1. At $300\ K$ and 1 atmospheric pressure, $10\ mL$ of a hydrocarbon required $55\ mL$ of O_2 for complete combustion and $40\ mL$ of CO_2 is formed. The formula of the hydrocarbon is:

   A. C_4H_8

   B. C_4H_7Cl

   C. C_4H_{10}

   D. C_4H_6

   General reaction for combustion of hydrocarbons:

   $$C_xH_y + \left(x + \frac{y}{4}\right) O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$$

   $$10\ mL \quad 10\left(x + \frac{y}{4}\right)\ mL \quad 10x\ mL$$

   By given data,
   $10\left(x + \frac{y}{4}\right) = 55$
   and
   $10x = 40$
   Solving the above two equations:
   $x = 4, y = 6 \Rightarrow C_4H_6$
   Hence, option D is correct.

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2. What would be the molality of 20% (mass/mass) aqueous solution of KI ?
Molar mass of KI is $166\ g\ mol^{-1}$

- **A.** 1.51
- **B.** 1.35
- **C.** 1.08
- **D.** 1.48

20% (mass/mass) aqueous solution of KI means $20\ g$ of KI in $100\ g$ of solution.
Mass of solution =100g
Mass of solute=20g
Mass of solvent=mass of solution - mass of solute
$= (100 - 20)\ g = 80\ g = 0.08\ kg$
Molar mass of KI is $166\ g\ mol^{-1}$

$$\text{Number of moles of solute } (n) = \frac{\text{mass of KI}}{\text{molar mass of KI}} = \frac{20}{166} = 0.121\ mol$$

So, molality of solution $m = \dfrac{\text{number of moles of solute}}{\text{weight of solvent (in kg)}}$

$$\Rightarrow m = \frac{0.121}{0.08} = 1.51\ mol/kg$$

Hence, option (A) is the correct.

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3. Complete combustion of $1.80\ g$ of an oxygen containing compound $(C_xH_yO_z)$ gave $2.64\ g$ of CO_2 and $1.08\ g$ of H_2O. The percentage of oxygen in the organic compound is :

A. 50.33

B. 53.33

C. 51.63

D. 63.53

General reaction:

$$C_xH_yO_z + \left(x + \frac{y}{4} - \frac{z}{2}\right) O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$$

From the above equation the relation for number of moles is:

$$n_C = n_{CO_2} = \frac{2.64}{44} = 0.06\ mol$$

$$n_H = 2 \times n_{H_2O} = \frac{1.08}{18} \times 2 = 0.12\ mol$$

Mass of carbon, $m_C = \frac{2.64}{44} \times 12 = 0.72\ g$

Mass of hydrogen, $m_H = \frac{1.08}{18} \times 2 = 0.12\ g$

Mass of oxygen,

$m_O = \text{Mass of hydrocarbon} - m_C - m_H$

$= 1.80 - 0.72 - 0.12 = 0.96\ g$

$\%\ O = \frac{0.96}{1.80} \times 100 = 53.33\%$

Hence the correct answer is option (b).

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4. At 300K and 1 atm, 15 mL of a gaseous hydrocarbon requires 375 mL air containing 20% O_2 by volume for complete combustion. After combustion, the gases occupy $330\ mL$. Assuming that the water formed is in liquid form and the volumes were measured at the same temperature and pressure. The formula of the hydrocarbon is :

A. C_3H_8

B. C_4H_8

C. C_4H_{10}

D. C_3H_6

Here given that for the complete combustion of 15 mL of a gaseous hydrocarbon 375 mL of air containing
20% of oxygen by volume is required. Thus the volume of oxygen required can be calculated as:
100 mL of air contains 20 mL of oxygen.
So,
1 mL of air contains $\frac{20}{100} mL$ of oxygen

375 mL of air contain $= \frac{20}{100} \times 375 = 75\ mL$
The ratio of the volume of oxygen used for combustion to the volume of hydrocarbon is:
$\frac{\text{volume of oxygen used}}{\text{volume of hydrogen}} = \frac{75}{15} = 5:1$
This ratio can be obtained in the case of propane as:
The chemical reaction for the combustion of propane
as:
$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
Here water obtained is in liquid form. The volume of hydrocarbon is given as 15 mL. Hence, 15 mL of
propane on combustion gives $= 3 \times 15 = 45mL$ of carbon dioxide gas
And the volume of oxygen used is 75 mL. Thus the volume of remaining air except oxygen is $(375 - 75) = 300\ mL$.
Hence the total volume will be $300 + 45 = 345mL$. Some quantity of carbon dioxide can dissolve in water hence the total volume occupied by the gas is less than $345\ mL$.
So, the total volume occupied by gas is $330\ mL$
Hence, the correct answer is option A.

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5. An unknown chlorohydrocarbon has 3.55% of chlorine. If each molecule of hydrocarbon has one chlorine atom only, then chlorine atoms present in $1\ g$ of chlorohydrocarbon are:
Atomic weight of $Cl = 35.5\ u$
Avogadro constant, $N_A = 6.023 \times 10^{23}$

A. 6.023×10^{9}

B. 6.023×10^{23}

C. 6.023×10^{21}

D. 6.023×10^{20}

An unknown chlorohydrocarbon has 3.55% of chlorine.
100 g of chlorohydrocarbon has 3.55 g of chlorine.
1 g of chlorohydrocarbon will have $3.55 \times \frac{1}{100} = 0.0355g$ of chlorine.
Atomic weight of $Cl = 35.5\ u$
Number of moles of $Cl = \frac{0.0355g}{35.5g/mol} = 0.001mol$
Number of atoms of $Cl = 0.001mol \times 6.023 \times 10^{23} mol^{-1} = 6.023 \times 10^{20}$
Hence, option D is correct.

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6. On heating, a sample of $NaClO_3$, it gets converted to $NaCl$ with a loss of 0.16 g of oxygen. The residue is dissolved in water and precipitated as $AgCl$. The mass of $AgCl$ (in g) obtained will be :
(Given molar mass of $AgCl = 143.5\ g\ mol^{-1}$)

A. 0.35

B. 0.54

C. 0.41

D. 0.48

The molar mass of $O_2 = 32g/mol$

$0.16\text{g of oxygen } = \dfrac{0.16g}{32g/mol} = 0.005mol$

$2NaClO_3 \rightarrow 2NaCl + 3O_2$

$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

3 moles of O_2=2 moles of $NaCl$=2 moles of $AgCl$.

$0.005 \text{ moles of } O_2 = 0.005 \times \dfrac{2}{3}\text{moles of AgCl}$

$\text{Molar mass of } AgCl = 143.5gmol^{-1}$

The mass of $AgCl$ (in g) obtained will be

$143.5\ g/mol^{-1} \times 0.005 \times \dfrac{2}{3}mol = 0.48g$

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7. 5 moles of AB_2 weigh $125 \times 10^{-3} kg$ and 10 moles of A_2B_2 weigh $300 \times 10^{-3} kg$ .The molar mass of $A(M_A)$ and molar mass of $B(M_B)$ in kg/mol are :

A. $M_A = 10 \times 10^{-3} and M_B = 5 \times 10^{-3}$

B. $M_A = 25 \times 10^{-3} and M_B = 50 \times 10^{-3}$

C. $M_A = 5 \times 10^{-3} and M_B = 10 \times 10^{-3}$

D. $M_A = 50 \times 10^{-3} and M_B = 25 \times 10^{-3}$

$$\text{Number of moles} = \frac{\text{Given mass}}{\text{Molar mass}}$$

For AB_2

$$5 = \frac{125}{M_A + 2M_B}$$

$M_A + 2M_B = 25$.....(1)

For A_2B_2

$$10 = \frac{300}{2M_A + 2M_B}$$

$2M_A + 2M_B = 30$.....(2)

Solving 1 and 2 ;

$M_A = 5 g/mol = 5 \times 10^{-3}$kg/mol

$M_B = 10 g/mol = 10 \times 10^{-3}$kg/mol

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8. 100 mL of a water sample contains 0.81g of calcium bicarbonate and 0.73g of magnesium bicarbonate. The hardness of this water sample expressed in terms of ppm of $CaCO_3$ is: (molar mass of calcium bicarbonate is 162 g/mol and magnesium bicarbonate is 146 g/mol.

