

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 when the necessary steps of the calculations are written. In problems having related sub-parts, consistency of answers of the related sub-parts is also checked during evaluation.

**Problem 1**
**23 marks**
**The golden alloy**

1.1		Yes	No	
	Cu & Ag	X		
	Cr & K		X	
	Cu & Al		X	
	Ag & Al		X	(2 marks)

1.2	300 °C – $\gamma + \epsilon$ phase	750 °C – $\gamma + \text{liquid phase}$	(1 mark)
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1.3 i)	$2 \text{Cu}^{2+}(\text{aq}) + 4\text{I}^{-}(\text{aq}) \rightarrow \text{Cu}_2\text{I}_2(\text{s}) + \text{I}_2(\text{aq})$ Or $2 \text{Cu}^{2+}(\text{aq}) + 5\text{I}^{-}(\text{aq}) \rightarrow \text{Cu}_2\text{I}_2(\text{s}) + \text{I}_3^{-}(\text{aq})$	(1 mark)
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ii)	$\text{I}_2(\text{aq}) + 2\text{Na}_2\text{S}_2\text{O}_3(\text{aq}) \rightarrow \text{Na}_2\text{S}_4\text{O}_6(\text{aq}) + 2 \text{NaI}(\text{aq})$	(1 mark)
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iii)	Cu (I) has $3d^{10}$ configuration. Magnetic Moment = 0 BM	(1 mark)
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iv) a)	<input checked="" type="checkbox"/>	(0.5 mark)
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v)	mmole of Cu (II) in the sample = 0.72 mmol mmole of Zn (II) in the sample = 0.277 mmol % Zn in the sample = 28.35%	(2.5 marks)
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vi)	$\alpha$ -brass	(0.5 mark)
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vii) a)	<input checked="" type="checkbox"/>	b)	<input checked="" type="checkbox"/>	(1 mark)
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1.4 i)	Molar mass of cupron, $\text{C}_{14}\text{NO}_2\text{H}_{13} = 227 \text{ g mol}^{-1}$ , $y = 2$	(2 marks)
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- ii)  $2\text{ZnNH}_4\text{PO}_4(\text{s}) \rightarrow \text{Zn}_2\text{P}_2\text{O}_7(\text{s}) + 2\text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{g})$  (1.5 marks)
- iii) Molar mass of zinc pyrophosphate =  $304 \text{ g mol}^{-1}$   
Mass of zinc pyrophosphate = 212.8 mg (2 marks)
- 1.5 b)  X c)  X (1 mark)

1.6 (4 marks)

Reaction	Metal ion(s) and their form in supernatant	Composition of precipitate
Ni-brass solution + excess NaOH (aq.)	$[\text{Zn}(\text{OH})_4]^{2-}$	$\text{Cu}(\text{OH})_2$ , $\text{Ni}(\text{OH})_2$
Ni-brass solution + excess $\text{NH}_3$ (aq.) till pH is 9.5	$[\text{Cu}(\text{NH}_3)_4]^{2+}$ , $[\text{Ni}(\text{NH}_3)_6]^{2+}$ #	$\text{Zn}(\text{OH})_2$

# In the supernatant,  $[\text{Zn}(\text{NH}_3)_4]^{2+}$  can also form in addition to  $\text{Zn}(\text{OH})_2$  precipitate.

- 1.7 i) Site A   $\text{Cu}^{2+}$  Site B   $\text{Zn}^{2+}$  ii)   $\text{Cu}^{2+}$  (2 marks)

**Problem 2**
**25 marks**
**Hydrogen Peroxide- a Versatile Reagent**

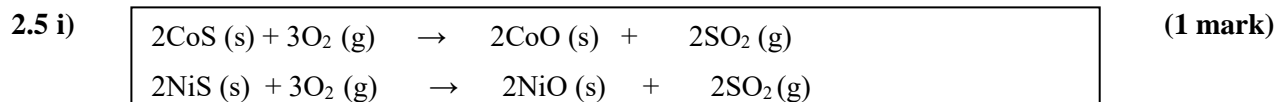
- 2.1 i)  $\text{:}\ddot{\text{O}}\text{---}\overset{-}{\ddot{\text{O}}}\text{---H}$  ii)  $\text{H}_2\text{O}_2(\text{aq}) + \text{OH}^-(\text{aq}) \rightleftharpoons [\text{HO}_2^-](\text{aq}) + \text{H}_2\text{O}(\text{l})$  (1.5 marks)

