, 1)$ (D) $\Psi_H(1s, 2) \Psi_{Cl}(3p_z, 1)$

[KSET 2016]

78. The unperturbed energy levels of a system are $E_0 = 0$, $E_1 = 2$ and $E_2 = 4$. The second order correction to energy for the ground state in the presence of the perturbation V for which $V_{10} = 2$, $V_{20} = 4$ and $V_{12} = 6$, is found to be

- (A) + 6 (B) - 6
 (C) - 8 (D) + 8

[KSET 2016]

79. When a particle of mass $9.10 \times 10^{-28} \text{g}$ in a certain 1-D box goes from $n = 5$ level to the $n=2$ level, it emits a photon of frequency $6.0 \times 10^{14} \text{cm}^{-1}$. The length of the box is:-

- (A) $1.8 \times 10^{-7} \text{m}$ (B) $1.8 \times 10^{-7} \text{cm}$
 (C) $8.1 \times 10^{-7} \text{cm}$ (D) $8.1 \times 10^{-7} \text{m}$

[KSET 2017]

80. Which of the following is incorrect about the de Broglie relationship?

- (A) $h = \lambda P$ (B) $E = \frac{hc}{\lambda}$
 (C) $\lambda = \frac{h}{mc}$ (D) $E_{kinetic} = \frac{2h\nu}{\lambda}$

[KSET 2017]

81. According to the Schrodinger's wave equation, the wave function (Ψ_n) of a particle in one dimensional box is:-

- (A) $\Psi_n = A \cdot \sin\left(\frac{n\pi x}{a}\right)$ (B) $\Psi_n = A \cdot \sin(n\pi x)$
 (C) $\Psi_n = A \cdot \sin\left(\frac{n\pi}{a}\right)$ (D) $\Psi_n = A \cdot x \sin(n\pi a)$

[KSET 2017]

82. Indicate which of the following function is acceptable as wave functions?

- (A) $\Psi = x$ (B) $\Psi = e^x$
 (C) $\Psi = e^{-x}$ (D) $\Psi = e^{-x^2}$

[KSET 2017]

83. In time independent perturbation theory, the perturbation is:-

- (A) Always present and unvarying
 (B) Not present and unvarying
 (C) Always present and varying
 (D) Not present and varying

[KSET 2017]

84. The wave function for the bonding molecular orbital for a heteronuclear diatomic XY molecule. Assuming that the electron on an average spends 70% of its time on nucleus X and 30% of its time on nucleus Y is:-

- (A) $\Psi_{MO} = 0.70\phi_x + 0.30\phi_y$
 (B) $\Psi_{MO} = 0.84\phi_x + 0.55\phi_y$
 (C) $\Psi_{MO} = 0.30\phi_x + 0.70\phi_y$
 (D) $\Psi_{MO} = 0.55\phi_x + 0.84\phi_y$

[KSET 2018]

85.

$$\nabla^2 \Psi + \frac{8\pi^2 m}{h^2} (E - V) \Psi = 0$$

is known as

- (A) Hamiltonian operator (B) Laplacian operator
 (C) Angular momentum (D) Energy operator

[KSET 2018]

86. If the function $f = e^{-ax}$ is acted upon by the operator $\frac{d}{dx}$, the eigen value and eigen function respectively are
- (A) $-a$ and e^{-ax} (B) $2a$ and e^{ax}
 (C) ax and e^{-2x} (D) $\frac{d}{dx}$ and e^{ax}

[KSET 2018]

87. The quantum mechanical operator for kinetic energy of a particle moving in three directions is

- (A) $\frac{-h^2}{8\pi^2 m} \nabla^2$ (B) $\frac{h}{2\pi i} \nabla$
 (C) $\frac{h}{8\pi^2 m} \nabla^2$ (D) $\frac{8\pi^2 m}{h^2} \nabla^2$

[KSET 2018]

88. According to Schrodinger equation the energy of a particle (E_n) in one dimensional

- (A) $E_n = n^2 h^2 / ma^2$ (B) $E_n = n^2 h^2 / 4ma$
 (C) $E_n = n^2 h^2 / 8ma^2$ (D) $E_n = nh / 8ma^2$

[KSET 2020]

89. The filling of molecular orbitals takes place according to

- (A) The Aufbau principle
 (B) Pauli Exclusion principle
 (C) Hund's rule of maximum multiplicity
 (D) All of the mentioned above

[KSET 2020]

90. Which of the following is not a Huckel approximation in Huckel Molecular Orbital Theory (HMOT)?

- (A) HMOT is applicable to planar molecules
 (B) The overlap integrals S_{ij} are taken as δ_{ij}
 (C) The energy integrals H_{ij} are taken as alpha
 (D) The energy integrals H_{ij} are taken as either beta or zero

[KSET 2020]

91. For a free particle in one direction which of the following is correct?

- (A) The energy is quantized
 (B) The energy can take any negative value
 (C) The wave function can be normalized
 (D) The energy can take any positive value

[KSET 2020]

92. Which of the following is true for the acceptable wave function for bound state?

- (A) The wave function must be real
 (B) The wave function must be even Function
 (C) The wave function must be quadratically integrable
 (D) The wave function must anti-symmetric with respect to interchange of any two particles

[KSET 2020]

93. For a function $f(x) = Ae^{-2ix}$ for $1 \leq x \leq 5$, which one of the following is the value A such that the function is normalised for the given range of values?

- (A) Zero (B) One
 (C) Two (D) Three

MH SET

[MHSET 2011]

94. The de Broglie wavelength of an electron in a Bohr orbit with radius r and quantum number n is proportional to:

- (A) nr (B) $1/nr$
 (C) n/r (D) r/n

[MHSET 2011]

95. Which of the following conditions is *not* essential for an eigen function of the Hamiltonian operator to be an acceptable wave function?

- (A) Continuous (B) Normalized
 (C) Always positive (D) Single valued

[MHSET 2011]

96. The number of nodes in a 3s orbital is:

- (A) 0 (B) 1
 (C) 2 (D) 3

[MHSET 2011]

97. The energy of an orbital in the hydrogen atom depends on the quantum number:

- (A) n (B) l
 (C) m (D) s

[MHSET 2011]

98. The three unpaired electrons on the nitrogen atom is ascribed to:

- (A) Pauli's exclusion principle
 (B) Aufbau principle
 (C) Hund's rule
 (D) Uncertainty principle

[MHSET 2013]

99. An atom with a single electron has an atomic number of z . m and e are the mass and charge of an electron, respectively. n is the principal quantum number of a circular orbit of the electron, around the nucleus. Considering the electrostatic attraction between the electron and the nucleus to be balanced exactly by the centrifugal force arising from the circular motion of the electron, the radius of the orbit of $n = 2$ is:

- (A) $\frac{4(h/2\pi)^2}{mze^2}$ (B) $\frac{2(h/2\pi)^2}{mze^2}$
 (C) $\frac{4mze^2}{(h/2\pi)^2}$ (D) $\frac{2mze^2}{(h/2\pi)^2}$

[MHSET 2013]

100. The number of quantum numbers of a free electron (one that is not bound to a nucleus) is:

- (A) 0 (B) 1
 (C) 2 (D) 4

[MHSET 2015]

101. The average value of r^2 (i.e., $\langle r^2 \rangle$) in the $1s$ orbital of hydrogen atom is (a_0 is the Bohr radius)

- (A) a_0 (B) $0.5 a_0^2$
 (C) $3a_0^2$ (D) $1.5 a_0^3$

[MHSET 2016]

102. The hydrogenic orbital having two radial nodes and one angular node in their appropriate representations is:

- (A) $3d$ (B) $4p$
 (C) $5d$ (D) $5p$

[MHSET 2016]

103. The hydrogenic orbital with its (unnormalized) spherical harmonic part being $\sin^2\theta \sin^2\phi$ represents which of the following orbital?

- (A) $d_{x^2-y^2}$ (B) d_{z^2}
 (C) d_{yz} (D) d_{xy}

[MHSET 2013]

104. An electron of mass ' m ' is confined to a 1-D box of length ' L '. It makes a radiative transition from second excited state to ground state. The wavenumber of the photon emitted is:

- (A) $\frac{h}{mL^2c}$ (B) $\frac{2h}{mL^2c}$
 (C) $\frac{9h}{mL^2c}$ (D) $\frac{3h}{mL^2c}$

[MHSET 2013]

105. The wave function of a 1-D harmonic oscillator between $x = -\infty$ and $x = +\infty$ is given by:

$$\Psi(x) = N \exp\left(-\frac{\beta x^2}{2}\right) \left(\int_0^\infty e^{-ax^2} \frac{1}{2} \left(\frac{\pi}{a}\right)^{1/2}\right)$$

The value of N , that normalizes the function $\Psi(x)$, is:

- (A) $\left(\frac{\beta}{\pi}\right)^{1/2}$ (B) $\left(\frac{\beta}{\pi}\right)^{1/4}$
 (C) $\left(\frac{\beta}{2\pi}\right)^{1/2}$ (D) $\left(\frac{\pi}{\beta}\right)^{1/4}$

[MHSET 2013]

106. The molecular orbitals of 1, 3-butadiene (not in proper order) are given below: (f_1, f_2, f_3, f_4 are the $2p_z$ orbitals on carbon atoms 1, 2, 3 and 4 respectively).

$$\psi_1 = 0.372f_1 - 0.602f_2 + 0.602f_3 - 0.372f_4.$$

$$\psi_2 = 0.602f_1 + 0.372f_2 - 0.372f_3 - 0.602f_4.$$

$$\psi_3 = 0.372f_1 + 0.602f_2 + 0.602f_3 + 0.372f_4.$$

$$\psi_4 = 0.602f_1 - 0.372f_2 - 0.372f_3 + 0.602f_4.$$

The HOMO and LUMO in the ground state of 1, 3-butadiene are respectively:

- (A) ψ_2 and ψ_3 (B) ψ_3 and ψ_2
 (C) ψ_2 and ψ_4 (D) ψ_2 and ψ_1

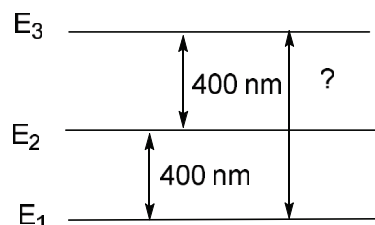
[MHSET 2013]

107. The Slater determinant (un-normalized) for the ground state of lithium atom is:

$$\begin{aligned} \text{(A)} & \begin{vmatrix} 1s(1)\alpha(1) & 1s(1)\beta(1) & 2s(1)\alpha(1) \\ 1s(2)\alpha(2) & 1s(2)\beta(2) & 2s(2)\alpha(2) \\ 1s(3)\alpha(3) & 1s(3)\beta(3) & 2s(3)\alpha(3) \end{vmatrix} \\ \text{(B)} & \begin{vmatrix} 1s(1)\alpha(1) & 1s(1)\beta(1) & 1s(1)\alpha(1) \\ 1s(2)\alpha(2) & 1s(2)\beta(2) & 1s(2)\alpha(2) \\ 1s(3)\alpha(3) & 1s(3)\beta(3) & 1s(3)\alpha(3) \end{vmatrix} \\ \text{(C)} & \begin{vmatrix} 1s(1)\alpha(1) & 1s(1)\beta(1) & 1s(1)\beta(1) \\ 1s(2)\alpha(2) & 1s(2)\beta(2) & 1s(2)\beta(2) \\ 1s(3)\alpha(3) & 1s(3)\beta(3) & 1s(3)\beta(3) \end{vmatrix} \\ \text{(D)} & \begin{vmatrix} 1s(1)\alpha(1) & 2s(1)\alpha(1) & 2s(1)\beta(1) \\ 1s(2)\alpha(2) & 2s(2)\alpha(2) & 2s(2)\beta(2) \\ 1s(3)\alpha(3) & 2s(3)\alpha(3) & 2s(3)\beta(3) \end{vmatrix} \end{aligned}$$

[MHSET 2013]

108. The separation between E_1 and E_3 in the following energy level diagram will be:



- (A) 800 nm (B) 400 nm
 (C) 200 nm (D) 300 nm

[MHSET 2013]

109. The commutator of $[x^2, p_x]$ is equal to:

- (A) $\frac{hx}{\pi i}$ (B) $\frac{2hx}{\pi i}$
 (C) $\frac{hx^2}{2\pi i}$ (D) $-\frac{hx}{\pi i}$

[MHSET 2013]

110. The life time of a state that gives rise to a spectral line of width 0.1 cm^{-1} is:

- (A) 53 nm (B) 53 pm
 (C) 33 nm (D) 33 pm

[MHSET 2013]

111. The wave function for a particle in a 1-D box of length 'L' is given as $\psi = A \sin \frac{\pi x}{L}$. The value of 'A' for a box of length 50 nm is:

- (A) $5\sqrt{2} (\text{nm})^{1/2}$ (B) $0.2 (\text{nm})^{-1/2}$
 (C) $0.2 (\text{nm})^{1/2}$ (D) $\sqrt{5}/10 (\text{nm})^{-1/2}$

[MHSET 2013]

112. The quantum state of a particle in a circular path in a plane is given by:

$$\Psi_m(\phi) = \left(\frac{1}{\sqrt{2\pi}}\right) e^{-im\phi}, m = 0, \pm 1, \pm 2, \dots$$

When a perturbation $H' = P \cos \theta$ is applied (P is a constant), what will be the first order correction to the energy of the m^{th} state?

