

Name:

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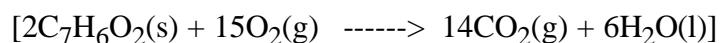
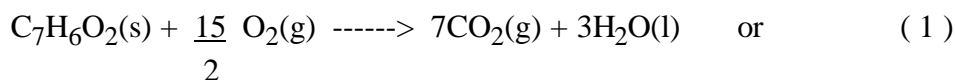
**Problem 1****23 points****PART A**

- 1-1. Determine the molecular formula and write a balanced equation with correct state of matters for the combustion of Q.

$$\text{Mole C : H : O} = \frac{(1.5144)(12.0/44.0)}{12.0} : \frac{(0.2656)(2.0/18.0)}{1.0} : \frac{(0.1575)}{16.0}$$

$$= 0.0344 : 0.0295 : 0.00984 = 7 : 6 : 2$$

The formula mass of  $\text{C}_7\text{H}_6\text{O}_2 = 122$  which is the same as the molar mass given. (2)



3 marks

2 marks for correct formula of Q.

1 mark for correct balanced equation with proper states.

- 1-2. Calculate the heat capacity of the calorimeter (excluding the water).

Calculation with proper units:

$$\text{Mole Q} = \frac{0.6000}{122.0} = 4.919 \times 10^{-3} \quad (0.5)$$

$$q_v = n\Delta U^0 = \frac{0.6000}{122.0} \times (-3079) = -15.14 \text{ kJ} \quad (2)$$

$$\text{Total heat capacity} = \frac{-q_v}{\Delta T} = \frac{15.14}{2.250} = 6.730 \text{ kJ K}^{-1} \quad (1.5)$$

$$= 6730 \text{ J K}^{-1}$$

$$\text{Heat capacity of water} = 710.0 \times 4.184 = 2971 \text{ J K}^{-1} \quad (1)$$

$$\text{Heat capacity of calorimeter} = 6730 - 2971 = 3759 \text{ J K}^{-1} \quad (1)$$

6 marks

The heat capacity of calorimeter is

3759

 $\text{J K}^{-1}$

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### Problem 1

1-3. Calculate the standard enthalpy of formation ( $\Delta H^\circ_f$ ) of Q.

Calculation with proper units:

$$\Delta n_g = \frac{7-15}{2} = -0.5 \text{ mol} \quad (0.5)$$

$$\Delta H^\circ = \Delta U^\circ + RT \Delta n_g \quad (0.5)$$

$$= -3079 + (8.314 \times 10^{-3})(298)(-0.5) \quad (1)$$

$$= -3079 - 1 \quad (0.5)$$

$$\Delta H^\circ = (7\Delta H^\circ_f, \text{CO}_2(\text{g}) + 3\Delta H^\circ_f, \text{H}_2\text{O}(\text{l})) - (\Delta H^\circ_f, \text{Q}) \quad (1)$$

$$\Delta H^\circ_f \text{ of Q} = 7(-393.51) + 3(-285.83) - (-3080) \quad (1)$$

$$= -532 \text{ kJ mol}^{-1} \quad (0.5)$$

5 marks

$\Delta H^\circ_f$  of Q is  kJ mol<sup>-1</sup>

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**Problem 1****PART B**

- 1-4. Show whether Q is monomer or dimer in benzene by calculation assume that Q is a monomer in water.

Calculation:

$C_B$ (mol L <sup>-1</sup> )	0.0118	0.0478	0.0981	0.156	
$C_W$ (mol L <sup>-1</sup> )	0.00281	0.00566	0.00812	0.0102	
either $C_B/C_W$	4.20	8.44	12.1	15.3	
or $C_B/C_W^2$	$1.49 \times 10^3$	$1.49 \times 10^3$	$1.49 \times 10^3$	$1.50 \times 10^3$	( 2 )
(or $\sqrt{C_B/C_W}$	38.6	38.6	38.6	38.7)	

From the results show that the ratio  $C_B/C_W$  varies considerably, whereas the ratio  $C_B/C_W^2$  or  $\sqrt{C_B/C_W}$  is almost constant, showing that in benzene, Q is associated into double molecule.

