

"Any alternative method of solution to any question that is scientifically and mathematically correct, and leads to the same answer will be accepted with full credit. Partially correct answers will gain partial credit."

For questions requiring calculations, full credit is given only if necessary steps of the calculations are written.

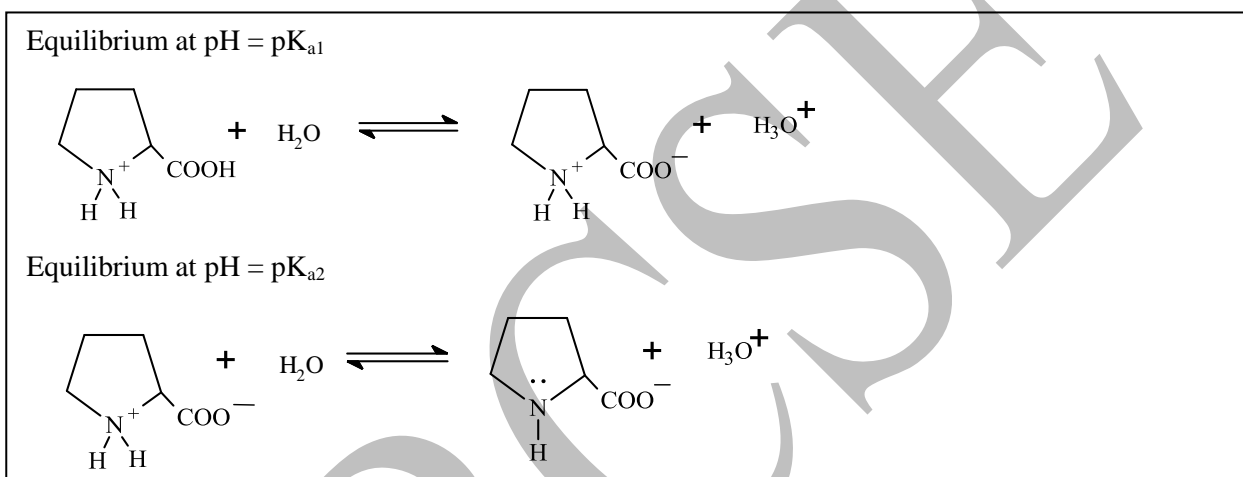
Frozen Solutions

Problem 1

23 marks

Common and Uncommon Amino Acids

1.1



(1 mark)

$$\text{pI} = \frac{\text{pK}_{a1} + \text{pK}_{a2}}{2}$$

1.2

(2.5 marks)

1.3. a.

True

b.

True

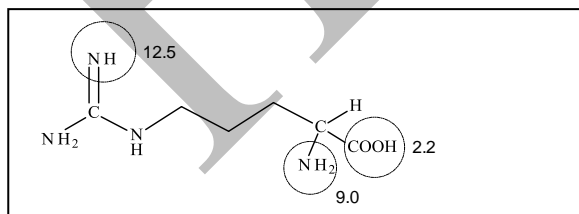
(1 mark)

1.4. a.

iv. 2.2, 9.0, 12.5

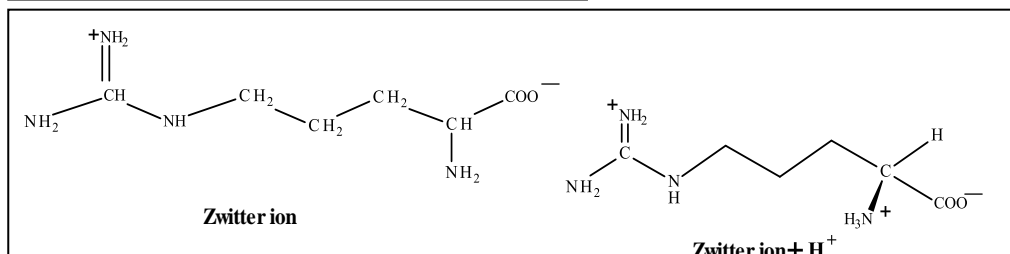
(1 mark)

b.



(1 mark)

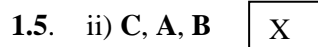
c.



