

EQUILIBRIUM

Date: _____

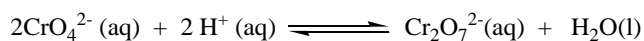
Name: _____

Partner: _____

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

Procedure: As in CHEM 1105 lab manual, pages _____.

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?			
I 2 c) Which of the ions in the table does HCl directly contribute to the equilibrium?			
I 2 d) Show the effect of the addition of the HCl on the other ions. Do they increase or decrease?			

I 2 e) In which direction did equilibrium I shift?

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

Questions for test tube 3, equilibrium I step 3

	[CrO ₄ ²⁻]	[H ⁺]	[Cr ₂ O ₇ ²⁻]
I 3 a) Initial colour _____ Which chemical is predominant?			
I 3 b) Final colour _____ Which chemical is predominant?			
I 3 c) With which ion in the table does the NaOH react? Does it increase or decrease the concentration of that ion?			
I 3 d) Show the effect of the addition of the NaOH on the other ions. Do they increase or decrease?			

I 3 e) In which direction did equilibrium I shift?

I 3 f) Explain why the colour did not change. Use Le Chatelier's principle

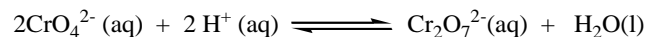
Questions for test tube 4, equilibrium I step 4

	[CrO ₄ ²⁻]	[H ⁺]	[Cr ₂ O ₇ ²⁻]
I 4 a) Initial colour _____ Which chemical is predominant?			
I 4 b) Final colour _____ Which chemical is predominant?			
I 4 c) With which ion in the table does the NaOH react? Does it increase or decrease the concentration of that ion?			
I 4 d) Show the effect of the addition of the NaOH on the other ions. Do they increase or decrease?			

I 4 e) Which direction did equilibrium I shift?

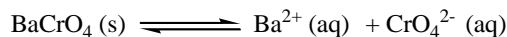
I 4 f) Explain why the colour changed. Use Le Chatelier's principle.

Equilibrium I



yellow solution orange solution

Equilibrium II



Questions for equilibrium II step 2

	BaCrO_4	$[\text{Ba}^{2+}]$	$[\text{CrO}_4^{2-}]$	$[\text{H}^+]$	$[\text{Cr}_2\text{O}_7^{2-}]$
II 2 a) What is formed? _____ Which chemical is this?					

Questions for equilibrium II step 3

	BaCrO_4	$[\text{Ba}^{2+}]$	$[\text{CrO}_4^{2-}]$	$[\text{H}^+]$	$[\text{Cr}_2\text{O}_7^{2-}]$
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:

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

II 3 d) In which direction did equilibrium II shift?

II 3 e) 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 barium or chromium salt) caused the BaCrO_4 to re-form?

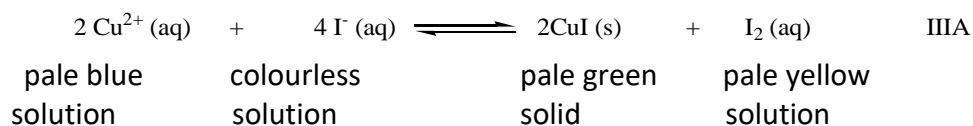
	BaCrO_4	$[\text{Ba}^{2+}]$	$[\text{CrO}_4^{2-}]$	$[\text{H}^+]$	$[\text{Cr}_2\text{O}_7^{2-}]$
II 4 b) On addition of the above, with which ion does it react?					
II 4 c) Therefore, which species have increased, and which decreased?					

II 4 d) In which direction did equilibrium I shift?

II 4 e) In which direction did equilibrium II shift?

II 4 f) Explain why the colour and precipitate changed. Use Le Chatelier's principle.

Equilibrium III



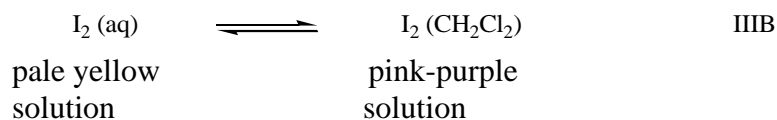
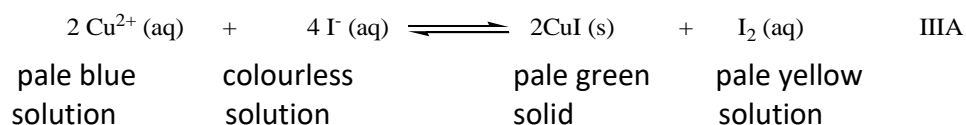
Questions for equilibrium III step 1

III 1 a) Name all the ions and compounds present in the test tube after step 1 has been carried out.

III 1 b) What colour is the solution in the test tube after all the chemicals have been added?

III 1 c) Describe dichloromethane.

Equilibrium III continued



Questions for equilibrium III step 2

Use the table below to *describe* what you observed (including changes) after the dichloromethane has been added and the contents of the test tube have been shaken.

