p Block Elements (Group 15, 16, 17 & 18)

Set -1

Table 7.1: Atomic and Physical Properties of Group 15 Elements

Property		N	P	As	Sb	Bi
Atomic number		7	15	33	51	83
Atomic mass/g mol^{-1}		14.01	30.97	74.92	121.75	208.98
Electronic configuration		$[He]2s^2 2p^3$	$[Ne]3s^2 3p^3$	$[Ar]3d^{10} 4s^2 4p^3$	$[Kr]4d^{10} 5s^2 5p^3$	$[Xe]4f^{14} 5d^{10} 6s^2 6p^3$
Ionisation enthalpy ($\Delta_i H$/(kJ mol^{-1})	I	1402	1012	947	834	703
	II	2856	1903	1798	1595	1610
	III	4577	2910	2736	2443	2466
Electronegativity		3.0	2.1	2.0	1.9	1.9
Covalent radius/pm[a]		70	110	121	141	148
Ionic radius/pm		171[b]	212[b]	222[b]	76[c]	103[c]
Melting point/K		63*	317[d]	1089[e]	904	544
Boiling point/K		77.2*	554[d]	888[f]	1860	1837
Density/[g cm^{-3}(298 K)]		0.879[g]	1.823	5.778[h]	6.697	9.808

Q1. Which of the following is the correct first ionisation enthalpy order of group 15 elements?

A. Bi
B. Sb
C. Sb
D. N

Ans. (A)

Q2. Which of the following is the correct Second ionisation enthalpy order of group 15 elements?

A. Sb
B. Sb
C. Sb
D. N

Ans. (C)

Q3. Which of the following is the correct Third ionisation enthalpy order of group 15 elements?

A. Sb
B. N
C. Sb
D. Sb

Ans. (D)

Q4. Which of the following is the correct Melting point order of group 15 elements?

A. N
B. N
C. Sb
D. Sb

Ans. (A)

Q5. Which of the following is the correct Boiling point order of group 15 elements?

A. N
B. N
C. Sb
D. Bi

Ans. (B)

Q6. Which of the following is the correct Density order of group 15 elements?

A. N
B. Bi
C. Sb
D. N

Ans. (D)

Set – 2

Table 7.2: Properties of Hydrides of Group 15 Elements

Property	NH_3	PH_3	AsH_3	SbH_3	BiH_3
Melting point/K	195.2	139.5	156.7	185	–
Boiling point/K	238.5	185.5	210.6	254.6	290
(E–H) Distance/pm	101.7	141.9	151.9	170.7	–
HEH angle (°)	107.8	93.6	91.8	91.3	–
$\Delta_f H^{\ominus}$/kJ mol^{-1}	–46.1	13.4	66.4	145.1	278
$\Delta_{diss}H^{\ominus}$(E–H)/kJ mol^{-1}	389	322	297	255	–

Q1. Which of the following is the correct order of melting point of group 15 hydrides?

A. $NH_3$333
B. $PH_3$333
C. $NH_3$333
D. $SbH_3$333

Ans. (B)

Q2. Which of the following is the correct order of boiling point of group 15 hydrides?

A. $PH_3$333
B. $NH_3$333
C. $SbH_3$333
D. $NH_3$333

Ans. (A)

Q3. Which of the following is the correct order of E-H distance (E= N,P,As,Sb)of group 15 hydrides?

A. $NH_3$333
B. $SbH_3$333

C. $NH_3$333

D. $PH_3$333

Ans. (C)

Q4. Which of the following is the correct order of HEH angle (where E= N,P,As,Sb) of group 15 hydrides?

A. $NH_3$333

B. $PH_3$333

C. $NH_3$333

D. $SbH_3$333

Ans. (D)

Q5. Which of the following is the correct order of enthalpy of formation of group 15 hydrides?

A. $NH_3$333

B. $PH_3$333

C. $NH_3$333

D. $SbH_3$333

Ans. (A)

Q6. Which of the following is correct about the E-H bond dissociation enthalpy of group 15 elements?

A. $NH_3$333

B. $NH_3$333

C. $SbH_3$333

D. $AsH_3$333

Ans. (C)

Set – 3

Table 7.3: Oxides of Nitrogen

Name	Formula	Oxidation state of nitrogen	Common methods of preparation	Physical appearance and chemical nature
Dinitrogen oxide [Nitrogen(I) oxide]	N_2O	+ 1	$NH_4NO_3 \xrightarrow{\text{Heat}} N_2O + 2H_2O$	colourless gas, neutral
Nitrogen monoxide [Nitrogen(II) oxide]	NO	+ 2	$2NaNO_2 + 2FeSO_4 + 3H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2NaHSO_4 + 2H_2O + 2NO$	colourless gas, neutral

Q1. Which of the following is colourless neutral gas?