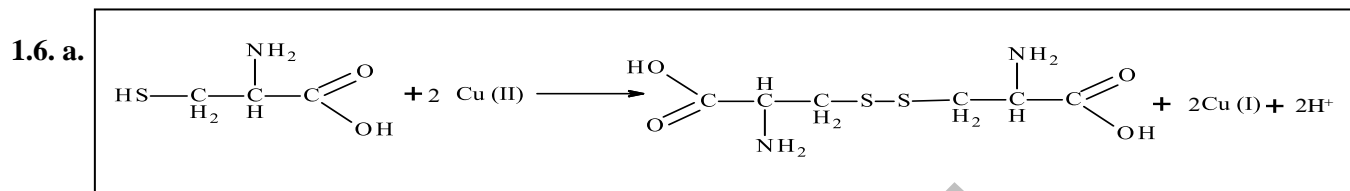
(1.5 marks)



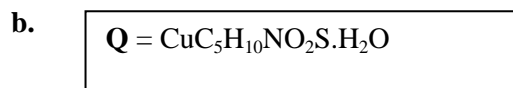
(1 mark)



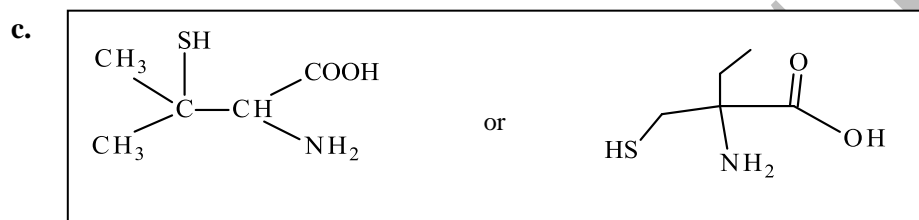
(1.5 marks)



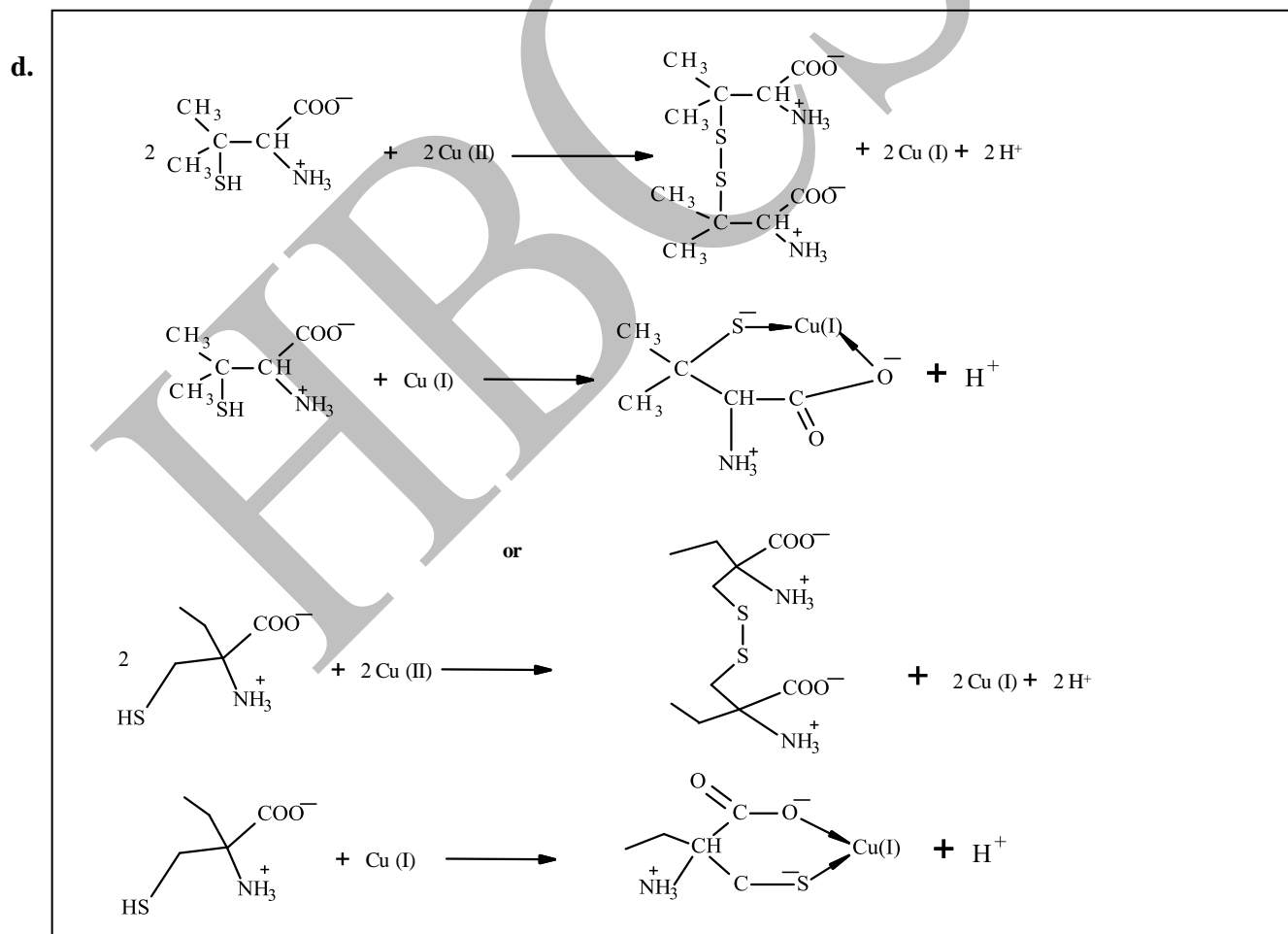
(0.5 mark)