- (A) 0 (B) $P/(2\pi)$
 (C) $P/(4\pi)$ (D) $Pm^2/(4\pi^2)$

[MHSET 2013]

113. The molecular orbitals of 1, 3-butadiene (not in proper order) are given below:

(f_1, f_2, f_3, f_4 are the $2p_z$ orbitals on carbon atoms.)

$$\psi_1 = 0.372f_1 - 0.602f_2 + 0.602f_3 - 0.372f_4$$

$$\psi_2 = 0.602f_1 + 0.372f_2 - 0.372f_3 - 0.602f_4$$

$$\psi_3 = 0.372f_1 + 0.602f_2 + 0.602f_3 + 0.372f_4$$

$$\psi_4 = 0.602f_1 - 0.372f_2 - 0.372f_3 + 0.602f_4$$

The correct order of the orbitals with increasing energy is:

- (A) $\psi_1 < \psi_2 < \psi_3 < \psi_4$
 (B) $\psi_3 < \psi_2 < \psi_4 < \psi_1$
 (C) $\psi_3 < \psi_4 < \psi_1 < \psi_2$
 (D) $\psi_4 < \psi_3 < \psi_2 < \psi_1$

[MHSET 2015]

114. The number of nodes of any orbital of hydrogen atom, other than the origin and at infinity, is given by

- (A) $n - l - 1$
 (B) $n - 1$
 (C) n
 (D) $n + l$

[MHSET 2015]

115. An electron in the ground state of hydrogen atom is excited to a level having principle quantum no. n. It was found to absorb at wavelength λ of the electromagnetic spectrum. The value of n is (R = Rydberg constant)

- (A) $\sqrt{\frac{R}{\lambda-1}}$ (B) $\sqrt{R\lambda(\lambda-1)}$
 (C) $\sqrt{\frac{R\lambda}{R\lambda-1}}$ (D) $\sqrt{\frac{R\lambda-1}{R\lambda}}$

[MHSET 2015]

116. Based on Huckel treatment of π electron in conjugated cyclic hydrocarbons, which of the following statements is incorrect.

- (A) Lowest energy level in all such system is degenerate.
 (B) Ground state of cyclobutadiene is a triplet.
 (C) Delocalization energy of benzene is about 150 kJ mol^{-1} .
 (D) The value of resonance integral between neighbouring atoms is β .

[MHSET 2015]

117. States arising from two p electrons are (symbols have their usual meaning)

- (A) $^3P, ^3D, ^1S$ (B) $^2D, ^1P, ^1S$
 (C) $^1S, ^3P, ^1P$ (D) $^3P, ^1D, ^1S$

[MHSET 2015]

118. The $M_s = 0$ component of triplet state arising from two electrons is (symbols have their usual meaning)

- (A) $\alpha(1)\beta(2)$
 (B) $\alpha(2)\beta(1)$
 (C) $\frac{1}{\sqrt{2}} [\alpha(1)\beta(2) + \beta(1)\alpha(2)]$
 (D) $\frac{1}{\sqrt{2}} [\alpha(1)\beta(2) - \beta(1)\alpha(2)]$

[MHSET 2015]

119. The degeneracy of the energy level that corresponds to energy $\frac{19}{m} \left(\frac{\pi\hbar}{a}\right)^2$ of a particle in a cubic box of length 'a' is:

- (A) 3 (B) 6
 (C) 9 (D) 1

[MHSET 2015]

120. The delocalization energy of butadiene molecule within the HMO framework of theory (β being the empirical parameter therein) is given by:

- (A) β (B) 0.472β
 (C) 2β (D) 4β

[MHSET 2015]

121. The most probable distance of 2s electron (in Å) in the ground state of H atom is:
 (A) 1.058 (B) 2.116
 (C) 0.529 (D) 0.794

[MHSET 2016]

122. The trial function for the particle in 1D box (with $0 \leq x \leq a$) leading to the best possible ground state energy employing the variational method should be
 (A) $x^a(a-x)^\beta$ (B) $\sin\left(\frac{\pi x}{a}\right)$
 (C) $x(a-x)$ (D) $x^2(a-x)^2$

[MHSET 2016]

123. The commutator $[\hat{x}, \hat{p}_x]$ is equal to:
 (A) $-i\hbar$ (B) 0
 (C) $\hat{p}_z$ (D) 1

[MHSET 2016]

124. The average separation of $2p_z$ electron of the H atom from the nucleus will be (a_0 Bohr radius):
 (A) $3a_0/2$ (B) $5a_0$
 (C) $4a_0$ (D) a_0

[MHSET 2016]

125. Which of the following statement is not correct about the quantum mechanical harmonic oscillator?
 (A) The amplitude of a quantum mechanical harmonic oscillator in its ground state will not exceed its classical value in lower energy states.
 (B) The average values of $\langle x \rangle$ and $\langle p \rangle$ are zero.
 (C) In highly excited states the quantum mechanical oscillator behaves as a classical oscillator
 (D) The wave function for quantum mechanical harmonic oscillator is always either odd or even

[MHSET 2017]

126. To every observable in classical mechanics there exists a corresponding linear in quantum mechanics.
 (A) Hamiltonian operator (B) Probability function
 (C) Hermitian operator (D) Non-commutator

[MHSET 2017]

127. Which of the following statements is not true for quantum mechanical harmonic oscillator?
 (A) The smaller the mass of the oscillation particle, the greater will be its zero-point energy, for a fixed force constant.
 (B) The frequency is the same as that of a classical oscillator with the same mass and force constant.
 (C) Increasing the force constant increases the spacing between adjacent energy levels.
 (D) The vibrational potential energy is a constant of motion.

[MHSET 2017]

128. The spin multiplicity of an atom in its ground state and having the outershell configuration $4s^23d^7$ is:
 (A) 19 (B) 15
 (C) 7 (D) 4

[MHSET 2017]

129. Which of the following is a prediction that would result from a simple HMO treatment of the butadienyl cation, $C_4H_6^+$?
 (A) The ESR coupling constant is larger for hydrogens attached to the two inner carbons.
 (B) The central C-C bond has a higher π -bond order than it has in the neutral molecule.
 (C) The positive charge resides mostly on the two central carbons.
 (D) The MO coefficients on the central pair of carbons are larger in all of the π MOs than they are in the neutral molecule.

[MHSET 2017]

130. Which of the following is/are acceptable quantum mechanical wave functions?
 (i) $f(X) = X^2 + 1$, for all values of X
 (ii) $\Psi = 1 / (4 - X)$; $0 \leq X \leq 10$
 (iii) $\Psi = 1 / (4 - X)$; $0 \leq X \leq 3$
 (A) (ii) and (iii) (B) (i) only
 (C) (i) and (iii) (D) (iii) only

[MHSET 2017]

131. The ionization energy for hydrogen atom is 13.6 eV. The ionization energy for the ground state of Li^{2+} is :
 (A) 27.2 eV (B) 6.8 eV
 (C) 122.4 eV (D) 40.8 eV

[MHSET 2017]

132. Which of the following is not a feature of Born Oppenheimer approximation?
 (A) Nuclear coordinates remain unchanged during electronic transitions
 (B) Excited and ground electronic states have the same internuclear distance
 (C) Electronic and vibrational motions are separable
 (D) Amplitude of nuclear vibrations is smaller than that of electrons

[MHSET 2018]

133. A particle in a one-dimensional box of length L can be excited from $n = 1$ to $n = 2$ state with frequency. If the box length is doubled, the frequency needed to achieve this transition is:
 (A) $v/4$ (B) $v/2$
 (C) $2v$ (D) $4v$

[MHSET 2018]

134. If operator $\hat{D}^n$ (n times differentiate with respect to x) operates on eigen function e^{ax} , the eigenvalue would be:
- (A) $n\alpha$ (B) n^α
(C) α^n (D) $n! \alpha$

[MHSET 2018]

135. The eigen functions of a rigid rotator are:
- (A) Spherical harmonics
(B) Laguerre polynomials
(C) Hermite polynomials
(D) Legendre transformers

[MHSET 2018]

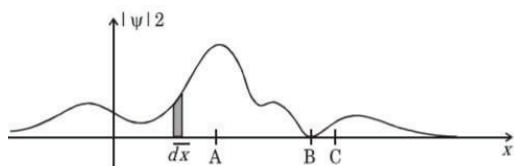
136. According to Hund's rule, most stable state for np^2 configuration is ...
- (A) 1S_0 (B) 3P_0
(C) 3P_1 (D) 3P_2

[MHSET 2018]

137. According to simple HMO theory, which one of the following statements about butadiene is true?
- (A) It has a non-bonding MO
(B) Exciting an electron from the HOMO to the LUMO will not change the π bond orders
(C) Exciting an electron from the HOMO to the LUMO will not change the π charge densities
(D) It is most likely to undergo electrophilic substitution at one of the two inner carbons

[MHSET 2018]

138. Given below is the wave function of a particle: Which of the following is correct?



- (A) The particle is more likely to be found near B
(B) The particle is more likely to be found near A
(C) The shaded area represents the energy of the particle when it travels through a distance dx
(D) The shaded area represents the amplitude of the particle in an area dx

[MHSET 2018]

139. The de Broglie wavelength of an electron travelling with 1% speed of light is about:
(mass of electron and speed of light are 9.109×10^{-31} kg and $2.998 \times 10^8 \text{ ms}^{-1}$ respectively):
- (A) 243 m (B) 243 cm
(C) 243 Å (D) 243 pm

[MHSET 2019]

140. If the radius of the hydrogen atom is 53 pm, the radius of the He^+ ion will be close to:
- (A) 75 pm (B) 38 pm
(C) 106 pm (D) 27 pm

[MHSET 2019]

141. Which of the following equations corresponds to photoelectric effect?
- (A) $h\nu = W_0 + K.E$ (B) $h\nu = W_0 - K.E$
(C) $h\nu = W_0 + K.E$ (D) $h\nu = W_0 - K.E$

[MHSET 2019]

142. The momentum operator in one-dimension is ...
- (A) $-\hbar \frac{\partial}{\partial x}$ (B) $-i \left(\hbar \frac{\partial}{\partial t} \right) - \hbar \frac{\partial}{\partial t}$
(C) $-i\hbar \frac{\partial}{\partial x}$ (D) $i - \hbar \frac{\partial}{\partial t}$

[MHSET 2020]

143. Which of the following is correct?
- (A) In X-ray photoelectron spectroscopy valence electrons are ejected.
(B) K. E of photoelectrons increase when the intensity of the incident X-rays is increased.
(C) K. E of photoelectrons decreases when the oxidation state of the surface is increased.
(D) Number of photoelectrons emitted increases with frequency of the incident X-rays.

