

EQUILIBRIUM

Date: _____

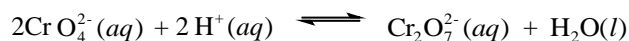
Names: _____

Section: _____

OBJECTIVE: To investigate various chemical equilibria and explain them using Le Chatelier's Principle.

PROCEDURE: As in Chem. 1105 lab manual, pp. _____

Equilibrium I



Questions for test tube 2, equilibrium I step 2

	[CrO ₄ ²⁻]	[H ⁺]	[Cr ₂ O ₇ ²⁻]
I 2 a) Initial colour _____ Which chemical is predominant?			
I 2 b) Final colour _____ Which chemical is predominant?			
Which of the ions in the table does HCl directly contribute to the equilibrium?			
Show the effect of the addition of the HCl on the other ions. Do they increase or decrease?			

I 2 c) In which direction did equilibrium I shift? _____

I 2 d) Explain why the colour changed. Use Le Chatelier's principle.

Questions for test tube 3, equilibrium I step 3

	$[\text{CrO}_4^{2-}]$	$[\text{H}^+]$	$[\text{Cr}_2\text{O}_7^{2-}]$
I 3 a) Initial colour _____ Which chemical is predominant?			
I 3 b) Final colour _____ Which chemical is predominant?			
With which ion in the table does the NaOH react? Does it increase or decrease the concentration of that ion?			
Show the effect of the addition of the NaOH on the other ions. Do they increase or decrease?			

I 3 c) In which direction did equilibrium I shift? _____

Explain why the colour did not change. Use Le Chatelier's principle.

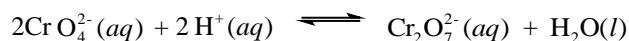
Questions for test tube 4, equilibrium I step 4

	$[\text{CrO}_4^{2-}]$	$[\text{H}^+]$	$[\text{Cr}_2\text{O}_7^{2-}]$
I 4 a) Initial colour _____ Which chemical is predominant?			
I 4 b) Final colour _____ Which chemical is predominant?			
With which ion in the table does the NaOH react? Does it increase or decrease the concentration of that ion?			
Show the effect of the addition of the NaOH on the other ions. Do they increase or decrease?			

I 4 c) Which direction did equilibrium I shift? _____

Explain why the colour changed. Use Le Chatelier's principle.

Equilibrium I



Equilibrium II



Questions for equilibrium II step 2 and 3

	BaCrO ₄	[Ba ²⁺]	[CrO ₄ ²⁻]	[H ⁺]	[Cr ₂ O ₇ ²⁻]
II 2 a) What is formed? _____ Which chemical is this?					
II 3 a) What happens to the precipitate on addition of HCl?					
II 3 b) What is the colour of the solution on addition of HCl?					
Therefore which species have increased, and which decreased after adding HCl?					

After adding HCl:

In which direction did equilibrium I shift? _____

In which direction did equilibrium II shift? _____

II 3 c) Explain why the colour and precipitate changed. Use Le Chatelier's principle.

Questions for equilibrium II step 4

II 4 a) What reagent (other than a barium or chromate salt) caused the BaCrO₄ to re-form? _____

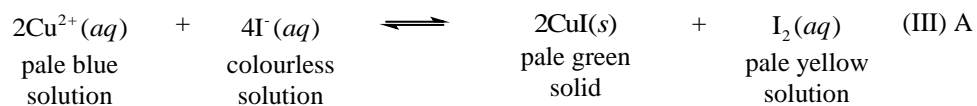
	BaCrO ₄	[Ba ²⁺]	[CrO ₄ ²⁻]	[H ⁺]	[Cr ₂ O ₇ ²⁻]
On addition of the above, with which ion does it react?					
Therefore which species have increased, and which decreased?					

Which direction did equilibrium I shift? _____

Which direction did equilibrium II shift? _____

II 4 b) Explain why the colour changed. Use Le Chatelier's principle.

