Indian Association for the Cultivation of Science
(Deemed to be university under de novo category)

Integrated Bachelor's-Master's Program in Science

Mid-Semester Examination-2019 (Spring Semester)

Paper: Electricity, Magnetism & Optics **Paper Code: PHS1201**
Full Marks: 50 **Time Allotted: 2hr**

1. Show that a charge free point in an electrostatic field cannot be a point of stable equilibrium. **(5 marks)**
2. Find the potential energy of a small dipole of dipole moment $\vec{\mu}$ in an external electrostatic field $\vec{E}$. **(5 marks)**
3. Show that in a charge distribution if the net charge is zero then the leading order term in the potential is $(\vec{\mu}.\vec{r})/r^3$ where $\vec{\mu}$ is the electric dipole moment of the distribution. Calculate the corresponding electric field. **(5 marks)**
4. Using Gauss's theorem find the electric field at a distance r from an infinite line charge with ρ charge per unit length. **(5 marks)**
5. If σ be the charge density on the surface of a conductor, show that the electric field near the surface is perpendicular to the surface and is equal to σ/ϵ_0. **(5 marks)**
6. Consider a point charge q placed at a distance r in front of an infinite earthed conducting plane. Using the method of image charge, find the surface charge density induced at different points in the conducting plane. What is the force experienced by q due to the induced charges? **(5 marks)**
7. Show that if $\vec{P}$ is the dipole moment per unit volume in a dielectric then density of polarised charge is given by,

$$\rho_P = -\vec{\nabla}.\vec{P}$$

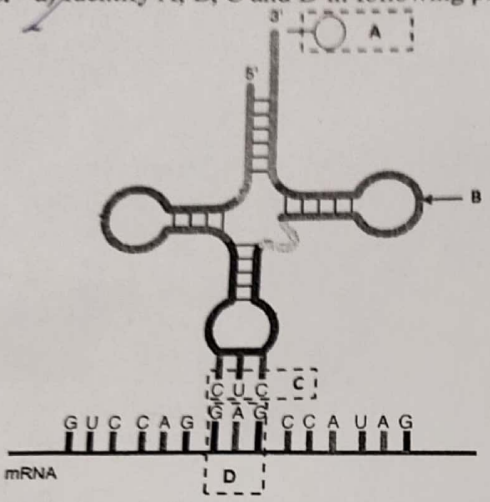
(5 marks)

8. Show that in an electrostatic field $\vec{E}$, $\vec{\nabla} \times \vec{E} = 0$. From this, show that the work taking a unit positive charge from one point to another in this field is independent of path. **(5 marks)**
9. Calculate the magnetic field at the centre of a circular loop carrying a current I. **(5 marks)**
10. Consider a charge of 2 e.s.u. located at x=2 cm, y=z=0 and another charge of -4 e.s.u. located at x=-2 cm, y=z=0. Hence, calculate the electric field at y=3 cm, x=z=0. **(5 marks)**

PART – B

Answer all questions

5. a) Identify A, B, C and D in following picture. b) Describe the process of translation



6. MCQ 1 mark for correct answer [2+3]

i) RNA contains which bases?

a) adenine, thymine, guanine, cytosine, uracil **b)** adenine, thymine, guanine, cytosine, **c)** thymine, guanine, cytosine, uracil, **d)** adenine, guanine, cytosine, uracil

ii). A DNA strand with the sequence AACGTAACG is transcribed. What is the sequence of the mRNA molecule synthesized?

a) AACGTAACG **b)** UUGCAUUGC, **c)** AACGUAACG, **d)** TTGCATTGC

iii). During Replication the complementary RNA bases to 3 ends of DNA strand are added by

a) RNA polymerase, **b)** telomerase, **c)** gyrase **d)** DNA polymerase

iv). Which of the following is correct about the Okazaki fragments?

a) Okazaki fragments are required for RNA polymerase activity. **b)** These fragments are made up of both DNA and RNA., **c)** They are made when DNA is exposed to ultraviolet rays., **d)** None of the above.

v).All eukaryots are haploid

a) True **b)** false, **c)** Depends on species, **d)** Depends on cells choice

7. a) Describe the structure of glycolipid (schematic). b) The glycolipid are oresent on both side of the plasma membrane, true or false? if false which side of the membrane is glycolipid present? [5] [3+2]

