FINAL JEE–MAIN EXAMINATION – JANUARY, 2020

(Held On Wednesday 08th JANUARY, 2020) TIME : 9 : 30 AM to 12 : 30 PM

CHEMISTRY

TEST PAPER WITH SOLUTION

1. A flask contains a mixture of isohexane and 3-methylpentane. One of the liquids boils at 63°C while the other boils at 60°C. What is the best way to seprate the two liquids and which one will be distilled out first?

(1) simple distillation, 3-methylpentane

(2) simple distillation, isohexane

(3) fractional distillation, isohexane

(4) fractional distillation, 3-methylpentane

NTA Ans. (3)

Sol. Liquid which have less difference in boiling point can be isolated by fractional distillation and liquid with less boiling point will be isolated first.

2. The first ionization energy (in kJ/mol) of Na, Mg, Al and Si respectively, are :

(1) 496, 737, 577, 786

(2) 786, 737, 577, 496

(3) 496, 577, 737, 786

(4) 496, 577, 786, 737

NTA Ans. (1)

Sol. Elecronic configuration of Na = [Ne] $3s^1$

Mg = [Ne] $3s^2$

Al = [Ne] $3s^2 3p^1$

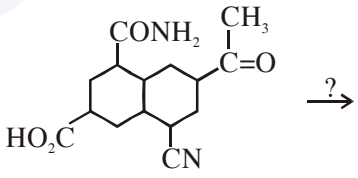
Si = [Ne] $3s^2 3p^2$

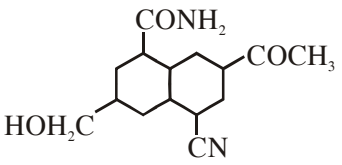
So order of first ionisation energy is

$$\underset{496}{Na} < \underset{737}{Mg} > \underset{577}{Al} < \underset{786}{Si} \text{ kj/mol}$$

Na < Al < Mg < Si (IE_1 order)

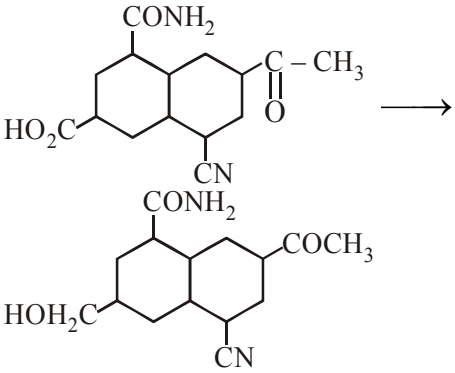
3. The most suitable reagent for the given conversion is :





(1) $LiAlH_4$ (2) $NaBH_4$

Sol.



Most suitable reagent for given conversion is B_2H_6 (electrophilic reducing agent)

4. The third ionization enthalpy is minimum for :

(1) Fe

(2) Ni

(3) Co

(4) Mn

NTA Ans. (1)

Sol. Electronic configuration of

	$_{25}Mn$	$_{26}Fe$	$_{27}Co$	$_{28}Ni$
M =	$[Ar]3d^5 4s^2$	$[Ar]3d^6 4s^2$	$[Ar]3d^7 4s^2$	$[Ar]3d^8 4s^2$
M^{2+} =	$[Ar]3d^5 4s^0$	$[Ar]3d^6 4s^0$	$[Ar]3d^7 4s^0$	$[Ar]3d^8 4s^0$

So third ionisation energy is minimum for Fe.

5. The predominant intermolecular forces present in ethyl acetate, a liquid, are :

(1) hydrogen bonding and London dispersion

(2) Dipole-dipole and hydrogen bonding

(3) London dispersion and dipole-dipole

(4) London dispersion, dipole-dipole and hydrogen bonding

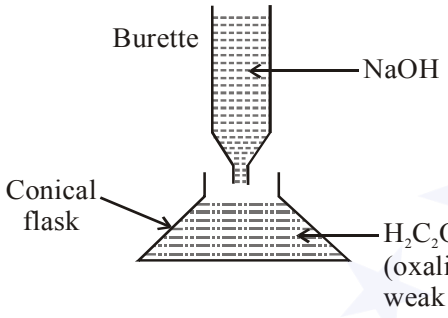
NTA Ans. (3)