(3 marks)

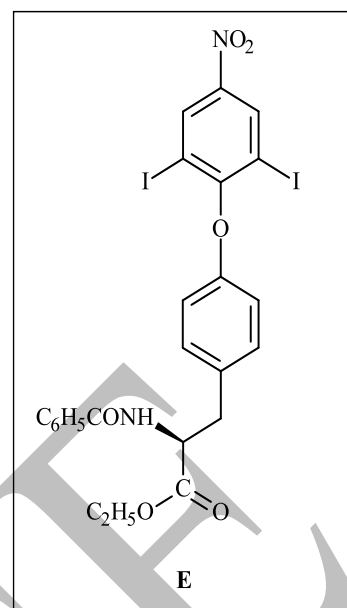
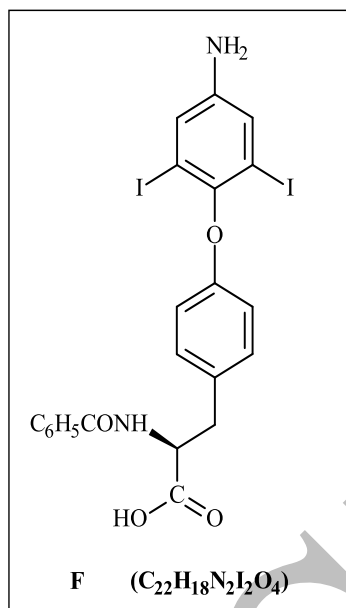
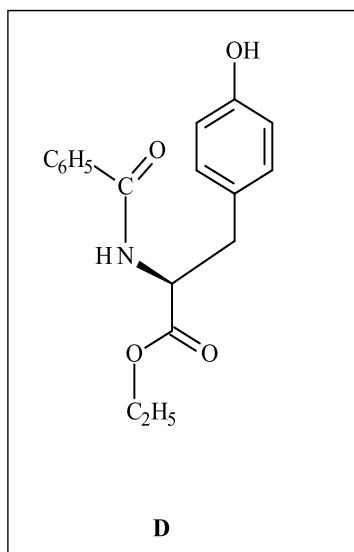


(1 mark)



(2 marks)

1.7.i)



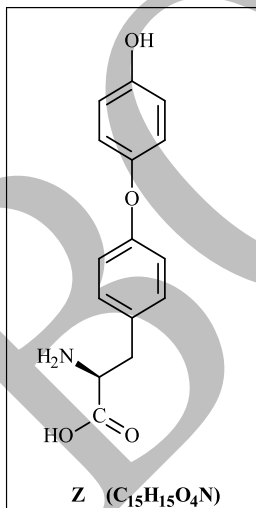
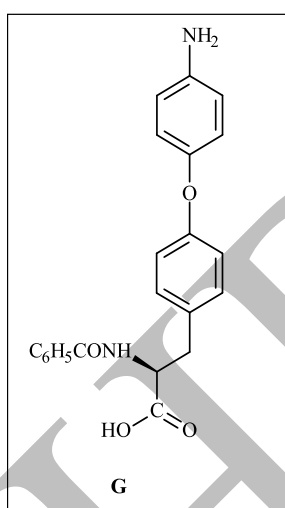
(3 marks)