8. Describe different conformations in which the proteins imbedded into lipid bilayer. [5]

9. Describe the ER structure and different functions [5]

Indian Association for the Cultivation of Science
(Deemed to be University under the *de novo* Category)
Integrated Bachelor's-Master's Program in Science
Mid-Semester Examination (Spring Semester-2019)

Subject: Molecular Structure and Chemical Reactivity
Subject Code(s): CHS 1201 ***Time Allotted: 2 h***
Full Marks: 50

Answer the Q1 and any three among the Q2 to Q5

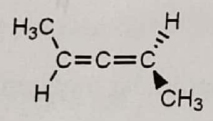
Q1) Answer the following questions. (any ten, 2x10 = 20)

a) Which orbital overlap develops following effects: i) hyperconjugation and ii) resonance.

b) Draw the most stable conformer of (±)-β-chloro-β-phenylethylalcohol.

c) Propose the structure of a carbocation that would have non-planar geometry. Explain the logic behind your proposal.

d) Which of the following molecule/s is/are achiral?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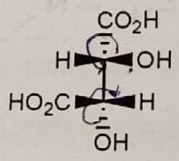
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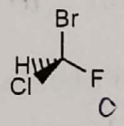
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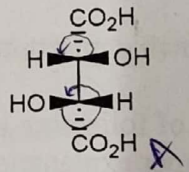
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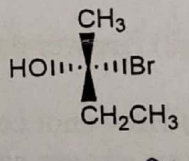

V

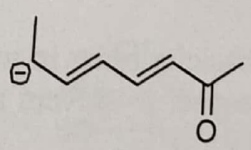
e) Draw orbital picture of the molecule having formula C_3H_4 indicating the states of hybridization of atoms.

f) Established that two fold alternating axis of symmetry (S_2) is equal to inversion point (i).

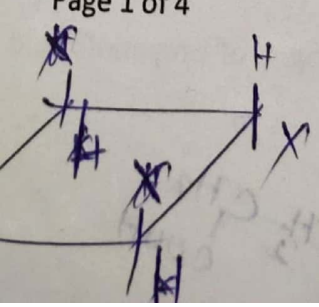
g) Among propyne and propene, which one is more polar molecule? Justify your answer.

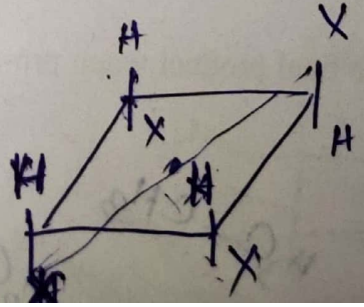
h) Explain with example that Fischer projection of a molecule having a definite configuration may be rotated by 180° in plane of the paper but not by 90°.

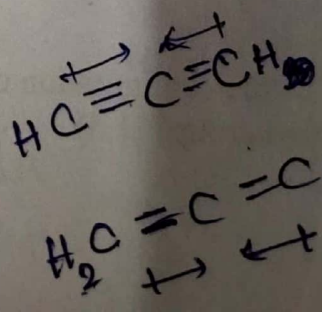
i) Draw all the possible resonance structures along with the resonance hybrid of the following anion?

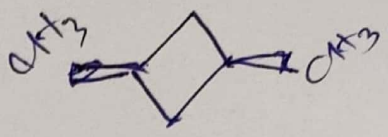


j) Arrange halogen acids in increasing order of their dipole moment.

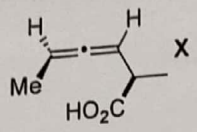


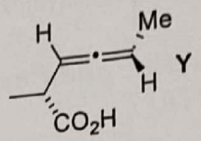




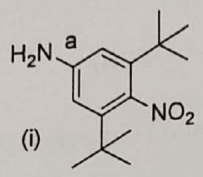


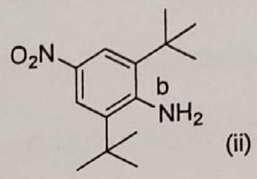
k) What is the correct stereochemical relation between the structures **X** and **Y**?





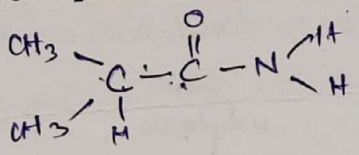
l) Compare the C-NH_2 bond length (a and b) in the given molecules with proper justification.