- 2.2 Molarity of  $\text{H}_2\text{O}_2 = 0.888 \text{ M}$   
pH = 5.9 (2.5 marks)

- 2.3 i)  $\text{H}_2\text{O}_2(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightleftharpoons [\text{H}_3\text{O}_2]^+(\text{aq}) + \text{HSO}_4^-(\text{aq})$  (1 mark)
- ii)  $\text{H}-\overset{+}{\text{O}}(\text{H})-\ddot{\text{O}}-\text{H} \longleftrightarrow \text{H}-\ddot{\text{O}}-\overset{+}{\text{O}}(\text{H})-\text{H}$

- 2.4 i)  $2\text{KI}(\text{aq}) + \text{H}_2\text{O}_2(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + \text{K}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$   
ii)  $2\text{KMnO}_4(\text{aq}) + 5\text{H}_2\text{O}_2(\text{aq}) + 3\text{H}_2\text{SO}_4(\text{aq}) \rightarrow 2\text{MnSO}_4(\text{aq}) + \text{K}_2\text{SO}_4(\text{aq}) + 8\text{H}_2\text{O}(\text{l}) + 5\text{O}_2(\text{g})$   
or  
i)  $2\text{I}^-(\text{aq}) + \text{H}_3\text{O}_2^+(\text{aq}) + \text{H}^+(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$   
ii)  $2\text{MnO}_4^-(\text{aq}) + 5\text{H}_3\text{O}_2^+(\text{aq}) + \text{H}^+(\text{aq}) \rightarrow 2\text{Mn}^{2+}(\text{aq}) + 8\text{H}_2\text{O}(\text{l}) + 5\text{O}_2(\text{g})$

(2.5 marks)



ii) Total  $\text{SO}_2$  produced = 2.215 mol  
 The volume of gas at  $850^\circ\text{C}$  = 203.97 L (3 marks)

2.6 i) Total moles of  $\text{H}_2\text{O}_2$  required = 9.097 mol  
 Mass of water in 30%  $\text{H}_2\text{O}_2$  =  $1031.3 - 309.39 = 0.722$  kg  
 Mass of water in the sulfuric acid solution is = 0.850 kg  
 Mass of water produced = 0.149 kg  
 Total mass of water = 1.719 kg  
 Molality of Mo =  $0.471 \text{ mol kg}^{-1}$  (6 marks)

ii)  $\text{Na}^+$ ,  $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{OH}^-$ ,  $\text{NH}_4^+$  and DMG (2.5 marks)

iii)  $\text{Na}_2\text{SO}_4$  (1 mark)

iv)

	reduces consumption of	enhances yield of	decreases contamination in	increases contamination in
I. When added in the chosen step __2__,	DMG			
When added in the chosen step __3__,	NaOH	$\text{Ca(OH)}_2$		
II. When added in another step __1__,				Ammonium Molybdate

(2 marks)

2.7 a)  It prevents formation of  $\text{SO}_2$  as waste product. (2 marks)

b)  It enhances formation of  $\text{Na}_2\text{SO}_4$  as a useful by-product.

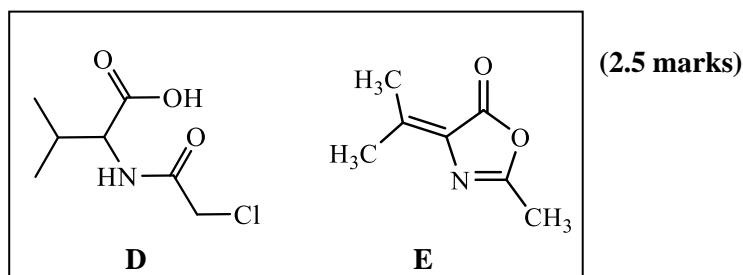
### Problem 3

21 Marks

#### Structure Elucidation of a Drug

3.1 c)  (1 mark)