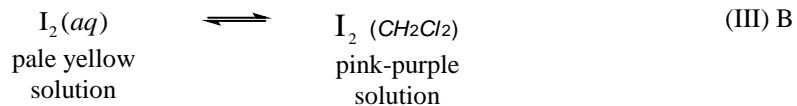
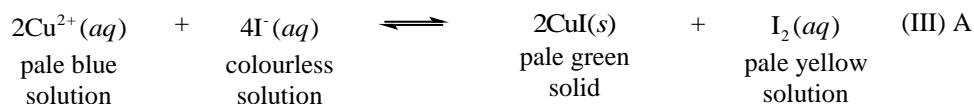
Equilibrium III



Questions for equilibrium III step 2

- III 2 a) Name **all** the ions and compounds present in both test tubes after step 2 has been carried out.
- III 2 b) What colour is the solution in the first test tube after all the chemicals have been added? _____
What colour is the solution in the second test tube after all the chemicals have been added? _____
- III 2 c) Why are the two test tubes different colours and why do they contain different amounts of solid CuI? Use Le Chatelier's principle in your explanation.

Equilibrium III continued



Questions for equilibrium III step 3

III 3 a) Use the table below to *describe* the what you observed before and after the dichloromethane has been added and the contents of the test tube have been shaken.

	Before dichloromethane has been added		After dichloromethane has been added	
	First Test Tube	Second Test Tube	First Test Tube	Second Test Tube
Observations of shade, colour and cloudiness of aqueous layer				
Shade, & Colour of Dichloromethane layer				

After the addition of CH_2Cl_2 , which species increased and which decreased:	$[\text{Cu}^{2+}]$	$[\text{I}^{-}]$	CuI	$[\text{I}_2]$	$[\text{I}_2(\text{CH}_2\text{Cl}_2)]$
In equilibrium (III) A?					
In equilibrium (III) B?					

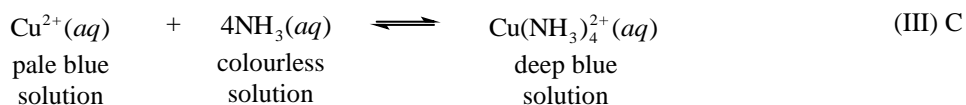
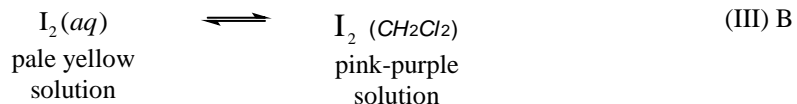
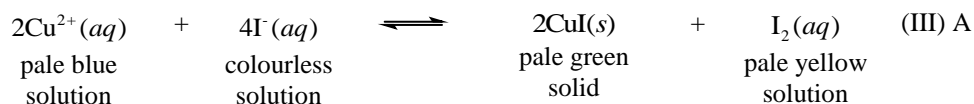
Which direction did equilibrium (III) A shift? _____

Which direction did equilibrium (III) B shift? _____

In which test tube was the shift more pronounced? _____

III 3 b) Explain the directions of the shifts. Use Le Chatelier's principle.

Equilibrium III continued



III 4 a) Use the table below to *describe* the changes observed as the concentrated ammonia ($\text{NH}_3(\text{aq})$) is added and the contents of the test tube are shaken.

Questions for equilibrium III step 4

	Before $\text{NH}_3(\text{aq})$ added		After $\text{NH}_3(\text{aq})$ added	
	First Test Tube	Second Test Tube	First Test Tube	Second Test Tube
Observations of shade, colour, and cloudiness of aqueous layer				
Shade, & Colour of Dichloro-methane layer				

Use the row marked III i) in the table below to indicate which species increase or decrease in (III) A.

Use the row marked III ii) in the table below to indicate which species increase or decrease in (III) B.

Use the row marked III iii) in the table below to indicate which species increase or decrease in (III) C.

