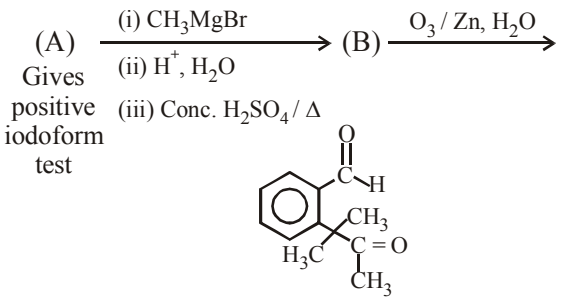
FINAL JEE–MAIN EXAMINATION – JANUARY, 2020

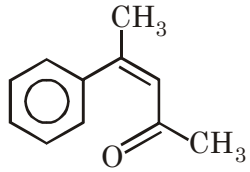
(Held On Thursday 09th JANUARY, 2020) TIME : 9 : 30 AM to 12 : 30 PM

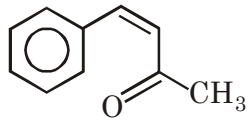
CHEMISTRY

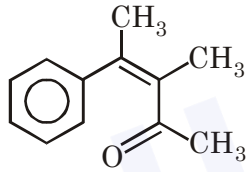
TEST PAPER WITH ANSWER & SOLUTION

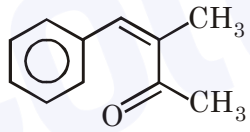
1. Identify (A) in the following reaction sequence :



(1) 

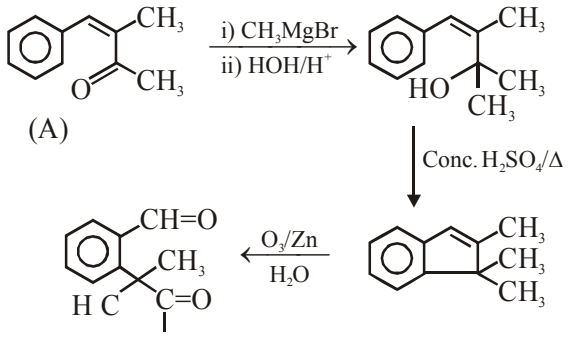
(2) 

(3) 

(4) 

NTA Ans. (4)

Sol.



2. For the following reactions

$$A \xrightarrow{700\,K} \text{Product}$$

$$A \xrightarrow[\text{catalyst}]{500\,K} \text{Product}$$

it was found that E_a is decreased by 30 kJ/mol in the presence of catalyst.

If the rate remains unchanged, the activation energy for catalysed reaction is (Assume pre exponential factor is same):

(1) 135 kJ/mol (2) 105 kJ/mol

(3) 198 kJ/mol (4) 75 kJ/mol

NTA Ans. (4)

Sol. $K_1 = Ae^{-\frac{Ea}{R\times700}}$

$K_2 = A\times e^{-\frac{(Ea-30)}{R\times500}}$

For same rate

$K_1 = K_2$

$e^{-\frac{Ea}{700R}} = e^{-\frac{(Ea-30)}{R\times500}}$

$\frac{Ea}{700R} = \frac{Ea-30}{R\times500}$

$5Ea = 7Ea - 210$

$210 = 2Ea$

$E_a = 105$ kJ/mole

$E_a - 30 = 75$

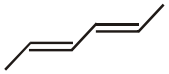
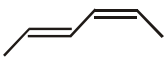
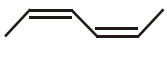
3. The correct order of heat of combustion for following alkadienes is :

(a)  (b)  (c) 

(1) (a) < (b) < (c) (2) (b) < (c) < (a)

(3) (c) < (b) < (a) (4) (a) < (c) < (b)

NTA Ans. (1)

Sol. (a)  (b)  (c) 

(Trans, Trans) (Trans, Cis) (Cis, Cis)

$\therefore$ Generally trans is more stable then cis form.

