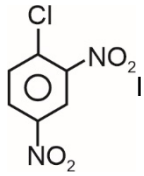
CHEMISTRY

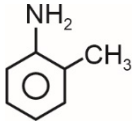
SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. Consider following statements:

Statement-I:  IUPAC name is 4-chloro-1, 3-dinitrobenzene.

Statement-II:  IUPAC name is 2-methylaniline.

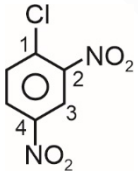
(1) Both statement-I and statement-II are correct

(2) Statement-I is correct, statement-II is incorrect

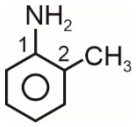
(3) Statement-I is incorrect, statement-II is correct

(4) Both statement-I and statement-II are incorrect

Answer (3)

Sol. Statement-I  1-chloro-2,4-dinitrobenzene

$\Rightarrow$ Statement-I is incorrect

Statement-II  2-methyl aniline

$\Rightarrow$ Statement-II is correct

2. We have two complexes $[Fe(H_2O)_6]^{2+}$ and $[Cu(H_2O)_6]^{2+}$, the magnetic properties respectively are

(1) Diamagnetic and Diamagnetic

(2) Paramagnetic and Paramagnetic

(3) Diamagnetic and Paramagnetic

(4) Paramagnetic and Diamagnetic

Answer (2)

Sol. $[Fe(H_2O)_6]^{2+} \Rightarrow Fe^{2+} \Rightarrow 3d^6 \Rightarrow t_{2g}^4 eg^2 \Rightarrow n = 4$

Paramagnetic

$[Cu(H_2O)_6]^{2+} \Rightarrow Cu^{+2} \Rightarrow 3d^9 \Rightarrow t_{2g}^6 eg^3 \Rightarrow n = 1$

paramagnetic

3. Match the following

	Column-I (Molecule)		**Column-II (Shape)**
(i)	NH_3	(p)	Trigonal bipyramidal
(ii)	BrF_5	(q)	Tetrahedral
(iii)	PCl_5	(r)	Pyramidal
(iv)	CCl_4	(s)	Square pyramidal

(1) (i)-(q), (ii)-(p), (iii)-(s), (iv)-(r)

(2) (i)-(s), (ii)-(r), (iii)-(q), (iv)-(p)

(3) (i)-(r), (ii)-(s), (iii)-(p), (iv)-(q)

(4) (i)-(r), (ii)-(s), (iii)-(q), (iv)-(p)

Answer (3)

Sol. $NH_3 \rightarrow$ Pyramidal (sp^3)

$BrF_5 \rightarrow$ Square pyramidal (sp^3d^2)

$PCl_5 \rightarrow$ Trigonal bipyramidal (sp^3d)

$CCl_4 \rightarrow$ Tetrahedral (sp^3)

4. Statement-I : Stability of +1 oxidation state increases as Ga< In < Tl

Statement-II : Stability of +1 oxidation state increases down the group due to inert pair effect.

(1) Statement-I and Statement-II both are correct

(2) Statement-I and Statement-II both are incorrect

(3) Statement-I is correct and Statement-II is incorrect

(4) Statement-I is incorrect and Statement-II is correct

Answer (1)

Sol. +1 oxidation state for group 13 elements increases down the group due to inert pair effect.

5. $CoCl_3.xNH_3$ on reaction with excess $AgNO_3$(aq.) gives two mole of AgCl as precipitate. Summation of oxidation state of Co in $CoCl_3.xNH_3$ and x is :

(1) 7 (2) 8

(3) 9 (4) 10

Answer (2)

Sol. $CoCl_3.xNH_3 \xrightarrow{AgNO_3} 2AgCl\downarrow$

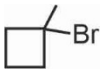
So, one Cl-atom is inside co-ordination sphere.

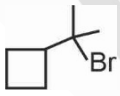
$\left[\overset{+3}{Co}(NH_3)_5Cl\right]Cl_2$

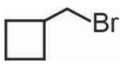
$\Rightarrow$ x = 5

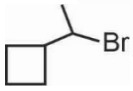
So, (O.N. + x) = 5 + 3 = 8

6. The molecule which will undergo S_N2 reaction with the fastest rate?

(1) 

(2) 

(3) 

(4) 

Answer (3)

Sol. Rate of S_N2 increases with decrease in steric hinderance near the leaving group.