ii) a) Reducing agent

X

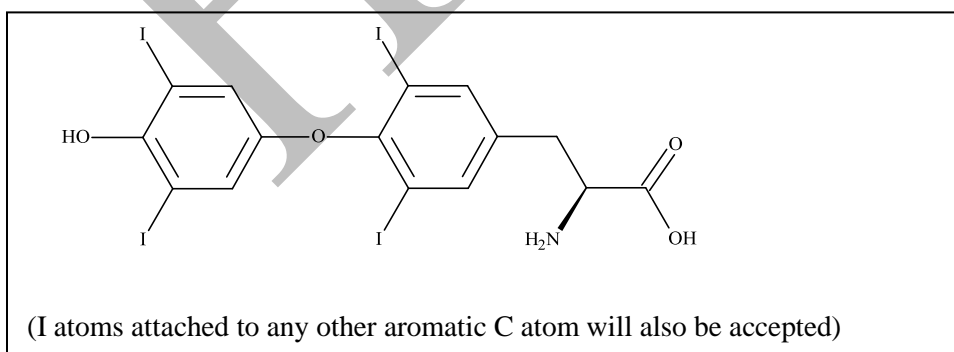
(0.5 mark)

iii) **



(1.5 marks)

iv)



(1 mark)

**During the exam, the following additional instruction was communicated to the students.

Q. 1.7(iii) Draw the structures of compounds **G** and **Z** with stereochemistry.

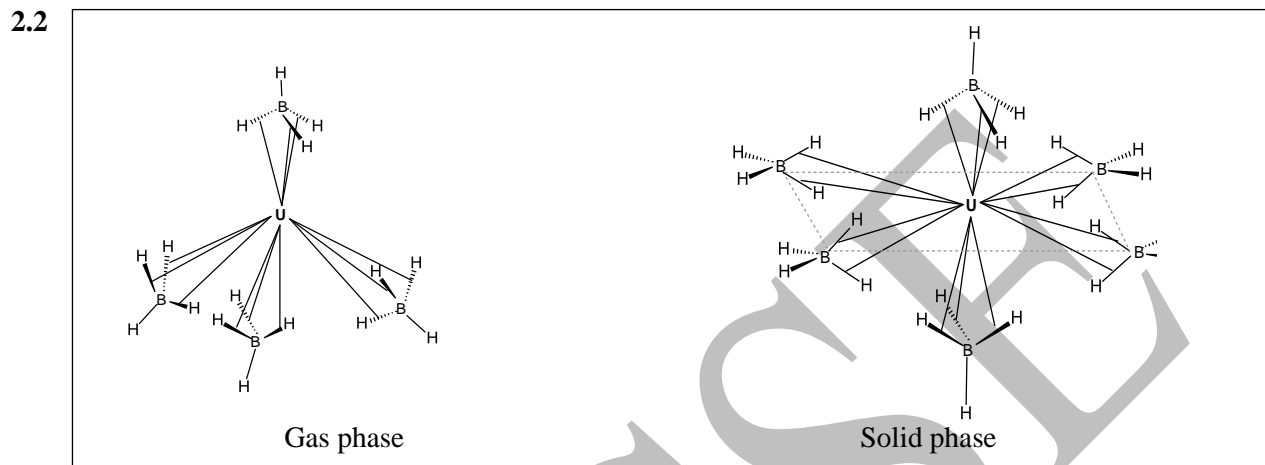
Problem 2

17 marks

Boron Compounds through the Ages

2.1 $\text{NaBH}_4 + 4\text{H}_2\text{O} \rightarrow 4\text{H}_2 + \text{NaB(OH)}_4$
 Volume $V = 257.6 \text{ L}$

(2.5 marks)



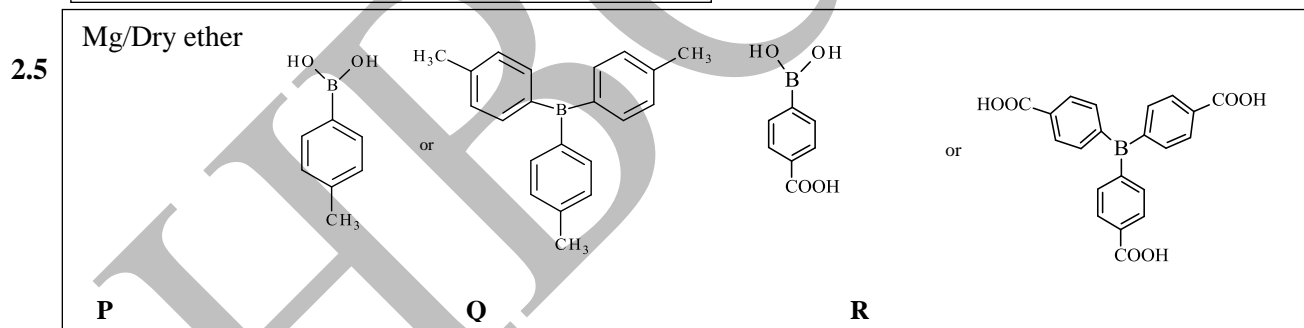
(3.5 marks)

