

16. There is force field  $\vec{F} = x^3y\hat{i} + y^2\hat{j}$  in which a particle moves along the line  $x = y$ . Find work done by the force as the particle moves from (0, 0) to (2, 2)

- (1)  $\frac{173}{15}$                       (2)  $\frac{136}{15}$   
(3)  $\frac{139}{17}$                       (4)  $\frac{171}{17}$

**Answer (2)**

**Sol.**  $w = \int_0^2 x^4 dx + \int_0^2 y^2 dy = \frac{2^5}{5} + \frac{2^3}{3} = \frac{136}{15}$

17. In a radioactive decay, decay constant of element  $A_2$  is 3 times that of element  $A_1$ . Find the ratio of nuclei of element 1 to element 2 after one half life of  $A_2$

(Assume initial number of nuclei are same for both elements)

- (1)  $2^{1/3}$   
(2)  $2^{2/3}$   
(3) 2  
(4)  $2^{5/3}$

**Answer (2)**

**Sol.**  $N_1 = N_0 e^{-\lambda_1 t}$

$N_2 = N_0 e^{-\lambda_2 t}$

$\frac{N_1}{N_2} = e^{-(\lambda_1 - \lambda_2)t}$

$e^{-(\lambda - 3\lambda) \frac{\ln 2}{3\lambda}}$

$= e^{\frac{2}{3} \ln 2}$

$= 2^{2/3}$

18.

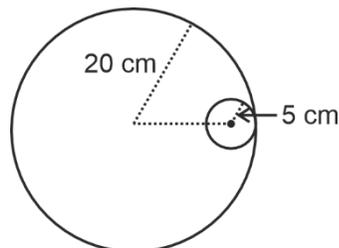
19.

20.

**SECTION - B**

**Numerical Value Type Questions:** This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. From a uniform circular disc of radius 20 cm a circular portion of radius 5 cm is removed. The shift in the position of centre of mass (in cm).



**Answer (1)**

**Sol.**  $X_{com} = \frac{-\frac{M}{16} \times 15 \text{ cm}}{M - \frac{M}{16}}$   
 $= \frac{-\frac{M}{16} \times 15 \text{ cm}}{15 \frac{M}{16}}$   
 $= -1 \text{ cm}$

22. A bullet of kinetic energy of 125 J strikes a lead block where temperature rises by 50°C. If specific heat of lead is 0.1 J/g°C then mass of lead block is (Assume half of kinetic energy of bullet is converted to heat)  $m$  gram then  $2m$  is

**Answer (25)**

**Sol.**  $Q = ms\Delta T \Rightarrow \frac{125}{2} = m \times 0.1 \times 50$

$m = \frac{125}{10} = 12.5 \text{ gm}$

23.

24.

25.

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## 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.

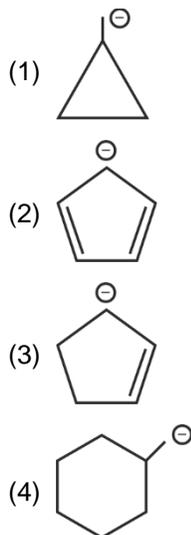
**Choose the correct answer :**

1. Which of the following compound can react with Hinsberg reagent?
- (A) Aniline  
(B) N,N-Dimethyl aniline  
(C) Methyl amine  
(D) N-phenyl aniline
- (1) A only                      (2) A and C only  
(3) A, C and D                (4) A and B only

**Answer (3)**

**Sol.** Primary and secondary amines reacts with Hinsberg reagent.

2. Among the following, the most stable carbanion is



**Answer (2)**

**Sol.** Only  is aromatic in the given options hence most stable.

3. Which of the following compound can show fac-mer isomerism?
- (1)  $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$   
(2)  $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$   
(3)  $[\text{Co}(\text{en})_2(\text{NH}_3)_2]\text{Cl}_3$   
(4)  $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$

**Answer (2)**

**Sol.**  $[\text{Ma}_3\text{b}_3]$  type complex compound can show fac-mer isomerism. Where a, b are monodentate ligands.