Q in benzene is  monomer  dimer. ( 1 )

3 marks

- 1-5. Calculate the freezing point ( $T_f$ ) of a solution containing 0.244 g of Q in 5.85 g of benzene at 1 atm.

Calculation

If Q is completely dimerized in benzene, the apparent molecular mass should be 244.	
Mole fraction of $Q_2$	$= \frac{0.244/244}{\frac{0.244}{244} + \frac{5.85}{78.0}} = 1.32 \times 10^{-2}$ (0.01316) ( 3 )
$\Delta T_f$	$= \frac{(8.314)(278.55)^2}{9.89 \times 10^3} \cdot 1.32 \times 10^{-2} = 0.861$ ( 2 )
$T_f$	$= 5.40 - 0.861 = 4.54$ °C ( 1 )

 $T_f$  of solution is

°C

6 marks

- 1 mark for incorrect temperature.  
-1 mark for incorrect heat of fusion.

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## Problem 2

20 points

### PART A

2-1. On adding 1.00 mL of HCl, what species reacts first and what would be the product?

Species which reacts first is



0.5 mark

The product is



0.5 mark

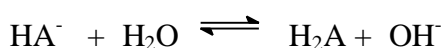
2-2. What is the amount (mmol) of the product formed in (2-1)?

mmol of product =

$$1.00 \times 0.300 = 0.300$$

0.5 mark

2-3. Write down the main equilibrium of the product from (2-1) reacting with the solvent?



1 mark

2-4. What are the amounts (mmol) of  $\text{Na}_2\text{A}$  and  $\text{NaHA}$  initially present?

Calculation:

At pH 8.34 which is equal to  $(\text{pK}_{\text{a}1} + \text{pK}_{\text{a}2})/2$  all  $\text{A}^{2-}$  are protonated as  $\text{HA}^-$ .

Therefore no. of  $\text{A}^{2-}$  initially present in the solution =  $0.300 \times 10.00$   
= 3.00 mmol

At pH 10.33, the system is a buffer in which the ratio of  $[\text{A}^{2-}]$  and  $[\text{HA}^-]$  is equal to 1. Thus

$$[\text{HA}^-]_{\text{initial}} + [\text{HA}^-]_{\text{formed}} = [\text{A}^{2-}]_{\text{initial}} - [\text{HA}^-]_{\text{formed}}$$

$$\text{The amount of initial } \text{HA}^- = 3.00 - 0.300 - 0.300 \text{ mmol} = 2.40 \text{ mmol}$$

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## **Problem 2**

mmol of  $\text{Na}_2\text{A}$  =  2.0 marks

mmol of  $\text{NaHA}$  =  2.5 marks

- 2-5. Calculate the total volume of  $\text{HCl}$  required to reach the second equivalence point.  
Calculation:

Total volume of $\text{HCl}$ required	=	$[(2 \times 3.00) + 2.40]/0.300$
	=	28.00 mL

1.5 marks

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**Problem 2****PART B**

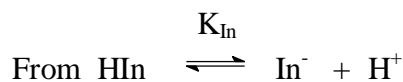
2-6. Calculate the absorbance at 400 nm of Solution III.

Calculation:

Solution III is the indicator solution at  $10^{-5}$  M in a solution containing 1.0 M  $\text{CH}_3\text{COOH}$ .

To obtain the absorbance of the solution, it is necessary to calculate the concentration of the basic form of the indicator which is dependent on the  $[\text{H}^+]$  of the solution.