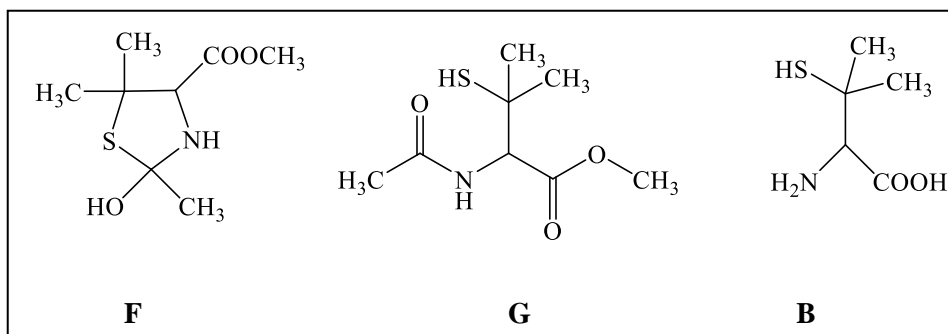
3.2 i)



ii) b) X

(1 mark)

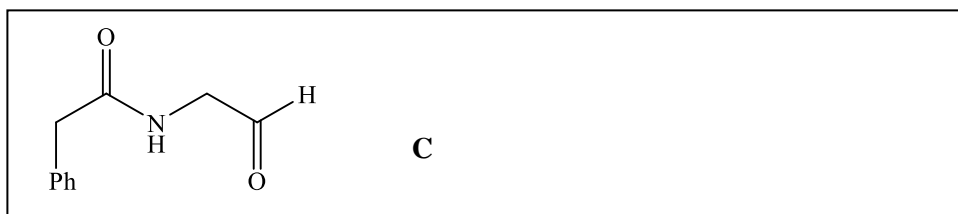
iii) (3 marks)



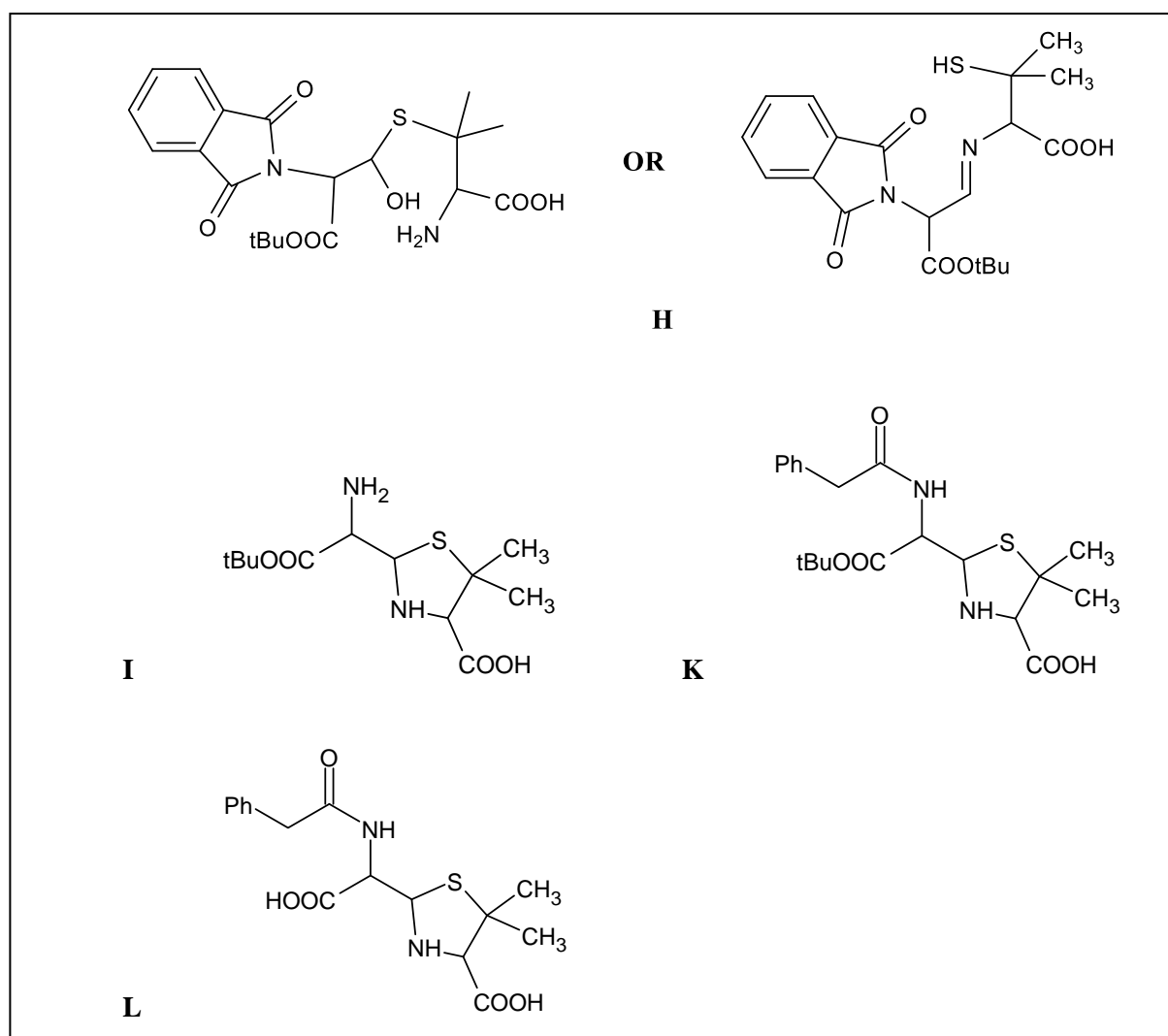
iv)  $pK_a = 1.8$  -COOH       $7.9$  -SH       $10.5$  -NH<sub>2</sub>      (1.5 marks)