[MHSET 2020]

144. A particle can occupy either the ground state at $E = 0$ or an excited state at $E > 0$. At a temperature T , the probability of the particle being in the excited state is:
- (A) 0 (B) $1 + \exp\left(-\frac{E}{K_B T}\right)$
(C) $\frac{\exp\left(-\frac{E}{K_B T}\right)}{1 + \exp\left(-\frac{E}{K_B T}\right)}$ (D) $\frac{1}{1 + \exp\left(-\frac{E}{K_B T}\right)}$

[MHSET 2020]

145. According to Einstein's photoelectric equation, the slope of the plot of kinetic energy of the photoelectrons vs. the frequency of the incident radiation:
- (A) Will depend upon the nature of the metal that emits the photoelectrons
(B) Will depend on the intensity of the incident radiation
(C) Will depend on both the intensity of the radiation and the nature of the metal
(D) Will be the same for all metals and independent of intensity of radiation

[MHSET 2020]

146. for a simple harmonic oscillator:
- (A) Potential energy varies linearly with displacement from equilibrium
- (B) Spacing between energy levels increases with increasing energy
- (C) Spacing between energy levels decreases with increasing energy
- (D) Number of nodes of the wave function increases with increase in energy

[MHSET 2020]

147. Which of the following is correct for H_2^+ ion?
- (A) A possible trial wave function for the ion is $\Psi = C_1 1S_A \pm C_2 1S_B$
- (B) The coefficients of the trial wave function are not equal
- (C) A possible trial wave function is $\Psi = C_1 1S_A / C_2 1S_B$
- (D) The $1S$ orbitals are not normalised

[MHSET 2020]

148. Which of the following is true according to variation theorem?
- (I) the ground state energy of a quantum mechanical system is zero.
- (II) $\frac{\langle \Psi | H | \Psi \rangle}{\langle \Psi | \Psi \rangle} \geq E_0$
- (III) $\frac{\langle \Psi | H | \Psi \rangle}{\langle \Psi | \Psi \rangle} = E_0$
- (IV) The ground state energy of a quantum mechanical system is infinite.
- (A) (I) and (II) (B) (II) only
- (C) (III) only (D) (I) and (IV)

[MHSET 2021]

149. The ratio of the energy of the electron in the ground state of hydrogen atom to that of the electron in the first excited state of Be^{3+} is :
- (A) 1 : 4 (B) 1 : 8
- (C) 2 : 9 (D) 1 : 16

[MHSET 2021]

150. A proton is 1836 times heavier than an electron. The ratio of the de Broglie wavelengths, λ_e / λ_p is :
- (A) 1 : (1836)² (B) (1836)^{1/2} : 1
- (C) 1836 : 1 (D) (1836)² : 1

[MHSET 2021]

151. The energy of a particle in a three-dimensional box of equal side lengths is given as :

$$E = \frac{h^2}{8ma^2} (n_x^2 + n_y^2 + n_z^2)$$

The degeneracy of energy for the levels $n_x n_y n_z = 1, 1, 1, 2, 1, 1$ and $3, 2, 1$ respectively are:

- (A) 3, 4, 6
(C) 1, 3, 6

- (B) 1, 1, 1
(D) 1, 3, 3

[MHSET 2021]

152. Ionization energy of hydrogen atom is 13.6 eV; the ionization energy for the ground state of Li^{2+} is approximately:
- (A) 27.2 eV (B) 40.8 eV
- (C) 54.4 eV (D) 122.4 eV

TAMILNADU SET

[TAMILNADU]

153. For an Eigen function α^{ihx} of linear momentum operator $\hat{P}_x$ the Eigen value is
- (A) ik (B) i
- (C) i (D) $\hbar$

[TAMILNADU]

154. _____ is Laplacian operator.
- (A) $\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ (B) $i \frac{\partial}{\partial x} + j \frac{\partial}{\partial y} + k \frac{\partial}{\partial z}$
- (C) $\hat{A}\psi = \alpha\psi$ (D) $\hat{A}\hat{A}^\dagger - \hat{A}^\dagger\hat{A}$

TELANGANA SET

[TELANGANA 2012]

155. The value of the Planck's constant is
- (A) 6.626×10^{-34} J-s (B) 6.626×10^{-27} J-s
- (C) 1.380×10^{-23} JK⁻¹ (D) 9.109×10^{-31} Kg

[TELANGANA 2012]

156. If an arbitrary wave function is used to calculate the energy of a quantum mechanical system the calculated energy is never less than the true energy of the system. This statement is
- (A) Heisenberg uncertainty principle
- (B) Perturbation theory
- (C) Law of conservation of energy
- (D) Variation principle

[TELANGANA 2013]

157. When the label of any two identical fermions are exchanged, the total wave function changes sign, when the labels of any two identical Bosons are exchanged the total wave function retains the same sign. This statement is
- (A) Pauli principle
- (B) Heisenberg uncertainty principle
- (C) Variation principle
- (D) Perturbation theory

[TELANGANA 2013]

158. Because the nuclei are so much more massive than the electrons, an electronic transition takes place very much faster than the nuclei can respond. This is the
 (A) Heisenberg uncertainty principle
 (B) Franck Condon principle
 (C) Pauli principle
 (D) Born-Oppenheimer approximation

[TELANGANA 2013]

159. The Balmer series in the spectrum of atomic H arise from the transitions $\left(\nabla = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)\right)$
 (A) $n_1 = 1$ (B) $n_1 = 2$
 (C) $n_1 = 3$ (D) all of the above

[TELANGANA 2013]

160. In the orbital approximation where each electron occupies its own orbital $\psi(r_1, r_2, r_3 \dots) =$
 (A) $\psi_1(r_1) + \psi_2(r_2) + \psi_3(r_3) + \dots$
 (B) $-\psi_1(r_1) - \psi_2(r_2) - \psi_3(r_3) \dots$
 (C) $\psi_1(r_1) \cdot \psi_2(r_2) \cdot \psi_3(r_3) \dots$
 (D) $\psi_1(r_1) + \psi_2(r_2) - \psi_3(r_3) \dots$

[TELANGANA 2014]

161. The number of radial nodes for a 3s orbital is
 (A) 0 (B) 1
 (C) 2 (D) 3

[TELANGANA 2014]

162. Wave function of a particle at some point x has the value ψ , then the probability of finding the particle between x and x + dx is proportional to
 (A) $|\psi| dx$ (B) $|\psi|^3 dx$
 (C) $|\psi|^2 dx$ (D) $|\psi|$

[TELANGANA 2014]

163. Zero-point energy (E_0) of a harmonic oscillator is
 (A) $E_0 = h^2/8 mL^2$ (B) $E_0 = \frac{1}{2} h \nu$
 (C) $E_0 = 0$ (D) $E_0 = 4h^2/8m$

[TELANGANA 2014]

164. The ground state term symbol of Li is
 (A) $^2S_{\frac{1}{2}}$ (B) $^2P_{\frac{1}{2}}$
 (C) $^4S_{\frac{1}{2}}$ (D) 1D_2

[TELANGANA 2017]

165. If uncertainty in position and momentum are equal, then uncertainty in velocity is:
 (A) $1/2m\sqrt{h/\pi}$
 (B) $1/m\sqrt{h/\pi}$
 (C) $1/3m\sqrt{h/2\pi}$
 (D) $1/4m\sqrt{h/\pi}$

[TELANGANA 2017]

166. The degeneracy of a quantum particle in cubic box having energy four times that of the lowest energy is:
 (A) 3 (B) 1
 (C) 6 (D) 4

[TELANGANA 2017]

167. Which of the following is not linear operator?
 (A) d^2/dx^2 (B) $\hat{P}_x$
 (C) $\hat{H}$ (D) $\sqrt{\quad}$

[TELANGANA 2017]

168. According to Huckel MO treatment the four π -MO energies of butadiene are given by $\alpha \pm 1.62\beta$ and $\alpha \pm 0.62\beta$. The delocalization energy of butadiene is:
 (A) 0.62β (B) 0.48β
 (C) 1.62β (D) 1.48β

[TELANGANA 2017]

169. If a trial wave function is used to calculate the energy of a quantum mechanical system, the calculated energy is always greater than the true energy. The statement is related to:
 (A) Perturbation theory
 (B) Variation principle
 (C) Born-Oppenheimer approximation
 (D) Heisenberg uncertainty principle

[TELANGANA 2012]

170. Huckel MO energy levels of ethylene are
 (A) $\alpha + 2\beta$; $\alpha - 2\beta$ (B) $\alpha + \beta$; $\alpha - \beta$
 (C) $\alpha + 1/2\beta$; $\alpha - 1/2\beta$; (D) $\alpha + 3\beta$; $\alpha - 3\beta$

[TELANGANA 2012]

171. Match the following :

List I

- I. $H\psi = E\psi$
 II. $E = h\nu$
 III. $|\psi|^2$
 IV. $\lambda = h/mv$

List II

1. Planck
 2. Born
 3. Dirac
 4. De Broglie
 5. Schrodinger

- | | I | II | III | IV |
|-----|---|----|-----|----|
| (A) | 5 | 1 | 2 | 4 |
| (B) | 1 | 2 | 3 | 4 |
| (C) | 4 | 5 | 2 | 1 |
| (D) | 3 | 2 | 4 | 1 |

[TELANGANA 2012]

172. In quantum mechanical tunnelling the transmission coefficient
 (A) Increases with the thickness of the barrier
 (B) Decreases exponentially with the thickness of the barrier

- (C) Decreases with the square of the thickness of the barrier
(D) Does not depend on the thickness of the barrier

[TELANGANA 2012]

173. Example of fermions are

- (A) Electron and proton (B) Photon and proton
(C) Electron and photon (D) Photons

[TELANGANA 2012]

174. Lowest allowed energy is equal to zero for a

- (A) Harmonic oscillator
(B) Particle in a two dimensional box
(C) A rigid rotator
(D) Hydrogen atom

[TELANGANA 2012]

175. An electron of mass 'm' is confined to a one dimensional box of length 'l'. The frequency of the radiation absorbed during its excitation from its second energy level to third level is

- (A) $\frac{5h}{8ml^2}$ (B) $\frac{h}{8ml^2}$
(C) $\frac{3h}{8ml^2}$ (D) $\frac{4h}{8ml^2}$

[TELANGANA 2013]

176. Match the following

List – I

- I) Planck
II) Rydberg
III) Boltzman
IV) Avogadro
V) Faraday

List – II

- 1) $6.023 \times 10^{23} \text{ mol}^{-1}$
2) $1.381 \times 10^{-23} \text{ JK}^{-1}$
3) $1.0974 \times 10^5 \text{ cm}^{-1}$
4) $6.626 \times 10^{-34} \text{ J-s}$

- | | 1 | 2 | 3 | 4 |
|-----|-----|-----|----|----|
| (A) | V | III | II | I |
| (B) | IV | III | II | I |
| (C) | III | II | I | IV |
| (D) | IV | V | I | II |

[TELANGANA 2013]

177. The correct statements among the following are

- 1) An acceptable wave function must be continuous
2) An acceptable wave function must be single valued
3) An acceptable wave function must not be square integrable
4) An acceptable wave function must have continuous first derivative