$$\begin{aligned}
 [\text{H}^+] \text{ of solution III} &= \sqrt{K_a \cdot C} \\
 &= \sqrt{1.75 \times 10^{-5} \times 1.0} \\
 &= 4.18 \times 10^{-3} \quad (1.0 \text{ mark})
 \end{aligned}$$



$$K_{\text{In}} = \frac{[\text{H}^+][\text{In}^-]}{[\text{HIn}]} \quad (0.5 \text{ mark})$$

$$\begin{aligned}
 \frac{[\text{In}^-]}{[\text{HIn}]} &= \frac{K_{\text{In}}}{[\text{H}^+]} \\
 &= \frac{10^{-3.38}}{10^{-2.38}} \\
 &= 0.100
 \end{aligned}$$

$$\frac{[\text{In}^-]}{[\text{HIn}]} = 0.100 \quad (1.0 \text{ mark})$$

$$\begin{aligned}
 \text{Whereas} \quad [\text{HIn}] + [\text{In}^-] &= 10^{-5} \\
 10[\text{In}^-] + [\text{In}^-] &= 10^{-5} \\
 [\text{In}^-] &= 0.091 \times 10^{-5} \quad (1.5 \text{ mark})
 \end{aligned}$$

$$\begin{aligned}
 \therefore \text{Absorbance of solution III} &= \frac{0.091 \times 10^{-5}}{1.00 \times 10^{-5}} \times 0.300 \\
 &= 0.027 \quad (1.0 \text{ mark})
 \end{aligned}$$

-0.5 mark for incorrect unit

The absorbance at 400 nm of Solution III =

0.027

5 marks

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**Problem 2**

- 2-7. Apart from  $H^+$ ,  $OH^-$ , and  $H_2O$ , what are all the chemical species present in the solution resulting from mixing Solution II and Solution III at 1:1 volume ratio?



1.5 marks

- 2-8. What is the absorbance at 400 nm of the solution in (2-7) ?

Calculation:

When solutions II and III are mixed at 1:1 volume ratio, a buffer solution of 0.05 M  $CH_3COO^-$  / 0.45 M  $CH_3COOH$  is obtained.

$$\begin{aligned} [H^+] \text{ of mixture solution} &= K_a \frac{[CH_3COOH]}{[CH_3COO^-]} \\ &= 1.75 \times 10^{-5} \times \frac{0.45}{0.05} \\ &= 15.75 \times 10^{-5} \quad (1.0 \text{ mark}) \end{aligned}$$

$$\begin{aligned} \text{therefore} \quad \frac{[In^-]}{[HIn]} &= \frac{K_{In}}{[H^+]} \\ &= \frac{10^{-3.38}}{15.75 \times 10^{-5}} \end{aligned}$$

$$\frac{[In^-]}{[HIn]} = 2.65 \quad (1.0 \text{ mark})$$

$$\text{Whereas } [HIn] + [In^-] = 10^{-5}$$

$$\frac{[In^-]}{2.65} + [In^-] = 10^{-5}$$

$$[In^-] = 0.726 \times 10^{-5} \quad (1.5$$

marks)

$$\begin{aligned} \therefore \text{Absorbance of solution} &= \frac{0.726 \times 10^{-5}}{1.0 \times 10^{-5}} \times 0.300 \\ &= 0.218 \end{aligned}$$

(0.5 mark)

-0.5 mark for incorrect unit

The absorbance at 400 nm of the solution = 0.218

4 marks

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**Problem 2**

2-9. What is the transmittance at 400 nm of the solution in (2-7)?

Calculation:

$$\begin{aligned} \text{Transmittance of solution} &= \text{antilog}(-\text{absorbance}) \\ &= 0.605 \end{aligned}$$

-0.5 mark for incorrect unit

Transmittance of the solution =

0.605 or 60.5%

1 mark



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**Problem 3**

**20 points**

3-1. How many beta decays in this series? Show by calculation.

Calculation:

$$A = 232 - 208 = 24; 24/4 = 6 \text{ alpha particles} \quad (1)$$

The nuclear charge is therefore reduced by  $2 \times 6 = 12$  units, however, the difference in nuclear charges is only  $90 - 82 = 8$  units. Therefore there must be  $12 - 8 = 4\beta^-$  emitted.

(1)

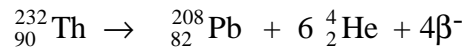
2 marks

Number of beta decays =

4

3-2. How much energy in MeV is released in the complete chain?