Sol. Ethyl acetate $\left(H_3C-\underset{\underset{O}{\|}}{C}-O-CH_2-CH_3\right)$ is polar molecule. Hence there will be dipole-dipole attraction and london dispersion forces are

6. The strength of an aqueous NaOH solution is most accurately determined by titrating :
(Note : consider that an appropriate indicator is used)
(1) Aq. NaOH in a volumetric flask and concentrated H_2SO_4 in a conical flask
(2) Aq. NaOH in a pipette and aqueous oxalic acid in a burette
(3) Aq. NaOH in a burette and concentrated H_2SO_4 in a conical flask
(4) Aq. NaOH in a burette and aqueous oxalic acid in a conical flask

NTA Ans. (4)

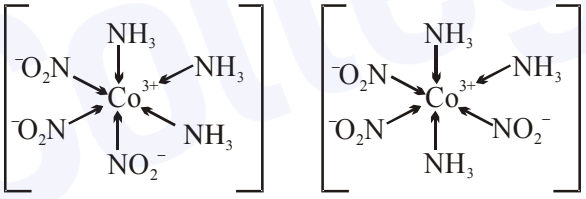
Sol.



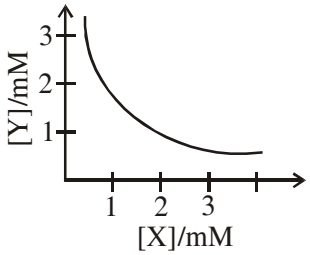
7. The complex that can show fac-and mer-isomers is :
(1) $[Pt(NH_3)_2Cl_2]$ (2) $[Co(NH_3)_4Cl_2]^+$
(3) $[Co(NH_3)_3(NO_2)_3]$ (4) $[CoCl_2(en)_2]$

NTA Ans. (3)

Sol. $[Ma_3b_3]$ type complex shows fac and mer isomerism.
$[Co(NH_3)_3(NO_2)_3]$



8. The stoichiometry and solubility product of a salt with the solubility curve given below is, respectively :



–9 3 –9 3

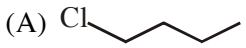
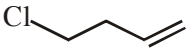
NTA Ans. (3)

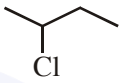
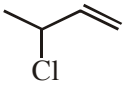
Sol. From the graph & dimensions salt is : XY_2
$[X] = 1 \times 10^{-3}M$
$[Y] = 2 \times 10^{-3}M$

$$XY_2(s) \rightleftharpoons X^{2+}_{(aq.)} + 2Y^-_{(aq.)}$$

$ksp = [X^{2+}] [Y^-]^2$
$= (10^{-3}) (2 \times 10^{-3})^2$
$= 4 \times 10^{-9} M^3$

9. The decreasing order of reactivity towards dehydrohalogenation (E_1) reaction of the following compounds is :

(A)  (B) 

(C)  (D) 

(1) B > D > A > C
(2) B > D > C > A
(3) D > B > C > A
(4) B > A > D > C

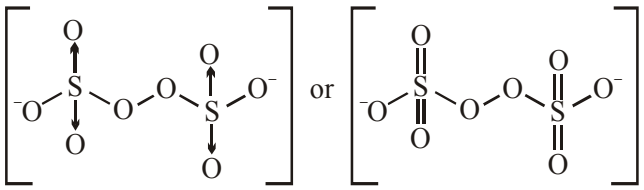
NTA Ans. (3)

Sol. Reactivity D > B > C > A
Carbocation formed from D is most stable
Carbocation formed from A is least stable

10. The number of bonds between sulphur and oxygen atoms in $S_2O_8^{2-}$ and the number of bonds between sulphur and sulphur atoms in rhombic sulphur, respectively, are :
(1) 4 and 8 (2) 4 and 6
(3) 8 and 8 (4) 8 and 6

NTA Ans. (3)

Sol. **$S_2O_8^{2-}$:**



8 bonds are present between sulphur and oxygen. (It is best answer in given options)

Rhombic sulphur :

(S_8) 