Heat of combustion (HOC) $\propto \frac{1}{\text{Stability}}$

4. A chemist has 4 samples of artificial sweetener A, B, C and D. To identify these samples, he performed certain experiments and noted the following observations :

(i) A and D both form blue-violet colour with ninhydrin.

(ii) Lassaigne extract of C gives positive $AgNO_3$ test and negative $Fe_4[Fe(CN)_6]_3$ test.

(iii) Lassaigne extract of B and D gives positive sodium nitroprusside test

Based on these observations which option is correct ?

(1) A : Aspartame ; B : Saccharin ; C : Sucralose ; D ; Alitame

(2) A : Alitame ; B : Saccharin ; C : Aspartame ; D ; Sucralose

(3) A : Saccharin ; B : Alitame ; C : Sucralose ; D ; Aspartame

(4) A : Aspartame ; B : Alitame ; C : Saccharin ; D ; Sucralose

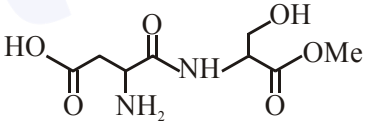
NTA Ans. (1)

Sol. (i) Blue voilet color with Ninhydrine → amino acid derivative. So it cannot be saccharide or sucralose.

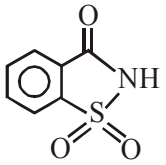
(ii) Lassaigne extract give +ve test with $AgNO_3$. So Cl is present, –ve test with $Fe_4[Fe(CN)_6]_3$ means N is absent. So it can't be Aspartame or Saccharine or Alitame, so C is sucralose.

(iii) Lassaigne solution of B and D given +ve sodium nitroprusside test, so it is having S, so it is Saccharine and Alitame.

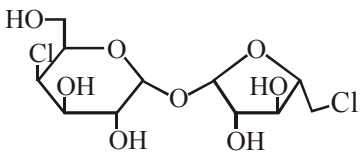
(A) Aspartame

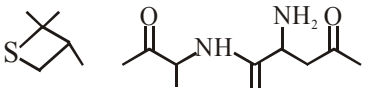


(B) Saccharine



(C) Sucralose





5. 'X' melts at low temperature and is a bad conductor of electricity in both liquid and solid state. X is :

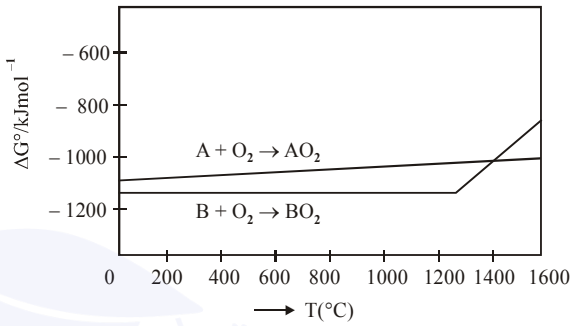
(1) Carbon tetrachloride (2) Mercury

(3) Silicon carbide (4) Zinc sulphide

NTA Ans. (1)

Sol. CCl_4 is molecular solid so does not conduct electricity in liquid & solid state.

6. According to the following diagram, A reduces BO_2 when the temperature is :



(1) < 1400 °C

(2) > 1400 °C

(3) < 1200 °C

(4) > 1200 °C but < 1400 °C

NTA Ans. (2)

Sol. A reduces BO_2 when temperature is above 1400°C because above 1400°C A has more –ve $\Delta G°$ for AO_2 formation than B to BO_2 formation.

7. The K_{sp} for the following dissociation is 1.6×10^{-5}

$$PbCl_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2Cl^-_{(aq)}$$

Which of the following choices is correct for a mixture of 300 mL 0.134 M $Pb(NO_3)_2$ and 100 mL 0.4 M NaCl ?

