

Note: The total marks of INChO-2017 paper are 111.5 (instead of 113). This is because:

- (i) Total marks of Problem 2 are 25.
- (ii) Total marks of Problem 3 are 22.5.

Common lapses observed in INChO 2017 answerscripts:

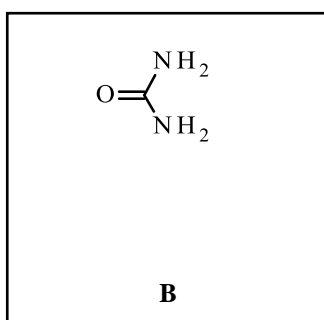
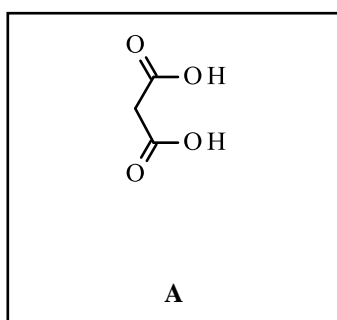
- 1) In sub-parts requiring detailed calculations, only final answer is written without showing the necessary steps.
- 2) Numerical answers being written without appropriate units.
- 3) In writing structures of molecules, valency of various atoms not being satisfied.

**Problem 1**

**17 Marks**

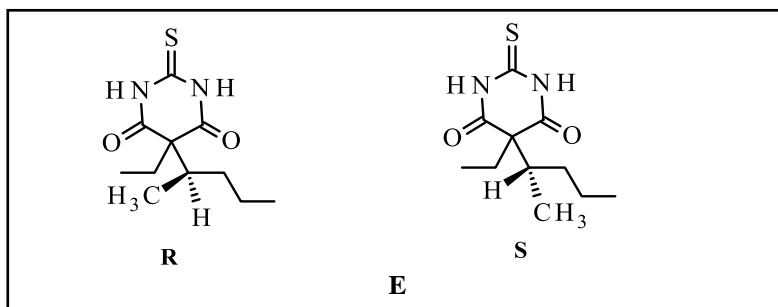
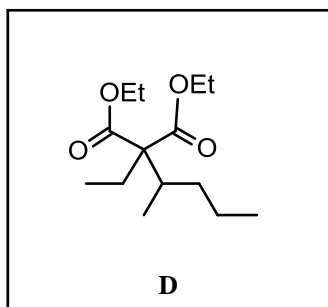
**Barbiturates in our lives**

1.1



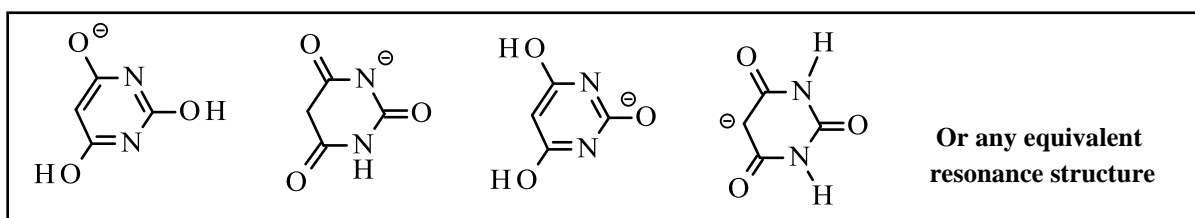
(1 mark)

1.2



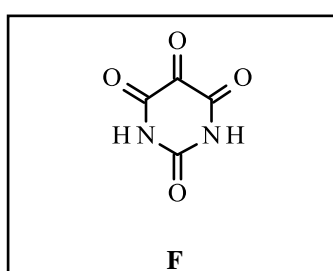
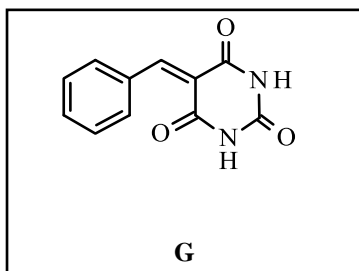
(2.5 marks)

1.3



(2 marks)

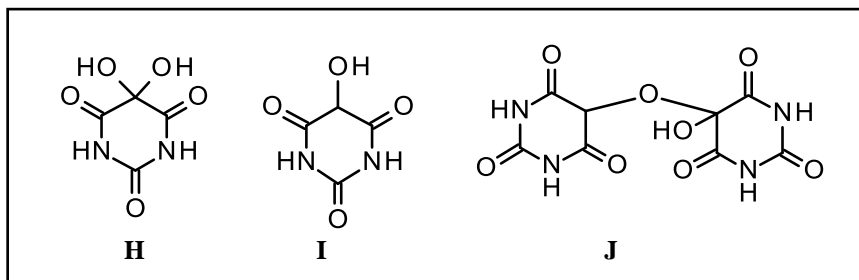
1.4



(1.5 marks)