v) Team 1      Statement(s) b and c      (1 mark)

3.3 (1 mark)

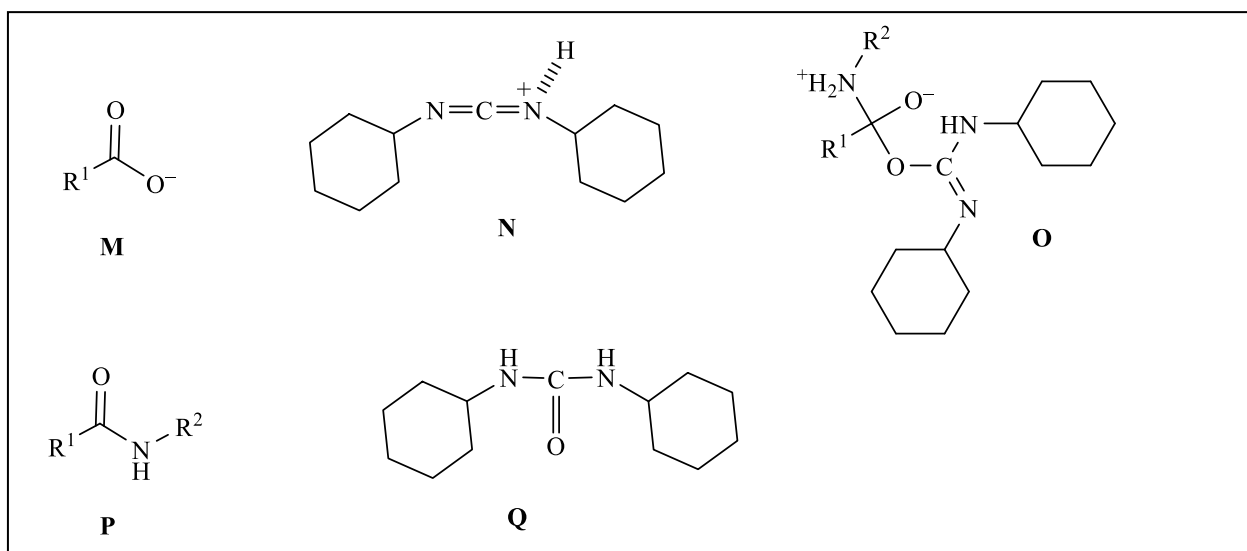


3.4 i)