4. Which of the following pair of ions have same colour?
- (1)  $\text{Ti}^{4+}$ ,  $\text{V}^{3+}$   
(2)  $\text{Cr}^{2+}$ ,  $\text{Cu}^{2+}$   
(3)  $\text{Cr}^{3+}$ ,  $\text{Ni}^{2+}$   
(4)  $\text{Mn}^{3+}$ ,  $\text{Fe}^{2+}$

**Answer (2)**

$\text{Ti}^{4+}$ = Colourless	;	$\text{Cr}^{2+}$ = Blue
$\text{V}^{3+}$ = Green	;	$\text{Cu}^{2+}$ = Blue

$\text{Cr}^{3+}$ = Violet	;	$\text{Mn}^{3+}$ = Violet
$\text{Ni}^{2+}$ = Green	;	$\text{Fe}^{2+}$ = Green

5. Which of the following does not belong to the same period in the modern periodic table?
- (1) Pd                                      (2) Ir  
(3) Pt                                        (4) Os

**Answer (1)**

**Sol.** Os, Ir, Pt belongs to 6<sup>th</sup> period, while Pd belongs to 5<sup>th</sup> period of modern periodic table.

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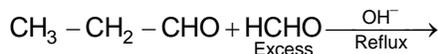
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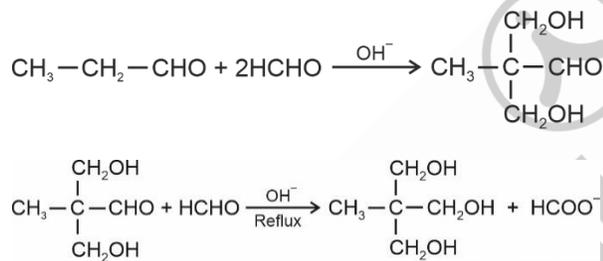
6. Identify the product formed in the following reaction



- (1)  $\text{CH}_3 - \underset{\text{CH}_2\text{OH}}{\overset{\text{CH}_2\text{OH}}{\text{C}}} - \text{CH}_2\text{OH}$       (2)  $\text{CH}_3 - \underset{\text{CH}_2}{\overset{\text{C}}{=}} - \text{CHO}$
- (3)  $\text{CH}_3 - \underset{\text{CH}_2\text{OH}}{\text{CH}} - \text{CHO}$       (4)  $\text{CH}_3 - \underset{\text{CH}_2\text{OH}}{\overset{\text{CH}_2\text{OH}}{\text{C}}} - \text{CHO}$

**Answer (1)**

**Sol.** Propanal undergoes aldol condensation with excess of HCHO in presence of OH<sup>-</sup> ions to 2, 2-dihydroxymethylpropanal which further reacts with HCHO and undergoes Cannizzaro reaction to give 2, 2-dihydroxymethylpropan-1-ol.



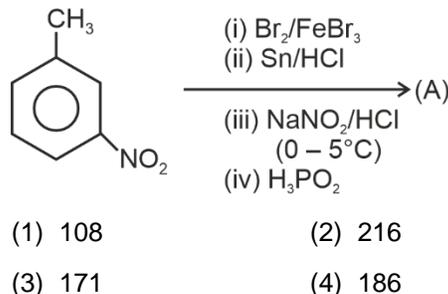
7. Incorrect statement among the following is

- (1) SO<sub>2</sub> act as oxidising agent but not reducing agent
- (2) NO<sub>2</sub> exists as dimer
- (3) PF<sub>5</sub> exists but NF<sub>5</sub> does not
- (4) PH<sub>3</sub> has lower proton affinity than NH<sub>3</sub>

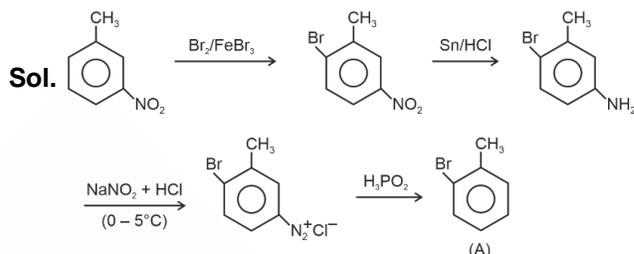
**Answer (1)**

**Sol.** SO<sub>2</sub> is oxidising as well as reducing agent as sulphur exists in +4 oxidation state.

8. Consider the following sequence of reactions and find the molecular mass of the final product (A) formed in g mol<sup>-1</sup>.