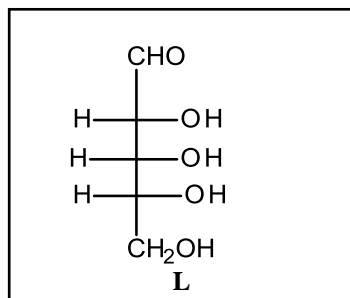
1.5 a)  $< 4.01$   b)  $> 4.01$   c)  $= 4.01$   (0.5 mark)

1.6



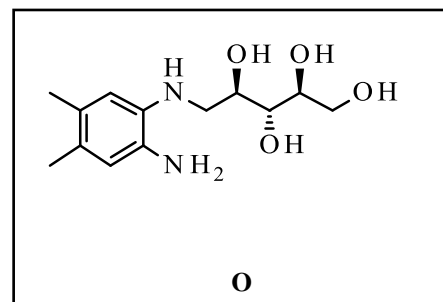
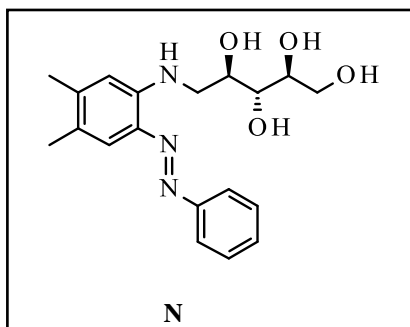
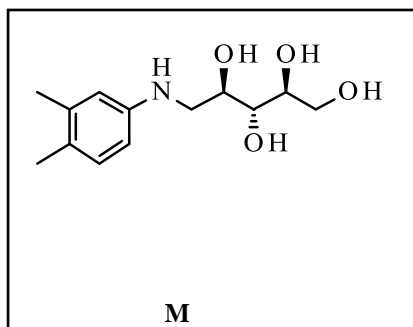
(2 marks)

1.7



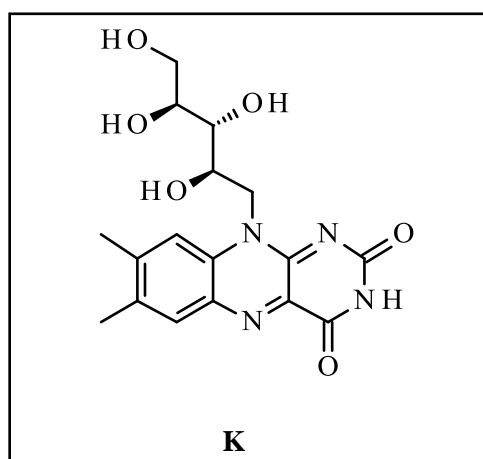
(2 marks)

1.8 a)



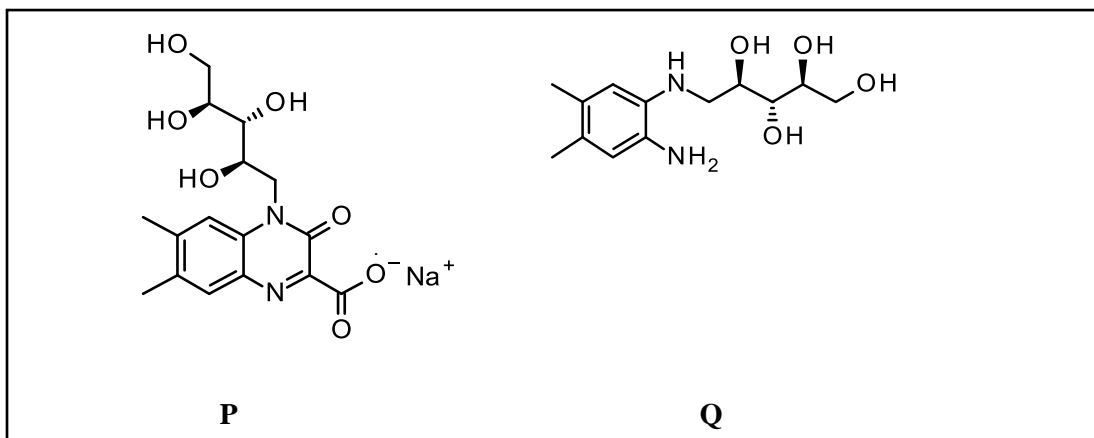
(2.5 marks)

b)



(2 marks)

1.9



(1 mark)

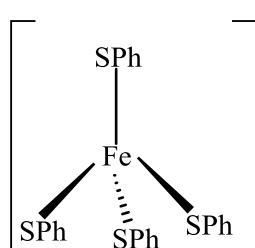
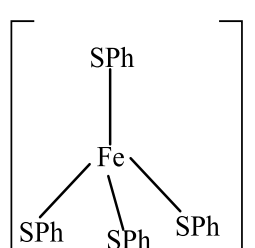
Problem No. 2