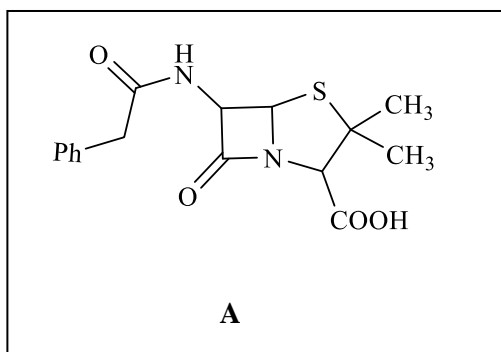
(4 marks)

ii)



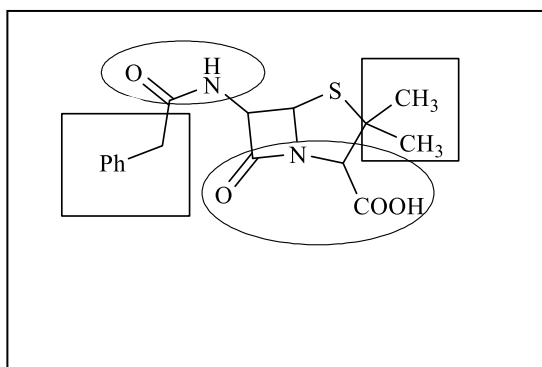
(3 marks)

iii)



(1 mark)

iv)



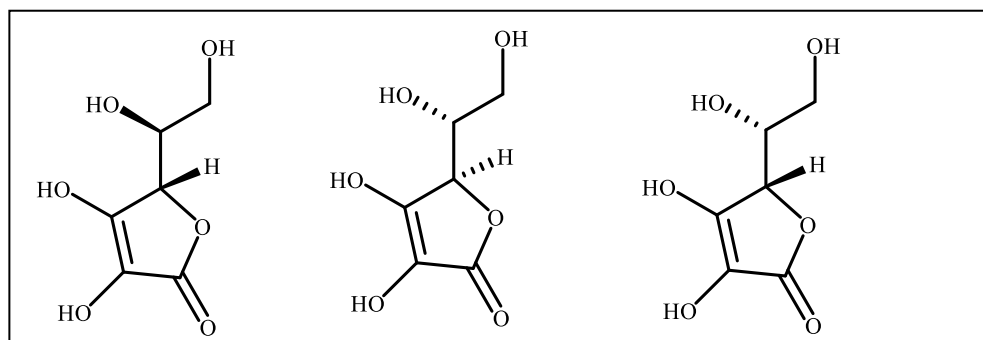
(2 marks)

**Problem 4**

**24 Marks**

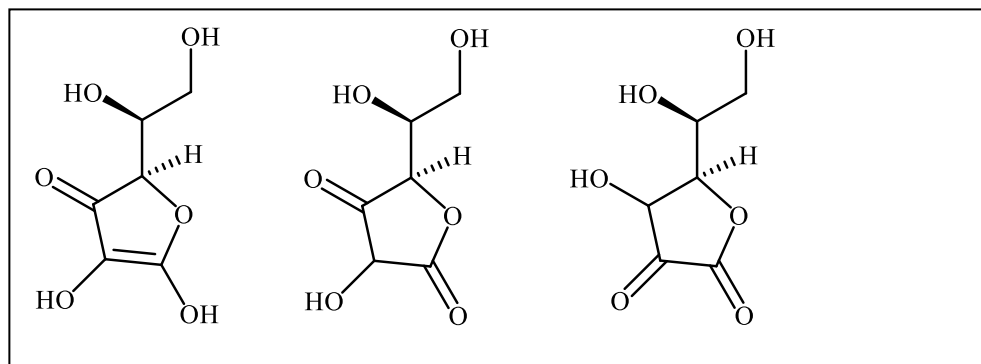
**An acid from sugar**

4.1



(1.5 marks)

4.2



(1.5 marks)