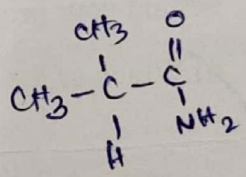




m) What are the symmetry elements present in (i) *cis*-1,3-dimethylcuclobutane and (ii) *meso*-tartaric acid (in staggered conformation)

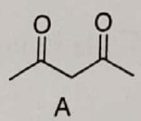
n) Write the IUPAC names of (i) $(CH_3)_2CHCONH_2$ and (ii) HO_2CCO_2H

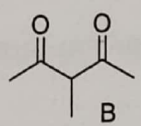


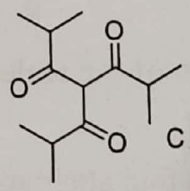


Q2) Answer the following questions: (10)

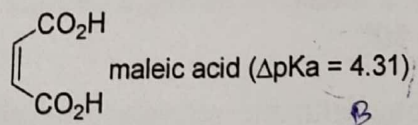
a) How enol contain of following ketones (A, B, and C) would vary in a particular medium? Justify your answer with proper explanation (2.5)

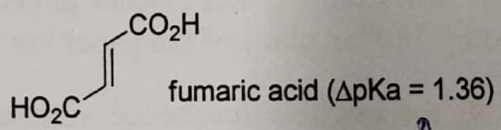




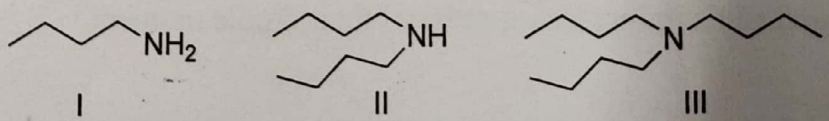


b) Difference in the two pKa values of Maleic acid is greater than that of fumaric acid. Explain the observation. (3)





c) Following aliphatic amines exhibit different Brønsted basicity order in water and chlorobenzene. Predict the correct basicity order of these amines with respect to solvent and justify your answer. (3)



d) What would be the configuration of the final product when pro-*R* hydrogen of propanoic acid is substituted by ethyl group? (1.5)

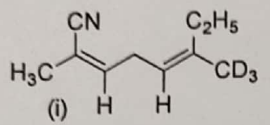
Q3) Answer the following questions: (10)

a) Draw the energy profile diagram for the rotation around C2-C3- bond in *meso*-2,3-dibromobutane. Comment on the relative stabilities of the conformers. (3)

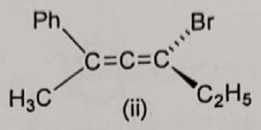
b) Write all possible stereoisomers of the following compound and comment on their optical activity. (3)

Ph-CH=CH-CH(CH_3)-CH=CH-Ph

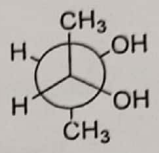
c) Assign R/S and E/Z configurations of the following compounds: (3)



(i)



(ii)



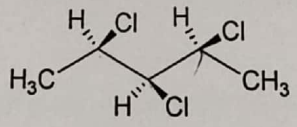
(iii)

(d) What is dissymmetric molecule? (1)

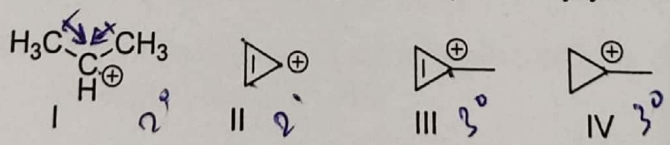
Q4) Answer the following questions: (10)

a) Explain the pseudo asymmetric centre with a proper example? (2)

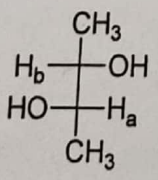
b) Comment on the stereogenicity and chirotopicity of C3 of the following structure: (2)



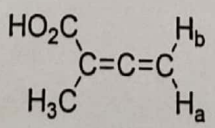
c) Arrange the following ions in order of increasing stability. Justify your answers (3)



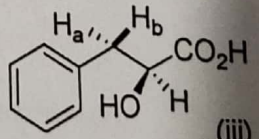
c) Identify topicity of H_a and H_b in each of the following structures (3)



(i)



(ii)



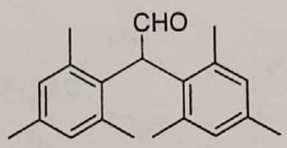
(iii)