(1) $Q < K_{sp}$

(2) $Q > K_{sp}$

(3) $Q = K_{sp}$

(4) Not enough data provided

NTA Ans. (2)

Sol. $\left[Pb^{2+}\right] = \dfrac{300 \times 0.134}{400} = 1.005 \times 10^{-1}$ M

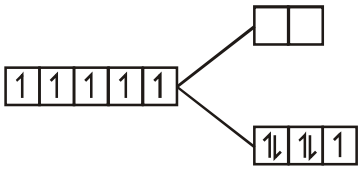
$\left[Cl^-\right] = \dfrac{100 \times 0.4}{400} = 10^{-1}$ M

$$PbCl_{2(s)} \rightleftharpoons Pb^{+2}_{(aq.)} + 2Cl^-_{(aq.)}$$

8. $[Pd(F)(Cl)(Br)(I)]^{2-}$ has n number of geometrical isomers. Then, the spin-only magnetic moment and crystal field stabilisation energy [CFSE] of $[Fe(CN)_6]^{n-6}$, respectively, are:
[Note : Ignore the pairing energy]
(1) 2.84 BM and $-1.6\ \Delta_0$
(2) 1.73 BM and $-2.0\ \Delta_0$
(3) 0 BM and $-2.4\ \Delta_0$
(4) 5.92 BM and 0

NTA Ans. (2)

Sol. $[Pb(F)(Cl)(Br)(I)]^{2-}$ have three geometrical isomer so formula for $[Fe(CN)_6]^{n-6}$ is $[Fe(CN)_6]^{3-}$ and CFSE for this complex is $Fe^{3\oplus} \Rightarrow 3d^5 4s^\circ$



Magnetic Moment = $\sqrt{3}$
= 1.73 B.M
CFSE = $[(-0.4\times5) + (0.6 \times 0)]\ \Delta_0$
$= -2.0\ \Delta_0$

9. If the magnetic moment of a dioxygen species is 1.73 B.M, it may be :
(1) O_2^- or O_2^+
(2) O_2 or O_2^+
(3) O_2 or O_2^-
(4) O_2, O_2^- or O_2^+

NTA Ans. (1)

Sol.

	number of unpaired electron	magnetic moment
$O_2^{\ominus}$	1	1.73 B.M
$O_2^{\oplus}$	1	1.73 B.M
O_2	2	2.83 BM

10. If enthalpy of atomisation for $Br_{2(l)}$ is x kJ/mol and bond enthalpy for Br_2 is y kJ/mol, the relation between them :
(1) is x = y (2) is x < y
(3) does not exist (4) is x > y

NTA Ans. (4)

Sol. Enthalpy of atomisation of $Br_2(l)$

$$Br_2(l) \xrightarrow{\Delta H_{vap}} Br_2(g) \xrightarrow{\Delta H_{BE}} 2Br(g)$$
$$\Delta H_{atom.}$$

$\Delta H_{atom} = \Delta H_{vap} + \Delta H_{BE}$
$x = \Delta H_{vap} + y$
So, x > y

11. The increasing order of basicity for the following intermediates is (from weak to strong)

(i) $H_3C - \overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{\overset{|}{\underset{|}{C^{\ominus}}}}}$

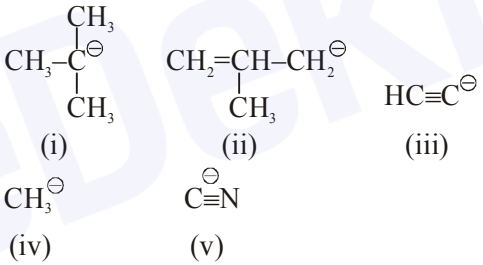
(ii) $H_2C = CH - \overset{\ominus}{C}H_2$

(iii) $HC\equiv\overset{\ominus}{C}$ (iv) $\overset{\ominus}{C}H_3$ (v) $\overset{\ominus}{C}N$

(1) (v) < (i) < (iv) < (ii) < (iii)
(2) (iii) < (i) < (ii) < (iv) < (v)
(3) (v) < (iii) < (ii) < (iv) < (i)
(4) (iii) < (iv) < (ii) < (i) < (v)

NTA Ans. (3)

Sol.