25 Marks

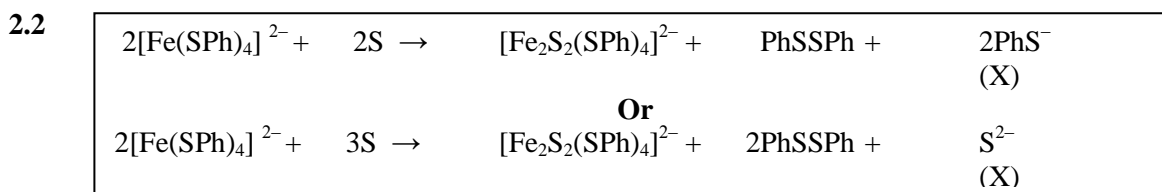
Chemistry of Iron

[The total marks for this question are 25 marks instead of 26 marks – This is due to deletion of subpart 2.9.]

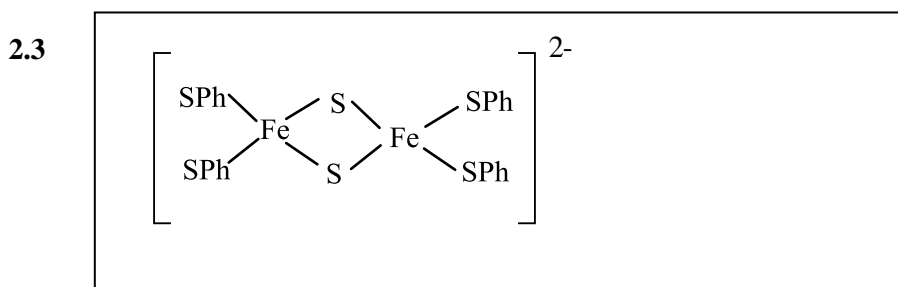
Part A: Iron Sulphur proteins

2.1	<p style="text-align: center;">Structure of <math>[\text{Fe}(\text{SPh})_4]^{2-}</math></p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p><b>Geometry: Tetrahedral</b></p> </div> <div style="text-align: center;"> <p>or</p>  </div> </div>	<p>Calculation for magnetic moment:</p> <p style="text-align: center;"><math>d^6</math> system</p> <p style="text-align: center;">4 unpaired electrons, 4.89 BM</p>
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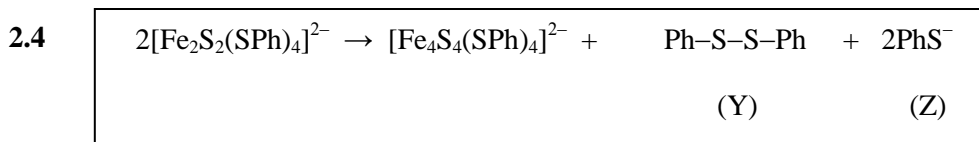
(2 marks)



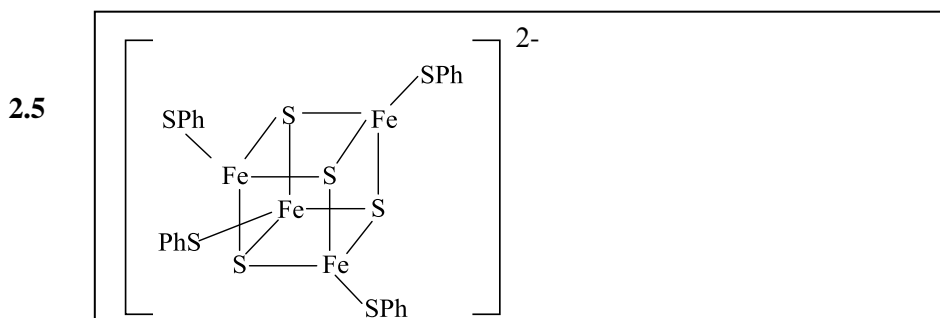
(1 mark)



(1.5 marks)



(1 mark)



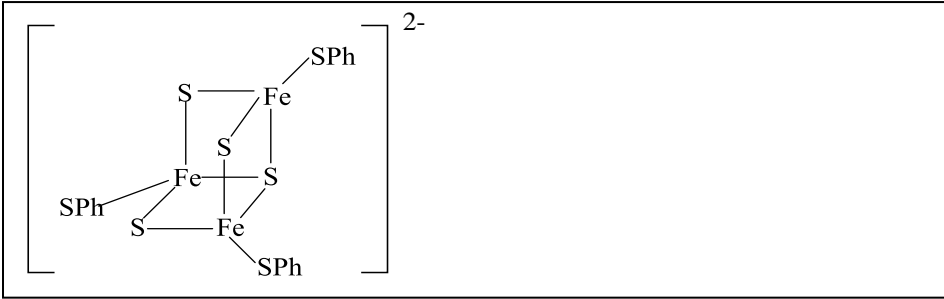
(1 mark)