A. $1000\ ppm$

B. $10000\ ppm$

C. $100\ ppm$

D. $5000\ ppm$

$Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2$

Now, this total amount of calcium carbonate formed is to be measured by taking into consideration both calcium as well as magnesium bicarbonate.

Thus, according to the data given we have to find the total degree of hardness which is given by,

$n_{eq}.\ CaCO_3 = n_{eq}.\ Ca(HCO_3)_2 + n_{eq}.\ Mg(HCO_3)_2$

$\frac{w}{100} \times 2 = \frac{0.81}{162} \times 2 + \frac{0.73}{146} \times 2$

$w = 1g$

Thus, 1 g of calcium carbonate is present in 100 mL and in terms of part per million in 100 mL it is:

$\Rightarrow \frac{1}{100} \times 10^6$

$\Rightarrow 10^4 ppm = 10000 ppm$

Thus, the correct answer is option B) 10000 ppm.

9. 1 gram of a metal carbonate (M_2CO_3) on treatment with excess HCl produces 0.01186 mole of CO_2. The molar mass of (M_2CO_3) in $gmol^{-1}$ is

A. 1186

B. 84.3

C. 118.6

D. 11.86

$M_2CO_3 + 2HCl \rightarrow 2MCl + H_2O + CO_2$

0.01186 moles $CO_2 = 0.01186$ moles of $M_2CO_3 = 1\ g\ M_2CO_3$

$$\text{Molar mass of } M_2CO_3 = \frac{\text{Mass of } M_2CO_3}{\text{No. of moles of } M_2CO_3} = \frac{1g}{0.01186mol} = 84.3g/mol$$

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10. Find the mole fraction of methanol in its 5.2 molal aqueous solution.

- **A.** 0.190
- **B.** 0.086
- **C.** 0.050
- **D.** 0.100

Mole fraction of solute (χ_{solute}) in aqueous solution $= \frac{molality}{molality + \frac{1000}{18}}$.

$$= \frac{5.2}{5.2 + \frac{1000}{18}} = 0.086$$

11. The density of a solution prepared by dissolving 120 g of urea (mol. mass = 60 g/mol) in 1000 g of water is 1.15 g/mL. The molarity of this solution is

- **A.** 1.78 M
- **B.** 1.02 M
- **C.** 2.05 M
- **D.** 0.50M

Total weight of solution = 1000 + 120 =1120g

Molarity $= \frac{120}{60} \times \frac{1000 \times 1.15}{1120} = 2.05\ M$

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12. The molarity of a solution obtained by mixing 750 mL of 0.5M HCl with 250 mL of 2M HCl will be

- **A.** 0.875 M
- **B.** 1.00 M
- **C.** 1.75 M
- **D.** 0.975 M

The molarity of a solution obtained by mixing 750 mL of 0.5M HCl with 250 mL of 2M HCl given by

$$Molarity = \frac{M_1V_1 + M_2V_2}{V_1 + V_2}$$

$$\text{Molarity} = \frac{750 \times 0.5 + 250 \times 2}{1000} = 0.875\ M$$

13. The molecular formula of a commercial resin used for exchanging ions in water softening is $C_8H_7SO_3Na$ $(Mol.Wt.\ 206\ g\ mol^{-1})$ .What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin?

- **A.** $\frac{1}{206}$
- **B.** $\frac{2}{309}$
- **C.** $\frac{1}{412}$
- **D.** $\frac{1}{103}$

$$2C_8H_7SO_3Na + Ca^{2+} \rightarrow (C_8H_7SO_3)_2Ca + Na^+$$

$2\ mol$ $\quad$ $1\ mol$
$412\ g$ $\quad$ $1\ mol$

Maximum uptake of Ca^{2+} ions by the resin (mole per gm resin) = $\frac{1}{412}$

Hence the correct option is (c).

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14. The most abundant elements by mass in the body of a healthy human adult are : Oxygen (61.4%); Carbon (22.9%), Hydrogen (10.0%); and Nitrogen (2.6%). The weight which a 75 kg person would gain if all H^1 atoms are replaced by H^2 is :

A. 7.5 kg

B. 10 kg

C. 15 kg

D. 37.5 kg

Mass of hydrogen in adult human = $(10/100) \times 75 = 7.5\ kg$
Replacing H^1 by H^2 would replace 7.5 kg with 15 kg.
∴ Net gain = $7.5\ kg$

Hence the correct option is (a).

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15. The ratio of mass percent of C and H of an organic compound $(C_XH_YO_Z)$ is 6 : 1. If one molecule of the above compound $(C_XH_YO_Z)$ contains half as much oxygen as required to burn one molecule of compound C_XH_Y completely to CO_2 and H_2O. The empirical formula of compound $C_XH_YO_Z$ is

A. $C_3H_6O_3$

B. C_2H_4O

C. $C_3H_4O_2$

D. $C_2H_4O_3$

$\frac{12X}{Y} = \frac{6}{1}$ (ratio of masses)

$2X = Y$ for $C_XH_YO_Z$

Equation for combustion of C_XH_Y

$$C_XH_Y + \left(X + \frac{Y}{4}\right) O_2 \rightarrow XCO_2 + \frac{Y}{2}H_2O$$

Number of oxygen atoms in $C_XH_YO_Z$=Z

Number of oxygen atoms required for combustion of C_XH_Y= $2\left(X + \frac{Y}{4}\right)$

$$\frac{1}{2}\left(2X + \frac{Y}{2}\right) = Z$$

$$\Rightarrow \quad \left(X + \frac{Y}{4}\right) = Z$$

$$\Rightarrow \quad \left(X + \frac{2X}{4}\right) = Z$$

$$\Rightarrow Z = \frac{3X}{2}$$

$X : 2X : \frac{3X}{2}$

$2X : 4X : 3X$

$2 : 4 : 3$

Hence, $C_2H_4O_3$

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16. The ratio of the mass percentages of 'C and H' and C &O of a saturated acyclic organic compound 'X' are 4:1 and 3:4 respectively. Then, the moles of oxygen gas required for complete combustion of two moles of organic compound 'X' is

Accepted Answers

5 5.0 5.00

Solution:

$C : H = 4 : 1$
$C : O = 3 : 4$
Mass ratio
$C : H : O$
$12 : 3 : 16$

Mole ratio:
$C : \ H : \ O$
$\frac{12}{12} : \frac{3}{1} : \frac{16}{16}$
$1 : \ 3 : \ 1$
Empirical formula $= CH_3O$
Molecular formula $= C_2H_6O_2$
(saturated acyclic organic compound)
General reaction:

$$C_xH_yO_z + \left(x + \frac{y}{4} - \frac{z}{2}\right) O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$$

$$C_2H_6O_2 + \frac{5}{2}O_2 \rightarrow 2CO_2 + 3H_2O$$

1 mol of organic compound reacts with 2.5 mol of oxygen
So,
2 moles of organic compound reacts with 5 moles of oxygen.