Basic strength order : (i) > (iv) > (ii) > (iii) > (v)

12. B has a smaller first ionization enthalpy than Be. Consider the following statements :
(I) It is easier to remove 2p electron than 2s electron
(II) 2p electron of B is more shielded from the nucleus by the inner core of electrons than the 2s electrons of Be.
(III) 2s electron has more penetration power than 2p electron.
(IV) atomic radius of B is more than Be
(Atomic number B = 5, Be = 4)
The correct statements are :
(1) (I), (II) and (III)
(2) (II), (III) and (IV)
(3) (I), (III) and (IV)

Sol. Be $\Rightarrow 1s^2\ 2s^2$

$B \Rightarrow 1s^2\ 2s^2\ 2p^1$

B has a smaller size than Be

it is easier to remove 2p electron than 2s electron due to less pentration effect of 2p than 2s.

2p electron of Boron is more shielded from the nucleus by the inner core of electron than the 2s electron of Be

B has a smaller size than Be

13. The acidic, basic and amphoteric oxides, respectively, are :

(1) MgO, Cl_2O, Al_2O_3

(2) Cl_2O, CaO, P_4O_{10}

(3) Na_2O, SO_3, Al_2O_3

(4) N_2O_3, Li_2O, Al_2O_3

NTA Ans. (4)

Sol. 1. MgO Basic

Cl_2O Acidic

Al_2O_3 amphoteric

2. Cl_2O Acidic

CaO Basic

P_4O_{10} Acidic

3. Na_2O Basic

SO_3 Acidic

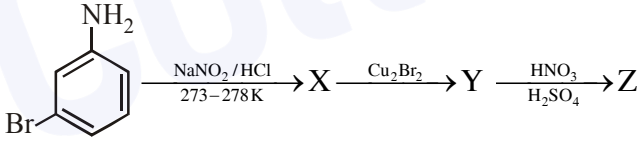
Al_2O_3 amphoteric

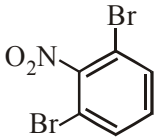
4. N_2O_3 Acidic

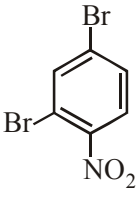
Li_2O Basic

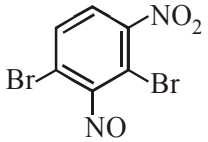
Al_2O_3 amphoteric

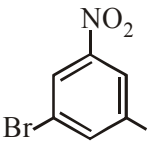
14. The major product Z obtained in the following reaction scheme is :



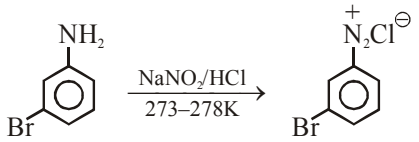
(1) 

(2) 

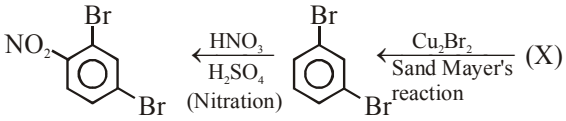
(3) 

(4) 

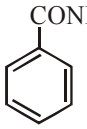
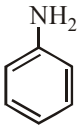
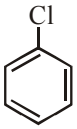
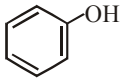
Sol.



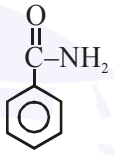
(Diazotisation) (m-Bromo benzene diazonium chloride)

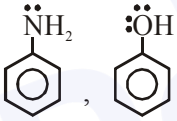


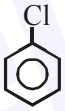
15. Which of these will produce the highest yield in Friedel Crafts reaction?