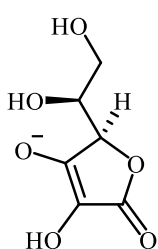
4.3

$pK_{a1} = 4.2$

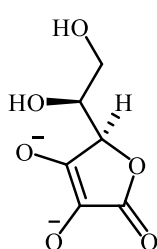
(2 marks)

4.4

pH 7.3

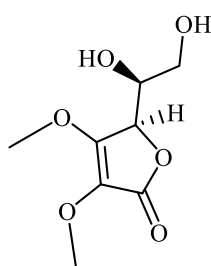


pH 12.0



(2 marks)

4.5



**B**  
( $C_8H_{12}O_6$ )

$NaIO_4 / Pb(OAc)_4 / HIO_4$

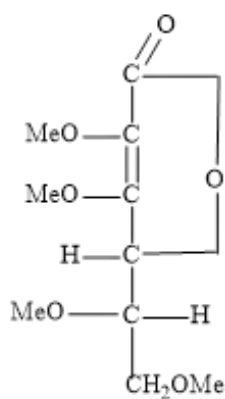
**X**

(2 marks)

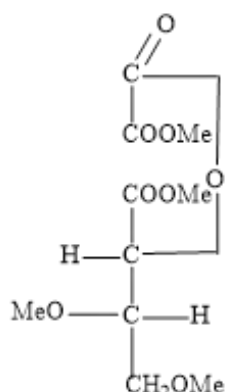
As incorrect molecular formula of **B** was provided in the question, 1 mark for **B** is given to all students uniformly.

4.6

Molecular Formula –  $C_{10}H_{16}O_8$



**C**



**D**

(4 marks)

Since there was error in percentage of carbon and hydrogen in **D** given in question, 2 marks (for structures **C** and **D**) are given to all students uniformly.

Derivation of molecular formula of **D** ( $C_{10}H_{16}O_7$ ) consistent with data given in question paper will be given 2 marks as per the solution written by student.

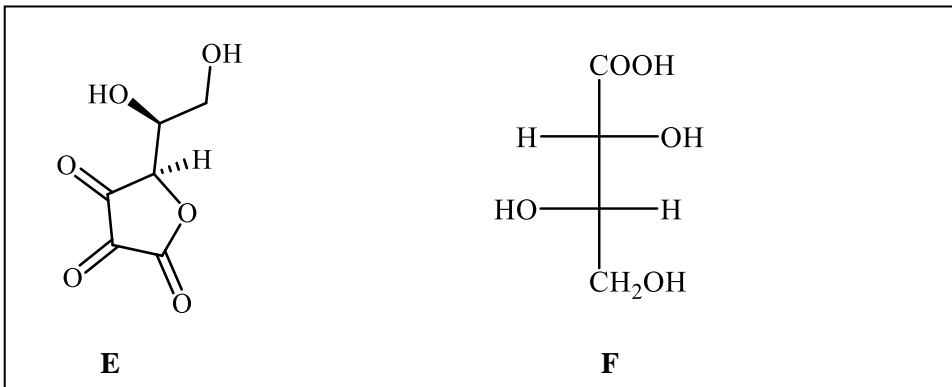
4.7 a)  X

(1 mark)

4.8 d)  X

(0.5 mark)

4.9

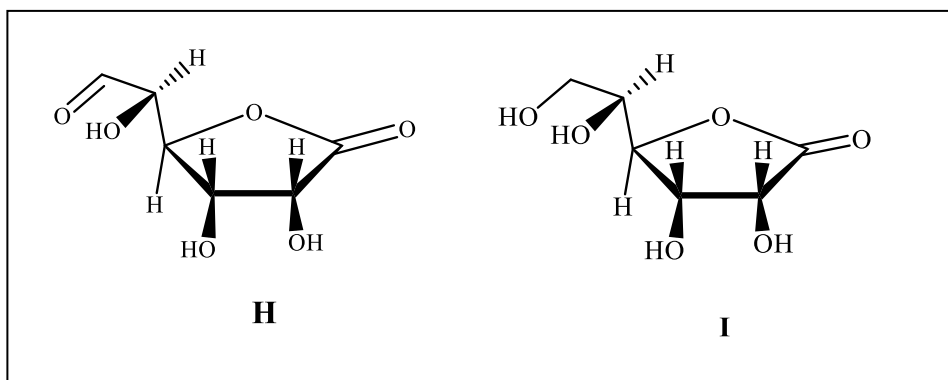


(2 marks)