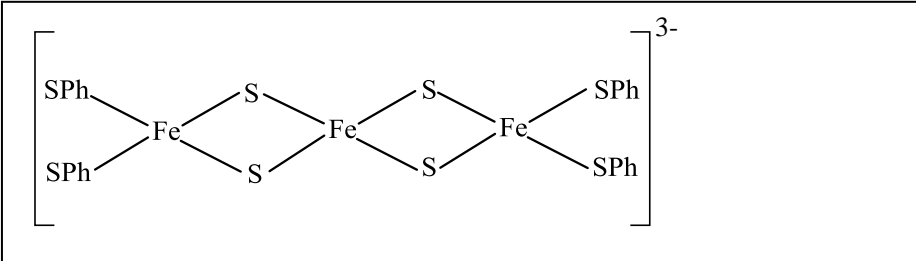
2.6 a) Fe (III) in  $[\text{Fe}_2\text{S}_2(\text{SPh})_4]^{2-}$

b) Fe (II) in  $[\text{Fe}_2\text{S}_2(\text{SPh})_4]^{2-}$

c) Fe (III) in  $[\text{Fe}_4\text{S}_4(\text{SPh})_4]^{2-}$

d) Fe (II) in  $[\text{Fe}_4\text{S}_4(\text{SPh})_4]^{2-}$

2.7  (2 marks)

2.8  (1 mark)

2.9 This subpart has been deleted.

2.10 b)  $[\text{Fe}_2\text{S}_2(\text{SR})_4]^{2-}$   c)  $[\text{Fe}_4\text{S}_4(\text{SR})_4]^{2-}$   (2 marks)

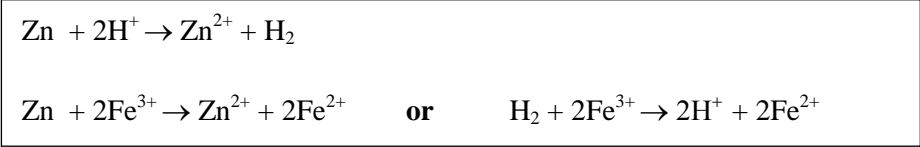
2.11 A  (1 mark)

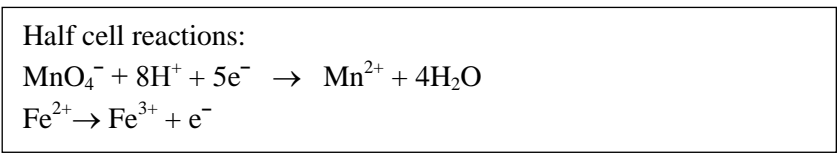
2.12 A is  B is  (1 mark)  
 If A = Copper but B = left blank then also 1 mark is awarded.

2.13  $\text{A}^{2+}$   (0.5 mark)

**Part B: Use of iron in “blue” colours**

2.14  (1.5 marks)

2.15  (1 mark)

2.16  (1 mark)

2.17

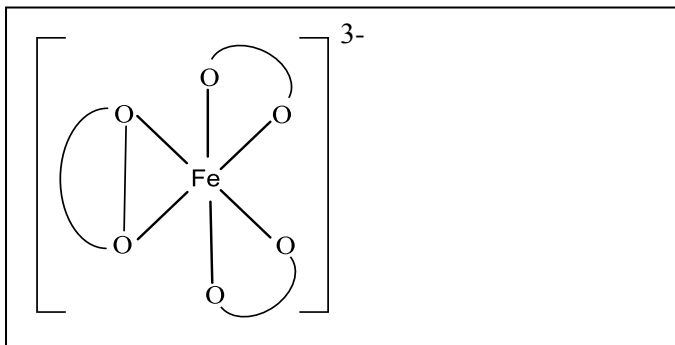
Moles of oxalate ion =  $1.52 \times 10^{-3}$  moles

Moles of  $\text{Fe}^{2+} = 4.998 \times 10^{-4}$  moles

Molar ratio of iron: oxalate (to the nearest whole number) :  $4.998 \times 10^{-4} / 1.52 \times 10^{-3} = 1:3$

(3 marks)

2.18 a)