2.3 $^{10}\text{B} = 20\%$

(1.5 marks)

2.4 Saturated solution of H_3BO_3

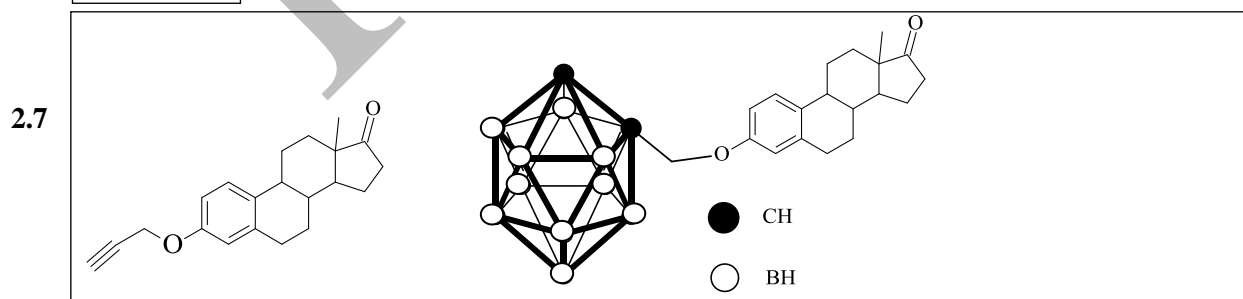
(2.5 marks)



(2 marks)

2.6 6

(1 mark)



(2 marks)

2.8 i. $+3$
 iii. $\text{X} = \text{F}$

ii. Tetrahedral
 iv. **b**

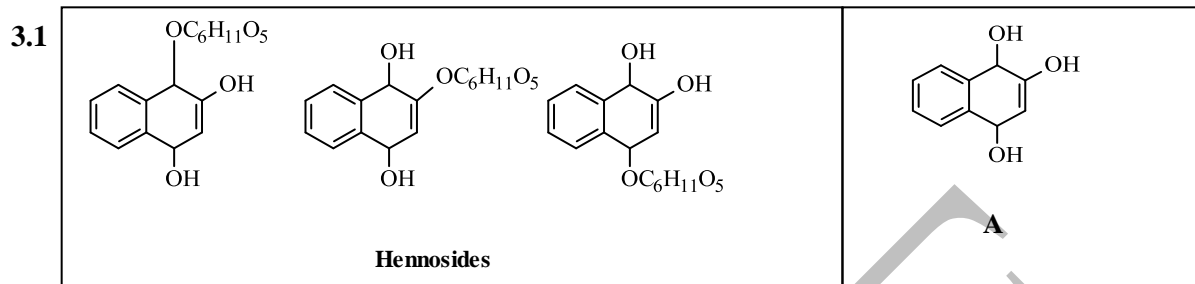
(2 marks)