	$[\text{Cu}(\text{NH}_3)_4^{2+}]$	$[\text{Cu}^{2+}]$	$[\text{I}^{-}]$	CuI	$[\text{I}_2]$	$[\text{I}_2(\text{CH}_2\text{Cl}_2)]$
III i)						
III ii)						
III iii)						

Which direction did equilibrium (III)A shift? _____,

(III)B shift? _____, (III)C shift? _____

In which test tube was the shift more pronounced? _____

III 4 b) Explain the directions of the shifts. Use Le Chatelier's principle.

Equilibrium IV

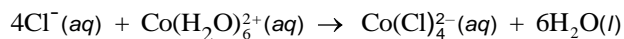


Questions for equilibrium IV step 2 and 3

	[Co(H ₂ O) ₆ ²⁺]	[Cl ⁻]	[Co(Cl) ₄ ²⁻]
IV 2 a) Initial colour _____			
IV 2 b) Which chemical is predominant?			
IV 2 c) Final colour _____			
Which chemical is predominant?			
Which ion in the table does HCl contribute to the equilibrium?			
Show the effect of the addition of HCl on the other chemicals. Do they increase or decrease?			
IV 3 a) Colour after cooling _____			
Which chemical is predominant?			
Show the effect of the cooling above on all chemicals present. Do they increase or decrease?			
IV 3 b) Colour after heating _____			
IV 3 c) Which chemical is predominant?			
Show the effect of the heating above on all chemicals present. Do they increase or decrease?			

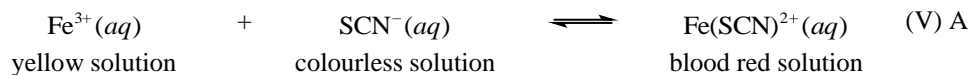
IV 2 d

IV 3 d) Taking this into consideration, is the reaction



exothermic or endothermic? Explain your answer clearly.

Equilibrium V



Questions for equilibrium V step 3

	[Fe ³⁺]	[SCN ⁻]	[Fe(SCN) ²⁺]
V 3a) Colour after adding FeCl ₃ _____			
V 3b) Which ion is predominant?			
Which ion in the table does FeCl ₃ directly contribute to the equilibrium?			
Show the effect of the addition of FeCl ₃ on the other ions. Do they increase or decrease?			

Which direction did equilibrium (V) A shift? _____

- V 3 c) Explain why the colour changed. Use Le Chatelier's principle.

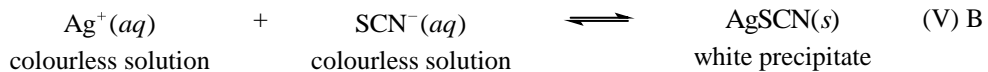
Questions for equilibrium V step 4

	[Fe ³⁺]	[SCN ⁻]	[Fe(SCN) ²⁺]
V 4 a) Colour after adding NH ₄ SCN _____ Which ion(s) is/are predominant?			
Which ion in the table does NH ₄ SCN directly contribute to the equilibrium?			
Show the effect of the addition of NH ₄ SCN on the other ions. Do they increase or decrease?			

Which direction did equilibrium (V) A shift? _____

- V 4 b) Explain why the colour changed. Use Le Chatelier's principle.

Equilibrium V continued



Questions for equilibrium V step 5

	[Fe ³⁺]	[SCN ⁻]	[Fe(SCN) ²⁺]	[Ag ⁺]	AgSCN
V 5 a) Solution colour after adding AgNO ₃ _____ Which chemicals are predominant in V (A)?					
Ppt colour after adding AgNO ₃ _____ Which chemicals are predominant in V (B)?					
Which ion visibly decreases on addition of AgNO ₃ ?					

Which direction did equilibrium (V) A shift? _____

Which direction did equilibrium (V) B shift? _____

V 5 b) Explain why the colour changed. Use Le Chatelier's principle.