4.10 a)  X

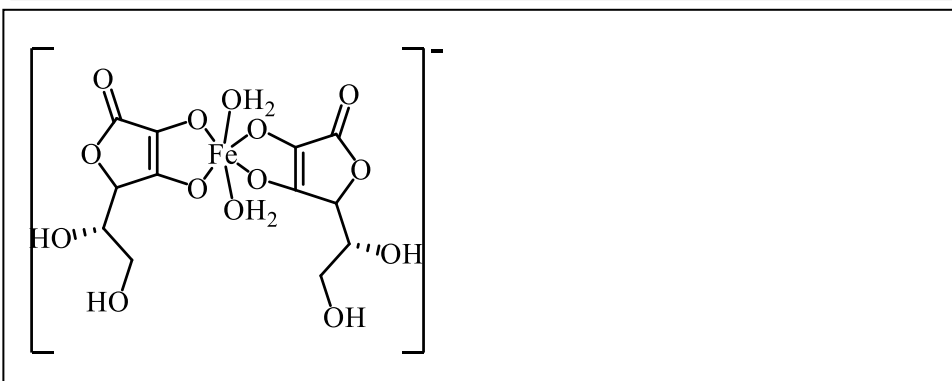
(1 mark)

4.11



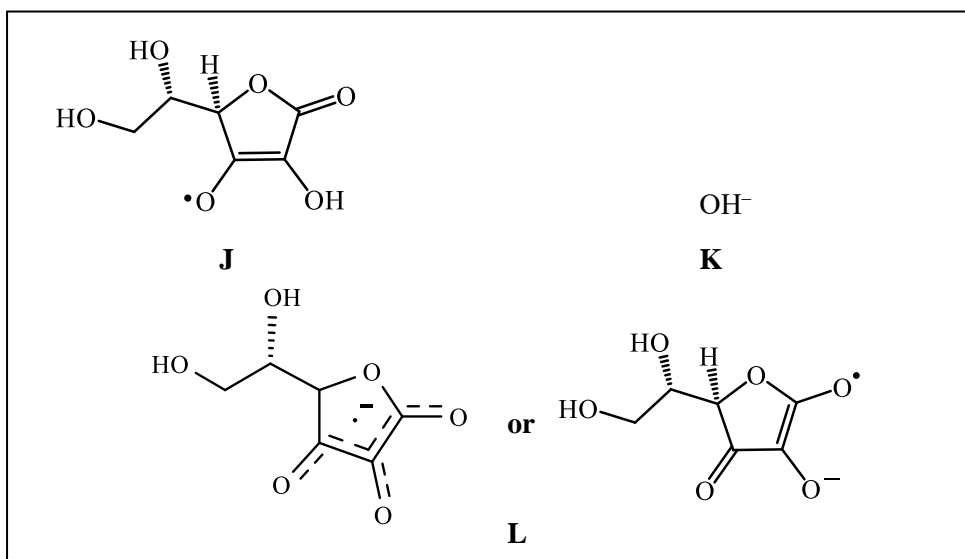
(1.5 marks)