Problem 3

19 Marks

Chemistry behind Henna – Lawsone

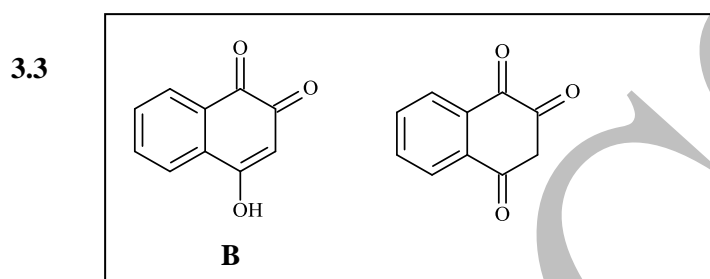
Part I: Properties of Lawsone



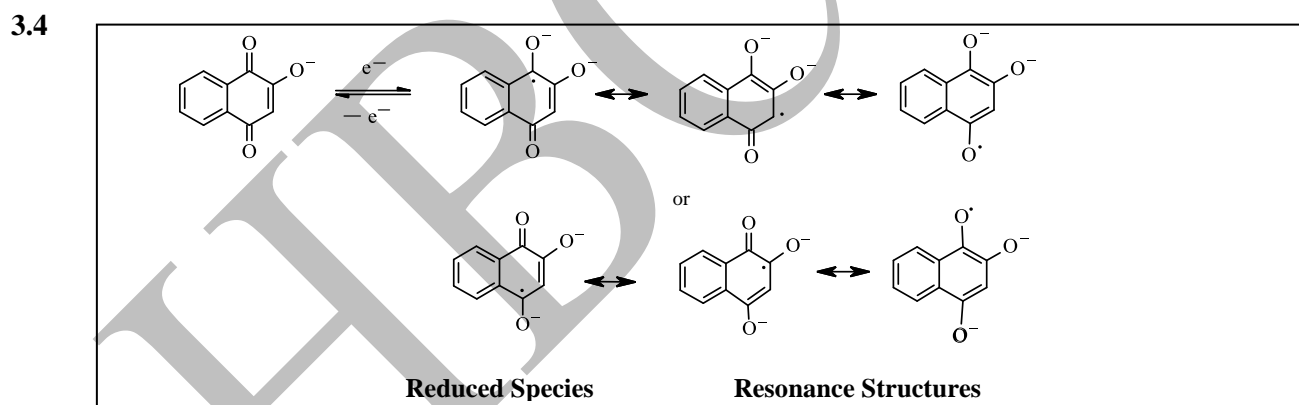
(2.5 marks)

3.2 a) Lemon juice

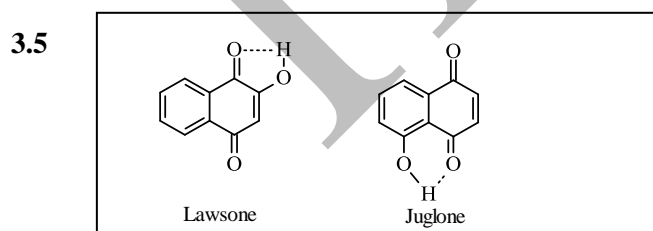
(1 mark)



(0.5 mark)



(2 marks)



(1 mark)

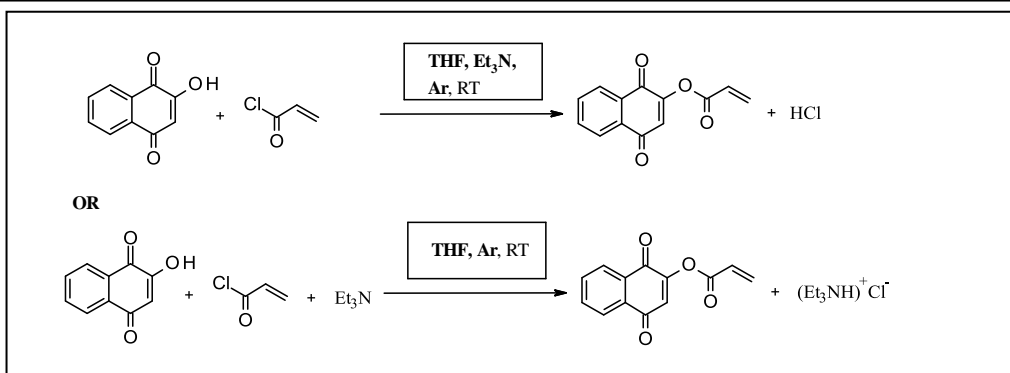
3.6 Lawsone Juglone

(1 mark)

3.7 Lawsone

(1 mark)

3.8



(2.5 marks)

3.9

a) Base

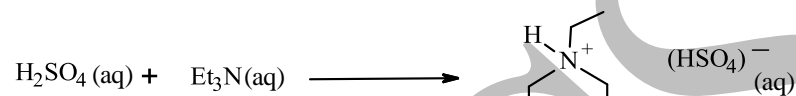
(0.5 mark)

3.10

2-propenoyl chloride

(2 marks)