(1)  (2)  (3)  (4) 

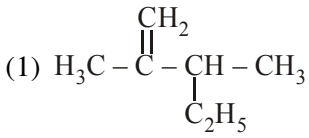
NTA Ans. (3)

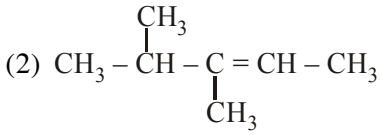
Sol. $\therefore$  (Deactivated ring due to –R effect of amide)

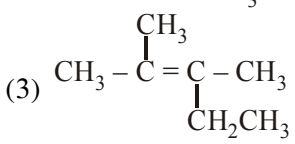
 (l.p.e. of $-NH_2$ and $-\ddot{O}H$ group do acid-base reaction with lewis acid $AlCl_3$, so ring is deactivated)

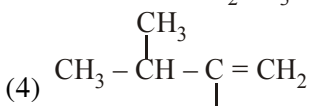
 (Highest yield produced)

16. The major product (Y) in the following reactions is :

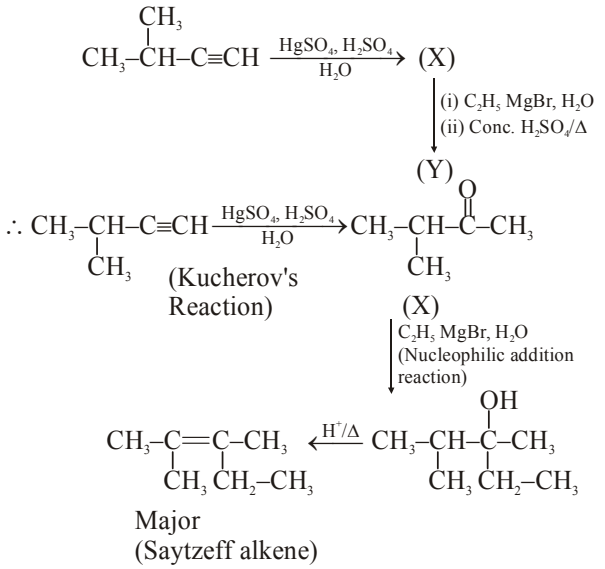
(1) 

(2) 

(3) 

(4) 

Sol.



17. Complex X of composition $Cr(H_2O)_6Cl_n$ has a spin only magnetic moment of 3.83 BM. It reacts with $AgNO_3$ and shows geometrical isomerism. The IUPAC nomenclature of X is :

(1) Tetraaquadichlorido chromium (III) chloride dihydrate

(2) Hexaaqua chromium (III) chloride

(3) Dichloridotetraaqua chromium (IV) chloride dihydrate

(4) Tetraaquadichlorido chromium(IV) chloride dihydrate

NTA Ans. (1)

Sol. $Cr(H_2O)_6\ Cl_n$

if magnetic mement is 3.83 BM then it contain three unpaired electrons. It means chromium in +3 oxidation state so molecular formula is $Cr(H_2O)_6\ Cl_3$

$\therefore$ This formula have following isomers

(a) $[Cr(H_2O)_6]Cl_3$: react with $AgNO_3$ but does not show geometrical isomerism.

(b) $[Cr(H_2O)_5Cl]Cl_2.H_2O$ react with $AgNO_3$ but does not show geometrical isomerism.

(c) $[Cr(H_2O)_4Cl_2]Cl.2H_2O$ react with $AgNO_3$ & show geometrical isomerism.

(d) $[Cr(H_2O)_3Cl_3].3H_2O$ does not react with $AgNO_3$ & show geometrical isomerism.

$[Cr(H_2O)_4Cl_2]Cl.2H_2O$ react with $AgNO_3$ & show geometrical isomerism and it's IUPAC nomenclature is Tetraaquadichlorido

18. The compound that cannot act both as oxidising and reducing agent is :

(1) H_2O_2 (2) H_2SO_3

(3) HNO_2 (4) H_3PO_4

NTA Ans. (4)

Sol. (i) H_2O_2 act as oxidising agent as well as reducing agent depending on condition.

(ii) H_2SO_3 act as oxidising agent as well as reducing agent depending on condition.