- (A) 1, 2, 4 (B) 1, 2, 3
(C) 2, 3, 4 (D) 1, 3, 4

[TELANGANA 2013]

178. Identify the eigen function of the operator d/dx from the following

- (A) x^2 (B) e^x
(C) x (D) $x^2 - x$

[TELANGANA 2013]

179. If an arbitrary wave function is used to calculate the energy using variation theory, the value calculated is

- (A) Never greater than the true energy
(B) Never less than the true energy
(C) Always equal to the true energy
(D) Always equal to zero

[TELANGANA 2014]

180. The Hamiltonian for the internal motion of a hydrogen like atom is given by

- (A) $\frac{-\hbar^2}{2\mu} \nabla^2 - \frac{Ze^2}{4\pi\epsilon_0 r}$ (B) $\frac{-\hbar^2}{2\mu} \nabla^2 + \frac{Ze^2}{4\pi\epsilon_0 r}$
(C) $\frac{-\hbar^2}{2\mu} \nabla^2$ (D) $\frac{-\hbar^2}{2\mu} \nabla^2 + \frac{1}{2} kx^2$

[TELANGANA 2014]

181. The correct statements among the following are:

- 1) Angular momenta of 1s, 2s and 3s orbitals are same
2) Energies of 1s, 2s and 3s orbitals are same
3) Angular momenta of 1s, 2s and 3s orbitals are different
4) Energies of 1s, 2s and 3s orbitals are different

- (A) 1, 2 (B) 2, 3
(C) 3, 4 (D) 1, 4

[TELANGANA 2014]

182. The perturbation Hamiltonian $H^{(1)}$, for the first order correction to the ground-state energy for a particle in a box with a variation in the potential $v = -\epsilon \sin(\pi x/L)$ is given by

- (A) $-\epsilon \sin(\pi x/L)$ (B) $\epsilon^2 \sin^2(\pi x/L)$
(C) $\epsilon^3 \sin^3(\pi x/L)$ (D) ϵ^3

[TELANGANA 2014]

183. A particle of mass 'm' is confined between two walls of a box at $x = 0$ and $x = 2L$. The potential energy is zero inside this one dimensional box but rises abruptly to infinity at the walls. The energy of this particle (E) is given by

- (A) $\frac{n^2 h^2}{8mL^2}, n = 1, 2, \dots$ (B) $\frac{n^2 h^2}{32mL^2}, n = 1, 2, \dots$
(C) $\frac{n^2 h^2}{16mL^2}, n = 1, 2, \dots$ (D) $\frac{n^2 h^2}{18mL^2}, n = 0, 1, 2, \dots$

[TELANGANA 2014]

184. The energies E_+ of bonding and E_- of antibonding orbitals of a homonuclear diatomic molecule are given

by the secular determinant $\begin{vmatrix} a - E & \beta - ES \\ \beta - ES & a - E \end{vmatrix}$ the solutions of this equations are

- (A) $E_{\pm} = \frac{a \mp \beta}{s}$ (B) $E_{\pm} = \frac{a \mp \beta}{1-s}$
(C) $E_{\pm} = \frac{a \beta}{1 \pm s}$ (D) $E_{\pm} = \frac{a \pm \beta}{1 \pm s}$

[TELANGANA 2014]

185. Match the following

List – I

- I. Orbital angular momentum quantum number
 II. Magnetic quantum number
 III. Spin quantum number
 IV. Total angular momentum quantum number

List – II

1. M_l
 2. l
 3. j
 4. S

- | | | | | |
|-----|-----|-----|-----|-----|
| | 1 | 2 | 3 | 4 |
| (A) | I | II | III | IV |
| (B) | I | III | II | IV |
| (C) | II | I | IV | III |
| (D) | III | IV | I | II |

[TELANGANA 2014]

186. Which one of the following spin wave functions (Ψ_{spin}) is antisymmetric?

- (A) $\Psi_{\text{spin}} = [\alpha(1)\beta(2) - \beta(1)\alpha(2)]$
 (B) $\Psi_{\text{spin}} = \beta(1)\beta(2)$
 (C) $\Psi_{\text{spin}} = \alpha(1)\alpha(2)$
 (D) $\Psi_{\text{spin}} = [\alpha(1)\beta(2) + \beta(1)\alpha(2)]$

[TELANGANA 2014]

187. According to HMO theory, the possible energy levels for ethylene in terms of coulombic (α) and exchange (β) integrals are

- (A) $(\alpha+\beta)$ and $(2\alpha + \beta)$ (B) $(\alpha+\beta)$ and $(\alpha - 2\beta)$
 (C) $(\alpha+2\beta)$ and $(\alpha-2\beta)$ (D) $(\alpha+\beta)$ and $(\alpha - \beta)$

[TELANGANA 2017]

188. What is the order of energies of 4s, 4p, 4d and 4f orbitals of hydrogen atom?

- (A) $4s > 4p > 4d > 4f$ (B) $4s < 4p < 4d < 4f$
 (C) $4s > 4p < 4d < 4f$ (D) $4s = 4p = 4d = 4f$

[TELANGANA 2017]

189. The valence bonding molecular orbital of a hydrogen chloride HCl molecule may be described as the linear combination of the hydrogen 1s and chloride 3p atomic orbitals.

$\Psi = 0.23\Psi_H + 0.77\Psi_{Cl}$. Calculate the probability of finding an electron in a 1s orbital on hydrogen is:

- (A) 8.2%
 (B) 23%
 (C) 77%
 (D) 54%

[TELANGANA 2017]

190. Calculated the probability that an electron described by a hydrogen atomic 1s wave function will be found within one Bohr radius of the nucleus.

- (A) 33.3% (B) 50%
 (C) 32.3% (D) 23%

[TELANGANA 2017]

191. The expression for the following operator $\left(\frac{d}{dx} + x\right)^2$ is:

- (A) $\frac{d^2}{dx^2} + x\frac{d}{dx} + x^2 + 1$ (B) $\frac{d^2}{dx^2} + 1 + x^2$
 (C) $\frac{d^2}{dx^2} + 1 - x^2$ (D) $\frac{d^2}{dx^2} + 2x\frac{d}{dx} + x^2$

[TELANGANA 2017]

192. The lowest allowed energy is equal to zero for:

- (A) Hydrogen atom
 (B) A particle in a three dimensional box
 (C) An harmonic oscillator
 (D) A rigid rotor

[TELANGANA 2018]

193. According to Huckel Molecular Orbital Theory (HMO) the possible energy in terms of Coulombic (α) and exchange (β) integrals are

- (A) $(\alpha + \beta)$, α , $(2\alpha + \beta)$, $(2\alpha - \beta)$
 (B) $(\alpha + 2\beta)$, 2α , $(\alpha - 2\beta)$, $(2\alpha + \beta)$
 (C) $(\alpha + 2\beta)$, α , α , $(\alpha - 2\beta)$
 (D) α , α , $(\alpha + \beta)$, $(\alpha + 2\beta)$

[TELANGANA 2018]

194. The average position of a particle in one dimensional box of length L is

- (A) L (B) L/2
 (C) 2L (D) 12L

[TELANGANA 2018]

195. Average distance for 2s orbital of He⁺ is

- (A) $1A^\circ$ (B) $2A^\circ$
 (C) $3A^\circ$ (D) $4A^\circ$

[TELANGANA 2018]

196. The radial function 'R' depends on

1. n
 2. l
 3. m
 4. s
 (A) 1, 2 (B) 1, 4
 (C) 2, 3 (D) 3, 4

WBSET

[WBSET 2015]

197. The average value of r^2 (i.e., $\langle r^2 \rangle$) in the 1s orbital of hydrogen atom is (a_0 is the Bohr radius)
- (A) a_0 (B) $0.5 a_0^2$
 (C) $3a_0^2$ (D) $1.5 a_0^3$

[WBSET 2017]

198. The wave function of the electron in the lowest energy state of hydrogen atom is proportional to $\exp(-r/a_0)$ where a_0 is a constant. The relative probability of finding the electron inside a volume d_v at a_0 relative to nucleus is:
- (A) 14.2 (B) 13.6
 (C) 0.71 (D) 7.1

[WBSET 2017]

199. The set of angular parts of 2pz, 2px, 2py orbitals of hydrogen atom are:
- (A) $\cos\theta, -\sin\theta e^{i\varphi}, \sin\theta e^{-i\varphi}$
 (B) $\cos\theta, -\sin\theta e^{i\varphi}, \sin\theta e^{i\varphi}$
 (C) $\sin\theta, -\cos\theta e^{i\varphi}, \sin\theta e^{-i\varphi}$
 (D) $\cos\theta, \sin\theta \cos\varphi, \sin\theta \sin\varphi$

[WBSET 2017]

200. For a hetero nuclear diatomic molecule which of the following statements is true?
 As the energy difference between the two interacting atomic orbitals increases
- (A) both bonding and antibonding effects increases.
 (B) both bonding and antibonding effects decreases.
 (C) bonding effect decreases but anti bonding effect increases.
 (D) bonding effect increases but anti bonding effect decreases.

[WBSET 2015]

201. The number of nodes of any orbital of hydrogen atom, other than the ones at the origin and at infinity, is given by
- (A) $n - 1 - 1$ (B) $n - 1$
 (C) n (D) $n + 1$

[WBSET 2015]

202. An electron in the ground state of hydrogen atom is excited to a level having principal quantum no. n . It was found to absorb at wavelength 2 of the electromagnetic spectrum. The value of n is
 (R = Rydberg constant)

(A) $\sqrt{\frac{R}{\lambda-1}}$ (B) $\sqrt{R\lambda(\lambda-1)}$
 (C) $\sqrt{\frac{R\lambda}{R\lambda-1}}$ (D) $\sqrt{\frac{R\lambda-1}{R\lambda}}$

[WBSET 2015]

203. Based on Hückel treatment of π it electrons in conjugated cyclic hydrocarbons, which of the following statements is incorrect.
- (A) Lowest energy level in all such systems is degenerate.
 (B) Ground state of cyclobutadiene is a triplet.
 (C) Delocalization energy of benzene is about 150 kJ / mole
 (D) The value of resonance integral between neighbouring atoms is B

[WBSET 2015]

204. The $M_s = 0$ component of triplet state arising from two electrons is (symbols have their usual meaning)
- (A) $\alpha(1) \beta(2)$
 (B) $\alpha(2) \beta(1)$
 (C) $\frac{1}{\sqrt{2}} [\alpha(1) \beta(2) + \beta(1) \alpha(2)]$
 (D) $\frac{1}{\sqrt{2}} [\alpha(1) \beta(2) - \beta(1) \alpha(2)]$

[WBSET 2017]

205. Which of the following trial wave functions may be used to calculate the first excited state of harmonic oscillator by variational method with a as a parameter?
- (A) e^{-ax^2} (B) xe^{-ax^2}
 (C) $(x^2 - 1)e^{-ax^2}$ (D) xe^{-ax}

[WBSET 2017]

206. The wavelength of a charged particle (λ), varies with potential difference (E) through which it is accelerated as:
- (A) $\lambda \propto \frac{1}{E}$ (B) $\lambda \propto E$
 (C) $\lambda \propto E^{-1/2}$ (D) $\lambda \propto \sqrt{E}$

[WBSET 2017]

207. If someone recognizes that $p(x) = Ce^{-2/2x^2}$ is an even function, then the value of C is determined to be:
- (A) $\left(\frac{\pi a^2}{2}\right)^{1/2}$ (B) $\frac{1}{2\pi a^2}$
 (C) $\frac{1}{(\pi a^2)^{1/2}}$ (D) $\frac{1}{(2\pi a^2)^{1/2}}$

[WBSET 2017]