Q5) Answer the following questions: (10)

a) Describe with example the conformational enantiomers. (2)

b) Define atropisomerism with example. (2)

c) The following compound exists mainly in enol form (95%), Explain (2)



d) Arrange the following compound in order of their increasing acid strength with proper explanation: (4)

(i) benzoic acid, (ii) 2-hydroxybenzoic cid, (iii) 4-hydroxybenzoic acid, (iv) 2,6-dihydroxybenzoic acid

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Indian Association for the Cultivation of Science
(Deemed to be University under the *de novo* Category)
Integrated Bachelor's-Master's Program in Science
Mid-Semester Examination (Spring Semester-2019)

Subject: **Mathematics & Computer**
Subject Code(s): **MCS 1201**
Full Marks: 50 ***Time Allotted:*** **2 h**

Group - A

1. (*i*) Define group. Let G be a group such that $a = a^{-1}$ for all $a \in G$. Show that G is a commutative group.

(*ii*) Does $G = \left\{ \begin{pmatrix} a & a \\ a & a \end{pmatrix} : a \neq 0 \right\}$ form a group w.r.t. matrix multiplication? Justify your answer. 5

2. (*i*) Let H be a non-empty subset of a group G. State a necessary and sufficient condition so that H forms a subgroup of G.

(*ii*) Define $GL(n, \mathbb{R})$ and $SL(n, \mathbb{R})$. Show that $SL(n, \mathbb{R})$ is a subgroup of $GL(n, \mathbb{R})$. 5

3. (*i*) Define cyclic group. Show that $(\mathbb{Q}, +)$ is not a cyclic group. Hence conclude that $(\mathbb{R}, +)$ is not a cyclic group.

(*ii*) Find number of subgroups of a cyclic group of order 60. 5

Group - B

2×3

1. Evaluate :

(*a*). $\int \left(\frac{x^2+\sin^2 x}{1+x^2}\right)(\sec^2 x)\,dx$ (*b*). $\int (\sqrt{\tan x}+\sqrt{\cot x})\,dx$ (*c*). $\int_0^{\pi} \frac{x\,dx}{a^2\cos^2 x + b^2 \sin^2 x}$

2. Evaluate the value of the definite integral $\int_a^b \sqrt{x}\,dx$ $(a > 0)$, by the method of summation.

3. Find $\lim_{n\to\infty}\left[\frac{1}{n}+\frac{\sqrt{n^2-1^2}}{n^2}+\ldots\ldots+\frac{\sqrt{n^2-(n-1)^2}}{n^2}\right]$ 3

4. If $I_n=\int_0^{\frac{\pi}{4}}\tan^n x$ (n being a positive integer greater than 1) then prove that $I_n+I_{n-1}=\frac{1}{(n-1)}$. 3

Group – C: Computer

Answer any *five questions from this group*:

1. If x is the radix or base in a number system, find out the value of x when the equation is given as: $(234)_x - (110)_2 = (58)_{16}$ [4]

2. What does the following C++ code fragment print?

```
  #define plus(a,b) a + b;
inti = 5 * plus(4,3) + 2 * 6;
cout<<i<<endl;
```

[4]

3. What would be the output of the following C++ program, if run from the command line as "myprogargument1 argument2 argument3"?

```
int main (intargc, char *argv[]){
  for (inti = 1; i<argc; i++) {
cout<<argv[i] + i<<endl;
  }
  return 0;
}
```

4. What does the following C++ code fragment print?

```
  int x = 10, *px = &x;
cout<< x <<endl;
int&rx = *px;
rx++;
cout<< x <<endl;
  *px++;
cout<< x <<endl;
```

5. What does the following C++ code fragment print?

```
void display(int *p) {
  int x = 5;
  p = &x;
cout<< *p <<endl;
}
int main() {
int a = 10;
int *pa = &a;
  display(pa);
cout<< *pa<<endl;
  return 0;
}
```

[4]

6. What does the following C++ code fragment print?

```
int fun(int x = 1, int y = 2, int z = 3);
int main (intargc, char *argv[]) {
  fun(4);
  fun(5, 6);
  fun();
  return 0;
}
int fun(int x, int y, int z) {
cout<< x + y + z <<endl;
}
```

[4]

7. What does the following C++ code fragment print?

```
  for (inti = 0; i< 20; i++) {
    switch(i){
        case 0:  i += 1;
        case 10: i += 3;
        default: i += 5;
    },
cout<<i<<endl;
  }
```