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17. Ferrous sulphate heptahydrate is used to fortify foods with iron.The amount (in grams) of the salt required to achieve 10 ppm of iron in 100 kg of wheat (Rounded-off to the nearest integer) is
[Atomic weight : Fe=55.85 S=32.00 O=16.00]

Accepted Answers

5 5.0 5.00

Solution:

$10\ ppm = \frac{\text{Mass of Fe(in g)}}{100 \times 1000} \times 10^6$
$\text{Mass of } Fe = 1g$
$\text{Molar mass of } FeSO_4.7H_2O = 278\ g\ mol^{-1}$
Mass of Fe is 56 g in 1 mol
i.e.
$1g \text{ in } \frac{1}{56} mol.$
The amount (in grams) of the salt required to achieve 10 ppm of iron in 100 kg of wheat
$\Rightarrow \frac{1}{56} \times 278 = 4.96g \approx 5g$

18. The number of atoms of Na in 8 g of its sample is $x \times 10^{23}$.The value of x(rounded off to the nearest integer) is

[Given : $N_A = 6.02 \times 10^{23} mol^{-1}$
and Atomic mass of Na=23.0u]

Accepted Answers

2 2.0 2.00

Solution:

$1\ mol$ of Na or $23\ g$ of Na has 6.02×10^{23} atoms.
$8\ g$ of Na has:
$\frac{8}{23} \times 6.02 \times 10^{23}$ atoms
$\Rightarrow 2.09 \times 10^{23}$ atoms
$\approx 2 \times 10^{23}$ atoms
The value of x is 2

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19. 100 g of propane is completely reacted with 1000g of oxygen.The mole fraction of carbon dioxide in the resulting mixture is $x \times 10^{-2}$.The value of 'x' is (Rounded off to the nearest integer) is
[Atomic weight :H=1.008;C=12.00;O=16.00]

Accepted Answers

19 19.0 19.00

Solution:

100 g of propane = 2.27mol
1000g oxygen= 31.25 mol
$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$
From the equation 1 mol of propane reacts with 5 mol of oxygen to give 3 moles of carbon dioxide and 4 moles of water
So, by stoichiometric calculations:
2.27 mol of propane will react with 11.35 mol oxygen to give 6.81 mol carbon dioxide and 9.08 mol water

	$C_3H_8(g)$	$+ 5O_2(g)$	$\rightarrow 3CO_2(g)$	$+ 4H_2O(l)$
$t = 0$	2.27	31.25	0	0
$t = \infty$	0	19.9	6.81	9.08

mole fraction of CO_2 in the final reaction mixture (heterogenous)

$$X_{CO_2} = \frac{6.81}{19.9 + 6.81 + 9.08}$$
$$= 0.1902 = 19.02 \times 10^{-2}$$

Value of x is 19

20. 4 g equimolar mixture of $NaOH$ and Na_2CO_3 contains x g of $NaOH$ and y g of Na_2CO_3.The value of x to the nearest integer (in g) is

Accepted Answers

1 1.0 1.00

Solution:

Total mass=4g
Now,
$moles\ of NaOH = moles\ of Na_2CO_3 = a$
$W_{NaOH} + W_{Na_2CO_3} = 4\ g$
$\Rightarrow 40a + 106a = 4$
$\Rightarrow 40a + 106a = 4$
$\Rightarrow a = \frac{4}{146} mol$
$\therefore \text{mass of NaOH } = \frac{4}{146} \times 40\ g = 1.095\ g \approx 1\ g$

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21. 250 mL of 0.5 M $NaOH$ was added to 500 mL of 1M HCl.The number of unreacted HCl molecules in the solution after compelete reaction is $x \times 10^{21}$. The value of x to the nearest integer is

Take

$(N_A = 6.022 \times 10^{23})$

Accepted Answers

226 226.0 226.00

Solution:

$\text{Millimoles of } NaOH = 250 \times 0.5 = 125$

$\text{Millimoles of } HCl = 500 \times 1 = 500$

Now reaction is

$$NaOH + HCl \rightarrow NaCl + H_2O$$

$t = 0$	125	500	–	–
$t = t$	0	375	125	125

So millimoles left of $HCl = 375$

Moles of $HCl = 375 \times 10^{-3}$

No.of HCl molecules

$= 6.022 \times 10^{23} \times 375 \times 10^{-3}$

$= 225.8 \times 10^{21}$

$\approx 226 \times 10^{21}$

value of x is 226

22. Complete combustion of 3 g ethane gives $x \times 10^{22}$ molecules of water. The value of x is

(Round off to the nearest integer)

[Use : $N_A = 6 \times 10^{23}$

Accepted Answers

18 18.0 18.00

Solution:

moles of ethane = $\frac{3g}{30g/mol} = 0.1mol$

$C_2H_6 + 3.5O_2 \rightarrow 2CO_2 + 3H_2O$

1 mol of ethane gives 3 mol of water

0.1 mol ethane gives 0.3 mol of water

Number of molecules in 0.3 mol water

$= 0.3 \times 6 \times 10^{23} = 18 \times 10^{22} molecules$

value of x is 18

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23. The number of chlorine atoms in 20 mL of chlorine gas at STP is $x \times 10^{21}$. The value of x (Rounded off to the Nearest integer) is

.

[Assume chlorine is an ideal gas at STP,
$N_A = 6.023 \times 10^{23}$]

Accepted Answers

1 1.0 1.00

Solution:

Moles of Cl_2 in $20\ mL$ of it at STP $= \frac{20}{22400} = 8.9 \times 10^{-4}\ mol$
Thus, no. of Cl atoms $= moles \times N_A \times atomicity$ ..... eq. (i)
Atomicity is the number of atoms per molecule of a species.
$\therefore$ Atomicity of $Cl_2 = 2$
Putting values in eq(i), we get;
no. of Cl atoms $= 8.9 \times 10^{-4} \times 6.022 \times 10^{23} \times 2 \approx 1 \times 10^{21}$
Thus value of $x = 1$.

24. When 35 mL of 0.15 M lead nitrate solution is mixed with 20 mL of 0.12 M chromic sulphate solution, $x \times 10^{-5}$ moles of lead sulphate are precipitated out.The value of x Rounded off to the nearest integer is

Accepted Answers

525 525.0 525.00

Solution:

$3Pb(NO_3)_2 + Cr_2(SO_4)_3 \rightarrow 3PbSO_4 + 2Cr(NO_3)_3$

$\text{mmol of } Cr_2(SO_4)_3 = 20 \times 0.12 = 2.4\ mmol$
$Pb(NO_3)_2 = 35 \times 0.15 = 5.25\ mmol$
$3\ mmol\ Pb(NO_3)_2 \text{reacts with } 1\ mmol\ Cr_2(SO_4)_3$
$5.25\ mmol\ Pb(NO_3)_2 \text{reacts with } 1.75\ mmol\ Cr_2(SO_4)_3$
Limiting reagent is lead nitrate
So, 5.25mmol of lead sulphate are precipitated.
$\text{Moles of } PbSO_4 \text{ formed} = 5.25 \times 10^{-3} = 525 \times 10^{-5}$
value of x is 525

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25. $NaClO_3$ is used even in spacecrafts to produce O_2. The daily consumption of pure O_2 by a person is 492 L at $1\ atm$ and $300\ K$. How much amount of $NaClO_3$ in
grams, is required to produce O_2 for the daily consumption of a person at STP?
$NaClO_3(s) + Fe(s) \rightarrow O_2(g) + NaC1(s) + FeO(s)$

Accepted Answers

21302130.02130.00

Solution:

$NaClO_3(s) + Fe(s) \rightarrow O_2(g) + NaC1(s) + FeO(s)$
Moles of $NaClO_3$ required = moles of O_2 produced
Moles of O_2 required
$n = \dfrac{PV}{RT} = \dfrac{1 \times 492}{0.082 \times 300} = 20\ mol$
Molar mass of $NaC1O_3 = 23 + 35.5 + (3 \times 16) = 106.5\ g\ mol^{-1}$
$\therefore$ Mass of $NaClO_3$ required $= 20 \times 106.5 = 2130\ g$

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1. The ground state energy of hydrogen atom is -13.6 eV. The energy of second excited state of He^+ ion in eV is

- **A.** -6.04
- **B.** -27.2
- **C.** -54.4
- **D.** -3.4

For hydrogen like species, energy of n^{th} shell is given by

$$(E)_{n^{th}} = (E_{GND})_H X \frac{Z^2}{n^2}$$

where,
$(E)_{n^{th}}$ is the energy of n^{th} state of hydrogen like species
$(E_{GND})_H$ is the ground state energy of hydrogen atom
Z is the atomic number
Thus,

$$E_{3^{rd}}(He^+) = (-13.6\ eV) X \frac{2^2}{3^2} = -6.04\ eV$$

Hence, correct option is (a).