208. If e^{ax} is an eigenfunction of the operator d^n/dx^n , the eigenvalue is found to be:
- (A) a^n (B) a
 (C) na (D) $\frac{1}{a^n}$

209. The probability of finding a particle in an one-dimensional box of length a is found to be:

- (A) between $-a/2$ to $a/2$ (B) between 0 and $-a/2$
(C) 0 (D) a

[WBSET 2018]

210. The degree of degeneracy for an energy level $\frac{17h^2}{8ml^2}$ of a particle in a cubical box of side 'L' is

- (A) 5 (B) 3
(C) 4 (D) 2

[WBSET 2018]

211. A particle of mass 'm' moving in one – dimension between $x=a$ and $x=b$ is described by a wave function $\Psi = \frac{N}{x}$ where N is normalization constant. The average value of x is

- (A) $\frac{b}{a}$ (B) $\frac{ab}{b-a} e^{b/a}$
(C) $\frac{ab}{b-a} \ln \frac{a}{b}$ (D) $\frac{ab}{b-a} [\ln b - \ln a]$

[WBSET 2018]

212. Ψ_1 and Ψ_2 are normalized and are mutually orthogonal to each other. The normalization constant for the function $\Psi_1 + \sqrt{3}\Psi_2$ is

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

[WBSET 2018]

213. Which of the following is correct wave function for helium atom?

- (A) $1s(1) 2s(2) (\alpha_1\beta_2 - \beta_1\alpha_2)$
(B) $[1s(1) 2s(2) - 2s(1) 1s(2)] (\alpha_1\beta_2 - \beta_1\alpha_2)$
(C) $1s(1) 2s(2) \alpha_1\beta_2 - 2s(1) 1s(2) \beta_1\alpha_2 + 1s(1) 2s(2) \beta_1\alpha_2 - 2s(1) 1s(2) \alpha_1\beta_2$
(D) $[1s(1) 2s(2) - 2s(1) 1s(2)] (\alpha_1\beta_2 - \beta_1\alpha_2)$

[WBSET 2018]

214. The degeneracy of the most probable energy level for an atom of mass 'm' of one mole of an ideal gas at TK and pressure P atm, assuming that the atom can be treated as a particle in a three-dimensional cubical box is

- (A) $\frac{2\sqrt{3mKT}}{h} \left(\frac{RT}{P}\right)^{\frac{1}{3}}$ (B) $\frac{2\sqrt{3mKT}}{h}$
(C) $\frac{\sqrt{3mKT}}{h} \left(\frac{RT}{P}\right)^{\frac{1}{2}}$ (D) $\frac{2\sqrt{mKT}}{h}$

[WBSET 2018]

215. A normalized trial function for a particle in a one-dimensional box of length 'L' is $\Psi = Nx(L-x)$ Where N is normalization constant. The upper bound to the ground state energy of the system

- (A) $\frac{Nh^2}{8ml^2}$ (B) $\frac{N^2h^2}{8ml^2}$
(C) $\frac{N^2h^2l^3}{6m}$ (D) $\frac{N^2h^2l^3}{8m}$

[WBSET 2018]

216. $\exp(-\alpha x^2)$ is an eigen function of $-\frac{d^2}{dx^2} + x^2$ provided

- (A) $\alpha = \frac{1}{2}$ (B) $\alpha = 1$
(C) $\alpha = \frac{1}{\sqrt{2}}$ (D) $\alpha = 2$

[WBSET 2020]

217. A quantum particle in a two-dimensional square box is in a state described by $n_1 = 1$ and $n_2 = 7$. State(s) in accidental degeneracy with this state is feasible with

- (A) $n_1 = 7, n_2 = 1$
(B) No permissible integral values of n_1 and n_2
(C) $n_1 = 5, n_2 = 5$
(D) both of ($n_1 = 7, n_2 = 1$) and ($n_1 = 5, n_2 = 5$)

[WBSET 2020]

218. The operator $\left(\frac{d}{dx} + x\right)^2$ equals to

- (A) $\frac{d^2}{dx^2} + 2x \frac{d}{dx} + x^2 + 1$ (B) $\frac{d^2}{dx^2} + 2x \frac{d}{dx} + x^2$
(C) $\frac{d^2}{dx^2} + x \frac{d}{dx} + x^2 + 1$ (D) $\frac{d^2}{dx^2} + x^2$

[WBSET 2020]

219. Brillouin theorem is related to

- (A) the physical significance of Hartree-Fock (HF).
(B) failure of HF theory in reproducing ionization spectra.
(C) consideration of electronic relaxation effect in excitation spectra.
(D) configuration interaction between HF determinant and single excited determinant.

[WBSET 2020]

220. If quantum-mechanical operator's P and Q are such that $[P, Q] = 1$, then $[P^2, Q^2]$ equals to

- (A) PQ (B) $2PQ + 2QP$
(C) $4PQ$ (D) $4QP$

[WBSET 2020]

221. Paschen-Back effect is related to

- (A) perturbation in atomic spectra due to electric field.
(B) anharmonicity in molecular vibration.
(C) effect of high magnetic field on atomic spectra.
(D) L-S coupling in atomic spectra

[WBSET 2020]

222. Due to space quantization, nuclear angular momentum can have discrete orientations about the applied magnetic field and its values (I_z) along the field axis are $I_z = Sml$, where ml can have values

- (A) $l, l-1, l-2, \dots, -l$. (B) $l, l-1, l-2, \dots, 2, 1, 0$.
(C) $l, l-1, l-2, \dots, 2, 1$. (D) $l, l-1, l-2, \dots, -2, -1$.

G SET

223. Mathematical expression for Hamiltonian operator, $\hat{H}$ is

(A) $+\frac{\hbar^2}{2m}\nabla^2 - V$ (B) $+\frac{\hbar^2}{2m}\nabla^2 + V$
 (C) $-\frac{\hbar^2}{2m}\nabla^2 - V$ (D) $-\frac{\hbar^2}{2m}\nabla^2 + V$

224. The magnitude of the angular momentum ($\vec{L}$) of an electron that couples the 3d orbital is

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

225. According to the huckel's theory for conjugated π - electron system, the lowest π - M.O. energy value for cyclobutenyl system is

(A) $\alpha - 2\beta$ (B) $\alpha + 2\beta$
 (C) $\alpha + \beta$ (D) $\alpha - \beta$

226. The lowest energy molecular orbital for the allyl system is

(A) $\frac{1}{\sqrt{2}}\chi_1 - \frac{1}{2}\chi_2 - \frac{1}{\sqrt{2}}\chi_3$
 (B) $\frac{1}{\sqrt{2}}\chi_1 - \frac{1}{\sqrt{3}}\chi_1 + \frac{1}{\sqrt{2}}\chi_1$
 (C) $\frac{1}{\sqrt{3}}\chi_1 - \frac{1}{3}\chi_2 + \frac{1}{\sqrt{3}}\chi_3$
 (D) $\frac{1}{\sqrt{3}}\chi_1 + \frac{1}{\sqrt{3}}\chi_2 + \frac{1}{\sqrt{3}}\chi_3$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
D	D	A	A	C	A	D	C	C	C
11	12	13	14	15	16	17	18	19	20
A	D	D	A	B	C	D	C	D	B
21	22	23	24	25	26	27	28	29	30
B	C	A	D	C	A	B	A	C	B
31	32	33	34	35	36	37	38	39	40
A	D	C	B	D	B	D	B	A	C
41	42	43	44	45	46	47	48	49	50
A	C	C	D	B	B	B	B	A	B
51	52	53	54	55	56	57	58	59	60
A	C	D	C	A	C	C	A	C	A
61	62	63	64	65	66	67	68	69	70
C	B	A	A	B	D	A	C	D	A
71	72	73	74	75	76	77	78	79	80
B	A	C	C	A	A	D	B	B	D
81	82	83	84	85	86	87	88	89	90
A	D	A	B	B	A	A	C	D	A
91	92	93	94	95	96	97	98	99	100
D	C	C	D	B	C	A	C	A	A
101	102	103	104	105	106	107	108	109	110
C	B	D	A	B	C	A	C	D	B
111	112	113	114	115	116	117	118	119	120
B	A	B	B	C	B	D	C	C	B
121	122	123	124	125	126	127	128	129	130
B	B	A	B	A	C	D	D	B	D
131	132	133	134	135	136	137	138	139	140
C	D	A	C	D	B	C	B	D	B
141	142	143	144	145	146	147	148	149	150
C	C	A	C	D	D	A	B	A	B
151	152	153	154	155	156	157	158	159	160
C	D	D	A	A	D	A	B	B	C
161	162	163	164	165	166	167	168	169	170
C	C	B	A	A	B	D	B	B	B
171	172	173	174	175	176	177	178	179	180
A	B	A	C	A	B	A	B	B	A
181	182	183	184	185	186	187	188	189	190
D	A	B	D	C	A	D	D	A	C
191	192	193	194	195	196	197	198	199	200
A	D	C	B	C	A	C	D	D	B
201	202	203	204	205	206	207	208	209	210
B	C	A	D	B	C	A	A	A	B
211	212	213	214	215	216	217	218	219	220
D	C	A	A	C	A	C	A	A	B
221	222	223	224	225	226				
C	A	D	C	B	D				

QUANTUM CHEMISTRY SOLUTION

HP SET

1. **Solution: (D)**

Condition for well behaved (Acceptable) wave function: -

* φ must be finite

* φ must be single valued

* φ must be continuous

$\sin^{-1}$ is not a single valued function. $\sin^{-1}$ is not acceptable wave function.

Option (d) is correct.

2. **Solution: (D)**

$$[\hat{x}, \hat{p}_x^2] \text{ Trick } [\hat{x}, \hat{p}_x^n] = i\hbar n \hat{p}_x^{n-1}$$

$$px^2 = \left(-i\hbar \left(\frac{d}{dx} \right) \right)^2 = -\frac{\hbar^2 d^2}{dx^2}$$

$$\begin{aligned} [x, px^2]\varphi &= \left[x \left(-\frac{\hbar^2 d^2}{dx^2} \right) - \left(-\frac{\hbar^2 d^2}{dx^2} \right) x \right] \varphi \\ &= \left[-x \times \frac{\hbar^2 d^2 \varphi}{dx^2} + \frac{\hbar^2 d^2 (x\varphi)}{dx^2} \right] \\ &= \left[-x \times \frac{\hbar^2 d^2 \varphi}{dx^2} + x \times \frac{\hbar^2 d^2 \varphi}{dx^2} + 2 \frac{\hbar^2 d \varphi}{dx} \right] = 2 \frac{\hbar^2 d \varphi}{dx} \end{aligned}$$

$$[x, px^2]\varphi = 2 \frac{\hbar^2 d \varphi}{dx}$$

$$[x, px^2] = 2 \frac{\hbar^2 d}{dx}$$

$$2 \frac{\hbar^2 d}{dx} = 2i\hbar p_x = 2i\hbar \left(-\frac{i\hbar d}{dx} \right) = 2 \frac{\hbar^2 d}{dx}$$

Option (d) is correct

3. **Solution: (A)**

First order correction to energy = ΔE

$$\Delta E = \int_0^l \psi^{o*} \Delta H \psi^o dx$$

$$\Delta H = \lambda x \quad \psi = \sqrt{\frac{2}{l}} \sin\left(\frac{n\pi x}{l}\right)$$

$$\Delta E =$$

$$\int_0^l \sqrt{\frac{2}{l}} \sin\left(\frac{n\pi x}{l}\right) \cdot \lambda x \cdot \sqrt{\frac{2}{l}} \sin\left(\frac{n\pi x}{l}\right) dx$$

$$\Delta E =$$

$$\lambda \int_0^l \sqrt{\frac{2}{l}} \sin\left(\frac{n\pi x}{l}\right) \cdot x \cdot \sqrt{\frac{2}{l}} \sin\left(\frac{n\pi x}{l}\right) dx$$

$$\Delta E = \lambda \times \frac{2}{l} \int_0^l x \sin^2\left(\frac{n\pi x}{l}\right) dx$$

$$\Delta E = \lambda \times \frac{2}{l} \int_0^l x \left(\frac{1 - \cos\left(\frac{2n\pi x}{l}\right)}{2} \right) dx$$

