Classification of Elements and Periodicity in Properties

1. The boiling point of Kr and Rn are –152°C and –62°C respectively. Find the approximate boiling point of Xe.
2. How much energy in joules must be needed to convert all the atoms of sodium to sodium ions present in 2.3 mg of sodium vapours ?

   Given : Ionisation energy of sodium is 495 kJ mol^{-1}.
3. The ionization energy of lithium is 520 kJ mol^{-1}. Find the amount of energy (in kJ) required to convert 70 mg of lithium atoms in gaseous state into Li^+ ions.
4. The electron affinity of bromine (g) is 3.9 eV. How much energy in kJ is released when 10.0 g of bromine is converted completely to Br^- in gaseous state?

   [Given. Atomic mass of Br = 80 ; 1 eV = 96.3 kJ mol^{-1}].
5. How many pairs are there in the following options in which first species has lower ionisation energy than second species?

   (i) N and O (ii) Br and K (iii) Be and B (iv) I and I^-
   (iv) Li and Li^+ (v) O and S

   (vii) Ba and Sr
6. How many elements of the following are electropositive element(s)?

   Sodium, calcium, germanium and polonium and chlorine.
7. An element 'X' has its electronic configuration of 'K' shell $(n-5)s^2$ and the total number of electrons in its outer-most, penultimate and antipenultimate shell are 2, 8 and 25 respectively, then find out the total number of unpaired electrons in element 'X' in its ground state.
8. Find the total number of element(s) from the following which have only single oxidation state (other than zero) in their corresponding stable compounds

   Cs, Ba, F, Zn, Be, Al, Sr, Ga, Pb
9. Consider the following order:

   (i) HF > HCl > HBr > HI : Lewis basic character
   (ii) $CH_4 < CCl_4 < CF_4$: Electronegativity of central 'C'-atom
   (iii) $Mg^{2+} < K^+ < S^{2-} < Se^{2-}$: Ionic radius
   (iv) Ni > Pd > Pt : Ionisation energy
   (v) $As^{5+} > Sb^{5+} > Bi^{5+}$: Stable oxidation state
   (vi) LiF > NaF > KF > RbF : Lattice energy
   (vii) F^- (aq.) > Cl^- (aq.) > Br^- (aq.)> I^- (aq.) : Electrical conductance
   (viii) $Li^+ < Mg^{2+} < Al^{3+}$: Hydration energy
   (ix) Cl > Br > F > I : Electron affinity
   (x) $BeCl_2 < AlCl_3 < SiCl_4$: Lewis acidic character

   Then calculate value of $(x - y)$, where x and y are correct and incorrect orders respectively.
10. Among the following, find the number of elements showing only one non-zero oxidation state

    O, Cl, F, N, P, Sn, Tl, Na, Ti

SOLUTIONS

1. (– 107)

According to the law of triad, the properties of middle element is average of rest two.

∴ Boiling point of Xe in a triad of Kr, Xe, Rn =

(boiling point of Kr + boiling point of Rn) / 2

$= (-152 - 62)/2 = -107\ ^\circ C$

2. (49.5)

According to the definition of ionisation energy,

$Na(g) + IE \rightarrow Na^+(g) + e^-$, I.E. $= 495\ kJ\ mol^{-1}$

The amount of energy needed to ionise 1 mole of sodium vapours $= 495\ kJ\ mol^{-1}$

Moles of sodium vapours present in given sample

$$= \frac{2.3 \times 10^{-3}}{23} = 1 \times 10^{-4}\ mol$$

∴ Amount of energy needed to ionise 1×10^{-4} moles of sodium vapours $= 495 \times 10^{-4}\ kJ/mol = 49.5\ J/mol$

3. (5.2)

$$70\ mg = 70 \times 10^{-3} g = \frac{70 \times 10^{-3}}{7}\ mol = 1 \times 10^{-2}\ mol$$

∴ Amount of energy required

$$= 1 \times 10^{-2} \times 520\ kJ = 5.2\ kJ$$

4. (46.95)

Given : $\underset{80g}{Br(g)} + e^- \longrightarrow Br^-(g) + 3.9\ eV.$

For conversion of 10g of Br to Br^-, the energy released will be $= \frac{3.9}{80} \times 10\ eV$

Thus energy released in kJ $= \frac{3.9}{8} \times 96.3\ kJ$

$= 46.946\ kJ.$

5. (2) (iv) $Li < Li^+$ (vii) $Ba < Sr$

6. (2) Two elements sodium and calcium are electropositive metals.

7. (7) For K shell $(n-5)s^2 = 1s^2$ so value of n is '6'

Electronic configuration of 'X' $\Rightarrow \underset{1}{\underset{K}{1s^2}}\ \underset{2}{\underset{L}{\_\_}}\ \underset{3}{\underset{M}{\_\_}}\ \underset{4}{\underset{N}{25}}\ \underset{2}{\underset{O}{8}}\ \underset{6}{\underset{P}{2}}$

$1s^2 \ldots\ldots 4s^2\ 4p^6\ 4d^{10}\ 4f^7\ 5s^2\ 5p^6\ 5d^0\ 6s^2$

2 5 8 2

Unpaired electron is 7.

8. (7) $Cs \rightarrow (+1)$ $Zn \rightarrow (+2)$ $Sr \rightarrow (+2)$

$Ba \rightarrow (+2)$ $Be \rightarrow (+2)$ $Ga \rightarrow (+1, +3)$

$F \rightarrow (-1)$ $Al \rightarrow (+3)$ $Pb \rightarrow (+2, +4)$

9. (4) (i), (ii), (iii), (v), (vi), (viii) &(ix) are true where as (iv), (vii) & (ix) are false.

10. (7) Fluorine generally shows 0 and –1 oxidation states while sodium shows 0 and + 1 oxidation state.