A. N_2O
B. N_2O_3
C. N_2O_5
D. NO_2

Ans. (A)

Q2. Which of the following is a brown gas formed during strong heating of Pb(NO3)2?

A. N_2O
B. NO_2
C. NO
D. N_2O_3

Ans. (B)

Q3. Which of the following is the blue acidic solid?

A. NO
B. N_2O_4
C. N_2O_5
D. N_2O_3

Ans. (D)

Q4. What is the oxidation state of N in N2O4?

A. +1
B. +3
C. +5
D. +4

Ans. (D)

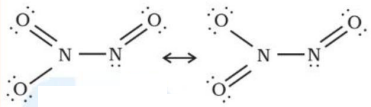
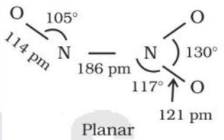
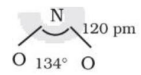
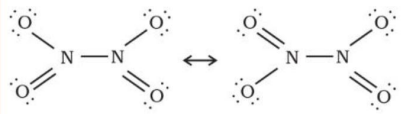
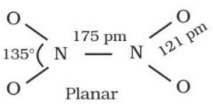
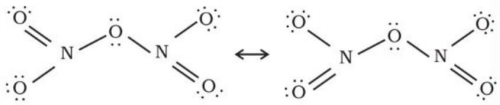
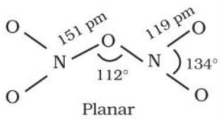
Q5. Which of the following oxide formed during the reaction of HNO3with P4O10?

A. N_2O_5
B. N_2O_3
C. NO
D. N_2O

Ans. (A)

Set – 4

Table 7.4: Structures of Oxides of Nitrogen

Formula	Resonance Structures	Bond Parameters
N_2O	$\ddot{N}=N=\ddot{O} \longleftrightarrow :N\equiv N-\ddot{O}:$	N — N — O 113 pm 119 pm Linear
NO	$:N=\ddot{O}: \longleftrightarrow :\dot{N}=\ddot{O}:$	N — O 115 pm
N_2O_3		 105° 114 pm 186 pm 130° 117° 121 pm Planar
NO_2		 120 pm 134° Angular
N_2O_4		 175 pm 135° 121 pm Planar
N_2O_5		 151 pm 119 pm 112° 134° Planar

Q1. Which of the following is not a planar oxide?

A. N_2O_4
B. N_2O_5
C. NO_2
D. N_2O_3

Ans. (C)

Q2. Which of the following oxides has the smallest N–O bond length?

A. N_2O_4
B. NO_2
C. NO
D. N_2O

Ans. (C)

Q3. Which of the following oxides has the largest N–N bond length?

A. N_2O
B. N_2O_5
C. N_2O_4
D. N_2O_3

Ans. (D)

Q5. Which of the following oxides contains N–O–N bonds?

A. N_2O_5
B. N_2O_4
C. NO
D. N_2O

Ans. (A)

Q6. Which of the following oxides contains only one N–O single bond?

A. N_2O_4
B. NO
C. N_2O_3
D. N_2O_5

Ans. (C)

Set – 5

Table 7.5: Oxoacids of Phosphorus

Name	Formula	Oxidation state of phosphorus	Characteristic bonds and their number	Preparation
Hypophosphorous (Phosphinic)	H_3PO_2	+1	One P – OH Two P – H One P = O	white P_4 + alkali
Orthophosphorous (Phosphonic)	H_3PO_3	+3	Two P – OH One P – H One P = O	$P_2O_3 + H_2O$
Pyrophosphorous	$H_4P_2O_5$	+3	Four P – OH One P – O – P	$PCl_3 + H_3PO_3$
Hypophosphoric	$H_4P_2O_6$	+4	Four P – OH Two P = O One P – P	red P_4 + alkali
Orthophosphoric	H_3PO_4	+5	Three P – OH One P = O	$P_4O_{10}+H_2O$
Pyrophosphoric	$H_4P_2O_7$	+5	Four P – OH Two P = O One P – O – P	heat phosphoric acid
Metaphosphoric*	$(HPO_3)_n$	+5	Three P – OH Three P = O Three P – O – P	phosphorus acid + Br_2, heat in a sealed tube

Q1. Which of the following is phosphinic acid?