Calculation:



Energy released is Q value

$$Q = [m({}^{232}\text{Th}) - m({}^{208}\text{Pb}) - 6m({}^4\text{He})]c^2$$

(the mass of  $4e^-$  are included in daughters)

(2)

$$= [232.03805 \text{ u} - 207.97664 \text{ u} - 6 \times 4.00260 \text{ u}] \times 931.5 \text{ MeVu}^{-1}$$

$$= (0.04581 \text{ u})(931.5 \text{ MeVu}^{-1}) = 42.67 \text{ MeV}$$

(2)

4 marks

Energy released =

42.67

MeV

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### Problem 3

- 3-3. Calculate the rate of production of energy (power) in watts ( $1\text{W} = \text{Js}^{-1}$ ) produced by 1.00 kilogram of  $^{232}\text{Th}$  ( $t_{1/2} = 1.40 \times 10^{10}$  years).

Calculation:

$$\begin{aligned} 1.00 \text{ kg contains} &= \frac{1000 \times 6.022 \times 10^{23} \text{ atoms mol}^{-1}}{232 \text{ g mol}^{-1}} \\ &= 2.60 \times 10^{24} \text{ atoms} \quad (1) \\ \text{Decay constant for } ^{232}\text{Th} \\ \lambda &= \frac{0.693}{(1.40 \times 10^{10} \text{ y})(3.154 \times 10^7 \text{ s y}^{-1})} \\ &= 1.57 \times 10^{-18} \text{ s}^{-1} \\ A = N\lambda &= (2.60 \times 10^{24})(1.57 \times 10^{-18}) \text{ where } A \text{ is activity} \\ &= 4.08 \times 10^6 \text{ dps (disintegrations s}^{-1}\text{)} \\ \text{Each decay liberates } &42.67 \text{ MeV} \quad (1) \\ \text{Rate of production of energy (power)} \\ 4.08 \times 10^6 \text{ dis s}^{-1} &\times 42.67 \text{ MeV dis}^{-1} \times 1.602 \times 10^{-13} \text{ J Mev}^{-1} \\ &= 2.79 \times 10^{-5} \text{ J s}^{-1} = 2.79 \times 10^{-5} \text{ W} \quad (2) \end{aligned}$$

5 marks

Rate of production of energy =  W

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**Problem 3**

- 3-4. What volume in  $\text{cm}^3$  of helium at  $0^\circ\text{C}$  and 1 atm collected when 1.00 gram of  $^{228}\text{Th}$  ( $t_{1/2} = 1.91$  years) is stored in a container for 20.0 years.

Calculation:

The half-lives of various intermediates are relatively short compared that of  $^{228}\text{Th}$ .

$$A = \lambda N = \left( \frac{0.693}{1.91\text{y}} \right) \left[ \frac{(1.00\text{g})(6.022 \times 10^{23}\text{mol}^{-1})}{228\text{gmol}^{-1}} \right]$$

$$= 9.58 \times 10^{20}\text{y}^{-1} \quad (1)$$

Number of He collected

$$N_{\text{He}} = (9.58 \times 10^{20}\text{y}^{-1})(20.0\text{y})(5\text{ particles})$$

$$= 9.58 \times 10^{22}\text{ particles of He} \quad (1)$$

$$V_{\text{He}} = \frac{(9.58 \times 10^{22})(22.4\text{Lmol}^{-1})(10^3\text{cm}^3\text{L}^{-1})}{6.022 \times 10^{23}\text{mol}^{-1}}$$

$$= 3.56 \times 10^3\text{cm}^3 \quad (2)$$

5 marks

Volume of He at  $0^\circ\text{C}$  and 1 atm =   $\text{cm}^3$

- 3-5. One member of thorium series, after isolation, is found to contain  $1.50 \times 10^{10}$  atoms of the nuclide and decays at the rate of 3440 disintegrations per minute. What is the half-life in years?