 : 1° halide : least hindered

7. $x \rightleftharpoons y$; $k_1 = 1$

$y \rightleftharpoons z$; $k_2 = 2$

$z \rightleftharpoons w$; $k_3 = 4$

Find k_{eq} for $x \rightleftharpoons w$

(1) 12 (2) 8

(3) 2 (4) 4

Answer (2)

Sol. $x \rightleftharpoons y$; $k_1 = 1$ …(i)

$y \rightleftharpoons z$; $k_2 = 2$ …(ii)

$z \rightleftharpoons w$; $k_3 = 4$ …(iii)

On adding equation (i), (ii) and (iii)

$x \rightleftharpoons w$

$k_{eq} = k_1 \times k_2 \times k_3$

$= 1 \times 2 \times 4 = 8$

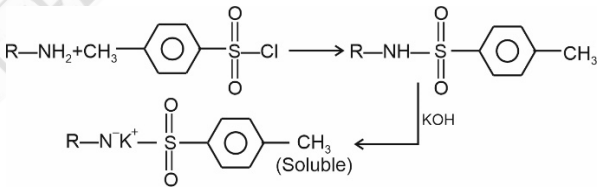
8. Which of the following compounds will not give Hinsberg's Test?

(1) $NH_2—NH—\overset{\overset{O}{\|}}{C}—NH_2$ (2) $CH_3—\overset{\overset{O}{\|}}{C}—NH_2$

(3) $CH_3—CH_2—NH_2$ (4) $CH_3—NH—CH_3$

Answer (2)

Sol. Hinsberg's Test is



9. Electron and proton have same de-Broglie wavelength. What is the ratio of their kinetic energy $\left(\text{i.e. } \frac{KE_e}{KE_P} = ?\right)$ $\left(\text{Given } \frac{M_e}{M_P} = \frac{1}{1836}\right)$

(1) 1836 (2) $\sqrt{1836}$

(3) $\frac{1}{1836}$ (4) $\frac{1}{\sqrt{1836}}$

Answer (1)

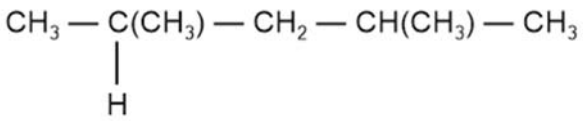
Sol. $\lambda_e = \lambda_P$

$$\Rightarrow \frac{h}{\sqrt{2M_e KE_e}} = \frac{h}{\sqrt{2M_P KE_P}}$$

$$\Rightarrow (M_e \times KE_e) = (M_P \times KE_P)$$

$$\frac{KE_e}{KE_P} = \frac{M_P}{M_e} = 1836$$

10. Total number of secondary carbon atom present in given compound is

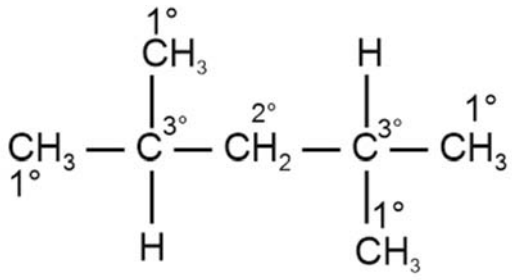


(1) 1 (2) 2

(3) 3 (4) 4

Answer (1)

Sol.



11. Which one of the following statements regarding D-Glucose is incorrect?

(1) It does not give Schiff's test.

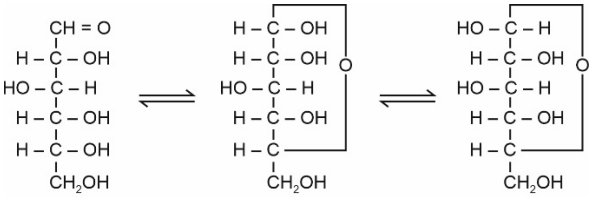
(2) It has asymmetrical C-atoms.

(3) It forms a dicarboxylic acid on reaction with Br_2 water

(4) In aqueous solution it exists as an equilibrium mixture of two anomeric forms.

Answer (3)

Sol. D-Glucose is an aldohexose which mainly exists in two cyclic anomeric forms. Since aldehyde group is not free, it does not give Schiff's test.