A. H_3PO_3
B. H_3PO_4
C. H_3PO_2
D. $H_4P_2O_5$

Ans. (C)

2. Which of the following is phosphonic acid?

A. $H_4P_2O_7$
B. $H_4P_2O_6$
C. H_3PO_4
D. H_3PO_3

Ans. (D)

Q3. Which of the following oxoacids of phosphorus has oxidation no. +4?

A. Hypophosphorous acid
B. Pyrophosphorous acid
C. Hypophosphoric acid
D. Pyrophosphoric acid

Ans. (C)

Q4. Which of the following doesn't have P–O–P bonds?

A. $(HPO_3)_n$
B. $H_4P_2O_7$
C. $H_4P_2O_5$
D. $H_4P_2O_6$

Ans. (D)

Q5. Which of the following is formed by heating phosphoric acid?

A. $H_4P_2O_7$
B. $H_4P_2O_5$
C. H_3PO_3
D. $H_4P_2O_6$

Ans. (A)

Q6. Which of the following oxoacids of phosphorus doesn't have oxidation no. +5?

A. $(HPO_3)_n$
B. $H_4P_2O_6$
C. $H_4P_2O_7$
D. H_3PO_4

Ans. (B)

Set – 6

Table 7.6: Some Physical Properties of Group 16 Elements

Property	O	S	Se	Te	Po
Atomic number	8	16	34	52	84
Atomic mass/g mol^{-1}	16.00	32.06	78.96	127.60	210.00
Electronic configuration	$[He]2s^2 2p^4$	$[Ne]3s^2 3p^4$	$[Ar]3d^{10} 4s^2 4p^4$	$[Kr]4d^{10} 5s^2 5p^4$	$[Xe]4f^{14} 5d^{10} 6s^2 6p^4$
Covalent radius/(pm)[a]	66	104	117	137	146
Ionic radius, E^{2-}/pm	140	184	198	221	230[b]
Electron gain enthalpy /$\Delta_{eg}H$ kJ mol^{-1}	–141	–200	–195	–190	–174
Ionisation enthalpy ($\Delta_i H_1$) /kJ mol^{-1}	1314	1000	941	869	813
Electronegativity	3.50	2.58	2.55	2.01	1.76
Density /g cm^{-3} (298 K)	1.32[c]	2.06[d]	4.19[e]	6.25	–
Melting point/K	55	393[f]	490	725	520
Boiling point/K	90	718	958	1260	1235
Oxidation states*	–2,–1,1,2	–2,2,4,6	–2,2,4,6	–2,2,4,6	2,4

Q1. Which of the following is the correct covalent radii order of Group 16 elements?

A. O
B. S
C. O
D. O

Ans. (A)

Q2. Which of the following is the correct electron gain enthalpy order of Group 16 elements?

A. O
B. S
C. S
D.S

Ans. (B)

Q3. Which of the following is the correct ionisation enthalpy order of Group 16 elements?

A. Po
B. Po
C. O
D. S

Ans. (A)

Q4. Which of the following is the correct electronegativity order of Group 16 elements?

A. Po
B. O
C. S
D. S

Ans. (A)

Q5. Which of the following is the correct melting point order of Group 16 elements?

A. S
B. Te
C. O
D. S

Ans. (C)

Q6. Which of the following is the correct boiling point order of Group 16 elements?

A. S
B. O
C. O
D. O

Ans. (B)

Q7. Which of the following does not show negative oxidation states?

A. S
B. Se
C. Te
D. Po

Ans. (D)

Set – 7

Table 7.7: Properties of Hydrides of Group 16 Elements

Property	H_2O	H_2S	H_2Se	H_2Te
m.p/K	273	188	208	222
b.p/K	373	213	232	269
H–E distance/pm	96	134	146	169
HEH angle (°)	104	92	91	90
$\Delta_f H$/kJ mol^{-1}	–286	–20	73	100
$\Delta_{diss} H$ (H–E)/kJ mol^{-1}	463	347	276	238
Dissociation constant[a]	1.8×10^{-16}	1.3×10^{-7}	1.3×10^{-4}	2.3×10^{-3}

Q1. Which of the following is the correct melting point order of group 16 hydrides?

A. $H_2O2S2Se2Te$
B. $H_2S2e2Te2O$
C. $H_2Se2Te2O2S$
D. $H_2S2Te2Se2O$

Ans. (B)

Q2. Which of the following is the correct boiling point order of group 16 hydrides?

