1. (*a*) **Answer the questions given below in the space provided.**

(i) **Of the three isolated ions Fe^{3+}, Cr^{3+} and Co^{2+}, which one has three unpaired electrons?**

(ii) **Of the three 3*d* block elements Ti, V and Cr, which one has a maximum of five electrons that can participate in bonding?**

(iii) **Of the three elements C, N and Si, which one has the lowest electronegativity?**

(iv) **Of the three elements Na, Mg and Al, which one has the highest first ionization energy?**

(v) **Of the three isoelectronic anions N^{3-}, O^{2-} and F^-, which one has the largest ionic radius?**

(vi) **Of the three cations Na^+, Ca^{2+} and Al^{3+}, which one has the smallest ionic radius?**

(*b*) Peroxonitrous acid (HOONO) is formed as an intermediate during the oxidation of acidified aqueous solutions of nitrites to nitrates using H_2O_2. Answer the Parts (i) to (vii) which are based on the peroxonitrite ion, $[OONO]^-$. Its skeleton is given below:

O—O—N—O

(i) Draw the **most** acceptable Lewis structure for this ion.

(ii) Draw resonance structures for this ion. Giving reason/s comment on their relative stabilities.

(iii) Deduce the shapes around the following atoms using the VSEPR theory.

I. N Valence electron pairs .....

VSEPR pairs Or sigma bonds and lone pairs .....

Lone pairs of electrons .....

Shape .....

II. O attached to both N and O

Valence electron pairs .....

VSEPR pairs Or sigma bonds and lone pairs .....

Lone pairs of electrons .....

Shape .....

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(iv) State the following:

I. electron pair geometry (arrangement of electron pairs) around the atoms

II. hybridization of the atoms

given in the table below.

	N	O attached to both N and O
electron pair geometry		
hybridization		

(v) Sketch the shape of the Lewis structure drawn in Part (i) above showing approximate bond angles.

(vi) Identify the atomic/hybrid orbitals involved in the formation of the following bonds in the Lewis structure drawn in Part (i) above. Oxygen atoms are labelled 1, 2 and 3 as given below:

$$O^1—O^2—N—O^3$$

I. O^1 and O^2

II. O^2 and N

(vii) Give an isomer of peroxonitrous acid.

(*c*) (i) Select two polar species from the list given below.

H_2CO (formaldehyde), SF_6, COS, ICl_4^-, $SiCl_4$ ..... and .....

(ii) State the type(s) of intermolecular forces that exist between the molecules in each of the following pairs.

I. HBr(g) and H_2S(g)

II. Cl_2(g) and CCl_4(g)

III. CH_3OH(l) and H_2O(l)

2013/Al/str/1

1. (*a*) Arrange the following in the **increasing** order of the property indicated in parenthesis. Reasons are **not** required.

(i) CO, CO_2, CO_3^{2-} (C—O bond distance)

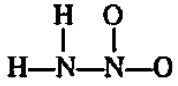
(ii) NO_2^+, NO_3^-, NH_3 (electronegativity of N atom)

(iii) $BeSO_4$, $MgSO_4$, $CaSO_4$ (decomposition temperature, $MSO_4 \longrightarrow MO + SO_3$, M = metal)

(iv) Ne, Ar, Kr (boiling point)

(v) S, F, Si, Cl (atomic radius)

(*b*) Nitramide ($H_2N—NO_2$) is a weak acid. It decomposes to N_2O and H_2O in the presence of a base. Answer the parts (i) to (v) which are based on nitramide. Its skeleton is given below:



(i) Draw the **most** acceptable Lewis structure for this molecule.

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(ii) Draw the resonance structures for this molecule. Giving reasons, comment on their stabilities.

(iii) State the following:

I. electron pair geometry (arrangement of electron pairs) around the atoms

II. shape around the atoms

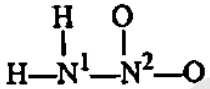
III. hybridization of the atoms

given in the table below.

	The N attached to two H atoms	The N attached to two O atoms
electron pair geometry		
Shape		
Hybridization		

(iv) Is this molecule polar or non-polar?

(v) Identify the atomic/hybrid orbitals involved in the formation of the following bonds in the Lewis structure drawn in part (i) above. N atoms are labelled 1 and 2 as given below:



I. N^1 and N^2

II. N^1 and H

(c) Xe, CH_3Cl, HF

Of the substances given above, which one/ones will have the forces given below?

(i) dipole - dipole forces

(ii) hydrogen bonding forces

(iii) London dispersion forces

2016/Al/str/1

1. (*a*) You are provided with the following list of some *p*-block elements in the Periodic Table.

B	C	N	O	F	Ne
Al	Si	P	S	Cl	Ar

From the list,

(i) identify the non-metallic element that forms a homoatomic covalent lattice of high hardness.

(ii) identify the element that exhibits the widest range of oxidation states.

(iii) identify the element that has the highest first ionization energy.

(iv) identify the element that exhibits amphoteric properties.

(v) identify the element that has two gaseous allotropes.

(vi) identify the element that is considered to be the strongest oxidizing agent.

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(*b*) The following parts (i) to (v) are based on the molecule CN_4. It has the following skeleton.

N—C—N—N—N

(i) Assuming that N—N bond lengths are approximately equal, draw the **most acceptable** Lewis structure for this molecule.

(ii) Draw **three** resonance structures for this molecule (excluding the structure drawn in part (i) above).

(iii) Based on the Lewis structure drawn in (i) above, state the following regarding the C and N atoms given in the table below.

I. VSEPR pairs around the atom. II. electron pair geometry around the atom.
III. shape around the atom. IV. hybridization of the atom.

The nitrogen atoms of CN_4 are numbered as follows:

N^1—C—N^2—N^3—N^4

		C	N^2	N^3
I.	VSEPR pairs			
II.	Electron pair geometry			
III.	Shape			
IV.	Hybridization			

(iv) In the Lewis structure drawn in part (i) above, indicate whether N^2 or N^3 has the **higher** electronegativity. Give reasons for your choice. [Numbering of atoms is as in part (iii).]

(v) Identify the atomic/hybrid orbitals involved in the formation of the following σ bonds in the Lewis structure drawn in part (i) above. [Numbering of atoms is as in part (iii).]

I. N^1—C

II. C—N^2

III. N^2—N^3

IV. N^3—N^4

(*c*) State whether the following statements are **true** or **false**. (Reasons are **not** required.)

(i) SF_6 and OF_6 are both stable molecules.

(ii) Although the electron pair geometry of $SiCl_4$, NCl_3 and SCl_2 is tetrahedral, their bond angles are different.

(iii) The boiling point of Kr is greater than that of Xe.

(iv) The solubility of group II sulphates decreases down the group primarily due to decrease in hydration enthalpy of the cations.

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