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2. The de Broglie wavelength (λ) associated with a photoelectron varies with the frequency (v) of the incident radiation as, [v_0 is threshold frequency]:

✗ **A.** $\lambda \propto \frac{1}{(v-v_0)^{\frac{3}{2}}}$

✓ **B.** $\lambda \propto \frac{1}{(v-v_0)^{\frac{1}{2}}}$

✗ **C.** $\lambda \propto \frac{1}{(v-v_0)^{\frac{1}{4}}}$

✗ **D.** $\lambda \propto \frac{1}{(v-v_0)}$

In photoelectric effect, incident energy = thershold energy + KE

$hv = hv_0 + \mathrm{KE}$

$\mathrm{KE} = hv - hv_0$

KE = $\frac{mv^2}{2} = h(v-v_0)$

v = $\sqrt{\frac{2h(v-v_0)}{m}}$

de broglie wavelength λ = $\frac{h}{mv}$

v = $\frac{h}{m\lambda}$. Substituting v,

v = $\frac{h}{m\lambda}$.= $\sqrt{\frac{2h(v-v_0)}{m}}$

or λ = $\frac{h}{m} X \sqrt{\frac{m}{2h(v-v_0)}}$

λ = $\sqrt{\frac{h}{2m(v-v_0)}}$

λ = $(\frac{h}{2m(v-v_0)})^{1/2}$

Since h and m are constants,

$\lambda \propto (\frac{1}{(v-v_0)})^{1/2}$

Hence, the correct option is option (b).

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3. What is the work function of the metal if the light of wavelength 4000 Å generates photoelectrons of velocity $6 \times 10^5\ ms^{-1}$ form it?
(Mass of electron $= 9 \times 10^{-31} kg$
Velocity of light $= 3 \times 10^8 ms^{-1}$
Planck's constant $= 6.626 \times 10^{-34} Js$
Charge of electron $= 1.6 \times 10^{-19} JeV^{-1}$)

A. 0.9 eV

B. 4.0 eV

C. 2.1 eV

D. 3.1 eV

$h\nu = \phi + \frac{1}{2}mv^2$

where,
h is Planck's constant
ν is frequency of light
ϕ is work function
m is mass of electron
v is velocity of light

$\phi = h\nu - \frac{1}{2}mv^2$

$\phi = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{4000 \times 10^{-10}} - \frac{1}{2} \times 9 \times 10^{-31} \times (6 \times 10^5)^2$

$\phi = 3.35 \times 10^{-19}\ J$

1 eV = 1.6×10^{-19} J

$\rightsquigarrow \Rightarrow\ \phi \simeq 2.1\ eV$

Option C is the correct answer

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4. The number of subshells associated with n = 4 and m = -2 quantum numbers is:

- **A.** 4
- **B.** 8
- **C.** 2
- **D.** 16

n = 4
For n=4, the possible 'l' values are 0,1,2,3.
l = 0 m = 0
l = 1 m = -1, 0, +1
l = 2 m = -2, +2, -1, +1, 0
l = 3 m = $\pm 3, \pm 2, \pm 1, 0$

Answer: '2' Subshells

5. The region in the electromagnetic spectrum where the Balmer series lines appear is:

- **A.** Microwave
- **B.** Infrared
- **C.** Visible
- **D.** None of the above

The question should be a bonus as lines of the Balmer series belong to both UV as well as visible regions of the EM spectrum. Hence, correct answer should be option (c).

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6. The shortest wavelength of H atom in the Lyman series is λ_1. The longest wavelength in the Balmer series of He^+ is

A. $\frac{5\lambda_1}{9}$

B. $\frac{36\lambda_1}{5}$

C. $\frac{27\lambda_1}{5}$

D. $\frac{9\lambda_1}{5}$

Shortest wavelength $\rightarrow \text{Max energy}(\infty \rightarrow 1)$ (Lyman series)

$$\frac{1}{\lambda_1} = R_H(1)^2\left[\frac{1}{1} - 0\right]$$

$$\frac{1}{\lambda_1} = R_H \Rightarrow R_H = \frac{1}{\lambda_1}$$

For Balmer series,

$$\frac{1}{\lambda} = R_H(2)^2\left[\frac{1}{2^2} - \frac{1}{3^2}\right] \Rightarrow R_H(4)\left(\frac{9-4}{36}\right)$$

$$\frac{1}{\lambda} = \frac{5R_H}{9} \Rightarrow \lambda = \frac{9}{5R_H} = \frac{9\lambda_1}{5}$$

Hence the correct answer is option (d).

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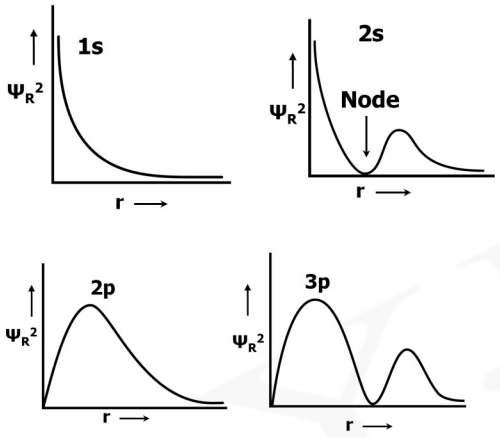
7. The correct statement about probability density (except at infinite distance from nucleus) is

A. It can never be zero for 2s orbital

B. It can be zero for 3p orbital

C. It can be zero for 1s orbital

D. It can be negative for 2p orbital



Probability density is the square of wave function and hence is always positive . So, option d is wrong.
Probality density changes with distance (radius) from nucleus. It becomes zero at radial nodes.

In 1s graph, the probability density curve does not become zero at any distance hence, option (c) is wrong.

In 2s graph, the probability density curve becomes zero at a point which is know as node. Hence, potion (a) is wrong.

In 3p graph, we have a minimum curve which denotes the node where probability density is zero.
Hence, option (b) is the correct statement.

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8. The difference between radii of 3rd and 4th orbits of Li^{2+} is ΔR_1. The difference between the radii of 3rd and 4th orbits of He^{+} is ΔR_2. Ratio $\Delta R_1 : \Delta R_2$ is

A. 3 : 2

B. 8 : 3

C. 2 : 3

D. 3 : 8

$r_n = a_0 \frac{n^2}{Z}$

$r_n \propto \frac{n^2}{Z}$

$r_3(Li^{2+}) \propto \frac{3^2}{Z_{Li^{2+}}}$

$r_4(Li^{2+}) \propto \frac{4^2}{Z_{Li^{2+}}}$

$\Delta R_1 = r_4 - r_3 \propto \frac{4^2 - 3^2}{Z_{Li^{2+}}}$

Similarly for He^{+}

$\Delta R_2 = r_4 - r_3 \propto \frac{4^2 - 3^2}{Z_{He^{+}}}$

$\therefore \quad \frac{\Delta R_1}{\Delta R_2} = \frac{Z_{HE^{+}}}{Z_{Li^{2+}}} = \frac{2}{3}$

Hence, (c) is the correct option

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9. The number of electron associated with quantum numbers $n = 5,\ m_s = +\frac{1}{2}$ is

- **A.** 15
- **B.** 50
- **C.** 25
- **D.** 11

The number of orbitals possible in a shell with principal quantum number 'n' is 'n^2'.
Each orbital can have one electron each of + and - spin.
Number of electrons with $m_s = +\frac{1}{2}$ is also 25
Hence, the correct answer is option (c).

10. The radius of the second Bohr orbit, in terms of the Bohr radius, $a_0,\ \text{in}\ Li^{2+}$ is:

- **A.** $\frac{2a_0}{3}$
- **B.** $\frac{2a_0}{9}$
- **C.** $\frac{4a_0}{9}$
- **D.** $\frac{4a_0}{3}$

$r = a_0\frac{n^2}{Z}\text{Å}$
Bohr's radius of Li^{2+} ion for n = 2
$= a_0\frac{n^2}{Z}$
$= \frac{4a_0}{3}$
Hence, option (d) is the correct answer.