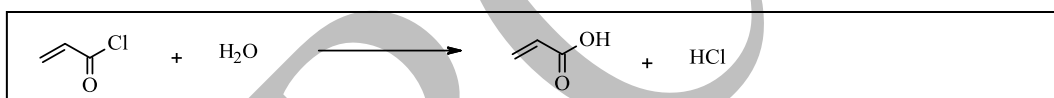
3.11



Aqueous phase (organic/aqueous interface also accepted)

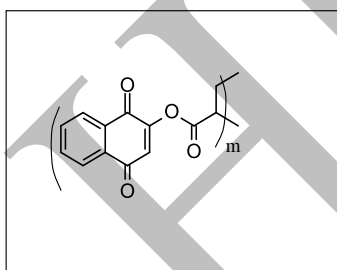
(1.5 marks)

3.12



(1 mark)

3.13



(1 mark)

3.14

True False

(i)

(ii)

(iii)

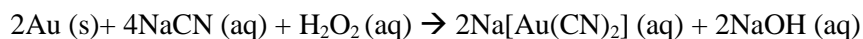
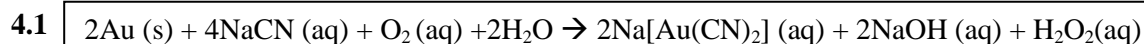
(1.5 marks)

Problem 4

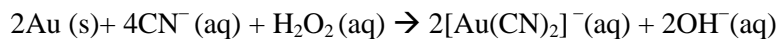
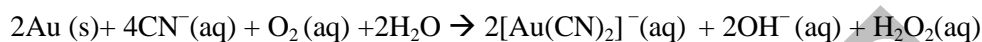
23.5 Marks

Gold Refining

Part I: Cyanidation Method



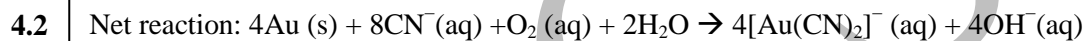
Or [ionic equation]



Or



(1.5 marks)



NaCN concentration = 0.105 g L^{-1} .

(2 marks)

4.3 Linear, $\mu_{\text{spin}} = 0$

(1 mark)

4.4
$$E_{\text{Au(CN)}_2^- / \text{Au}} = -0.57 - 0.059 \log \frac{[\text{CN}^-]^2}{[\text{Au(CN)}_2]^-}$$

(2.5 marks)

4.5 (i) Au, Ag, Pd, Pt

(ii) Au > Ag > Pd > Pt

(3 marks)

4.6 pH \approx 9.1

(1 mark)

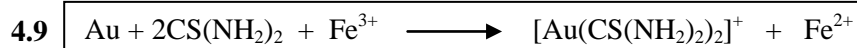
4.7 $[\text{Cu(CN)}_4]^{3-}$, $[\text{Cu(CN)}_3]^{2-}$

(1 mark)

4.8 a) d)

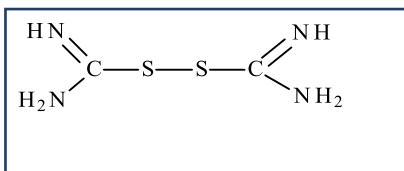
(2 marks)

Part II: Thiourea Method



(1 mark)

4.10



(1 mark)

4.11

295 K

(2.5 marks)

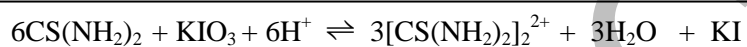
4.12

(A)

(C)

(1 mark)

4.13



(1 mark)

4.14

Mass of gold recovered = 5.91 g L^{-1}

(3 marks)

Problem 5

24 marks

Phosphate and Struvite

Part I: Struvite from Phosphate

5.1

13.26 mg L⁻¹

(1.5 marks)

5.2

Molar ratio MAP: MKP = 3.3: 1

(2 marks)

5.3

A = MgHPO₄, Molar mass = 120.4 g mol⁻¹B = Mg₂P₂O₇, Molar mass = 222.6 g mol⁻¹

(3 marks)

Part II: Precipitation Conditions for Struvite

5.4

At pH 7,
 ([PO₄³⁻]/[H₂PO₄⁻]) = 3.02 × 10⁻⁶:1
 At pH 11,
 [PO₄³⁻]/[HPO₄²⁻] = 0.048:1