8 bonds are present between sulphur and

11. The rate of a certain biochemical reaction at physiological temperature (T) occurs 10^6 times faster with enzyme than without. The change in the activation energy upon adding enzyme is :

(1) $-6RT$ (2) $+6RT$

(3) $+6(2.303)RT$ (4) $-6(2.303)RT$

NTA Ans. (4)

Sol. $K = Ae^{\frac{-E_a}{RT}}$

$K' = Ae^{\frac{-E_a'}{RT}} = 10^6 K$

$Ae^{\frac{-E'}{RT}} = 10^6 \times Ae^{\frac{-E_a}{RT}}$

$\frac{-E_a'}{RT} = \frac{-E_a}{RT} + \ln 10^6$

$E_a' = E_a - RT \ln 10^6$

$E_a' - E_a = - RT \ln 10^6 = -6RT \times 2.303$

12. Which of the following statement is not true for glucose?

(1) The pentaacetate of glucose does not react with hydroxylamine to give oxime

(2) Glucose gives Schiff's test for aldehyde

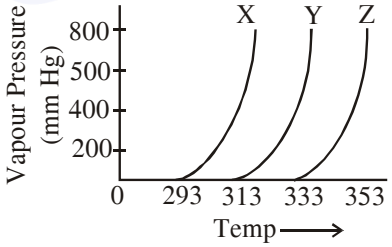
(3) Glucose exists in two crystalline forms α and β

(4) Glucose reacts with hydroxylamine to form oxime

NTA Ans. (2)

Sol. Glucose gives negative test with Schiff reagent

13. A graph of vapour pressure and temperature for three different liquids X, Y and Z is shown below :



The following inferences are made :

(A) X has higher intermolecular interactions compared to Y.

(B) X has lower intermolecular interactions compared to Y.

The correct inference(s) is/are :

(1) A (2) (C)

(3) (B) (4) (A) and (C)

NTA Ans. (3)

Sol. Order of B.P. is : Z > Y > X

Order of vapour pressure : Z < Y < X

order of intermolecular interaction : Z > Y > X.

14. Among the gases (a) - (e), the gases that cause greenhouse effect are :

(a) CO_2 (b) H_2O (c) CFCs (d) O_2 (e) O_3

(1) (a), (b), (c) and (d) (2) (a), (c), (d) and (e)

(3) (a) and (d) (4) (a), (b), (c) and (e)

NTA Ans. (4)

Sol. CO_2, H_2O, CFCs and O_3 are green house gases.

15. As per Hardy-Schulze formulation, the flocculation values of the following for ferric hydroxide sol are in the order :

(1) $AlCl_3 > K_3[Fe(CN)_6] > K_2CrO_4 > KBr = KNO_3$

(2) $K_3[Fe(CN)_6] < K_2CrO_4 < AlCl_3 < KBr < KNO_3$

(3) $K_3[Fe(CN)_6] > AlCl_3 > K_2CrO_4 > KBr > KNO_3$

(4) $K_3[Fe(CN)_6] < K_2CrO_4 < KBr = KNO_3 = AlCl_3$

NTA Ans. (4)

Sol. Since, $Fe(OH)_3$ is positively charged sol, hence, anionic charge will flocculate

As per Hardy Schulze rules coagulation power of anion follows the order :

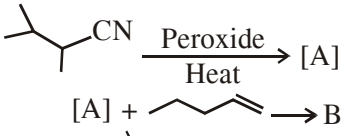
$Fe(CN)_6^{3-} > CrO_4^{2-} > Cl^- = Br^- = NO_3^-$

Higher the coagulation power lower will be its flocculation value

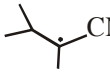
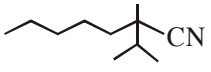
therefore order will be :

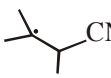
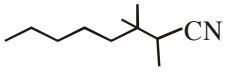
$Fe(CN)_6^{3-} < CrO_4^{2-} < Cl^- = Br^- = NO_3^-$

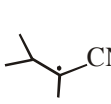
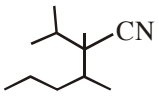
16. The major products A and B in the following reactions are :

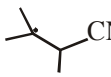
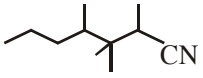


[A] + → B

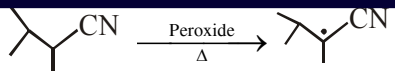
(1) A =  and B = 

(2) A =  and B = 

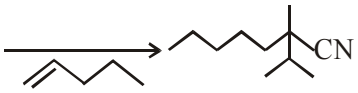
(3) A =  and B = 

(4) A =  and B = 

Sol.