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11. The de Broglie wavelength of an electron in the 4th Bohr orbit is:

- ✗ **A.** $6\pi a_0$
- ✗ **B.** $4\pi a_0$
- ✗ **C.** $2\pi a_0$
- ✓ **D.** $8\pi a_0$

de Broglie wavelength (λ)
$2\pi r = n\lambda$
n is integer
r raduis of orbit
Z is atomic number
$n = 4$ & $r = a_0 \frac{n^2}{Z}$

$2\pi a_0 \frac{n^2}{z} = n\lambda$
$2\pi \frac{4^2 a_1}{1} = 4\lambda$
$\lambda = 8\pi a_0$

12. Amongst the following statements, that which was not proposed by Dalton was

- ✗ **A.** All the atoms of a given element have identical properties including identical mass. Atoms of different elements differ in mass
- ✗ **B.** Matter consists of indivisible atoms.
- ✗ **C.** Chemical reactions involve reorganization of atoms. These are neither created nor destroyed in a chemical reaction.
- ✓ **D.** When gases combine or reproduced in a chemical reaction, they do so in a simple ratio by volume provided all gases are at the same T & P

Statement d) is not proposed by Dalton but by Gay Lussac
Hence, (d) is the correct option.

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13. Given below are two statements:
Statement I: Rutherford's gold foil experiment cannot explain the line spectrum of hydrogen atom.
Statement II: Bohr's model of hydrogen atom contradicts Heisenberg's uncertainty principle.
In the light of the above statement, choose the most appropriate answer from the options given below:

A. Both the statement I and statement II are false

B. Statement I is true but statement II is false.

C. Statement I is false but statement II is true

D. Both statement I and statement II are true

One of the drawback of Rutherford model is that, it says nothing about the electronic structure of atom. It cannot explain the line spectra of hydrogen atom.

Since uncertainty principle rules of existence of definite paths of trajectories of particles like electrons. So Bohr's model contradicts H.U.P.
Option (d) is the correct answer.

14. A certain orbital has no angular nodes and two radial nodes. The orbital is

A. $2p$

B. $3p$

C. $3s$

D. $2s$

Only s orbitals have no angular nodes.
For 3s, Number of radial nodes = n - l -1 = 3- 0-1 =2
So,$3s$ has no angular node but has two radial nodes.
Hence, the correct answer is option (c).

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15. Given below are two statements :

Statement I : Bohr's theory accounts for the stability and the line spectrum of Li^{+} ion.

Statement II : Bohr's theory was unable to explain the splitting of spectral lines in the presence of a magnetic field.
In the light of the above statements. choose the most appropriate answer from the options given below.

A. Both statement I and statement II are true

B. Statement I is false but statement II is true

C. Both statement I and statement II are false

D. Statement I is true but statement II is false

Bohr's theory is applicable for unielectronic species only.
It is not applicable to multi electronic sytems like Li^{+} which has two electrons
Bohr's theory could not explain the splitting of spectral lines in the presence of external magnetic field (Zeeman effect)
Statement I - false
Statement II - true
Correct option is (b).

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16. A metal surface is exposed to 500 nm radiation. The threshold frequency of the metal for photoelectric current is $4.3 \times 10^{14} Hz$. The velocity of ejected electron is $\times 10^5\ ms^{-1}$. (Nearest integer)
[Use : $h = 6.63 \times 10^{-34} Js,\ m_e = 9.0 \times 10^{-31}\ kg$]

Accepted Answers

5 5.0 5.00

Solution:

$$h\nu = h\nu_0 + \frac{1}{2} m_e v^2$$
$$\frac{hc}{\lambda} = h\nu_0 + \frac{1}{2} m_e v^2$$

Here,
$\nu_0 =$ threshold frequency of the metal
h is planck's constant
$m_e$is mass of electron
v is velocity of ejected electron
Putting values:

$$\frac{6.63 \times 10^{-34} \times 3 \times 10^8}{500 \times 10^{-9}} = 6.63 \times 10^{-34} \times 4.3 \times 10^{14} + \frac{1}{2} \times 9 \times 10^{-31} \times v^2$$

$$v = 5 \times 10^5\ ms^{-1}$$

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17. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is equal to $\frac{h^2}{xma_0^2}$. The value of 10x is .

(a_0 is radius of Bohr's orbit) (Nearest integer)

[Given: $\pi = 3.14$]

Accepted Answers

31553155.03155.00

Solution:

Kinetic energy of an electron in nth orbit of Bohr atom :

$\frac{1}{2}mv^2 = \frac{(mv)^2}{2m}$

In Bohr's model,

$mvr = \frac{nh}{2\pi}$ or

$mv = \frac{nh}{2\pi r}$

$KE = \frac{n^2h^2}{8\pi^2mr^2}$

For 2nd orbit of H-atom

$n = 2 \text{ and } r = 4a_0$

$\therefore \quad KE = \frac{4h^2}{8\pi^2m \times 16a_0^2} = \frac{h^2}{315.5\, ma_0^2}$

$\therefore \quad x = 315.5;\ 10x = 3155$

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18. The number of photons emitted by a monochromatic (single frequency) infrared range finder of power 1 mW and wavelength of 1000 nm, in 0.1 second is $x \times 10^{13}$. The value of x is . (Nearest integer)
($h = 6.63 \times 10^{-34}\ Js,\ c = 3.00 \times 10^{8}\ ms^{-1}$)

Accepted Answers

50 50.0 50.00

Solution:

Power $= 1\ mW$
$= 10^{-3}\ J$ in 1 sec.
$= 10^{-4}\ J$ in 0.1 sec.

$\therefore\ \text{Energy} = \dfrac{nhc}{\lambda}$

$$10^{-4} = \frac{n \times 6.63 \times 10^{-34} \times 3 \times 10^{8}}{1000 \times 10^{-9}}$$

$n = 50.2 \times 10^{13}$
$\therefore\ \ x = 50$

19. The value of magnetic quantum number of the outermost electron of Zn^{+} ion is . (Integer answer)

Accepted Answers

0 0.0

Solution:

$Zn(30) = [Ar]4s^{2}3d^{10}$

$Zn^{+} = [Ar]4s^{1}3d^{10}$

Outermost electron is present in 4s
n = 4 l = 0 $m_1 = 0$

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20. A 50 watt bulb emits monochromatic red light of wavelength of 795 nm. The number of photons emitted per second by the bulb is $x \times 10^{20}$. The value of x is . (Nearest integer)
[Given: $h = 6.63 \times 10^{-34}\ Js$ and $c = 3.0 \times 10^{8}\ ms^{-1}$]

Accepted Answers

2 2.0 2.00

Solution:

$E = nh\nu = \dfrac{nhc}{\lambda}$
50 watt bulb emits 50 J energy per second.

$$50 = \frac{n \times 6.63 \times 10^{-34} \times 3 \times 10^{8}}{795 \times 10^{-9}}$$

$$n = \frac{50 \times 795 \times 10^{-9}}{6.63 \times 10^{-34} \times 3 \times 10^{8}}$$

$n = 2 \times 10^{20}$
Value of x =2

21. The Azimuthal quantum number for the valence electrons of Ga^{+} ion is . (Atomic number of Ga = 31)

Accepted Answers

0 0.0

Solution:

$Ga - 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^1$
$Ga - 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}$
$4s^2$ are the valence electrons,
So, azimuthal quantum l = 0.