[4]

Indian Association for the Cultivation of Science

(Deemed to be University under the *de novo* category)

Integrated Bachelor's-Master's Programme of IACS

MID-Semester Examination-2019 (Spring Semester)

Subject: Biophysics ***Subject Code(s): BIS 1201***

Full marks: 50 ***Time allotted: 2 hrs***

PART - A

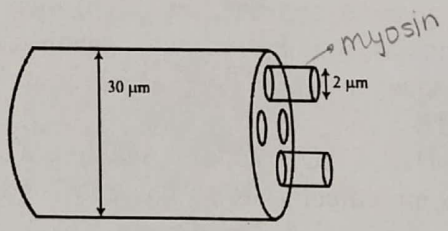
Answer all questions

1. Draw the characteristic length versus time plot of a dynamic microtubule and mark various features describing the dynamics. How would you compare this with the length of a treadmilling actin polymer. Sketch the distributions (in the same figure) $f(x)$ of microtubules having length $x\mu$m and average length 5μm in cells with radius 30μm and 3μm. **[3+2+2]**

OR

Consider two microtubule arrays in $1-$*dimension* with N microtubules from each, separated by a distance $2x$, are interacting with each other. Calculate the overlap (interaction cross-section) between the arrays. **[7]**

2. What are the main constituents of Lamellipodia? How does a lamellipodium structurally differ from a fillopodium - draw and describe. What is a Focal Adhesion? **[2+2+2]**



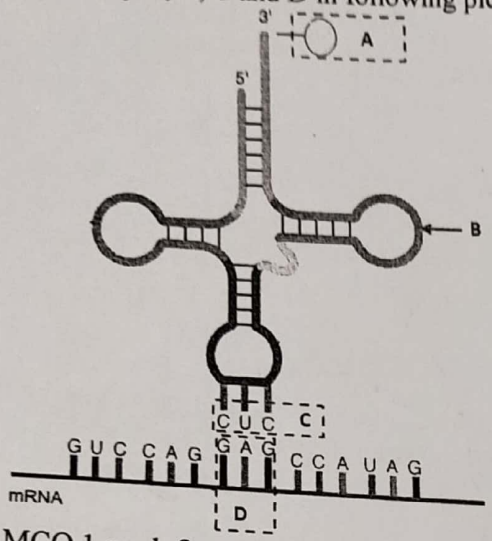
3. Figure shows a schematic depiction of a muscle cell made up of muscle fibers or myofibrils. The myofibrils are themselves composed of contractile units called sarcomeres. Myosin molecules are arranged in a cylindrically symmetric structure called the thick filament, and exert forces on the outer actin filaments. Take the number of myosins per thick filament $\sim$ 300. Assume, one is lifting 10 kg mass. Estimate the force generated by a single myosin head. **[5]**

4. Which type of motors are required for inward and outward cellular transportation? Name two motors that walk on actin and microtubule respectively. A typical motor protein can generate a force of 6 pN. Given that the viscosity of cytoplasm is $\sim$ 1000 times that of water, how fast could a single kinesin molecule move an *E. coli* through a cell? Diameter of E.coli = 2 μm, viscosity of water is $10^{-3} kg.m^{-1}.s^{-1}$ **[2+2+3]**

PART – B

Answer all questions

5. a) Identify A, B, C and D in following picture. b) Describe the process of translation



6. MCQ 1 mark for correct answer **[2+3]**

i) RNA contains which bases?

a) adenine, thymine, guanine, cytosine, uracil **b)** adenine, thymine, guanine, cytosine, **c)** thymine, guanine, cytosine, uracil, **d)** adenine, guanine, cytosine, uracil

ii). A DNA strand with the sequence AACGTAACG is transcribed. What is the sequence of the mRNA molecule synthesized?

a) AACGTAACG **b)** UUGCAUUGC, **c)** AACGUAACG, **d)** TTGCATTGC

iii). During Replication the complementary RNA bases to 3' ends of DNA strand are added by

a) RNA polymerase, **b)** telomerase, **c)** gyrase **d)** DNA polymerase

iv). Which of the following is correct about the Okazaki fragments?

a) Okazaki fragments are required for RNA polymerase activity. **b)** These fragments are made up of both DNA and RNA., **c)** They are made when DNA is exposed to ultraviolet rays., **d)** None of the above.