A. $H_2S2Te2Se2O$
B. $H_2O2S2Se2Te$
C. $H_2S2Te2Se2O$
D. $H_2Se2Te2O2S$

Ans. (A)

Q3. Which of the following is the correct HEH angle order of group 16 hydrides?

A. $H_2O2S2Se2Te$
B. $H_2S2Te2Se2O$
C. $H_2O2SeTe2S$
D. $H_2Te2Se2S2O$

Ans. (D)

Q4. Which of the following is the correct enthalpy of formation order of group 16 hydrides?

A. $H_2O2Se2Te2s$
B. $H_2O2S2Te2Se$
C. $H_2O2S2Se2Te$
D. $H_2S2Se2Te2O$

Ans. (C)

Q5. Which of the following is the correct Hâ€“E bond dissociation enthalpy order of group 16 hydrides?

A. $H_2Te2Se2S2O$
B. $H_2S2Te2Se2O$
C. $H_2Te2Se2S2O$
D. $H_2O2S2Se2Te$

Ans. (C)

Q6. Which of the following has the highest dissociation constant?

A. H_2Se
B. H_2S
C. H_2Te
D. H_2O

Ans. (C)

Set – 8

Table 7.8: Atomic and Physical Properties of Halogens

Property	F	Cl	Br	I	At[a]
Atomic number	9	17	35	53	85
Atomic mass/g mol^{-1}	19.00	35.45	79.90	126.90	210
Electronic configuration	$[He]2s^2 2p^5$	$[Ne]3s^2 3p^5$	$[Ar]3d^{10} 4s^2 4p^5$	$[Kr]4d^{10} 5s^2 5p^5$	$[Xe]4f^{14} 5d^{10} 6s^2 6p^5$
Covalent radius/pm	64	99	114	133	–
Ionic radius X^-/pm	133	184	196	220	–
Ionisation enthalpy/kJ mol^{-1}	1680	1256	1142	1008	–
Electron gain enthalpy/kJ mol^{-1}	–333	–349	–325	–296	–
Electronegativity[b]	4	3.2	3.0	2.7	2.2
$\Delta_{Hyd}H(X^-)$/kJ mol^{-1}	515	381	347	305	–
	F_2	Cl_2	Br_2	I_2	–
Melting point/K	54.4	172.0	265.8	386.6	–
Boiling point/K	84.9	239.0	332.5	458.2	–
Density/g cm^{-3}	1.5 (85)[c]	1.66 (203)[c]	3.19(273)[c]	4.94(293)[d]	–
Distance X – X/pm	143	199	228	266	–
Bond dissociation enthalpy /(kJ mol^{-1})	158.8	242.6	192.8	151.1	–
$E^\ominus/V^e$	2.87	1.36	1.09	0.54	–

Q1. Which of the following is the correct order of ionic radii of halogens?

A. F

B. Br

C. I

D. I

Ans. (A)

Q2. Which of the following is the correct order of ionisation enthalpy of halogens?

A. Br

B. F

C. I

D. I

Ans. (C)

Q3. Which of the following is the correct order of electron gain enthalpy of halogens?

A. F
B. Cl
C. Cl
D. F

Ans. (B)

Q4. Which of the following is the correct order of hydration enthalpy of halides?

A. Cl^{-}---
B. I^{-}----
C. F^{-}----
D. Cl^{-}----

Ans. (B)

Q5. Which of the following is the correct order of Melting points of halogens molecules?

A. $F_2$222
B. $Cl_2$222
C. $F_2$222
D. $I_2$222

Ans. (A)

Q6. Which of the following is the correct order of boiling points of halogens molecules?

A. $I_2$222
B. $F_2$222
C. $Cl_2$222
D. $F_2$222

Ans. (D)

Q7. Which of the following is the correct order of X–X bond distance of halogens molecules?

A. $Cl_2$222
B. $F_2$222

C. $I_2$222
D. $F_2$222

Ans. (B)

Q8. Which of the following is the correct order of X–X bond dissociation enthalpy of halogens molecules?

A. I_2l222
B. $I_2$222
C. $Cl_2$222
D. $F_2$222

Ans. (B)

Set – 9

Table 7.9: Properties of Hydrogen Halides

Property	HF	HCl	HBr	HI
Melting point/K	190	159	185	222
Boiling point/K	293	189	206	238
Bond length (H – xJ/pm	91.7	127.4	141.4	160.9
$\Delta_{diss}H^{\ominus}$/kJ mol^{-1}	574	432	363	295
pK_a	3.2	–7.0	–9.5	–10.0

Q1. Which of the following is correct order of melting point of hydrogen halides?