Calculation:

$$A = \lambda N;$$

$$t_{1/2} = \frac{0.693}{\lambda} = \frac{0.693}{A/N} \quad (1.5)$$

$$= \frac{(0.693)(1.50 \times 10^{10}\text{atom})}{3440\text{atomsmin}^{-1}} \quad (1.5)$$

$$= 3.02 \times 10^6\text{ min}$$

$$= 5.75\text{ years} \quad (1)$$

4 marks

Half-life =  years

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### Problem 4

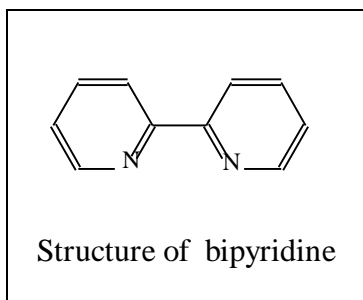
28 points

4-1. The molecular formula of **L** is  $C_{10}H_8N_2O_2$

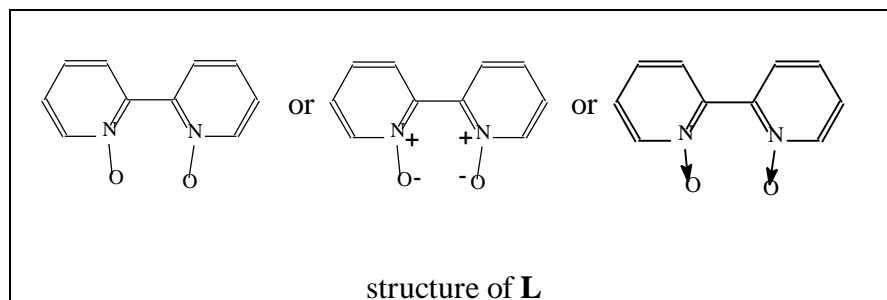
2 marks

Knowing that **L** was synthesized from bipyridine and during the reaction bipyridine was simply oxidized to bipyridine oxide. The molecular mass of bipyridine is 156 (for  $C_{10}H_8N_2$ ) while the molecular mass of **L** is 188. The difference of 32 is due to 2 atoms of oxygen. Therefore, the molecular formula of **L** is  $C_{10}H_8N_2O_2$ .

4-2. The structures of bipyridine and **L**



2 marks



2 marks

4-3. Does the ligand **L** have any charge, i.e., net charge? (Please tick).

- 2 charge
<input type="checkbox"/>

- 1 charge
<input type="checkbox"/>

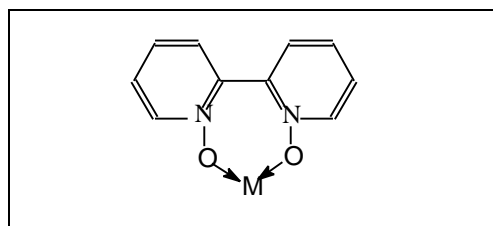
no charge
<input checked="" type="checkbox"/>

+ 1 charge
<input type="checkbox"/>

+ 2 charge
<input type="checkbox"/>

1 mark

4-4. Draw the structure when one molecule of **L** binds to metal ion (**M**).



2 marks

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**Problem 4**

4-5. Determine the empirical formula of A.

Calculation:

	Fe	C	H	Cl	N	O
%	5.740	37.030	3.090	10.940	8.640	34.560*
mol	0.103	3.085	3.090	0.309	0.617	2.160
mol ratio	1.000	29.959	30.00	2.996	5.992	20.971
atom ratio	1	30	30	3	6	21

(\* Percentage of O is obtained by difference.)

The empirical formula of A is



3 marks

What are the values of m and n in  $\text{FeL}_m(\text{ClO}_4)_n \cdot 3\text{H}_2\text{O}$ ?

m =

3

1 mark

n =

3

1 mark

Since the molecular formula contains one atom of Fe, so in this case the empirical formula is equivalent to the molecular formula. The molecular formula of L has been obtained previously in (4a) and (4b), therefore we can work to find  $m = 3$ . Having obtained the value of m, one can work out for n and find that  $n = 3$ .

The complete formula of A is



1 mark

The ratio of cation to anion is

1 : 3

1 mark

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### Problem 4

The three  $(\text{ClO}_4)^-$  groups will dissociate as free ion in solution.  
So the entire complex will be in the ion forms as  $[\text{FeL}_3]^{3+}$  and  
3  $(\text{ClO}_4)^-$  in solution.