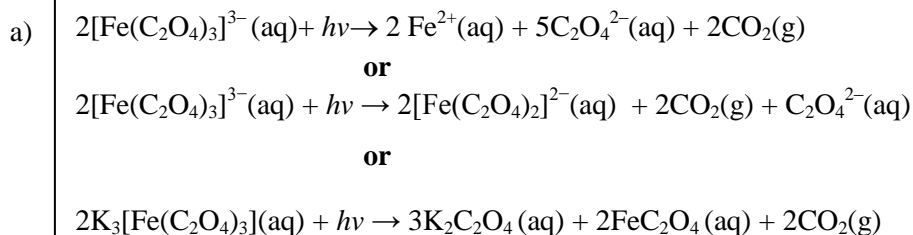
(1 mark)

b) ii)

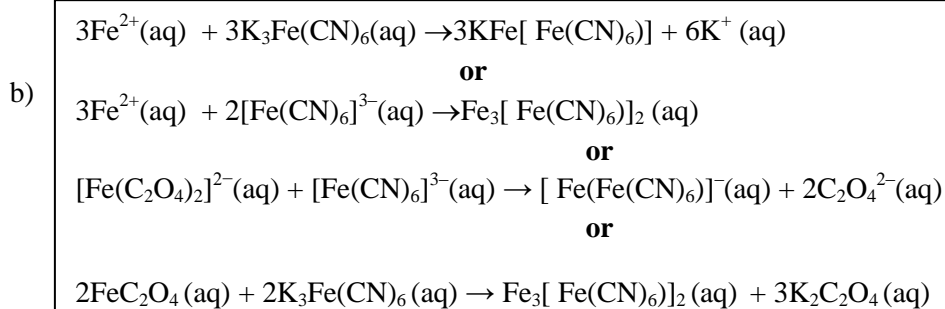


(0.5 mark)

2.19



(1 mark)



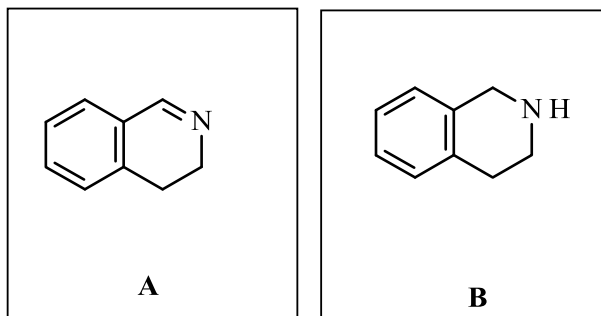
(1 mark)

Problem 3

22.5 Marks

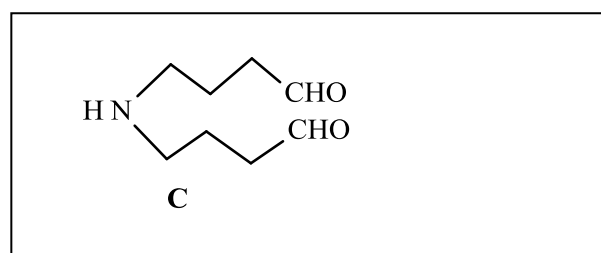
Alkaloids

3.1



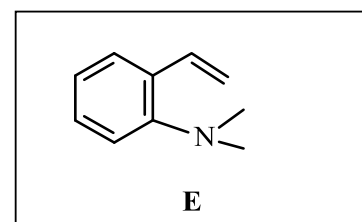
(2 marks)

3.2



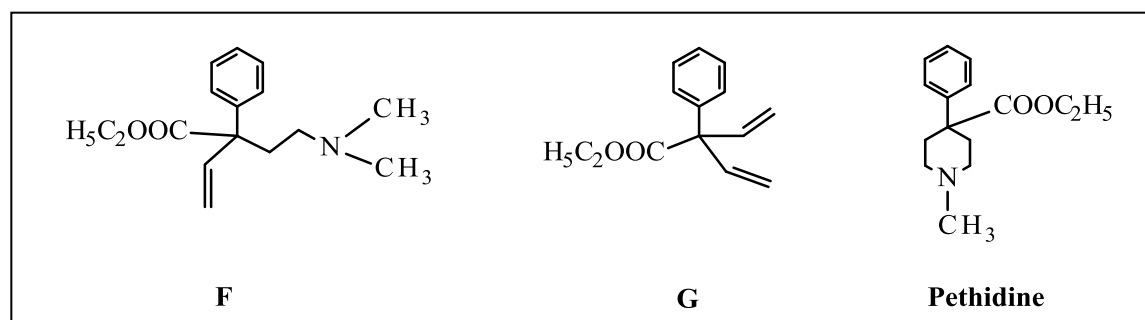
(1.5 marks)

3.3



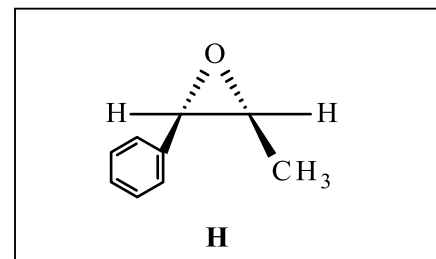
(1 mark)