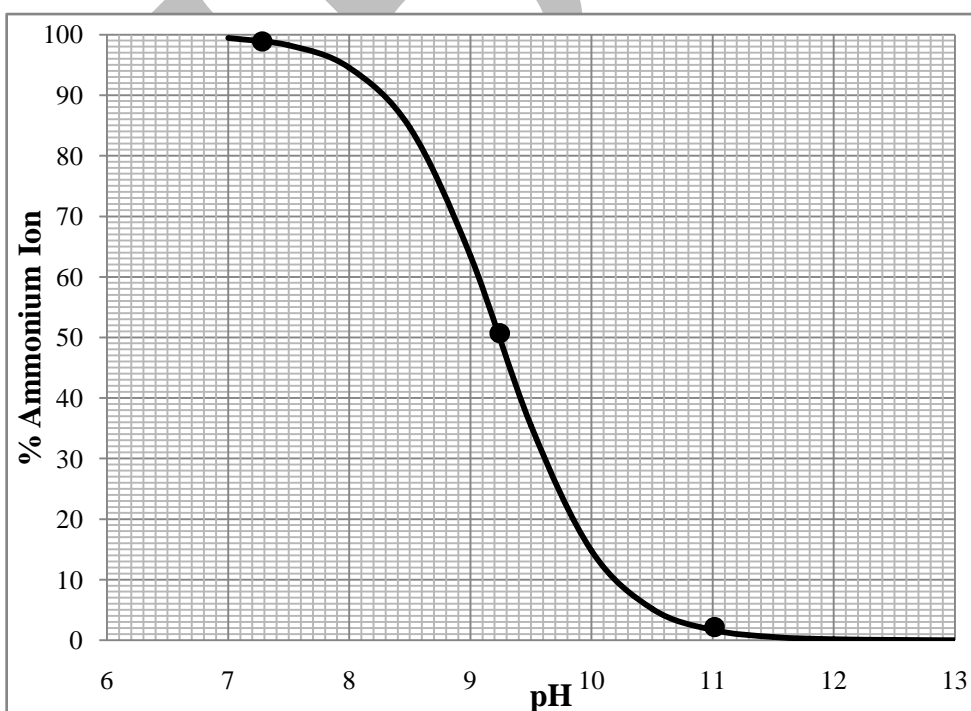
(2 marks)

5.5

a) % NH₄⁺ = 50%b) % NH₄⁺ = 1.67%

c) pH ≈ 7.24

(2.5 marks)



(1.5 marks)

5.6

$$\% \text{Mg}^{2+} = 71.56\%$$

(2 marks)

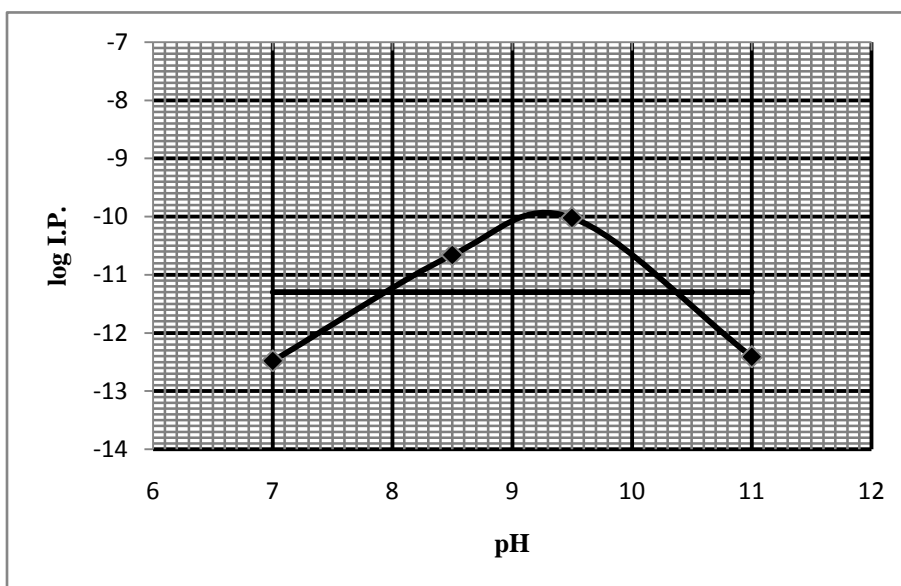
5.7

(i) At pH 7, I.P. = 3.24×10^{-13}

At pH 11, I.P. = 3.85×10^{-13}

(4 marks)

(ii)



pH Range: 7.9- 10.4

(2.5 marks)

5.9

c) X

(1 mark)

5.10

Effect

a) iii

b) iii

c) iii

d) i

(2 marks)