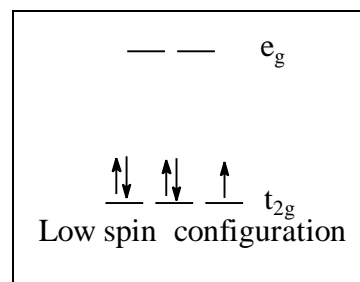
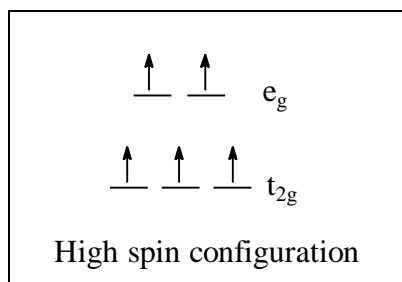
4-6. The oxidation number of Fe in complex A is

0.5 marks

The number of *d*-electrons in Fe ion in the complex =

0.5 marks

Write the high spin and the low spin configuration that may exist for this complex.



2 marks

Which configuration , high or low spin , is the correct one (please tick)?

<input checked="" type="checkbox"/>	High spin
<input type="checkbox"/>	Low spin

1 mark

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### Problem 4

The best evidence to support your answer for this high/low spin selection:

<input type="checkbox"/>	Color
<input type="checkbox"/>	Elemental analysis data
<input checked="" type="checkbox"/>	Magnetic moment
<input type="checkbox"/>	Molar conductance

1 mark

We can use a simple relation between number of unpaired electrons and the magnetic moment as follows.

$$\mu = \sqrt{n(n+2)}$$

where  $\mu$  is the so-called 'spin-only' magnetic moment and  $n$  is the number of unpaired electrons. Thus, for high spin case,

$$\mu = \sqrt{5(5+2)} = \sqrt{35} = 5.92 \text{ B.M.}$$

And for low spin case,  $\mu = \sqrt{1(1+2)} = \sqrt{3} = 1.73 \text{ B.M}$

The measured magnetic moment,  $\mu$ , of A given in Table 4b is 6.13 B.M. which is in the range for high spin case. Therefore, we can conclude that A would exist as a high spin complex.

4-7.  $\lambda_{\max}$  of complex A is  nm.

1 mark

From Table 4c, the color absorbed is complementary to the color seen.

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### Problem 4

4-8 Calculate the 'spin-only' magnetic moment of complex **B**:

Calculation:

From  $\mu = \sqrt{n(n+2)}$

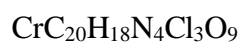
For  $\text{Cr}^{3+}$ ,  $n = 3$  1 mark

Therefore,  $m = \sqrt{3(3+2)} = \sqrt{15} = 3.87$  B.M.

The 'spin-only' magnetic moment of complex **B** =  M.

1 mark

4-9 The empirical formula of **B** is



1 mark

x =

1 mark

y =

1 mark

z =

1 mark

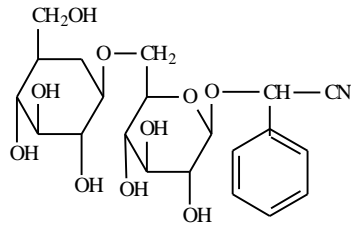
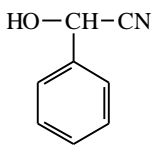
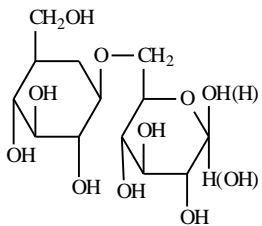
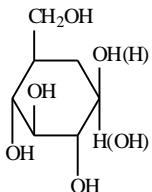


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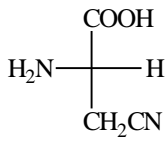
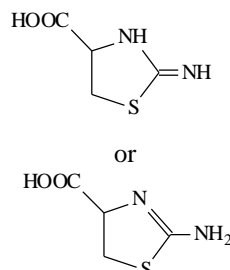
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**Problem 5****23 points**

5-1. Write structures of **A - D** with appropriate stereochemistry in Haworth projection, except for **B**.