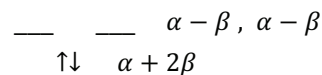
on solving integration

$$\Delta E = \frac{\lambda l}{2}$$

Option (a) is correct

4. **Solution: (A)**

The energy levels of cyclopropenyl cation are $\alpha + 2\beta$, $\alpha - \beta$ and $\alpha - \beta$



here one ethylene unit is present in cyclopropenyl cation

Delocalisation energy

$$= E_{total} - \text{ethylene unit energy}$$

$$= 2 \times (\alpha + 2\beta) - (2\alpha + 2\beta) = 2\beta$$

Delocalisation energy = 2β

option (a) is correct

5. **Solution: (C)**

Energy of the harmonic oscillator is:-

$$E = \left(n + \frac{1}{2} \right) h\nu = \left(n + \frac{1}{2} \right) h\omega$$

for zero point energy (n=0)

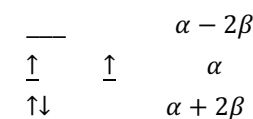
$$E(Z.P.E) = \left(n + \frac{1}{2} \right) h\omega = \left(0 + \frac{1}{2} \right) h\omega = \frac{1}{2} h\omega$$

$$E(Z.P.E) = \frac{1}{2} h\omega$$

option (c) is correct

6. **Solution: (A)**

Energy levels of cyclo-butadiene



here two ethylene unit is present in cyclobutadiene

Delocalisation energy

$$= E_{total} - \text{ethylene unit energy}$$

$$= 2 \times (\alpha + 2\beta) + 2\alpha - 2(2\alpha + 2\beta) = 0$$

So Delocalisation energy in cyclobutadiene = 0

option (a) is correct

7. **Solution: (D)**

Uncertainty principle also called Heisenberg uncertainty principle. According to Heisenberg uncertainty principle the position and the velocity of an object cannot both be measured exactly, at the same time.

$$\text{According to uncertainty principle: } \Delta x \cdot \Delta p \geq \frac{\hbar}{2}$$

Δx = change in position

$\Delta p = m\Delta v$ = change in momentum

option (d) is correct

8. **Solution: (C)**

When hydrogen atom is placed in an electric field along the y-axis, the orbital that mixes most with the ground state 1s orbital is $2p_y$. On the y-axis $2p_y$ orbital is present so hydrogen orbital mix with $2p_y$ option (c) is correct

9. **Solution: (C)**

Energy for one dimensional box is :-

$$E_n = \frac{n^2 h^2}{8ma^2} \quad \text{--- (i)}$$

$$E_{n+1} = \frac{(n+1)^2 h^2}{8ma^2} \quad \text{--- (ii)}$$

for separation between energy levels (ii) – (i)

$$E_{n+1} - E_n = \frac{(n+1)^2 h^2}{8ma^2} - \frac{n^2 h^2}{8ma^2} = \frac{h^2}{8ma^2} (n^2 + 1 + 2n - n^2) = (2n + 1) \frac{n^2 h^2}{8ma^2}$$

separation between energy levels is $= (2n + 1) \frac{n^2 h^2}{8ma^2}$

option (c) is correct

10. **Solution: (C)**

$$\text{Energy} = \frac{hc}{\lambda}$$

h = planks constant $= 6.626 \times 10^{-34} \text{ Js}$

c = velocity of light $= 3 \times 10^8 \text{ ms}^{-1}$

λ = wavelength (in meters)

wavelength given $= 200 \text{ nm} = 200 \times 10^{-9} \text{ m}$

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ Js})(3 \times 10^8 \text{ ms}^{-1})}{200 \times 10^{-9} \text{ m}} = 9.9 \times 10^{-19} \text{ joules}$$

energy of photon is $9.9 \times 10^{-19} \text{ J}$

option (c) is correct

11. **Solution: (A)**

Eigen value and Eigen function

$\hat{A}\psi = a\psi$ a = Eigen value ψ = Eigen function $= e^{ax}$

$\hat{A}$ = operator

for $\hat{A} = \frac{d}{dx}$ $\hat{A}\psi = \frac{d}{dx} e^{ax} = a e^{ax}$ Eigen value = a

for $\hat{A} = \frac{d^2}{dx^2}$ $\hat{A}\psi = \frac{d^2}{dx^2} e^{ax} = a^2 e^{ax}$ Eigen value = a^2

for $\hat{A} = \frac{d^3}{dx^3}$ $\hat{A}\psi = \frac{d^3}{dx^3} e^{ax} = a^3 e^{ax}$ Eigen value = a^3

for $\hat{A} = \frac{d^n}{dx^n}$ $\hat{A}\psi = \frac{d^n}{dx^n} e^{ax} = a^n e^{ax}$ Eigen value = a^n

So eigen value for this function is a^n

option (a) is correct.

12. **Solution: (D)**

According to uncertainty principle: $\Delta x \cdot \Delta p \geq \frac{h}{2}$

Δx = change in position

$\Delta p = m\Delta v$ = change in momentum (mass in kg)

$$\Delta x \cdot m \cdot \Delta v = \frac{h}{4\pi}$$

$$\Delta x \times 0.001 \text{ kg} \times 1 \times 10^{-6} \text{ ms}^{-1} = \frac{6.626 \times 10^{-34} \text{ Js}}{4 \times 3.14}$$

$$\Delta x = 4.77 \times 10^{-26} \text{ m}$$

$$\Delta x \approx 5 \times 10^{-26} \text{ m}$$

minimum uncertainty in its position is $5 \times 10^{-26} \text{ m}$

option (d) is correct

KERALA SET

13. **Solution: (D)**

According to de Broglie light can behave as particle and wave so

$$\text{Energy} = \frac{hc}{\lambda} \text{ for wave --(i)}$$

c is velocity of light

$$\text{Energy} = mc^2 \text{ for light --(ii)}$$

(i) and (ii) both will be equal

$$\frac{hc}{\lambda} = mc^2$$

$$\lambda = \frac{h}{mc} = \frac{h}{mv} = \frac{h}{p} \text{ --(iii)}$$

p is momentum $= mv$

from (iii) equation we can say wavelength is inversely proportional to its momentum

option (d) is correct

14. **Solution: (A)**

According to de-Broglie hypothesis

$$\lambda = \frac{h}{mv} = \frac{h}{p}$$

Electron is the lightest among all the particle, so the momentum least for an electron

$$\lambda = \frac{h}{p}$$

So the longest wavelength is of an electron So electron have maximum wavelength So maximum wave character

option (a) is correct

15. **Solution: (B)**

The energy of a particle in a one-dimensional box is given by:-

$$\text{Energy} = \frac{n^2 h^2}{8ma^2}$$

n = principle quantum number

h = planks constant

m = mass

a = length of the box

option (b) is correct

16. **Solution: (C)**

Number of Radial nodes $= n - l - 1$

n = principle quantum number

l = Azimuthal quantum number

for 3s orbital principle quantum number is 3 and azimuthal quantum number is 0

So number of radial nodes will be $= n - l - 1 = 3 - 0 - 1 = 2$

so number of radial nodes comes out to be 2

option (c) is correct

17. **Solution: (D)**

A fermion is a particle that follows Fermi-Dirac statistics and generally has half-odd integer spin:-

Spin = $1/2, 3/2$

Helium-3 with two protons and one neutron has an odd number of nuclei so that atom is a fermion but Helium-4 with two protons and two neutrons has an even nuclei so that atom is not a fermion.

Option (d) is correct

18. **Solution: (C)**

$$\text{Energy} = \frac{hc}{\lambda}$$

h = planks constant $= 6.626 \times 10^{-34} \text{ Js}$

c = velocity of light $= 3 \times 10^8 \text{ ms}^{-1}$

λ = wavelength (in meters)

wavelength given $= 3.313 \text{ \AA} = 3.313 \times 10^{-10} \text{ m}$

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ Js})(3 \times 10^8 \text{ ms}^{-1})}{3.313 \times 10^{-10} \text{ m}} = 6 \times 10^{-16} \text{ J}$$

Energy of the photon having a wavelength $3.313 \text{ \AA}$ is $6 \times 10^{-16} \text{ J}$

option (c) is correct

19. **Solution: (D)**

Number of nodes $= n - 1$

So for 3 nodes $n = 4$

for 2 nodes $n = 3$

Energy for level having 3 nodes

$$= E_4 = \frac{n^2 h^2}{8ma^2} = 16 \times \frac{h^2}{8ma^2} \text{ -----1}$$

Energy for level having 2 nodes

$$= E_3 = \frac{n^2 h^2}{8ma^2} = 9 \times \frac{h^2}{8ma^2} \text{ ---2}$$

for energy difference $1 - 2$

$$\Delta E = \frac{h^2}{8ma^2} (16 - 9) = 7 \times \frac{h^2}{8ma^2}$$

in units of $\frac{h^2}{8ma^2}$ energy difference is 7

option (d) is correct

20. **Solution: (B)**

Energy of photon $= h\nu = 6.626 \times 10^{-34} \text{ Js} \times 5 \times 10^{20} \text{ s}^{-1} = 3.313 \times 10^{-13} \text{ J}$

$$\text{Energy } E = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E} = (6.626 \times 10^{-34} \text{ Js}) \times \frac{(3 \times 10^8 \text{ ms}^{-1})}{3.313 \times 10^{-13} \text{ J}} = 6 \times 10^{-13} \text{ m}$$

According to de-Broglie hypothesis

$$\lambda = \frac{h}{mv} = \frac{h}{p}$$

$$p = \frac{h}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ Js})}{6 \times 10^{-13} \text{ m}} = 1.1 \times 10^{-21} \text{ kgms}^{-1}$$

$$p(\text{momentum}) = 1.1 \times 10^{-21} \text{ kgms}^{-1}$$

option (b) is correct

21. **Solution: (B)**

Einstein's photoelectric equation state

$$h\nu = W_0 + K.E$$

where ν is the frequency of incident light, W_0 is the work potential of the metal, and KE is the maximum kinetics energy of released electron.

$$\text{kinetic energy} = \frac{1}{2}mv^2$$

$$h\nu = W_0 + \frac{1}{2}mv^2$$

$$\frac{1}{2}mv^2 = h\nu - W_0$$

option (b) is correct

22. **Solution: (C)**

$$\text{wave number} = \frac{1}{\lambda} = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] z^2$$

For balmer series $n_1 = 2, n_2 = 3$

helium atomic number is 2

$$\text{wave number} = \frac{1}{\lambda} = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] z^2 = R_H \left[\frac{1}{2^2} - \frac{1}{3^2} \right] 2^2 = R_H \left[\frac{1}{4} - \frac{1}{9} \right] 4 = \frac{5}{9} R_H$$

$$\frac{1}{3^2} \left[\frac{1}{4} - \frac{1}{9} \right] 4 = \frac{5}{9} R_H$$

So wavenumber is $\frac{5}{9} R_H$

option (c) is correct

23. **Solution: (A)**

For Eigen function

$$\hat{A}\psi = a\psi \quad a = \text{Eigen value} \quad \psi = e^{ikx} \quad \hat{A} = \text{operator}$$

here operator is $\hat{p}x = -i\hbar \frac{d}{dx}$

for option (a) $\psi = e^{ikx}$

$$\hat{A}\psi = -i\hbar \frac{d}{dx} e^{ikx} = -i\hbar(ik)e^{ikx} = \hbar k e^{ikx}$$