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22. The wavelength of electrons accelerated from rest through a potential difference of 40 kV is $x \times 10^{-12} m$. The value of x is . (Nearest integer)
Given: Mass of electron $= 9.1 \times 10^{-31}\ kg$
Charge on an electron $= 1.6 \times 10^{-19}\ C$
Planck's constant $= 6.63 \times 10^{-34}\ Js$

Accepted Answers

6

Solution:

Wavelength $(\lambda)$of electron is given by

$$\lambda = \frac{h}{\sqrt{2mqV}}$$

Here
h is planck's constant
m is mass of electron
q is harge on electron
V is potential difference

Putting the values:

$$\lambda = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19} \times 40 \times 10^{3}}}$$

$$= \frac{6.63 \times 10^{-34}}{\sqrt{116.48 \times 10^{-46}}} = 6.144 \times 10^{-12} = 6 \times 10^{-12}$$

$x = 6$

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23. A source of monochromatic radiation of wavelength 400 nm provides 1000 J of energy in 10 seconds. When this radiation falls on the surface of sodium, $x \times 10^{20}$ electrons are ejected per second. Assume that wavelength 400 nm is sufficient for ejection of electron from the surface of sodium metal. The value of x is . (Nearest integer)
$(h = 6.626 \times 10^{-34}\ Js)$

Accepted Answers

2

Solution:

$$E = nh\nu = \frac{nhc}{\lambda}$$

$$1000 = \frac{n \times 6.626 \times 10^{-34} \times 3 \times 10^{8}}{400 \times 10^{-3}}$$

$$n = 20.122 \times 10^{20} \quad \text{photons incidented on metal surface in 10 seconds}$$
$$n = 2.0122 \times 10^{20} \quad \text{photon incidented on metal surface in 1 second}$$

Since wavelength required for electron ejection is same as incident radiation, number of electrons ejected is equal to number of photon incidented.
Value of X = 2

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24. An accelerated electron has a speed of $5 \times 10^6\ ms^{-1}$ with an uncertainty of 0.02%. The uncertainty in finding its location while in motion is $x \times 10^{-9}\ m$. The value of x is .
[Use mass of electron $= 9.1 \times 10^{-31}\ kg,\ h = 6.63 \times 10^{-34}\ Js,\ \pi 3.14$]

Accepted Answers

58 58.0 58.00

Solution:

Uncertainty in speed of electron $= \frac{0.02}{100} \times 5 \times 10^6$

$= 10^3\ ms^{-1}$

$m\Delta v \times \Delta x = \frac{h}{4\pi}$

$$\Delta x = \frac{6.63 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31} \times 10^3}$$

$= 5.80 \times 10^{-8} m = 58.00 \times 10^{-9}\ m$

Value of X =58

25. The number of orbital with $n = 5, m, = +2$ is/are: (Round off to the Nearest Integer)

Accepted Answers

3 3.0 3.00

Solution:

Possible values of $l = 4, 3, 2, 1, 0$
$m_l = 2$ is possible for $l = 4, 3$ & 2
as m_l takes values from $(-l \text{ to } l)$
∴ Possible orbitals (n, l, m_l) : $(5, 4, 2)\ (5, 3, 2)\ (5, 2, 2)$
Number of orbitals with $n = 5$ and $m_l = +2 = 3$

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1. Which of the following are isostructural pairs?

A. SO_4^{2-} and CrO_4^{2-}

B. $SiCl_4$ and $TiCl_4$

C. NH_3 and NO_3^-

D. BCl_3 and $BrCl_3$

A. A and C only

B. B and C only

C. A and B only

D. C and D only

Isostructural species are those which have the same shape.
SO_4^{2-} and CrO_4^{2-} have tetrahedral shape.
$SiCl_4$ and $TiCl_4$ have tetrahedral shape.
NH_3 has trigonal pyramidal shape but NO_3^- has trigonal planar shape.
BCl_3 has trigonal planar shape but $BrCl_3$ has T-shape.

So, option (c) is the correct answer.

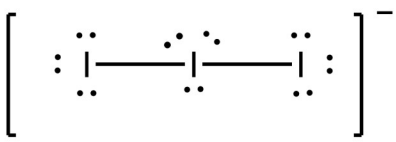
2. The correct shape and $[I—I—I]^-$ bond angles respectively in I_3^- ion are:

A. Distorted trigonal planar; 135° and 90°

B. Trigonal planar; 120°

C. T-shaped; 180° and 90°

D. Linear; 180°



Shape = Linear
Angle $\angle I-I-I$ is 180°.
Hence, option (d) is correct.

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3. According to molecular orbital theory, the species among the following that does not exist is:

A. He_2^-

B. Be_2

C. He_2^+

D. O_2^{2-}

Species with bond order equal to zero will not exist.

Species	Bond order
He_2^-	0.5
Be_2	0
He_2^+	0.5
O_2^{2-}	1

Hence, option (b) is correct answer.

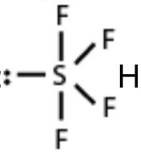
4. Which among the following species has unequal bond lengths?

A. XeF_4

B. BF_4^-

C. SF_4

D. SiF_4

SF_4 has trigonal bipyramidal geometry and see-saw shape as shown in below structure: 

Here, axial bonds are longer than equatorial bonds.

Thus, SF_4 has unequal bond length.
BF_4^-, SiF_4 have tetrahedral geometry where all bonds are equal in respective compounds.
XeF_4 has square planar shape where all four $Xe-F$ bonds are equal.
Hence, option (c) is the correct answer.

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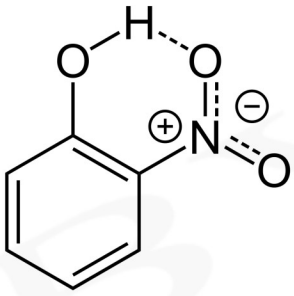
5. Given below are two statements:
Statement I: *o*-Nitrophenol is steam volatile due to intramolecular hydrogen bonding.
Statement II: *o*-Nitrophenol has high melting point due to hydrogen bonding.
In the light of the above statements, choose
the most appropriate answer from the
options given below:

A. Both statement I and statement II are true

B. Statement I is false but statement II is true

C. Statement I is true but statement II is false

D. Both statement I and statement II are false



It has intramolecular hydrogen bonding and steam volatile.

- Melting point is not effected by intramolecular hydrogen bonding but boiling point of a molecule decreases on intramolecular hydrogen bonding.

Hence, statement I is true, but statement II is false.

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6. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R

Assertion A: Dipole-dipole interactions are only non-covalent interactions, resulting in hydrogen bond formation.

Reason R: Fluorine is the most electronegative element and hydrogen bonds in HF are symmetrical.

In the light of the above statements, choose the most appropriate answer from the options given below:

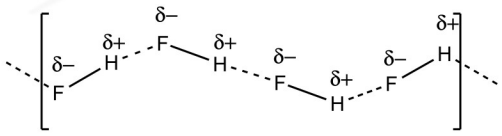
A. A is false but R is true

B. Both A and R are true and R is the correct explanation of A

C. A is true but R is false

D. Both A and R are true but R is NOT the correct explanation of A

- Dipole - Dipole are not only the interaction responsible for hydrogen bond formation. Ion-dipole can also be responsible for hydrogen bond formation.
- F is most electronegative element and anhydrous HF in solid phase has symmetrical hydrogen bonding. The strongest H-bonds are formed by F-atoms. Some hydrogen bonding also occurs in the gas, which consists of a mixture of cyclic $(HF)_6$ polymers, dimeric $(HF)_2$, and monomeric HF.



Hence, option (a) is the correct answer.

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7. Match list-I with list-II:

List-I (Molecule)	List-II (Bond order)
(a)Ne_2	(i) 1
(b)N_2	(ii) 2
(c)F_2	(iii) 0
(d)O_2	(iv) 3

Choose the correct answer from the options given below

A. $(a)-(iv);(b)-(iii);(c)-(ii);(d)-(i)$

B. $(a)-(ii);(b)-(i);(c)-(iv);(d)-(iii)$

C. $(a)-(i);(b)-(ii);(c)-(iii);(d)-(iv)$

D. $(a)-(iii);(b)-(iv);(c)-(i);(d)-(ii)$

List-I (Molecule)	List-II (Bond order)
(a)Ne_2	(iii) 0
(b)N_2	(iv) 3
(c)F_2	(i) 1
(d)O_2	(ii) 2

Hence, the correct option is (d).
$(a)-(iii);(b)-(iv);(c)-(i);(d)-(ii)$

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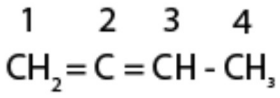
8. In given molecule,



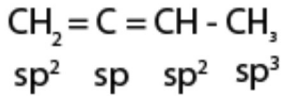
the hybridization of carbon 1, 2, 3 and 4 respectively, are :

A. sp^2, sp^2, sp^2, sp^3

B. sp^2, sp, sp^2, sp^3

C. sp^3, sp, sp^3, sp^3

D. sp^2, sp^3, sp^2, sp^3



Hybridization of carbon 1, 2, 3 and 4 respectively are sp^2, sp, sp^2 and sp^3.