 <p style="text-align: center;"><b>A</b> (3 marks)</p> <p>Remark: 1 for cyanohydrin moiety, 1 for two D-glucose units and 1 for 1,6-linkage</p>	 <p style="text-align: center;"><b>B</b> (1 mark)</p>
 <p style="text-align: center;"><b>C</b> (2 marks)</p> <p>Remark: 1 for two glucose units 0.5 for 1,6-linkage 0.5 for <math>\beta</math>-linkage</p>	 <p style="text-align: center;"><b>D</b> (1.5 marks)</p> <p>Remark: 0.5 for correct structure 1 for stereochemistry</p>

5-2. Write molecular formula each for compounds **F** and **G** and structural formula for compound **H** and **I** and indicate stereochemistry of **H**.

<p>Molecular formula of compound <b>F</b> = <b>HCN</b> (0.5 mark)</p>	 <p style="text-align: center;"><b>Compound H</b> (2 marks)</p>	 <p style="text-align: center;"><b>Compound I</b> (2 marks)</p>
<p>Molecular formula of compound <b>G</b> = <b>H<sub>2</sub>S</b> (0.5 mark)</p>	<p>Remark: 1 mark for structure 1 mark for correct stereochemistry</p>	<p>Remark: 2 marks for structure (5 marks)</p>

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**Problem 5**

5-3. Deduce the absolute configuration of (-) **E** and the structure with configuration of each intermediate (**J-O**) in the sequence with the proper **R,S**-assignment.

$\begin{array}{c} \text{COOH} \\   \\ \text{H} - \text{C} - \text{OH} \\   \\ \text{C}_6\text{H}_5 \end{array}$ <p>(-) <b>E</b>  <input checked="" type="checkbox"/> <b>R</b> or <input type="checkbox"/> <b>S</b>            (2 marks)</p> <p>Remark:            1 mark for structure            0.5 mark for <b>R, S</b>            0.5 mark for correct stereochemistry</p>	$\begin{array}{c} \text{COOC}_2\text{H}_5 \\   \\ \text{H} - \text{C} - \text{OC}_2\text{H}_5 \\   \\ \text{C}_6\text{H}_5 \end{array}$ <p>(-) <b>J</b>            (1.5 mark)</p> <p>Remark:            0.5 mark for ester            0.5 mark for ether            0.5 mark for correct stereochemistry</p>	$\begin{array}{c} \text{CH}_2\text{OH} \\   \\ \text{H} - \text{C} - \text{OC}_2\text{H}_5 \\   \\ \text{C}_6\text{H}_5 \end{array}$ <p>(-) <b>K</b>            (1 mark)</p> <p>Remark:            0.5 mark for structure            0.5 mark for correct stereochemistry</p>	$\begin{array}{c} \text{CH}_2\text{OSO}_2\text{C}_6\text{H}_5 \\   \\ \text{H} - \text{C} - \text{OC}_2\text{H}_5 \\   \\ \text{C}_6\text{H}_5 \end{array}$ <p>Compound <b>L</b>            (1 mark)</p> <p>Remark:            0.5 mark for structure            0.5 mark for correct stereochemistry</p>
$\begin{array}{c} \text{CH}_3 \\   \\ \text{H} - \text{C} - \text{OC}_2\text{H}_5 \\   \\ \text{C}_6\text{H}_5 \end{array}$ <p>(-) <b>M</b>            (1 mark)</p> <p>Remark:            0.5 mark for structure            0.5 mark for correct stereochemistry</p>	$\begin{array}{c} \text{CH}_3 \\   \\ \text{H} - \text{C} - \text{OH} \\   \\ \text{C}_6\text{H}_5 \end{array}$ <p>(-) <b>N</b>  <input type="checkbox"/> <b>R</b> or <input checked="" type="checkbox"/> <b>S</b>            (1.5 mark)</p> <p>Remark:            0.5 mark for structure            0.5 mark for <b>R, S</b>            0.5 mark for correct stereochemistry</p>	$\begin{array}{c} \text{CH}_3 \\   \\ \text{H} - \text{C} - \text{OSO}_2\text{C}_6\text{H}_5 \\   \\ \text{C}_6\text{H}_5 \end{array}$ <p>Compound <b>O</b>            (1 mark)</p> <p>Remark:            0.5 mark for structure            0.5 mark for correct stereochemistry</p>	$\begin{array}{c} \text{CH}_3 \\   \\ \text{D} - \text{C} - \text{H} \\   \\ \text{C}_6\text{H}_5 \end{array}$ <p>(-) <b>1-phenylethane-1-d</b>  <input checked="" type="checkbox"/> <b>R</b> or <input type="checkbox"/> <b>S</b>            (0.5 mark)</p> <p>Remark:            0.5 mark for <b>R, S</b></p>