$\hbar k$ both is a constant value comes out to be so it is a eigen function and eigen value is $\hbar k$

So option (a) is correct

24. **Solution: (D)**

The angular momentum of an electron is given by:-

$$= \sqrt{l(l+1)}\hbar$$

l = Azimuthal quantum number (for S = 0, p = 1, d = 2, f = 3)

$$\hbar = \frac{h}{2\pi}$$

for 4d orbital $l=2$

$$\text{Angular momentum} = \sqrt{l(l+1)}\hbar = \frac{\sqrt{2(2+1)}h}{2\pi} = \frac{\sqrt{6}h}{2\pi}$$

Option (d) is correct

25. **Solution: (C)**

$$\langle x \rangle = \int_{-\infty}^{\infty} \psi^* \hat{x} \psi d\tau$$

$$\langle r \rangle$$

$$= \int_{-\infty}^{\infty} \frac{1}{\sqrt{\pi}} \left(\frac{1}{a_o^{3/2}} \right) e^{-r/a_o} \cdot r \cdot \frac{1}{\sqrt{\pi}} \left(\frac{1}{a_o^{3/2}} \right) e^{-r/a_o} d\tau$$

in case of hydrogen atom $\psi =$

$$\frac{1}{\sqrt{\pi}} \left(\frac{1}{a_o^{3/2}} \right) e^{-r/a_o} \quad \text{and } d\tau = r^2 dr \sin\theta d\theta d\phi$$

$$\begin{aligned} \langle r \rangle &= \frac{1}{\pi a_o^3} \int_0^{\infty} r^3 e^{-2r/a_o} dr \int_0^{\pi} \sin\theta d\theta \int_0^{2\pi} d\phi \\ &= \frac{1}{\pi a_o^3} \left(\frac{3!}{(2/a_o)^{3+1}} \right) [-\cos\theta]_0^{\pi} [2\pi] = \frac{4\pi}{\pi a_o^3} \times \frac{3 \times 2 \times 1 a_o^4}{2^4} = 1.5 a_o \end{aligned}$$

So average radius is $1.5 a_o$

OR

Direct formula to find out average radius

$$\text{Average radius} = \frac{a_o}{2} [3n^2 - l(l+1)]$$

So for 1s orbital l is 0 and $n=1$ if we put it we get average radius is $1.5 a_o$

option (c) is correct

26. **Solution: (A)**

$$\text{Number of Radial nodes} = n - l - 1$$

n = principle quantum number

l = Azimuthal quantum number

for 4f orbital $n=4$ and $l=3$

$$\text{Number of Radial nodes} = n - l - 1 = 4 - 3 - 1 = 0$$

So radial nodes is zero

option (a) is correct

27. **Solution: (B)**

Variational principle: -

* Hit and trial method

* Used for large deviations

* Average energy is calculated

According to variational principle:- The calculated average energy is always greater than exact/true energy.

Option (b) is correct

28. **Solution: (A)**

According to MO theory the ground state wave function including spin of H_2 molecule is represented

as:

$$\frac{1}{\sqrt{2}} \begin{vmatrix} \sigma_g 1s(1)\alpha(1) & \sigma_g 1s(1)\beta(1) \\ \sigma_g 1s(2)\alpha(2) & \sigma_g 1s(2)\beta(2) \end{vmatrix}$$

option (a) is correct

29. **Solution: (C)**

The angle between two hybrid orbital is:

$$\cos\theta = \frac{\psi_1 \cdot \psi_2}{|\psi_1| |\psi_2|}$$

$\psi_1 \cdot \psi_2$ = dot product of wave function

$$|\psi| = \sqrt{a^2 + b^2 + c^2}$$

a, b and c are coefficient (coefficient of S - orbital does not participate

$$\psi_1 = \frac{1}{\sqrt{3}} 2s - \frac{1}{\sqrt{6}} 2p_x + \frac{1}{\sqrt{2}} 2p_y$$

$$\psi_2 = \frac{1}{\sqrt{3}} 2s - \frac{1}{\sqrt{6}} 2p_x - \frac{1}{\sqrt{2}} 2p_y$$

$$\begin{aligned} \cos\theta &= \frac{\left(\frac{1}{\sqrt{6}} 2p_x + \frac{1}{\sqrt{2}} 2p_y \right) \left(-\frac{1}{\sqrt{6}} 2p_x - \frac{1}{\sqrt{2}} 2p_y \right)}{\sqrt{\left(\frac{1}{6} \right) + \left(\frac{1}{2} \right)} \times \sqrt{\left(\frac{1}{6} \right) + \left(\frac{1}{2} \right)}} \\ &= \frac{\frac{1}{6} - \frac{1}{2}}{0.66} = -0.5 \end{aligned}$$

$$\theta = \cos^{-1} 0.5 = 120^\circ$$

So angle is 120°

option (c) is correct

30. **Solution: (B)**

Condition for linear operator is: -

$$f(x+y) = f(x) + f(y)$$

$$\sqrt{x+y} \neq \sqrt{x} + \sqrt{y}$$

so square root is not a linear operator

Option (b) is correct

31. **Solution: (A)**

$$\text{probability of finding electron} = \int_0^{a/2} \psi^* \psi dx$$

$$\Delta H = \lambda x \quad \psi = \sqrt{\frac{2}{l}} \sin\left(\frac{n\pi x}{l}\right)$$

$$= \int_0^{a/2} \sqrt{\frac{2}{l}} \sin\left(\frac{n\pi x}{l}\right) \sqrt{\frac{2}{l}} \sin\left(\frac{n\pi x}{l}\right) dx$$

$$= \int_0^{a/2} \frac{2}{l} \sin^2\left(\frac{n\pi x}{l}\right) dx$$

$$= \frac{2}{l} \int_0^{a/2} \sin^2\left(\frac{n\pi x}{l}\right) dx$$

$$\text{probability} = \frac{2}{l} \int_0^{a/2} \frac{(1 - \cos(\frac{2n\pi x}{l}))}{2} dx$$

on solving integration

$$\text{Probability} = \frac{1}{a} \times \frac{a}{2} = \frac{1}{2}$$

So probability is 0.5

option (a) is correct

32. **Solution: (D)**

The angular momentum of an electron is given by:-

$$= \sqrt{l(l+1)}\hbar$$

l = Azimuthal quantum number (for $s=0$, $p=1$, $d=2$, $f=3$)

$$\hbar = \frac{h}{2\pi}$$

for f orbital $l=3$

$$\begin{aligned} \text{Angular momentum} &= \sqrt{l(l+1)}\hbar = \frac{\sqrt{3(3+1)}h}{2\pi} \\ &= \frac{\sqrt{12}h}{2\pi} \end{aligned}$$

option(d) is correct

33. **Solution: (C)**

According to Born-Oppenheimer approximation

Nucleus to nucleus relative motion may be neglected

option (c) is correct

34. **Solution: (B)**

For hydrogen molecule in the excited state $\sigma_g^1\sigma_u^1$, the spin part of the triplet state with $m_s = 0$ is proportional to $\alpha(1)\beta(2) + \beta(1)\alpha(2)$

Option (b) is correct

35. **Solution: (D)**

For term symbol valence electron and orbital in which electron is present

here it is $3\sigma_g^1$ for σ $L=0$ so term symbol is Σ

value of $2S+1 = 2$ (because it contains only one electron)

also it contains (+ sign)

it is $3\sigma_g$ so grade also comes term symbol is $^2\Sigma_g^+$

option (d) is correct

36. **Solution: (B)**

Energy levels for butadiene

$$\alpha - 1.62\beta$$

$$\alpha - 0.62\beta$$

$$\alpha + 0.62\beta$$

$$\alpha + 1.62\beta$$

Delocalisation energy $= E_{total} - \text{ethylene unit energy}$

$$\begin{aligned} E_{total} &= 2 \times (\alpha + 1.62\beta) + 2 \times (\alpha + 0.62\beta) \\ &= 4\alpha + 4.48\beta \end{aligned}$$

Here 2 ethylene unit is present so energy of 2 ethylene unit is $= 2 \times (2\alpha + 2\beta) = 4\alpha + 4\beta$

Delocalisation energy $= E_{total} -$

$$\text{ethylene unit energy} = 4\alpha + 4.48\beta - 4\alpha + 4\beta = 0.48\beta$$

Delocalisation energy $= 0.48\beta$

option (b) is correct

37. **Solution: (D)**

For a well behaved function it should follow boundary condition.

At boundary probability of finding the electron will approx. zero.

(A) $y = \exp(ax^2)$ ∞ at boundary if $x = \infty$

(B) $y = ax + b$ ∞ at boundary if $x = \infty$

(C) $y = ax^2$ ∞ at boundary if $x = \infty$

(D) $y = \exp(-ax^2)$ zero at boundary if $x = \infty$

It is a well behaved function

option (d) is correct

38. **Solution: (B)**

The time independent Schrodinger equation is

$$\frac{i\hbar d\psi_{x,t}}{dt} = \left[-\frac{\hbar^2}{2m} \nabla^2 + V_{x,t} \right]$$

$$\frac{i\hbar d\psi_{x,t}}{dt} = \left[-\frac{\hbar^2}{2m} \frac{d^2\psi}{dx^2} + V_{x,t}\psi_{x,t} \right]$$

$$\frac{i\hbar d\psi_{x,t}}{dt} = \left[-\frac{\hbar^2}{2m} \frac{d^2}{dx^2} + V_{x,t} \right] \psi_{x,t}$$

$$\left[-\frac{\hbar^2}{2m} \frac{d^2}{dx^2} + V_{x,t} \right] = \hat{H}$$

$$\frac{i\hbar d\psi_{x,t}}{dt} = \hat{H}\psi_{x,t}$$

Option (b) is correct

39. **Solution: (A)**

$$\text{Energy for 3d box} = \frac{(n_x^2 + n_y^2 + n_z^2) h^2}{8ma^2} \quad a = L$$

$$\text{Given energy is } \frac{3h^2}{8mL^2}$$

if we compare both $(n_x^2 + n_y^2 + n_z^2) = 3$

n_x, n_y, n_z can't be zero

so $n_x, n_y, n_z = 1$ for ground state

for first excited state n_x, n_y, n_z any can equal to 2.

Three degeneracy

$$\text{energy of first excited state is } \frac{(n_x^2 + n_y^2 + n_z^2) h^2}{8ma^2} =$$

$$\frac{(1^2 + 1^2 + 2^2) h^2}{8ma^2} = \frac{6h^2}{8mL^2}$$

$$\Delta E = \frac{6h^2}{8mL^2} - \frac{3h^2}{8mL^2} = \frac{3h^2}{8mL^2}$$

Energy required for the excitation of the particle into

the next higher energy level is $\frac{3h^2}{8mL^2}$

Option (a) is correct

40. **Solution: (C)**

Number of Radial nodes = $n - l - 1$

Angular nodes = l

For 4f orbital $n=4, l=3$

So angular nodes = $l=3$

Radial nodes = $4 - 3 - 1 = 0$

So 0 radial nodes and 3 angular nodes

Option (c) is correct

41. **Solution: (A)**

For Eigen function

$\hat{A}\psi = a\psi$ a = Eigen value $\psi = e^{ikx}$ $\hat{A}$ = operator

here operator is $\hat{p}x = -i\hbar \frac{d}{dx}$

for option (a) $\psi = e^{ikx}$

$\hat{A}\psi = -i\hbar \frac{d}{dx} e^{ikx} = -i\hbar(ik)e^{ikx} = \hbar k e^{ikx}$

$\hbar k$ both is a constant value comes out to be so it is a eigen function and eigen value is $\hbar k$

So option (a) is correct

42. **Solution: (C)**

Energy for 3d box = $\frac{(n_x^2 + n_y^2 + n_z^2) \hbar^2}{8ma^2}$

Given energy is $\frac{14 \hbar^2}{8mL^2}$

if we compare both $(n_x^2 + n_y^2 + n_z^2) = 14$

possible n_x, n_y, n_z values is (3,2,1), (3,1,2), (1,2,3), (1,3,2), (2,3,1), (2,1,3) all will give equal value of energy so degeneracy is 6.