**Answer (3)**



Molecular mass of (A) = 171 g mol<sup>-1</sup>

9. Match the Column I with Column II and choose the correct option.

	Column I		Column II
A.	BF <sub>3</sub>	(i)	Odd e <sup>-</sup> species
B.	CCl <sub>4</sub> , CO <sub>2</sub>	(ii)	Expanded octet
C.	PCl <sub>5</sub> , BrF <sub>5</sub>	(iii)	Complete octet
D.	NO	(iv)	Electron deficient

- (1) A – (iii), B – (iv), C – (i), D – (ii)
- (2) A – (iv), B – (ii), C – (iii), D – (i)
- (3) A – (iv), B – (iii), C – (ii), D – (i)
- (4) A – (i), B – (ii), C – (iii), D – (iv)

**Answer (3)**

**Sol.** • BF<sub>3</sub> ⇒ 6 e<sup>-</sup> in central atom, octet incomplete, e<sup>-</sup> deficient

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- $\text{CCl}_4, \text{CO}_2 \Rightarrow 8e^-$  in central atom  $\Rightarrow$  Complete octet
- $\text{PCl}_5 \Rightarrow 10e^-$  in central atom,  $\text{BrF}_5 \Rightarrow 12e^-$  in central atom  
 $\therefore \text{PCl}_5, \text{BrF}_5 = \text{Expanded octet}$
- $\text{NO} \Rightarrow$  It is an odd electron species  $\left[ \cdot \ddot{\text{N}} = \ddot{\text{O}} \right]$   
 $\Rightarrow 1 \text{ odd } e^- \text{ is present}$

10. Match the column and choose the correct option

	Column-I		Column-II
(A)	$\xrightarrow[\text{D.E.}]{\text{Na}}$ $\text{Cl}$	(P)	Sandmeyer reaction
(B)	$\xrightarrow[\text{HCl}]{\text{CuCl}}$ $\text{Cl}^-$	(Q)	Fittig reaction
(C)	$\text{Cl} + \text{CH}_3 - \text{Cl} \xrightarrow[\text{D.E.}]{\text{Na}}$	(R)	Wurtz-Fittig reaction
(D)	$\text{CH}_3 - \text{Cl} + \text{AgF} \rightarrow$	(S)	Swarts reaction

- (1) (A) – (Q), (B) – (P), (C) – (R), (D) – (S)  
 (2) (A) – (Q), (B) – (P), (C) – (S), (D) – (R)  
 (3) (A) – (Q), (B) – (R), (C) – (S), (D) – (P)  
 (4) (A) – (P), (B) – (Q), (C) – (R), (D) – (S)

**Answer (1)**

**Sol.**  $2\text{Ph} - \text{Cl} \xrightarrow[\text{D.E.}]{\text{Na}} \text{Ph} - \text{Ph}$  (Fittig reaction)

$\text{Ph} - \text{N}_2\text{Cl} \xrightarrow[\text{HCl}]{\text{CuCl}} \text{Ph} - \text{Cl}$  (Sandmeyer reaction)

$\text{Ph} - \text{Cl} + \text{CH}_3\text{Cl} \xrightarrow[\text{D.E.}]{\text{Na}} \text{Ph} - \text{CH}_3$  (Wurtz Fittig reaction)

$\text{CH}_3 - \text{Cl} + \text{AgF} \rightarrow \text{CH}_3\text{F}$  (Swarts reaction)

11.  $\text{Co}^{2+}$  is forming an octahedral complex with spin only magnetic moment 3.83 BM. The correct electronic configuration for cobalt in the complex is?

- (1)  $t_{2g}^5 e_g^2$   
 (2)  $t_{2g}^6 e_g^1$   
 (3)  $t_{2g}^4 e_g^3$   
 (4)  $e^4 t_2^3$

**Answer (1)**

**Sol.** Since  $\text{Co}^{2+}$  has spin only magnetic moment = 3.83 BM

$\text{Co}^{2+} = 3d^7$ ;  $\boxed{\uparrow\downarrow} \boxed{\uparrow\downarrow} \boxed{\uparrow} \boxed{\uparrow} \boxed{\uparrow}$

$\mu = 3.83 \text{ BM}$ , means it has 3 unpaired electrons, so ligand should be WFL.