5-4. The mechanism involved in the conversion of compound **O** to (-) **1-phenylethane-1-d** is

<input type="checkbox"/>	$\text{S}_{\text{N}}1$
<input checked="" type="checkbox"/>	$\text{S}_{\text{N}}2$
<input type="checkbox"/>	$\text{S}_{\text{N}}i$
<input type="checkbox"/>	E1
<input type="checkbox"/>	E2

1 mark

Name:

Student Code:

**Problem 6**

**16 points**

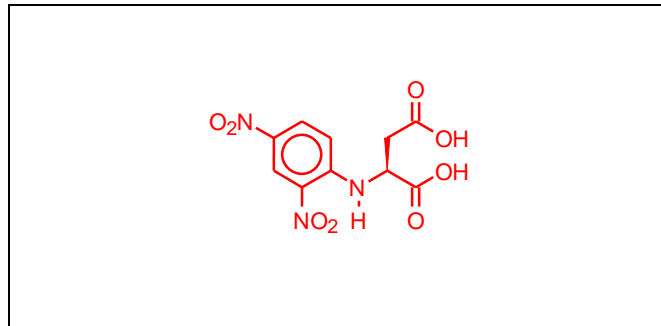
6-1.

2

sulfonic acid groups are formed from oxidation of a disulfide bond.

1 mark

6-2. Complete structure of DNP-Asp at its isoelectric point is



2 marks

Remarks

- 2 marks for exactly the same structure
- 1 mark for the condensed structure
- 0.5 mark for Zwitterionic form
- 0 mark for misplaced DNP group

6-3.

The sequence of B8 is

Cya-Tyr-Ile-Glu

2 marks

Remarks

- 0.5 marks if the sequence is correct but the symbol "Cys" is used in place of "Cya"
- 1 mark if "Cya" is put correctly at N-terminus but the sequence is incorrect
- 0 mark for the reverse sequence

6-4.

The sequence of B9 is

Asp-Cya-Pro-Leu

1 mark

Remarks

- 0.5 marks if the sequence is correct but the symbol "Cys" is used in place of "Cya"
- 0 mark for wrong sequence even if Asp and Leu are placed correctly since the information is already provided in the question

Name:

Student Code:

**Problem 6**

6-5. The *complete* structure of A is

Cys-Tyr-Ile-Glu-Asp-Cys-Pro-Leu-Gly-NH<sub>2</sub>

5 marks

Remarks

- 5 marks for exactly the same sequence with correct placement of disulfide bond
- 1 mark for missing or misplaced the disulfide bond.
- 0.5 marks for missing "NH<sub>2</sub>" group at C-terminus.
- 0.5 for using the symbol "Cya" is used in place of "Cys".
- 0 mark if the sequence wrong.

6-6. Write the revised structure of A below and circle the site(s) to indicate all the possible source of ammonia

Cys-Tyr-Ile-Gln-Asn-Cys-Pro-Leu-Gly-NH<sub>2</sub>

3 marks

Remarks

- 0.5 marks for each correct position of the amide group (Glu->Gln, Asp->Asn and at C-terminus)
- 0.5 marks for each circle at appropriate places (circle at Gly is allowed)

6-7.

The isoelectric point of A is

9

2 marks