(iii) HNO_2 act as oxidising agent as well as reducing agent depending on condition.

(iv) H_3PO_4 can not act both as oxidising and reducing agent.

H_3PO_4 can act as only oxidising agent.

$H_3PO_4 \rightleftharpoons 3H^+ + PO_4^{3-}$

19. The de Broglie wavelength of an electron in the 4^{th} Bohr orbit is :

(1) $8\pi a_0$

(2) $2\pi a_0$

(3) $4\pi a_0$

(4) $6\pi a_0$

NTA Ans. (1)

Sol. $2\pi r = n\lambda$

for $n = 1,\ r = a_0$

$n = 4,\ r = 16a_0$

So, $2\pi \times 16a_0 = 4 \times \lambda$

$\lambda = 8\pi a_0$

20. The electronic configurations of bivalent europium and trivalent cerium are

(atomic number : Xe = 54, Ce = 58, Eu = 63)

(1) [Xe] $4f^4$ and [Xe] $4f^9$

(2) [Xe] $4f^7$ and [Xe] $4f^1$

(3) [Xe] $4f^7\ 6s^2$ and [Xe] $4f^2\ 6s^2$

(4) [Xe] $4f^2$ and [Xe] $4f^7$

NTA Ans. (2)

Sol. $Eu_{63} \Rightarrow$ [Xe] $4f^7\ 5d^\circ\ 6s^2$

$Eu^{2\oplus} \Rightarrow$ [Xe] $4f^7$

$Ce_{58} \Rightarrow$ [Xe] $4f^1\ 5d^1\ 6s^2$

$Ce^{3\oplus} \Rightarrow$ [Xe] $4f^1$

21. The hardness of a water sample containing 10^{-3} M $MgSO_4$ expressed as $CaCO_3$ equivalents (in ppm) is _____.

(molar mass of $MgSO_4$ is 120.37 g/mol)

Sol. 1 Litre has 10^{-3} moles $MgSO_4$

So , 1000 litre has 1 mole $MgSO_4$

= 1 mole $CaCO_3$

= 100 ppm

22. The molarity of HNO_3 in a sample which has density 1.4 g/mL and mass percentage of 63% is _____. (Molecular Weight of HNO_3 = 63)

NTA Ans. (14.00)

Sol. 100 gm soln $\rightarrow$ 63 gm HNO_3

$$\frac{100}{1.4}\text{mL} \rightarrow 1 \text{ mole } HNO_3$$

$$\text{Molarity} = \frac{1}{\frac{100}{1.4}\times\frac{1}{1000}} = 14\text{M}$$

23. 108 g of silver (molar mass 108 g mol^{-1}) is deposited at cathode from $AgNO_3$(aq) solution by a certain quantity of electricity. The volume (in L) of oxygen gas produced at 273 K and 1 bar pressure from water by the same quantity of electricity is _____.

NTA Ans. (5.66 to 5.68)

Sol. gm eq. of Ag = $\frac{108}{108}$ = 1

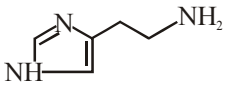
gm eq. of $O_2(g) = 1$

Volume of $O_2(g) = 22.7\times\frac{1}{4}$ = 5.675 litre

24. The mass percentage of nitrogen in histamine is _____.

NTA Ans. (37.80 to 38.20)

Sol.



M.F. of Histamine is $C_5H_9N_3$

Molecular mass of Histamine is 111

Now, mass % of nitrogen = $\left(\frac{42}{111}\right)\times 100$

= 37.84%

25. How much amount of NaCl should be added to 600 g of water (ρ = 1.00 g/mL) to decrease the freezing point of water to – 0.2 °C ? _____. (The freezing point depression constant for water = 2K kg mol^{-1})

NTA Ans. (1.74 to 1.76 or 0.03)

Sol. $\Delta T_f = i\times m\times K_f$

$$0.2 = 2\times 2\times \frac{w/58.5}{600/1000}$$

w = 1.755 gm