3.4



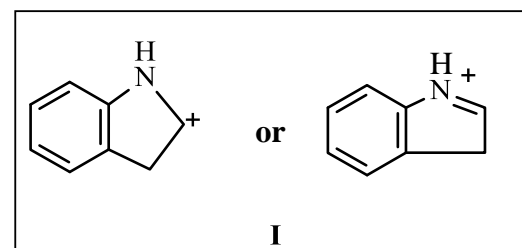
(3 marks)

3.5



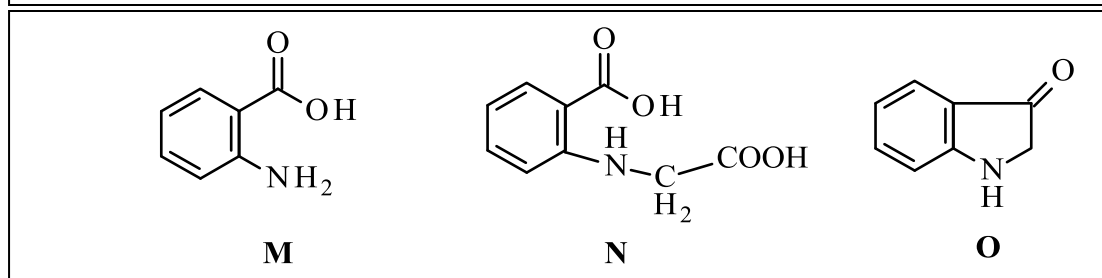
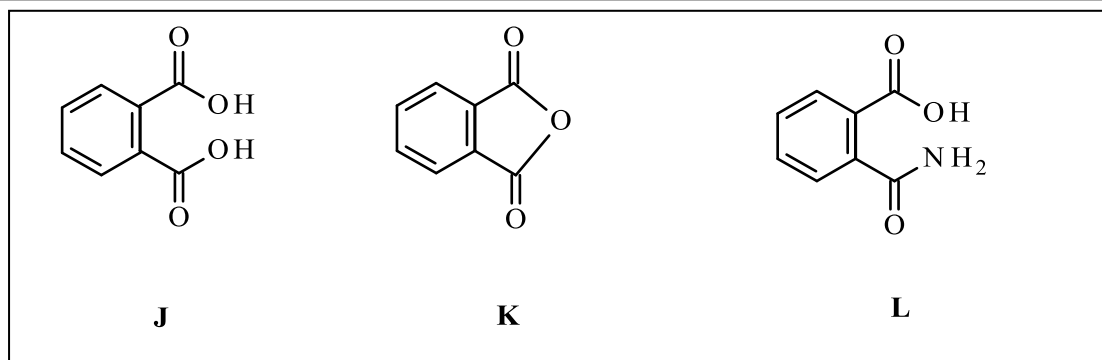
(2 marks)

3.6.



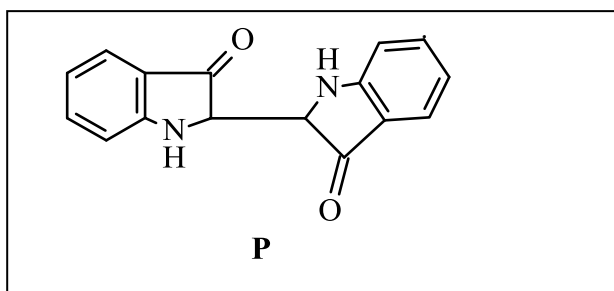
(1 mark)

3.7



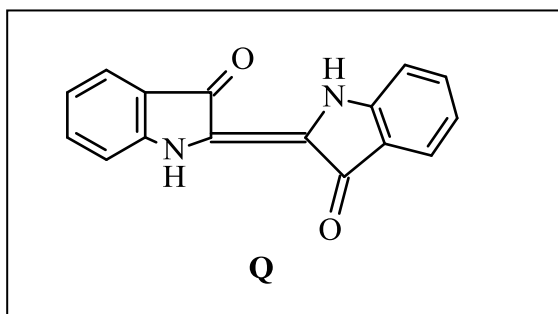
(4 marks)

3.8



(1 mark)

3.9



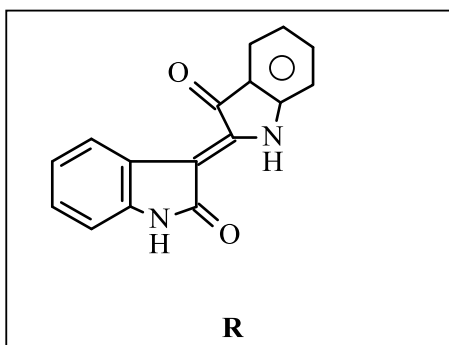
(1 mark)