4.12



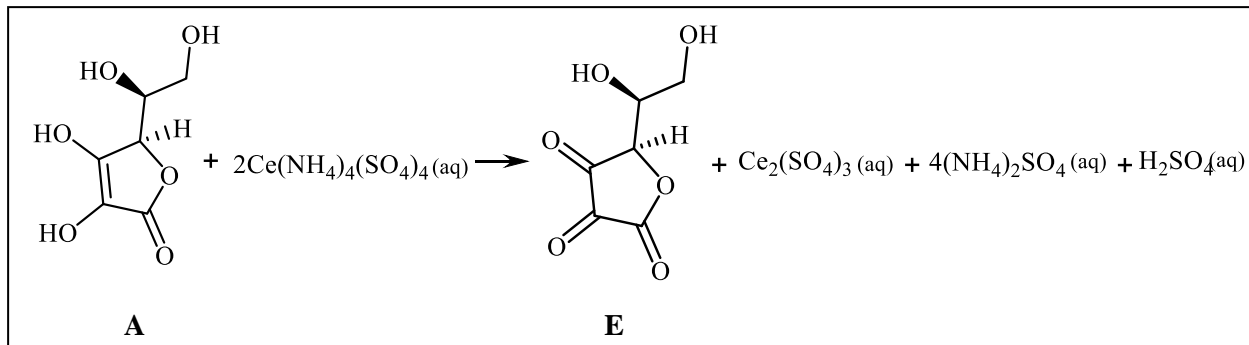
(1 mark)

4.13



(2 marks)

4.14



(2 marks)

**Problem 5**

**16 marks**

**The purple hydrogen**

5.1 Frequency of lowest energy line is =  $4.57 \times 10^{14}$  Hz (1.5 marks)

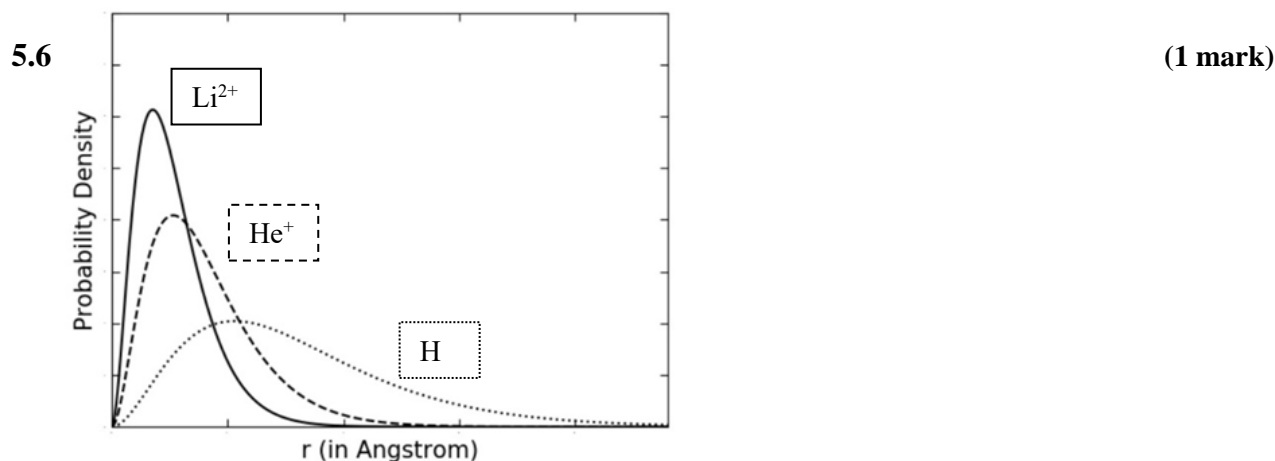
5.2 i) The wavelength 121.6 nm should correspond to  $n = 2$  to  $n = 1$  transition (4 marks)  
 Energy of photon for this transition is  $= hv/(121.6 \text{ nm}) = -C/2^2 + C/1^2$   
 $C = 109,769 \text{ cm}^{-1} = 2.18 \times 10^{-18} \text{ J}$

ii) 102.6 nm,  $n = 3 \rightarrow 1$  (2 marks)  
 434.0 nm,  $n = 5 \rightarrow 2$

5.3  $v = 2.185 \times 10^6 \text{ m/s}$  (2 marks)  
 Ratio of velocity of electron in hydrogen atom to speed of light = 1:137

5.4  $\frac{df(r)}{dr} = 0, r = a_0$  (2 marks)

5.5 d) X (1.5 marks)



5.7

When intensity drops to 10% of the initial intensity,  $0.1 = e^{-kt}$

$$t = 2.303 \times 10^{-8} \text{ s}$$

(1.5 marks)

5.8

No color

(0.5 mark)

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