Hence, the correct answer is option (b).

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9. Given below are two statements one is labelled as Assertion A and the other is labelled as Reason R.
Assertion A: The H — O — H bond angle in water molecule is 104.5°.
Reason R: The lone pair-lone pair repulsion of electrons is higher than the bond pair-bond pair repulsion.
In the light of the above statements, choose the correct answer from the options given below.

✗ **A.** A is false but R is true

✗ **B.** A is true but R is false

✓ **C.** Both A and R are true, and R is the correct explanation of A

✗ **D.** Both A and R are true, but R is not the correct explanation of A

The H — O — H bond angle in water molecule is 104.5° as shown above in the structure.
Repulsion between lone pair-lone pair electrons is higher than bond pair-bond pair electrons because bond pair electrons are stuck between two nuclei. So, option (c) is correct.

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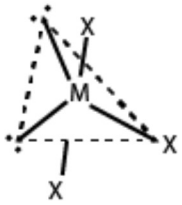
10. A central atom in a molecule has two lone pairs of electrons and forms three single bonds. The shape of this molecule is,

- ✗ **A.** Trigonal pyramidal
- ✗ **B.** See-saw
- ✓ **C.** T-shaped
- ✗ **D.** Trigonal planar

The shape of a molecule (MX_3) whose central atom (M) has two lone pairs of electrons and forms three single bonds is T-shaped.



11. Which of the following compound cannot act as a Lewis base?

- ✗ **A.** NF_3
- ✓ **B.** PCl_5
- ✗ **C.** ClF_3
- ✗ **D.** SF_4

Lewis bases are compound or ionic species which can donate a pair of electron.
PCl_5 cannot act as a lewis base because P has no lone pair of electrons hence it cannot acts as a base.
But NF_3 (3 B.P. + 1 L.P.) , ClF_3 (3 B.P. + 2 L.P.) and SF_4 (4 B.P. +1 L.P.) has lone pair of electrons so they will act as lewis base.
PCl_5 is a lewis acid because it has vacant orbitals to abstract electrons.
Hence, option (b) is the correct answer.

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12. Amongst the following, the linear species is

- A. N_3^-
- B. OCl_2
- C. O_3
- D. NO_2

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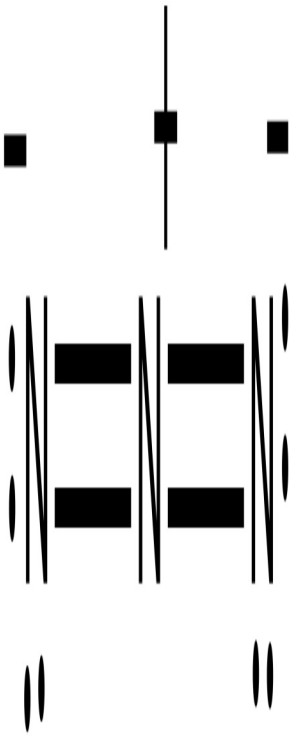
(a)N_3^-



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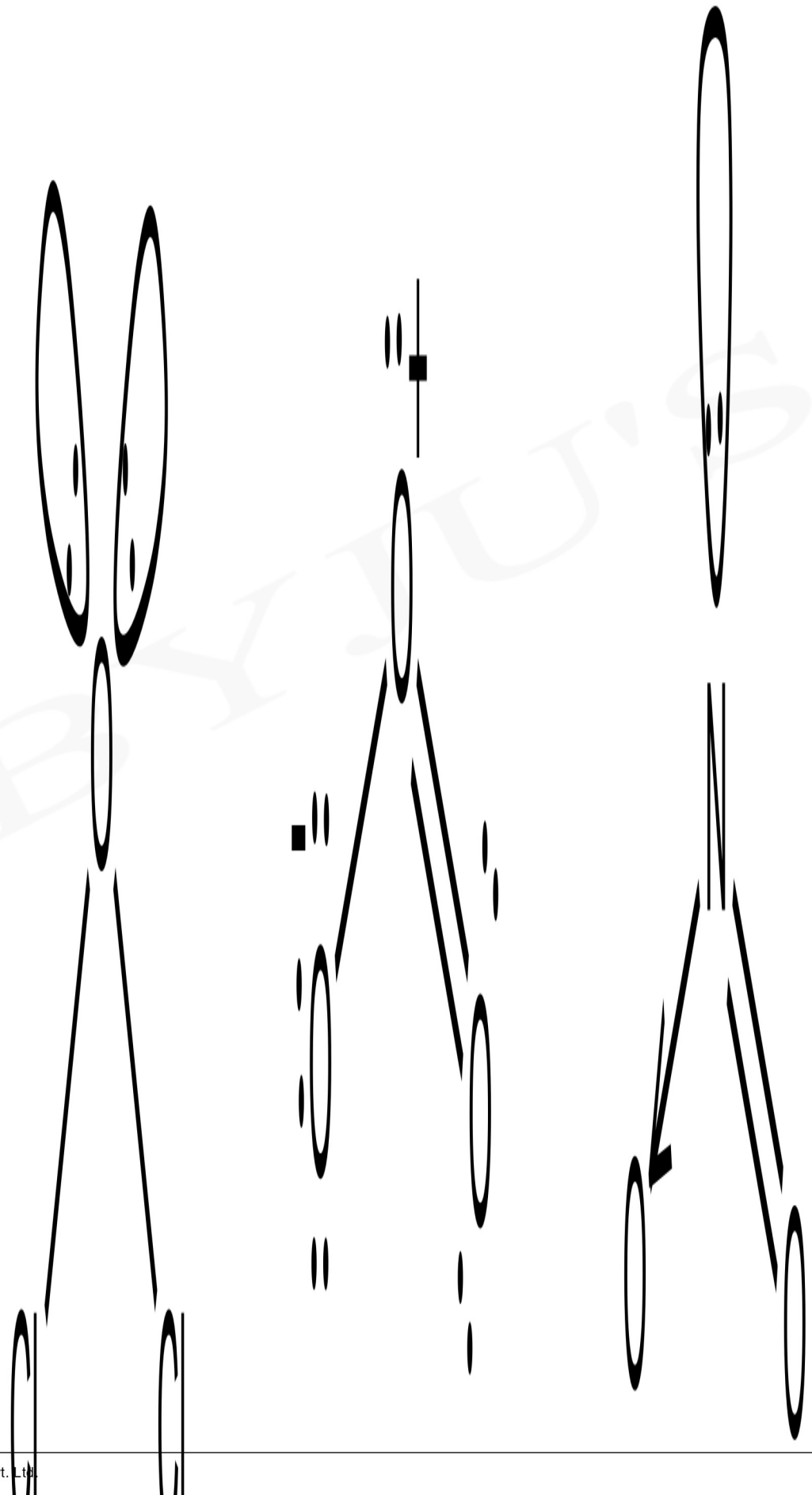

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(b) sp^3 (Bent) (c) sp^2 (Bent) (d) sp^2 (Bent)

Hence, only linear species is N_3^-.
Hence, option (a) is correct answer.

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13. The hybridizations of the atomic orbitals of nitrogen in NO_2^-, NO_2^+ and NH_4^+ respectively are,

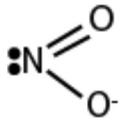
A. sp^3, sp^2 and sp

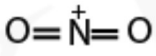
B. sp, sp^2 and sp^3

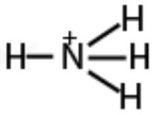
C. sp^2, sp and sp^3

D. sp^3, sp and sp^2

The type of hybridzation of atomic orbitals of nitrogen in the given species is,

NO_2^- : sp^2 

NO_2^+ : sp 

NH_4^+ : sp^3 

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14. Match List-I with List-II

List-I (Species)	List-II (Hybrid orbitals)
(a) SF_4	(i) sp^3d^2
(b) IF_5	(ii) d^2sp^3
(c) NO_2^+	(iii) sp^3d
(d) NH_4^+	(iv) sp^3
	(v) sp

Choose the correct answer from the options given below :

A. $(a)-(ii),(b)-(i),(c)-(iv),(d)-(v)$

B. $(a)-(iv),(b)-(iii),(c)-(ii),(d)-(v)$

C. $(a)-(i),(b)-(ii),(c)-(v),(d)-(iii)$

D. $(a)-(iii),(b)-(i),(c)-(v),(d)-(iv)$

SF_4- S is surrounded by 4 sigma bond pair and 1 lone pair. Thus, its steric number is 5. So it is sp^3d hybridised.