3.10

2

(0.5 mark)

3.11



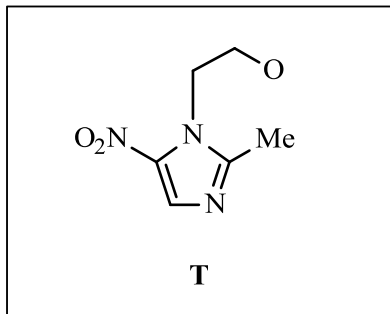
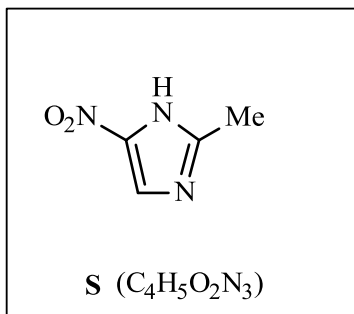
(1 mark)



3.12 iii) X

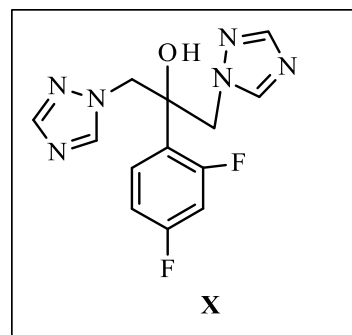
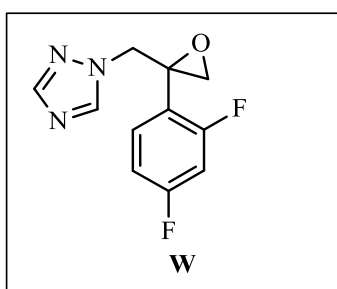
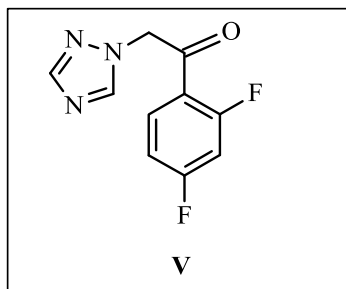
(1 mark)

3.13



(1 mark)

3.14



(2.5 marks)

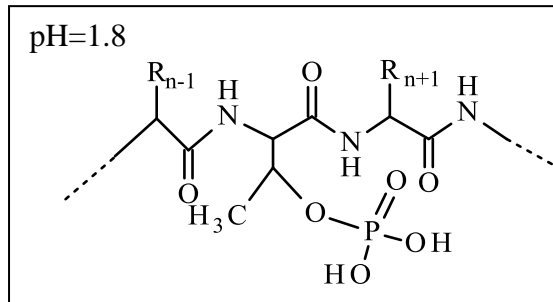
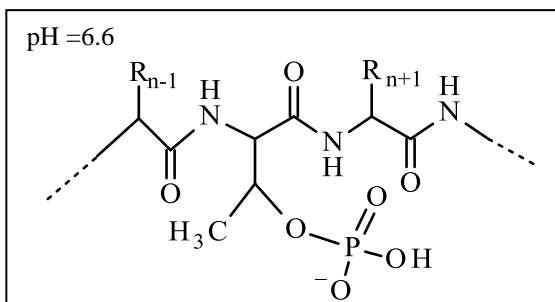
**Problem 4**

**26 marks**

**Understanding Milk**

**Part A: Proteins in Milk**

4.1



(1.5 marks)

4.2.

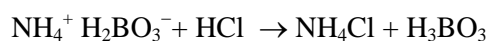
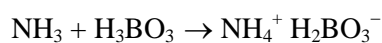
b)

e)

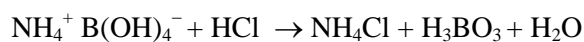
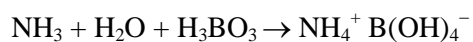
f)

(2.5 marks)

4.3



Or



(1.5 marks)

4.4

a)

(1 mark)

4.5

Mass of protein that would be reported = 43.5 g L<sup>-1</sup>

(2 marks)

4.6.

Concentration of caseins in milk sample = 34.3 g L<sup>-1</sup>

(2 marks)

4.7

Concentration of non-protein N = 1.23 g L<sup>-1</sup>

(3 marks)

4.8.