So electronic configuration is  $t_{2g}^5 e_g^2$ .

12. Given below are two statements :

**Statement-I** : During Lassaigne's test, covalent compound is converted to ionic compound.

**Statement-II** :  $\text{Na}_4[\text{Fe}(\text{CN})_6]$  gives Prussian blue colour on reaction with  $\text{Fe}_2(\text{SO}_4)_3$ .

- (1) S-I is correct, S-II is incorrect  
 (2) S-I is incorrect, S-II is correct  
 (3) Both S-I and S-II are correct  
 (4) Both S-I and S-II are incorrect

**Answer (3)**

**Sol.**  $3\text{Na}_4[\text{Fe}(\text{CN})_6] + 2\text{Fe}_2(\text{SO}_4)_3 \rightarrow \text{Fe}_4[\text{Fe}(\text{CN})_6]_3 + 6\text{Na}_2\text{SO}_4$   
 (Prussian blue)

$\therefore$  Both S-I and S-II are correct.

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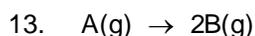
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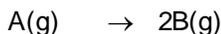
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For the given reaction, initial pressure was 0.6 atm and rate constant is  $4.606 \times 10^{-2} \text{ sec}^{-1}$ . Find the pressure at 100 sec

- (1) 0.6 atm                      (2) 1.194 atm  
(3) 0.594 atm                  (4) 0.006 atm

**Answer (2)**



**Sol.**  $t = 0$                       0.6  
 $t = 100 \text{ sec.}$               0.6 - p                  2p

$$kt = 2.303 \log \frac{0.6}{0.6 - p}$$

$$4.606 \times 10^{-2} \times 100 = 2.303 \log \frac{0.6}{0.6 - p}$$

$$(0.6 - p)100 = 0.6$$

$$60 - 100p = 0.6$$

$$p = 0.594 \text{ atm}$$

$$\begin{aligned} \text{Total pressure} &= 0.6 + p \\ &= 0.6 + 0.594 \\ &= 1.194 \text{ atm} \end{aligned}$$

14. Consider the following statements and choose the correct option.

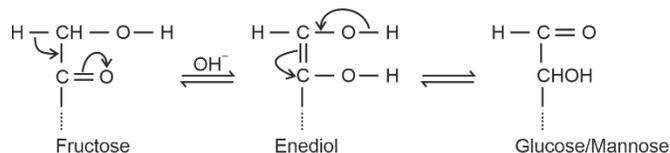
Statement-I: Fructose does not contain aldehyde group but it gives Tollen's test.

Statement-II: In disaccharides, if the reducing groups are bonded, these are non-reducing sugar e.g., sucrose. If these functional groups are free then they are reducing sugar e.g. maltose and Lactose.

- (1) Statement-I and Statement-II are correct  
(2) Statement-I is correct and Statement-II is incorrect  
(3) Statement-I in incorrect Statement-II is correct  
(4) Statement-I and Statement-II both are incorrect

**Answer (1)**

**Sol.** Fructose has  $\alpha$ -hydroxy ketone group which tautomerises to aldehyde group in presence of base. Therefore, it reduces Tollen's reagent.



Sucrose is non reducing sugar because the aldehyde group of glucose and ketonic group of function are bounded. Maltose and Lactose are reducing sugar.

15. For a sample of Hydrogen atom, the wavelength observed is 656 nm during a transition. The transition and corresponding series in hydrogen spectrum will be

- (1)  $3 \rightarrow 2$ , Balmer              (2)  $4 \rightarrow 1$ , Lyman  
(3)  $5 \rightarrow 2$ , Balmer              (4)  $4 \rightarrow 3$ , Paschen

**Answer (1)**

**Sol.**  $\frac{1}{\lambda} = R_H Z^2 \left[ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$

$$\frac{1}{656 \times 10^{-7}} = 109677 \times (1)^2 \times \left[ \frac{1}{2^2} - \frac{1}{n_2^2} \right] \text{ cm}^{-1}$$

$$0.139 = 0.25 - \frac{1}{n_2^2}$$

$$\frac{1}{n_2^2} = 0.111$$

$$n_2 = 3$$

16.  
17.  
18.  
19.  
20.

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