v).All eukaryots are haploid

a) True **b)** false, **c)**Depends on species, **d)** Depends on cells choice

7. a) Describe the structure of glycolipid (schematic). b) The glycolipid are oresent on both side of the plasma membrane, true or false? if false which side of the membrane is glycolipid present? **[5]** **[3+2]**

8. Describe different conformations in which the proteins imbedded into lipid bilayer. **[5]**

9. Describe the ER structure and different functions **[5]**

5. Consider the set $A = \{y \in \mathbb{R} : y^3 < 2\}$.
   (a) Show that A is non-empty and bounded above.
   (b) Denoting $x = \sup A$, show that neither $x^3 < 2$ nor $x^3 > 2$ are possible. Hence conclude that x is the unique positive real number such that $x^3 = 2$.

6. (a) Show that if there is a one-to-one map from a set A to a finite set B, then A must be finite and $|A| \leq |B|$.
   (b) Let A be a non-empty finite set with $|A| = n$ and let B denote the collection of all subsets of A (including the empty set). Show that $B \sim \{0,1\}^n$ and hence conclude that B has 2^n elements.

7. (a) For a positive integer k, let A_k denote the collection of all subsets of $\mathbb{N}$ of size k. Show that $A_k \subseteq \mathbb{N}^k$ and hence conclude that A_k is countably infinite.
   (b) Let A denote the collection of all finite subsets of $\mathbb{N}$. Show that $A \sim \mathbb{N}$.

8. (a) Let A be an uncountable set and B a countable subset of A. Show that $A \backslash B \sim A$.
   (b) Show that the set A of all functions on $\mathbb{N}$ into $\{0,1\}$ is uncountable.

Indian Association for the Cultivation of Science
(Deemed to be University under the *de novo* Category)
Integrated Bachelor's-Master's Program in Science
Mid-Semester Examination (Spring Semester-2019)

Subject: Molecular Structure and Chemical Reactivity
Subject Code(s): CHS 1201
Full Marks: 50 ***Time Allotted: 2 h***

Answer the Q1 and any three among the Q2 to Q5

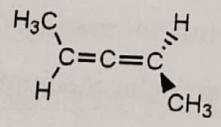
Q1) Answer the following questions. (any ten, 2x10 = 20)

a) Which orbital overlap develops following effects: i) hyperconjugation and ii) resonance.

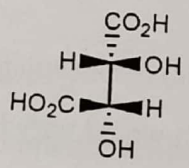
b) Draw the most stable conformer of (±)-β-chloro-β-phenylethylalcohol. expl. ?

c) Propose the structure of a carbocation that would have non-planar geometry. Explain the logic behind your proposal.

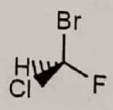
d) Which of the following molecule/s is/are achiral?



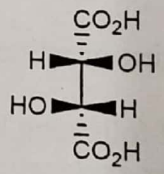
I



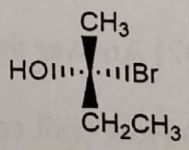
II



III



IV



V

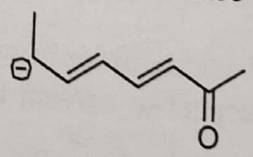
e) Draw orbital picture of the molecule having formula C_3H_4 indicating the states of hybridization of atoms.

f) Established that two fold alternating axis of symmetry (S_2) is equal to inversion point (*i*).

g) Among propyne and propene, which one is more polar molecule? Justify your answer.

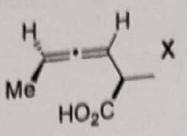
h) Explain with example that Fischer projection of a molecule having a definite configuration may be rotated by 180° in plane of the paper but not by 90°.

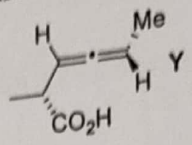
i) Draw all the possible resonance structures along with the resonance hybrid of the following anion?



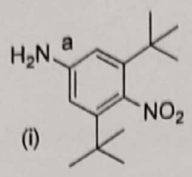
j) Arrange halogen acids in increasing order of their dipole moment.

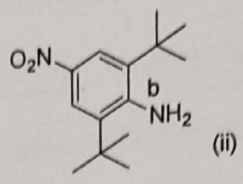
k) What is the correct stereochemical relation between the structures **X** and **Y**?





l) Compare the C-NH_2 bond length (a and b) in the given molecules with proper justification.