IF_5- I is surrounded by 5 sigma bond pair and 1 lone pair. Thus, its steric number is 6. So, it is sp^3d^2 hybridised.

NO_2^+- N has 2 sigma bond pair and no lone pair. Thus, its steric number is 2. So, it is sp hybridised.

NH_4^+- N has 4 sigma bond pair and no lone pair. Thus, its steric number is 4. So it is sp^3 hybridised.

Hence, option (d) is correct.

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15. In the following the correct bond order sequence is:

A. $O_2^+ > O_2^- > O_2^{2-} > O_2$

B. $O_2^+ > O_2 > O_2^- > O_2^{2-}$

C. $O_2^{2-} > O_2^+ > O_2^- > O_2$

D. $O_2 > O_2^- > O_2^{2-} > O_2^+$

Electronic configuration and bond order of the given species:

$O_2 : \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2 \sigma 2p_z^2\ \pi 2p_x^2 = \pi 2p_y^2\ \pi^* 2p_x^1 = \pi^* 2p_y^1$

$B.O. = 2$

$O_2^+ : \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2 \sigma 2p_z^2\ \pi 2p_x^2 = \pi 2p_y^2\ \pi^* 2p_x^1$

$B.O. = 2.5$

$O_2^- : \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2 \sigma 2p_z^2\ \pi 2p_x^2 = \pi 2p_y^2\ \pi^* 2p_x^2 = \pi^* 2p_y^1$

$B.O. = 1.5$

$O_2^{2-} : \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2 \sigma 2p_z^2\ \pi 2p_x^2 = \pi 2p_y^2\ \pi^* 2p_x^2 = \pi^* 2p_y^2$

$B.O. = 1.0$

∴Correct bond order sequence is,

$O_2^+ > O_2 > O_2^- > O_2^{2-}$

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16. AX is a covalent diatomic molecule where A and X are second row elements of periodic table. Based on molecular orbital theory, the bond order of AX is 2.5. The total number of
electrons in AX is
(Round off to the Nearest Integer).

Accepted Answers

15 15.0

Solution:

NO bond order :

$B.O. = \frac{1}{2}(N_b - N_a)$

NO :

$\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_z^2\ \pi 2p_x^2\ \pi 2p_y^2\ \pi^* 2p_x^1$

$B.O. = \frac{1}{2}(10 - 5) = 2.5$

The compound AX is NO its bond order is 2.5 and it has total 15 electrons.

Note: Total number of electrons equal to 13 will also have the 2.5 bond order. But in this case neutral diatomic molecule will not be possible.

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17. $SF_4, BF_4^-, ClF_3, AsF_3, PCl_5, BrF_5, XeF_4, SF_6$

The number of species that have two lone pairs of electrons in their central atom is/are

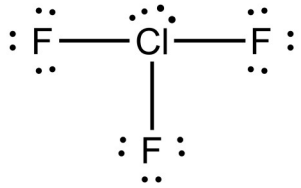
Accepted Answers

2 2.0 2.00

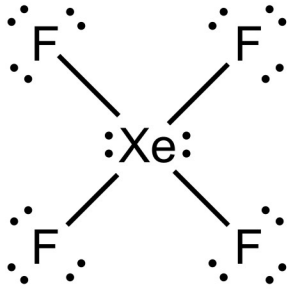
Solution:

Species	No. of lone pair of electron present on central atom
SF_4	1
BF_4^-	0
ClF_3	2
AsF_3	1
PCl_5	0
BrF_5	1
XeF_4	2
SF_6	0

ClF_3 has T-shape



XeF_4 has Square planar shape



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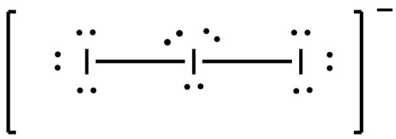
18. The number of lone pairs of electrons on the central I-atom in I_3^- is

Accepted Answers

3

Solution:



Central iodine has 3 lone pair of electrons.

19. The difference between bond orders of CO and NO^+ is $\frac{x}{2}$ where x is (Round off to the Nearest Integer)

Accepted Answers

0 0.0

Solution:

Bond order of $CO = 3$

$\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_z^2\ \pi 2p_x^2\ \pi 2p_y^2$

$B.O. = \frac{10-4}{2} = 3$

NO^+ :

$B.O. = \frac{8-2}{2} = 3$

Difference = 3 - 3 = 0

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20. In gaseous triethylamine the$''-C-N-C-''$ bond angle is degree.

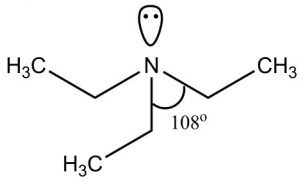
Accepted Answers

108 108.0 108.00

Solution:

In triethylamine, nitrogen has 3 bonds pairs and 1 lone pair, so by VSEPR theory, it is sp^3 hybridised and bond angle is 108^o.

Pyramidal shape of triethylamine:



21. The total number of electrons in all bonding molecular orbitals of O_2^{2-} is (Round off to the Nearest Integer).

Accepted Answers

10

Solution:

O_2^{2-}

$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^2 = \pi^* 2p_y^2$

Total number of electrons in bonding molecular orbitals is $= 10$

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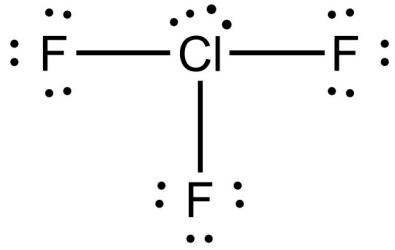
22. AB_3 is an interhalogen T- shaped molecule. The number of lone pairs of electrons on A is

Accepted Answers

2 2.0

Solution:

Example of the compound of the type AB_3 which is T-shaped is ClF_3



Number of lone pairs of electrons on central atom = 2

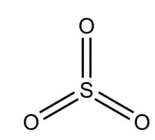
23. The number of species having non-pyramidal shape among the following is _____.

$(A) SO_3$
$(B) NO_3^-$
$(C) PCl_3$
$(D) CO_3^{2-}$

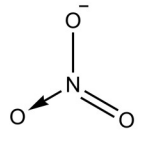
Accepted Answers

3 3.0 3.00

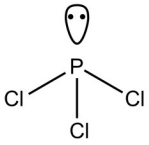
Solution:



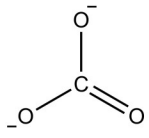
Trigonal planar



Trigonal planar



Pyramidal



Trigonal planar

Thus, answer is 3.

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24. According to molecular orbital theory, the number of unpair electrons(s) in O_2^{2-} is

Accepted Answers

0 0.0

Solution:

Electro configuration of O_2^{2-} (according to MOT) is
$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^2 = \pi^* 2p_y^2$
Total unpaired electrons in O_2^{2-} is zero.

25. The spin only magnetic moment value of B_2^+ species is $x \times 10^{-2}\ B.M.$.
[Given : $\sqrt{3} = 1.73$] x is : (Nearest integer)

Accepted Answers

173 173.0 173.00

Solution:

According to MOT, electronic configuration of B_2^+ is

$\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \begin{matrix} \pi 2p_x^1 \\ \pi 2p_y \end{matrix}\ \sigma 2p_z$

It has one unpaired electron.
(μ) Spin - only magnetic moment $= \sqrt{n(n+2)} B.M.$

$n =$ Number of unpaired electrons

$\mu = \sqrt{1(1+2)}\ B.M.$

$\mu = 1.73\ B.M.$

$\mu = 173 \times 10^{-2}\ B.M.$
$x = 173$

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