It has asymmetrical C-atom and is dextrorotatory. Br_2 water oxidises glucose to monocarboxylic acid called gluconic acid. In aqueous solution it exists as an equilibrium mixture of α- and β-anomers.

12. One mole of monoatomic gas and one mole of diatomic gas is present in a mixture. Find out ratio of heat capacities at constant volume and constant pressure $\left(i.e.\ \frac{C_v}{C_P}\right)$

(1) $\frac{2}{3}$ (2) $\frac{7}{5}$

(3) $\frac{5}{7}$ (4) $\frac{3}{5}$

Answer (1)

Sol. $C_v = \frac{1\left(\frac{3R}{2}\right)+1\left(\frac{5R}{2}\right)}{2}$

$$= \frac{8R}{4} = 2R$$

$$C_p = \frac{1\left(\frac{5R}{2}\right)+1\left(\frac{7R}{2}\right)}{2}$$

$$= \frac{12R}{4} = 3R$$

$$\frac{C_v}{C_P} = \frac{2R}{3R}$$

$$= \frac{2}{3}$$

13. Which of the following has all paired electrons in t_{2g}?

(1) $[Cr(H_2O)_6]^{3+}$ (2) $[Co(H_2O)_6]^{2+}$

(3) $[Co(H_2O)_6]^{3+}$ (4) $[Fe(H_2O)_6]^{2+}$

Answer (3)

Sol. $[Cr(H_2O)_6]^{3+} \Rightarrow Cr^{+3} \Rightarrow 3d^3 \Rightarrow d^2sp^3 \Rightarrow t_{2g}^3 e_g^0$

$[Co(H_2O)_6]^{2+} \Rightarrow Co^{+2} \Rightarrow 3d^7 \Rightarrow sp^3d^2 \Rightarrow t_{2g}^5 e_g^2$

$[Co(H_2O)_6]^{3+} \Rightarrow Co^{3+} \Rightarrow 3d^6 \Rightarrow d^2sp^3 \Rightarrow t_{2g}^6 e_g^0$

$[Fe(H_2O)_6]^{2+} \Rightarrow Fe^{2+} \Rightarrow 3d^6 \Rightarrow sp^3d^2 \Rightarrow t_{2g}^4 e_g^2$

In $[Co(H_2O)_6]^{3+}$ all electron are present in t_{2g} set t_{2g} set have all paired electrons.

14. Which of the following will undergo disproportionation reaction in aqueous alkaline medium?

(1) I_2, Cl_2 only (2) F_2, Cl_2 only

(3) I_2, Br_2 only (4) Cl_2, Br_2, I_2 only

Answer (4)

Sol. $\overset{\circ}{X}_2(aq) + \underset{\text{(Cold and diluted)}}{OH^{\ominus}} \longrightarrow \overset{-1}{X^{\ominus}}(aq) + \overset{+1}{XO^{\ominus}}(aq)$

$\overset{\circ}{X}_2 + \underset{\text{(Hot and Conc.)}}{OH^{\ominus}} \longrightarrow \overset{-1}{X^{\ominus}}(aq) + \overset{+5}{XO_3^{\ominus}}(aq)$

[X = Cl, Br or I]

15. Match the List-I (Complexes) with List-II (Colour) and choose the correct option.

	List-I (Complex)		List-II (Colour)
(i)	$Fe_4[Fe(CN)_6]_3$	(A)	Red
(ii)	$[Fe(SCN)]^{2+}$	(B)	Green
(iii)	$FeSO_4 \cdot 7H_2O$	(C)	Prussian blue

(1) (i)-(C), (ii)-(A), (iii)-(B)

(2) (i)-(B), (ii)-(A), (iii)-(C)

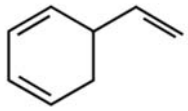
(3) (i)-(A), (ii)-(B), (iii)-(C)

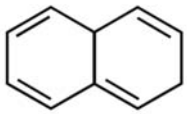
(4) (i)-(C), (ii)-(B), (iii)-(A)

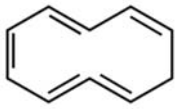
Answer (1)

Sol. (i)-(C), (ii)-(A), (iii)-(B)

16. Which of the following molecules is aromatic?

(1) 