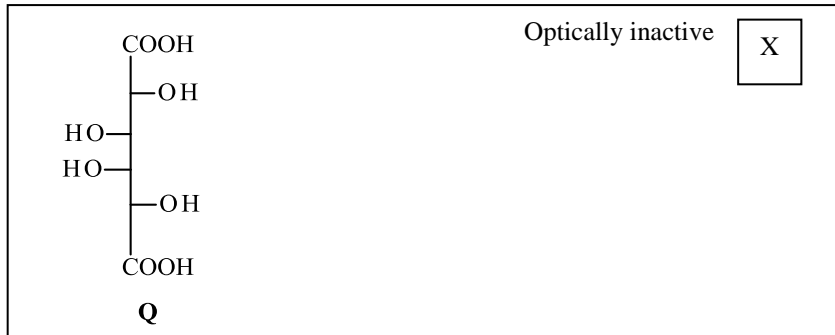
a)

b)

(1.5 marks)

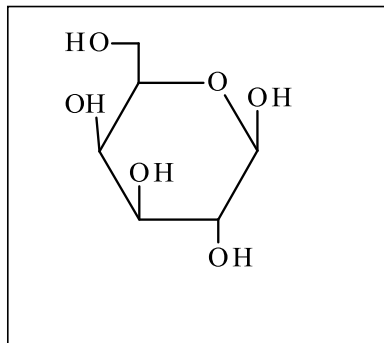
Part B: Carbohydrates in Milk

4.9



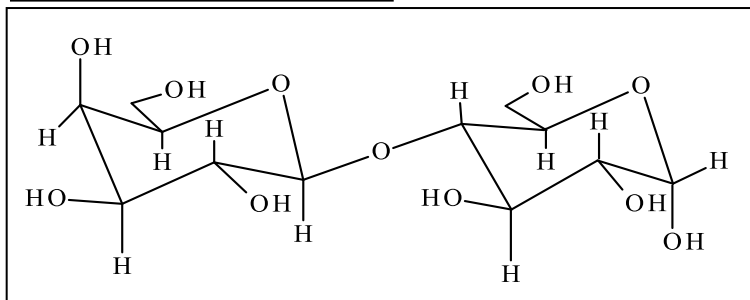
(1.5 marks)

4.10



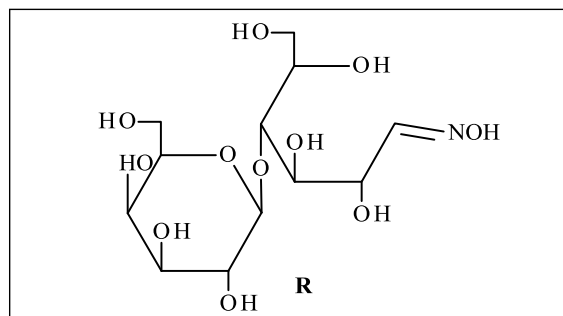
(0.5 mark)

4.11



(2 marks)

4.12



(1 mark)

4.13

$L_1 = 38\%$     $L_2 = 62\%$

(1 mark)

4.14

Lactose amount in the solution: 184.2 g

(2 marks)

4.15

Yes:   a)  X      d)  X      e)  X  
 No:    b)  X      c)  X      f)  X

(3 marks)

## Problem 5

21 Marks

## Isotope Effects

- 5.1  $\lambda_{\text{H}} - \lambda_{\text{D}} = 1.8 \text{ \AA}$  (2 marks)
- 5.2 At equilibrium, total number of moles in the gas = 0.7269 mol (2.5 marks)
- 5.3 Mol% HD in liquid = 0.35% (3.5 marks)
- 5.4 Enrichment factor = 1.75 (1 mark)
- 5.5 The mixture consists of 52.47 mol %  $\text{H}_2$  and 47.53 mol % of HD. (2 marks)
- 5.6 True: b)  c)   
False: a)  d)  (2 marks)
- 5.7  $\text{HDO} \rightleftharpoons \frac{1}{2} \text{O}_2 + 2\text{e}^- + \text{H}^+ + \text{D}^+$  (1 mark)
- 5.8 ii)  (1 mark)
- 5.9 If  $K_{\text{eq}} = [\text{HDO}(\text{l})] / [\text{D}_2\text{O}(\text{l})] [\text{H}_2\text{O}(\text{l})]$  is taken (as mistakenly given in the question paper), then  
33.6 mol  $\text{dm}^{-3}$  of  $\text{H}_2\text{O}$ , 0.34 mol  $\text{dm}^{-3}$  of  $\text{D}_2\text{O}$  and 21.4 mol  $\text{dm}^{-3}$  of HDO.  
**or**  
If  $K_{\text{eq}} = [\text{HDO}(\text{l})]^2 / [\text{D}_2\text{O}(\text{l})] [\text{H}_2\text{O}(\text{l})]$  is taken, then  
35.5 mol  $\text{dm}^{-3}$  of  $\text{H}_2\text{O}$ , 2.25 mol  $\text{dm}^{-3}$  of  $\text{D}_2\text{O}$  and 17.6 mol  $\text{dm}^{-3}$  of HDO.  
Both solutions are given full credit. (2.5 marks)
- 5.10 b)  c)  (2 marks)
- 5.11 a)  (1.5 marks)