(A)



(B)

17. For the Balmer series in the spectrum of H atom, $\bar{\nu} = R_H\left\{\frac{1}{n_1^2} - \frac{1}{n_2^2}\right\}$, the correct statements among (I) and (IV) are :

(I) As wavelength decreases, the lines in the series converge

(II) The integer n_1 is equal to 2

(III) The lines of longest wavelength corresponds to $n_2 = 3$

(IV) The ionization energy of hydrogen can be calculated from wave number of these lines

(1) (II), (III), (IV) (2) (I), (II), (III)

(3) (I), (III), (IV) (4) (I), (II), (IV)

NTA Ans. (2)

Sol. For balmer : $n_1 = 2$, $n_2 = 3, 4, 5, \ldots \infty$

$$\bar{\nu} = \frac{1}{\lambda} = R_H\left[\frac{1}{2^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda_{longest}} = R_H\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

Ans.(2)

18. Arrange the following compounds in increasing order of C–OH bond length :

methanol, phenol, p-ethoxyphenol

(1) phenol < methanol < p-ethoxyphenol

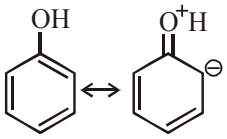
(2) phenol < p-ethoxyphenol < methanol

(3) methanol < p-ethoxyphenol < phenol

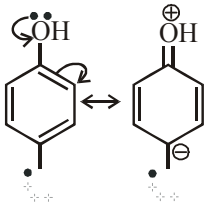
(4) methanol < phenol < p-ethoxyphenol

NTA Ans. (2)

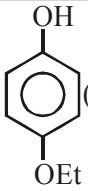
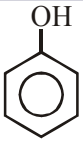
Sol. $H_3C - OH$ (100% single bond)



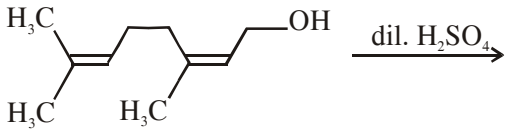
C–OH bond has partial double bond character

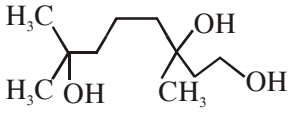


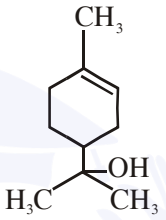
(C–OH bond has some double bond character but double bond character is less)

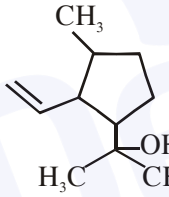
Ans. $CH_3OH >$  (p-ethoxyphenol) > 

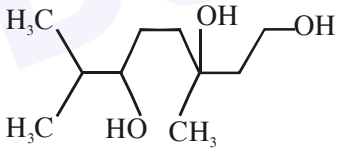
19. The major product of the following reaction is :



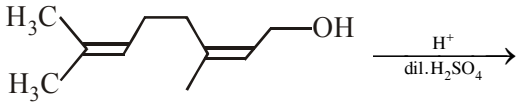
(1) 

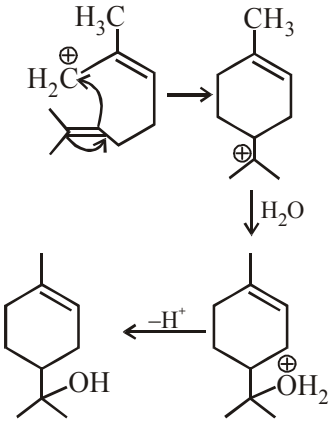
(2) 

(3) 

(4) 

NTA Ans. (2)

Sol. 