So option (c) is correct

43. **Solution: (C)**

Variational principle: -

* Hit and trial method

* Used for large deviations

* Average energy is calculated

According to variational principle: - The calculated average energy is always greater than exact/true energy. So $E \geq E_0$. E_0 is true energy

Option (c) is correct

44. **Solution: (D)**

first Hermite polynomial – 1

Second Hermite polynomial- 2ξ

third Hermite polynomial - $4\xi^2 - 2$

option (d) is correct

45. **Solution:**

Energy levels for benzene molecule

$\alpha - 2\beta$
 $\alpha - \beta$
 $\alpha + \beta$

$\uparrow\downarrow$ $\alpha + 2\beta$

Delocalisation Energy

$$= 2 \times (\alpha + 2\beta) + 4 \times (\alpha + \beta) - 3 \times (2\alpha + 2\beta) \\ = 6\alpha + 8\beta - 6\alpha - 6\beta = 2\beta$$

Delocalisation Energy = 2β

option (b) is correct

46. **Solution: (B)**

For 1D box Energy = $\frac{n^2 \hbar^2}{8ma^2}$

for first energy level $n=1$ (Ground state)

$$E_1 = \frac{\hbar^2}{8ma^2} = 0.6032 \times 10^{-17} \text{ J (Given)}$$

for second energy level $n=2$ (first excited state)

$$E_2 = \frac{4\hbar^2}{8ma^2}$$

$$\text{Energy gap} = \Delta E = \frac{4\hbar^2}{8ma^2} - \frac{\hbar^2}{8ma^2} = \frac{3\hbar^2}{8ma^2}$$

Energy gap is the three times of the Ground state energy = $3 \times G.S.E = 3 \times 0.6032 \times 10^{-17} \text{ J}$

$$\Delta E = 1.8096 \times 10^{-17} \text{ J}$$

option (b) is correct

47. **Solution: (B)**

$$[\hat{L}_x, \hat{L}_y] = i\hbar \hat{L}_z$$

$$[\hat{L}_y, \hat{L}_z] = i\hbar \hat{L}_x$$

$$[\hat{L}_z, \hat{L}_x] = -i\hbar \hat{L}_y$$

$$[\hat{L}_y, \hat{L}_x] = -i\hbar \hat{L}_z$$

Option (B) is correct

48. **Solution: (B)**

Spherical harmonics: -

$$Y_{l,m}(\theta, \phi) = \sqrt{\frac{2l+1}{4\pi} \frac{(l-m)!}{(l+m)!}} \cos\theta \cdot \cos(m\phi)$$

$Y_{1,0}(\theta, \phi)$ here in this function $l=1$ and m is 0

Put values of l and m in spherical harmonics

$$Y_{1,0}(\theta, \phi)$$

$$= \sqrt{\frac{2 \times 1 + 1}{4\pi} \frac{(1+0)!}{(1+0)!}} \cos\theta \cdot \cos(0 \cdot \phi)$$

$$\cos 0^\circ = 1$$

$$Y_{1,0}(\theta, \phi) = \sqrt{\frac{3}{4\pi}} \cos\theta$$

Option (b) is correct

49. **Solution: (A)**

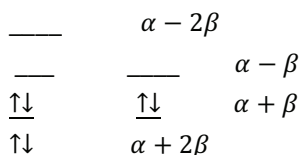
The Huckel theory secular determinant equation for cyclobutadiene is:-

$$\begin{vmatrix} x & 1 & 0 & 1 \\ 1 & x & 1 & 0 \\ 0 & 1 & x & 1 \\ 1 & 0 & 1 & x \end{vmatrix} = 0$$

Option (a) is correct

50. **Solution: (B)**

Energy levels for benzene molecule



Delocalisation Energy

$$\begin{aligned}
 &= 2 \times (\alpha + 2\beta) + 4 \times (\alpha + \beta) - 3 \times (2\alpha + 2\beta) \\
 &= 6\alpha + 8\beta - 6\alpha - 6\beta = 2\beta
 \end{aligned}$$

Delocalisation Energy = 2β

option (b) is correct

51. **Solution: (A)**

According to uncertainty principle: $\Delta x \cdot \Delta p \geq \frac{h}{2}$

Δx = change in position

$\Delta p = m\Delta v$ = change in momentum (mass in kg)

Here $\Delta p = \Delta x$ (Given)

$$\text{So } \Delta p^2 = \frac{h}{4\pi}$$

$$m \cdot \Delta v \cdot m \cdot \Delta v = \frac{h}{4\pi}$$

$$m^2 \Delta v^2 = \frac{h}{4\pi}$$

$$\Delta v^2 = \frac{h}{m^2 4\pi}$$

$$\Delta v = \sqrt{\frac{h}{m^2 4\pi}} = \frac{1}{2m} \sqrt{\frac{h}{\pi}} = \frac{1}{2m} \left(\frac{h}{\pi}\right)^{1/2}$$

Option (a) is correct

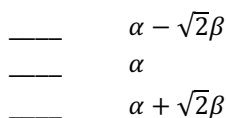
52. **Solution: (C)**

If two operators commute and consequently have the same set of eigen functions, then the corresponding physical quantities can be evaluated or. Measured exactly simultaneously with no limit on the uncertainty. So if two operators commute, then they have the same Eigen functions.

Option (c) is correct

53. **Solution: (D)**

Energy levels for Allylic radical



so energy levels correct order is $\alpha + \sqrt{2}\beta, \alpha, \alpha - \sqrt{2}\beta$

option (d) is correct

54. **Solution: (C)**

Hence, option (c) is correct.

55. **Solution: (A)**

The quantity $h m_e c$ is known as the Compton wavelength of the electron; it is equal to $2.43 \times 10^{-12} m$

The wavelength shift $\lambda' - \lambda$ is at least zero for $\theta = 0$ and at most twice the Compton wavelength of the electron for $\theta = 180^\circ$ $\Delta \lambda$ at corresponding to the scattering angle θ equal to 90°
option (a) is correct

K SET

56. **Solution: (C)**

The square of the wave function in quantum mechanics represents the Probability density of finding the particle around a specific location in space.

Option (c) is correct

57. **Solution: (C)**

$$\text{Energy for 1-D box} = \frac{n^2 h^2}{8ma^2}$$

for zero-point energy put $n = 1$

Zero-point energy of an electron is equal to

$$= \frac{1^2 h^2}{8ma^2} = \frac{h^2}{8ma^2}$$

option (c) is correct

58. **Solution: (A)**

Condition for well behaved (Acceptable) wave function: -

- * φ must be finite
- * φ must be single valued
- * φ must be continuous
- * Square integrable

Option (a) follow these conditions

Option (a) is correct

59. **Solution: (C)**

The square of the wave function in quantum mechanics represents the Probability density of finding the particle around a specific location in space.

Option (c) is correct

60. **Solution: (A)**

$$\nabla^2 \Psi + \frac{8\pi^2 m(E-V)}{h^2} \Psi = 0$$

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$$

∇^2 is Laplacian operator

option (a) is correct

61. **Solution: (C)**

Hamiltonian operator (H) in $H\Psi = E\Psi$

E here is Energy the sum of potential energy and kinetic energy

So Hamiltonian operator (H) in $H\Psi = E\Psi$ is the operator for the total energy of the system

option (c) is correct

62. **Solution: (A)**

Violet
Blue
Green
Yellow
Orange
Red

↓
Going from up to down side
wavelength increases

So here wavelength of Red will be maximum and wavelength of violet will lowest i.e (ii)-(d) and (iv)-(a)

option (a) is correct

63. **Solution: (A)**

$$\langle x \rangle = \sum x \times p(x)$$

$$\text{so } \langle x \rangle = \sum x \times p(x) = 1 \times 0.20 + 3 \times 0.25 + 4 \times 0.55$$

$$= 0.20 + 0.75 + 2.2 = 3.15$$

$$\langle x \rangle = 3.15$$

Option (a) is correct

64. **Solution: (A)**

Condition for linear operator is:-

$$f(x+y) = f(x) + f(y)$$

$$\sqrt{x+y} \neq \sqrt{x} + \sqrt{y} \text{ So } \sqrt{} \text{ is not a linear operator}$$

$$(x+y)^2 \neq x^2 + y^2 \text{ so } x^2 \text{ is not a linear operator}$$

$$\frac{d}{dx}(x+y) = \frac{d}{dx}x + \frac{d}{dx}y \text{ So } \frac{d}{dx} \text{ is a linear operator}$$

$$\frac{d^2}{dx^2}(x+y) = \frac{d^2}{dx^2}x + \frac{d^2}{dx^2}y$$

$$\text{So } \frac{d^2}{dx^2} \text{ is a linear operator}$$

So only $\frac{d}{dx}$ and $\frac{d^2}{dx^2}$ is a linear operator

option (a) is correct

65. **Solution: (B)**

Shape is given by angular node or angular wave function, Radial wave function gives energy So Radial and angular wave function gives Energy, size and shape, orientation of the orbitals respectively

option (b) is correct

66. **Solution: (D)**

Energy for a Particle for 1 dimensional box is $E_n = \frac{n^2 h^2}{8ma^2}$

So According to the Schrodinger's wave equation the energy of a particle (E_n) in 1 – D box = $\frac{n^2 h^2}{8ma^2}$

option (d) is correct

67. **Solution: (A)**

Perturbation theory is a method for continuously improving a previously obtained approximate solution

to a problem, as it is an important and general method for finding approximate solutions to the Schrodinger equation.

option (a) is correct

68. **Solution: (C)**

S-Orbital are spherical So S-Orbitals are spherically symmetric

A harmonic oscillator obeys Hooke's law

Spin quantum number, S, for an electron $S = \frac{1}{2}$

An azeotrope is a mixture that boils without change of composition

Spin quantum number is incorrect here

Option (c) is correct

69. **Solution: (D)**

Particles with spins that come in half-integer multiple

(e.g., $\pm \frac{1}{2}, \pm \frac{3}{2}, \pm \frac{5}{2}$ etc are known as Fermions

Example: - Proton, Neutron and electron

Deuteron nucleus has Ground state has spin = 1

thus it is a boson not Fermion

So i, ii and iii are fermions

Option (d) is correct

70. **Solution: (A)**

A Function is called an even function if its graph is unchanged under reflection in its y-axis. Suppose $f(x)$ is a function such that it is said to be an even function if $f(-x)$ is equal to $f(x)$

ex- $f(x) = x^2$ even function

$f(-x) = (-x)^2 = x^2$ so it is a even function

$f(-x) = -f(x)$ is a odd function

$f(x) = x^3$ odd function

$f(-x) = (-x)^3 = -x^3$ so it is a odd function

property of odd function

* Product of two even functions will be an even function

* Product of two odd functions will be an even function

So statement I, ii and iii is correct

Option (a) is correct

71. **Solution: (B)**

According to de-Broglie hypothesis

$$\lambda = \frac{h}{mv} = \frac{h}{p}$$

$$p = \frac{h}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ Js})}{350 \times 10^{-9} \text{ m}} = \frac{6.626 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-2} \cdot \text{s}^{-1}}{350 \times 10^{-9} \text{ m}} =$$

$$0.0189 \times 10^{-25} \text{ kg m s}^{-1}$$

$$\text{linear momentum} = 1.89 \times 10^{-27} \text{ kg m s}^{-1}$$

Option (b) is correct