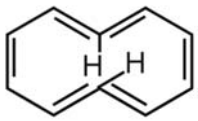
(2) 

(3) 

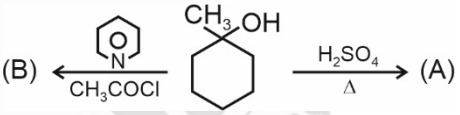
(4) 

Answer (4)

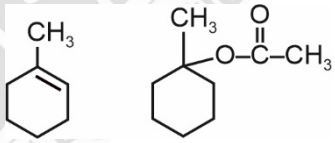
Sol. In (1) & (2) there is no cyclic delocalisation in (3) the two ring changes its plane due to hinderance of the two H-atoms:

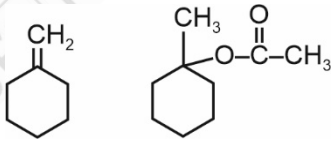


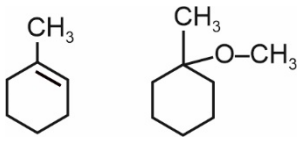
In (4) all conditions are present for aromaticity.

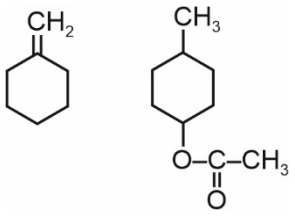
17. (B) 

Product (A) and (B) are respectively:

(1) 

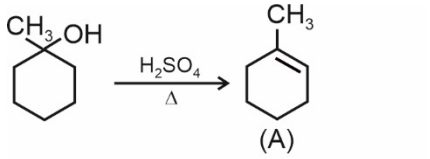
(2) 

(3) 

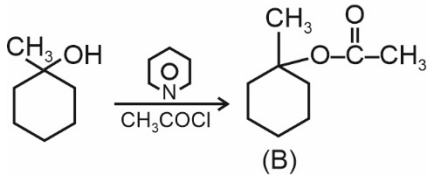
(4) 

Answer (1)

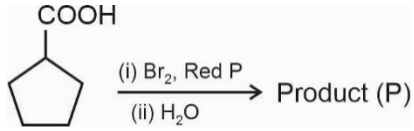
Sol.



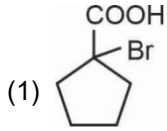
(A)

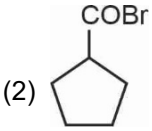


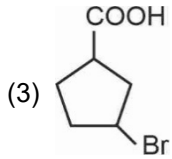
(B)

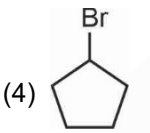
18. 

The product (P) is :

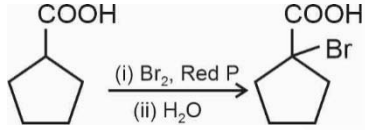
(1) 

(2) 

(3) 

(4) 

Answer (1)

Sol. 

This is HVZ reaction

19. Which of the following reaction(s) is/are correct?

(a) $Fe^{3+} + I^- \longrightarrow I_2 + Fe^{2+}$

(b) $Fe^{3+} + I^- \longrightarrow FeI_3$

(c) $Fe^{2+} + S_2O_8^{2-} \longrightarrow Fe + 2SO_4^{2-}$

(d) $Fe^{2+} + S_2O_8^{2-} \longrightarrow Fe^{3+} + 2SO_4^{2-}$

(1) (a) only (2) (b) and (c) only

(3) (a) and (d) only (4) (b) and (d) only

Answer (3)

Sol. Fe^{3+} ions oxidises I^- ions to I_2 and itself gets reduced to Fe^{2+} ions

$2Fe^{3+} + 2I^- \longrightarrow I_2 + 2Fe^{2+}$

Fe^{2+} ions are oxidised by $S_2O_8^{2-}$ to Fe^{3+} ions and Itself gets reduced to SO_4^{2-} ions

$2Fe^{2+} + S_2O_8^{2-} \longrightarrow 2Fe^{3+} + 2SO_4^{2-}$

20. Match the following

	Column-I	Column-II
(i)	Borax bead test	(a) $MCO_3 \xrightarrow[\Delta]{HCl} MCl_2 + CO_2 + H_2O$
(ii)	Cobalt nitrate test	(b) $Na_2B_4O_7 + Co^{2+} \rightarrow Co(BO_2)_2$
(iii)	Flame test	(c) $HgO + C \rightarrow Hg + CO$
(iv)	Charcoal cavity test	(d) $CoO + ZnO \rightarrow CoO.ZnO$