20. When gypsum is heated to 393 K, it forms :

(1) Dead burnt plaster (2) Anhydrous $CaSO_4$

(3) $CaSO_4.5H_2O$ (4) $CaSO_4.0.5H_2O$

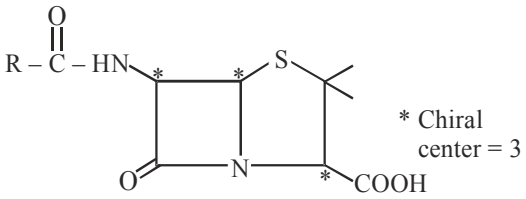
NTA Ans. (4)

Sol. $\underset{\text{Gypsum}}{CaSO_4.2H_2O} \xrightarrow{393K} \underset{\text{Plaster of paris}}{CaSO_4.\frac{1}{2}H_2O} + \frac{3}{2}H_2O$

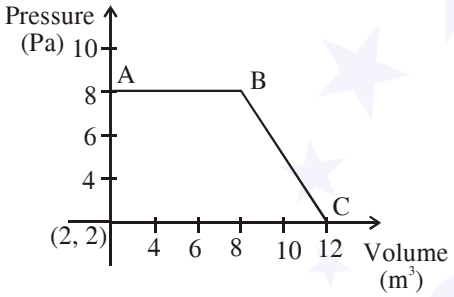
21. The number of chiral centres in penicillin is _____.

NTA Ans. (3.00)

Sol. The structure of penicillin is



22. The magnitude of work done by a gas that undergoes a reversible expansion along the path ABC shown in the figure is _____



NTA Ans. (48.00)

Sol. Area enclosed under

P V curve = 48 = 48 Joule

23. The volume (in mL) of 0.125 M $AgNO_3$ required to quantitatively precipitate chloride ions in 0.3 g of $[Co(NH_3)_6]Cl_3$ is _____.

$^{M}[Co(NH_3)_6]Cl_3$ = 267.46 g/mol

$^{M}AgNO_3$ = 169.87 g/mol

NTA Ans. (26.60 to 27.00)

Sol. Number of moles of Cl^- precipitated in $[Co(NH_3)_6]Cl_3$ is equal to number of moles of $AgNO_3$ used.

$$\frac{0.3}{267.46}\times 3 = \frac{0.125\times V}{1000}$$

where V is volume of $AgNO_3$ (in mL)

V = 26.92 mL

24. What would be the electrode potential for the given half cell reaction at pH = 5 ?_____

$2H_2O \rightarrow O_2 + 4H^{\oplus} + 4e^-$; E^0_{red} = 1.23 V

(R = 8.314 J mol^{-1} K^{-1} ; Temp = 298 K; oxygen under std. atm. pressure of 1 bar)

NTA Ans. (–0.93 to –0.94)

Sol. $2H_2O(l) \rightarrow O_2(g) + 4H^+ + 4e^-$; $E^0_{red.} = 1.23V$

From nernst equation

$$E_{cell} = E^0_{cell} - \frac{RT}{nF}\ln Q$$

at 1 bar & 298 K

$$\frac{2.303RT}{F} = 0.059$$

pH = 5 $\Rightarrow [H^+] = 10^{-5}$ M

$E^\circ_{oxidation}$ = – 1.23 volt

$$E_{cell} = -1.23 - \frac{0.059}{4}\log[H^+]^4$$

$$E_{cell} = -1.23 - \frac{0.059}{4}\log(10^{-5})^4$$

= –1.23 + 0.059 × 5 = – 0.935 V

25. 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 is _____.

Atomic weight : Fe = 55.85 ; S = 32.0 ; O = 16.00

NTA Ans. (4.95 to 4.97)

Sol. $FeSO_4.7H_2O$ (M = 277.85)

$$\text{ppm} = \frac{\text{wt. of Fe}}{\text{wt. of wheat}}\times 10^6$$

let the wt. of salt be = w gm

$$\text{moles} = \frac{w}{277.85}$$

$$\text{wt. of Fe} = \left(\frac{W}{277.85}\times 55.85\right)\text{gm}$$

$$10 = \frac{\frac{W}{277.85}\times 55.85}{10^5}\times 10^6$$

$$W = \frac{277.85}{55.85} = 4.97$$