A. HF
B. HI
C. HCl
D. HCl

Ans. (C)

Q2. Which of the following is correct order of boiling point of hydrogen halides?

A. HCl
B. HF

C. HCl
D. HI

Ans. (A)

Q3. Which of the following is correct order of H–X bond length of hydrogen halides?

A. HCl
B. HI
C. HCl
D. HF

Ans. (D)

Q4. Which of the following is correct order of H–X bond length of hydrogen halides?

A. HI
B. HCl
C. HF
D. HBr

Ans. (A)

Q5. Which of the following has PKa>0?

A. HF
B. HBr
C. HCl
D. HI

Ans. (A)

Set – 10

Table 7.10: Oxoacids of Halogens

Halic (I) acid (Hypohalous acid)	HOF (Hypofluorous acid)	HOCl (Hypochlorous acid)	HOBr (Hypobromous acid)	HOI (Hypoiodous acid)
Halic (III) acid (Halous acid)	– –	HOClO (chlorous acid)	– –	– –
Halic (V) acid (Halic acid)	– –	$HOClO_2$ (chloric acid)	$HOBrO_2$ (bromic acid)	$HOIO_2$ (iodic acid)
Halic (VII) acid (Perhalic acid)	– –	$HOClO_3$ (perchloric acid)	$HOBrO_3$ (perbromic acid)	$HOIO_3$ (periodic acid)

Q1. Which of the following is chlorous acid?

A. HOCl
B. HOClO
C. $HOClO_2$
D. $HOClO_3$

Ans. (B)

Q2. No. of lone pairs in central atom in HOIO2is:

A. 1
B. 0
C. 3
D. 2

Ans. (D)

Q3. No. of OH bonds in HOClO2 is:

A. 0
B. 1
C. 2
D. 3

Ans. (B)

Q4. F can make oxoacid in which of the following states?

A. 0
B. +3
C. +5
D. +1

Ans. (D)

Q5. Cl can not make oxoacid in which of the following states?

A. +6
B. +5
C. +7
D. +3

Ans. (A)

Set – 11

Table 7.12: Atomic and Physical Properties of Group 18 Elements

Propery	He	Ne	Ar	Kr	Xe	Rn*
Atomic number	2	10	18	36	54	86
Atomic mass/ g mol^{-1}	4.00	20.18	39.95	83.80	131.30	222.00
Electronic configuration	$1s^2$	$[He]2s^22p^6$	$[Ne]\ 3s^23p^6$	$[Ar]3d^{10}4s^24p^6$	$[Kr]4d^{10}5s^25p^6$	$[Xe]4f^{14}5d^{10}6s^26p^6$
Atomic radius/pm	120	160	190	200	220	–
Ionisation enthalpy /kJmol^{-1}	2372	2080	1520	1351	1170	1037
Electron gain enthalpy /kJmol^{-1}	48	116	96	96	77	68
Density (at STP)/gcm^{-3}	1.8×10^{-4}	9.0×10^{-4}	1.8×10^{-3}	3.7×10^{-3}	5.9×10^{-3}	9.7×10^{-3}
Melting point/K	–	24.6	83.8	115.9	161.3	202
Boiling point/K	4.2	27.1	87.2	119.7	165.0	211
Atmospheric content (% by volume)	5.24×10^{-4}	1.82×10^{-3}	0.934	1.14×10^{-4}	8.7×10^{-6}	–

* *radioactive*

Q1. Which of the following is the correct ionisation enthalpy order of group 18 elements?

A. Xe
B. He
C. He
D. Ar

Ans. (A)

Q2. Which of the following has the least electron gain enthalpy order of group 18 elements?

A. Xe
B. Kr
C. He
D. Ar

Ans. (A)

Q3. Which of the following is the correct melting point order of group 18 elements?

A. Ar
B. He
C. Xe
D.He

Ans. (D)

Q4. Which of the following has the highest density?

A. He
B. Ne
C. Ar
D. Xe

Ans. (D)

Q5. Which of the following is the correct boiling point order of group 18 elements?

A. Ar
B. Xe
C. He
D. He

Ans. (C)

Q6. Which of the following is most abundant in nature?

A. Kr
B. Ne
C. He
D. Ar

Ans. (D)