(1) i-(d), ii-(c), iii-(b), iv-(a)

(2) i-(b), ii-(d), iii-(a), iv-(c)

(3) i-(a), ii-(b), iii-(c), iv-(d)

(4) i-(d), ii-(b), iii-(a), iv-(c)

Answer (2)

Sol. Borox bead test :

$Na_2B_4O_7 + Co^{2+} \xrightarrow{\Delta} \underset{\text{Blue}}{Co(BO_2)_2}$

Cobalt nitrate test :

$CoO + ZnO \longrightarrow \underset{\text{Green}}{CoO.ZnO}$

Flame test :

$MCO_3 \xrightarrow[\Delta]{HCl} MCl_2 + CO_2 + H_2O$: Flame test

$\underset{\text{Brick red}}{M^{2+} : Ca^{2+}}$, $\underset{\text{Crimson red}}{Sr^{2+}}$, $\underset{\text{Apple green}}{Ba^{2+}}$

Charcoal cavity test :

$\underset{\text{Red}}{HgO(s)} + \text{Charcoal} \longrightarrow \underset{\text{Silver grey}}{Hg} + CO$

SECTION - B

Numerical Value Type Questions: This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Find the spin only magnetic moment (nearest integer) of M in MO_4^{2-}, M being the atom having least atomic radii among Sc, Ti, V, Cr, Mn, Zn

Answer (0)

Sol. Radii $\rightarrow$ Sc > Ti > Mn $\simeq$ Zn > V > Cr

So, M is Cr.

$\overset{+6}{Cr}O_4^{2-}$: $\overset{+6}{Cr} \rightarrow [Ar]4s^0 3d^0 \Rightarrow$ zero unpaired electron

$\mu_{spin} = 0$

22. A solution contains 100 g water and 10 g of AB_2. The boiling point of solution was found to be 100.52°C. The degree of dissociation of $AB_2(\alpha)$ = _____$\times 10^{-1}$

$$\left[\text{MW of } AB_2 = \frac{200\text{ g}}{\text{mol}}; K_b = 0.52\frac{K\cdot kg}{\text{mole}}\right]$$

Answer (5)

Sol. ΔT_b = (i) (.52) (m)

$$0.52 = (i)\,(0.52)\left(\frac{10(10)}{(200)(1)}\right)$$

i = 2

$2 = 1 + 2\alpha$

$1 = 2\alpha$

$\alpha = 0.5$

23. Find the mass (in g) of O_2 required for the complete combustion of 900 g glucose.

Answer (960)

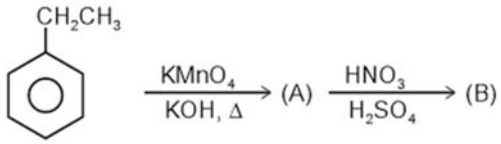
Sol. Glucose has molecular formula = $C_6(H_2O)_6$ or $C_6H_{12}O_6$

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

$$\text{Moles of glucose} = \frac{900}{180} = 5$$

Hence moles of O_2 required = 5 × 6 = 30

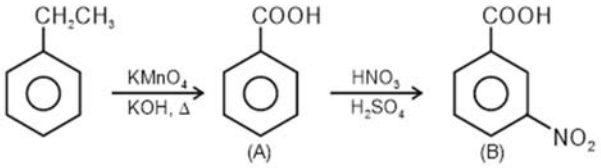
Mass (in g) of O_2 required = 30 × 32 = 960

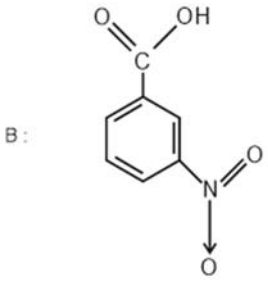
24. 

The number of π–bonds in product (B) is

Answer (5)

Sol.