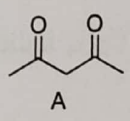


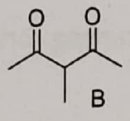
m) What are the symmetry elements present in (i) *cis*-1,3-dimethylcyclobutane and (ii) *meso*-tartaric acid (in staggered conformation)

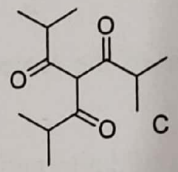
n) Write the IUPAC names of (i) $(CH_3)_2CHCONH_2$ and (ii) HO_2CCO_2H

Q2) Answer the following questions: (10)

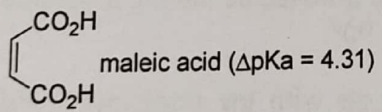
a) How enol contain of following ketones (A, B, and C) would vary in a particular medium? Justify your answer with proper explanation (2.5)

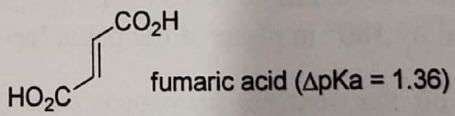




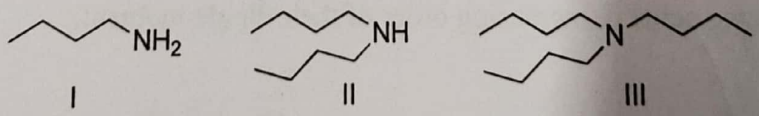


b) Difference in the two pKa values of Maleic acid is greater than that of fumaric acid. Explain the observation. (3)





c) Following aliphatic amines exhibit different Brønsted basicity order in water and chlorobenzene. Predict the correct basicity order of these amines with respect to solvent and justify your answer. (3)



d) What would be the configuration of the final product when pro-*R* hydrogen of propanoic acid is substituted by ethyl group? (1.5)

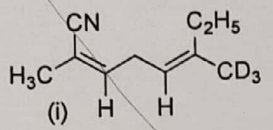
Q3) Answer the following questions: (10)

a) Draw the energy profile diagram for the rotation around C2-C3- bond in *meso*-2,3-dibromobutane. Comment on the relative stabilities of the conformers. (3)

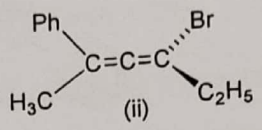
b) Write all possible stereoisomers of the following compound and comment on their optical activity. (3)

Ph-CH=CH-CH(CH_3)-CH=CH-Ph

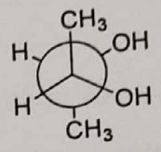
c) Assign R/S and E/Z configurations of the following compounds: (3)



(i)



(ii)



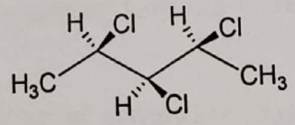
(iii)

(d) What is dissymmetric molecule? (1)

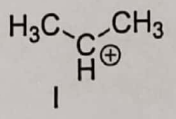
Q4) Answer the following questions: (10)

a) Explain the pseudo asymmetric centre with a proper example? (2)

b) Comment on the stereogenicity and chirotopicity of C3 of the following structure: (2)

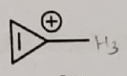


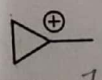
c) Arrange the following ions in order of increasing stability. Justify your answers (3)



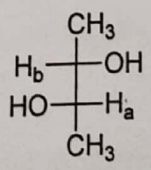
I


II R

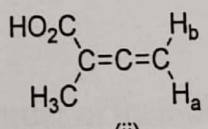

III 3H


IV 7H

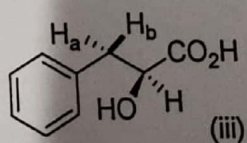
c) Identify topicity of H_a and H_b in each of the following structures (3)



(i)



(ii)



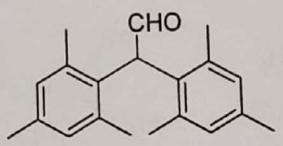
(iii)

Q5) Answer the following questions: (10)

a) Describe with example the conformational enantiomers. (2)

b) Define atropisomerism with example. (2)

c) The following compound exists mainly in enol form (95%), Explain (2)



d) Arrange the following compound in order of their increasing acid strength with proper explanation: (4)

(i) benzoic acid, (ii) 2-hydroxybenzoic cid, (iii) 4-hydroxybenzoic acid, (iv) 2,6-dihydroxybenzoic acid

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