No. of π-bonds = 5

25. Find out magnitude of work done on the gas at 18°C when 1 mole of an ideal gas undergoes compression from 9 litre to 1 litre through a reversible isothermal process (in joule) (Nearest integer). (Take log3 = 0.48)

Answer (5349)

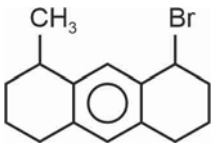
Sol. W = 2.303 × (1) × (8.314) × (291) log9

= (2.303) (8.314) (291) (0.48) (2)

= 4981.2 joule

$\approx$ 5349 J

26. Find the number of optical isomers of the following compound.



Answer (4)

Sol. The given structure has two chiral centres without possibility of symmetry hence optical isomers $2^n = 2^2 = 4$

27. Consider the reaction.

$$A + B \rightarrow C$$

Time taken by A to become $\frac{1}{4^{th}}$ of initial concentration is twice the time taken by it to become $\frac{1}{2}$ of its same concentration. Rate of change of [B] with time gives an equation, whose slope is negative and intercept is positive. The overall order of reaction is

Answer (1)

Sol. For I order kinetics, $t_{75\%} = 2 \times t_{50\%}$

Therefore, order w.r.t. [A] = 1

For zero order kinetics,

$$[R]_t = [R]_0 - kt$$

Negative slope and positive intercept

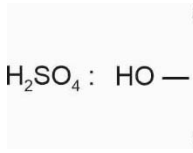
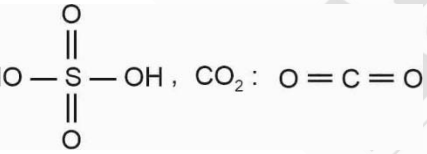
Therefore, order w.r.t. [B] = 0

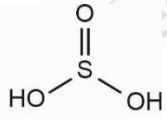
Overall order = 0 + 1 = 1

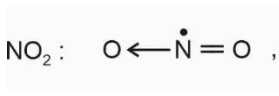
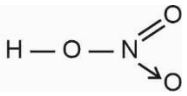
28. How many of the given compounds follow(s) octet rule?

H_2SO_4, CO_2, SO_2, SO_3, H_2SO_3, NO_2, HNO_3

Answer (2)

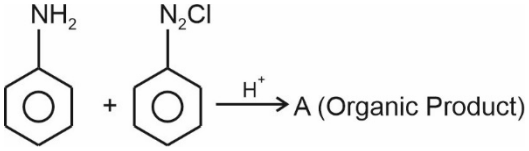
Sol. H_2SO_4 :  , CO_2 : 

SO_2 :  , H_2SO_3 : 

NO_2 :  , HNO_3 : 

Only CO_2 and HNO_3 follow octet rule.

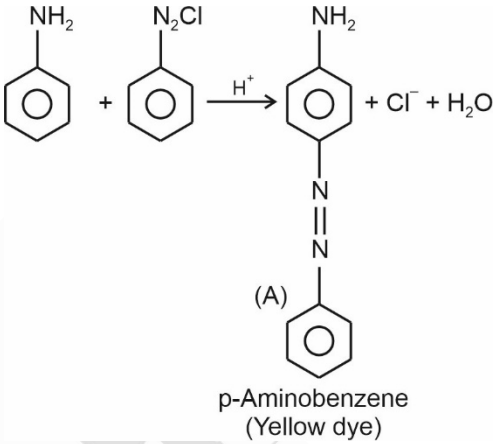
29. Consider the following reaction



What is the mass of nitrogen (in g) in one mole A?

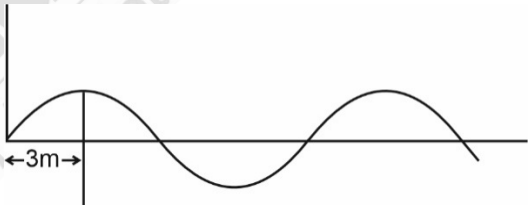
Answer (42)

Sol.



One mole A has three mole nitrogen atoms hence mass of nitrogen in 1 mole A = 14 × 3 = 42 g

30. Frequency of following electromagnetic wave is given by _____ × 10^6 Hz.



Answer (25)

Sol. $\lambda = 12$ m

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^8}{12}$$

$$= \frac{1}{4} \times 10^8$$

$$= 0.25 \times 10^8$$

$$= 25 \times 10^6 \text{ Hz}$$