III 2 a) Observations of the shade, colour and cloudiness of the aqueous layer	
III 2 b) Observations of the shade, colour and cloudiness of the dichloromethane layer	

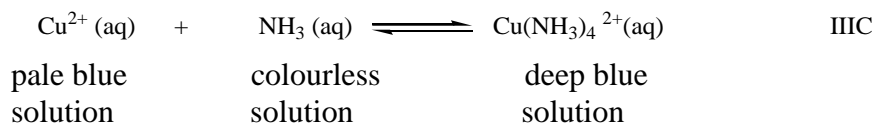
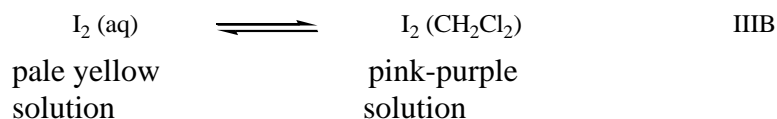
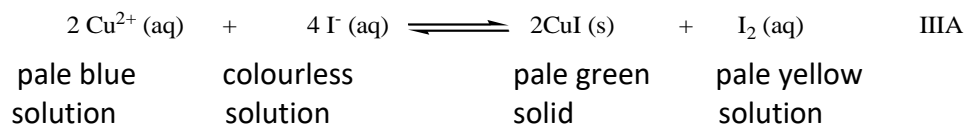
After the addition of CH_2Cl_2 , which species increased and which decreased:	$[\text{Cu}^{2+}]$	$[\text{I}^{-}]$	CuI	$[\text{I}_2 (\text{aq})]$	$[\text{I}_2 (\text{CH}_2\text{Cl}_2)]$
III 2 c) In equilibrium (III) A?					
III 2 d) In equilibrium (III) B?					

III 2 e) Which direction did equilibrium (III) A shift?

III 2 f) Which direction did equilibrium (III) B shift?

III 2 g) Explain the directions of the shifts. Use Le Chatelier's principle.

Equilibrium III continued



Questions for equilibrium III step 3

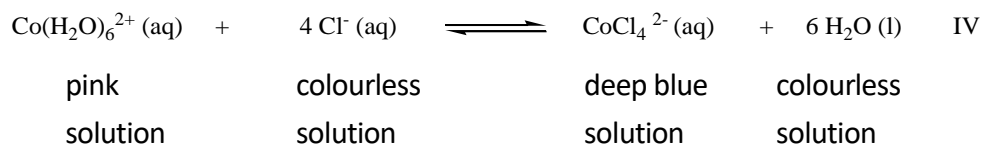
Use the table below to *describe* the changes observed as the concentrated ammonia ($\text{NH}_3(\text{aq})$) is added and the contents of the test tube are shaken.

III 3 a) Observations of the shade, colour and cloudiness of the aqueous layer	
III 3 b) Observations of the shade, colour and cloudiness of the dichloromethane layer	

After the addition of NH_3 which species increased and which decreased:	$[\text{Cu}(\text{NH}_3)_4^{2+}]$	$[\text{Cu}^{2+}]$	$[\text{I}^{-}]$	$[\text{CuI}]$	$[\text{I}_2(\text{aq})]$	$[\text{I}_2(\text{CH}_2\text{Cl}_2)]$
III 3 c) In equilibrium (III) A?						
III 3 d) In equilibrium (III) B?						
III 3 e) In equilibrium (III) C?						

- III 3 f) Which direction did equilibrium (III) A shift?
- III 3 g) Which direction did equilibrium (III) B shift?
- III 3 h) Which direction did equilibrium (III) C shift?
- III 3 i) Explain the directions of the shifts. Use Le Chatelier's principle.

Equilibrium IV

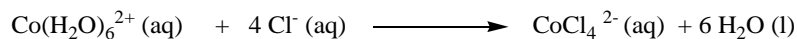


Questions for equilibrium IV step 3

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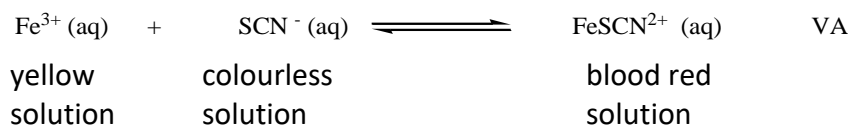
	$[\text{Co(H}_2\text{O)}_6^{2+}]$	$[\text{Cl}^-]$	$[\text{CoCl}_4^{2-}]$
IV 3 a) Colour after cooling _____ Which chemical is predominant?			
IV 3 b) Show the effect of the cooling above on all chemicals present. Do they increase or decrease?			
IV 3 c) Colour after heating _____ Which chemical is predominant?			
IV 3 d) Show the effect of the heating above on all chemicals present. Do they increase or decrease?			

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

V 3 d) Which direction did equilibrium (V) A shift?

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

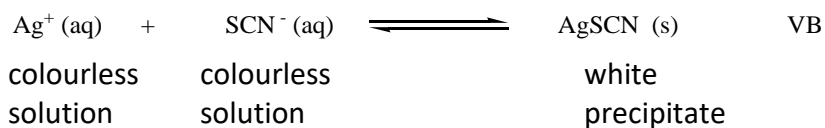
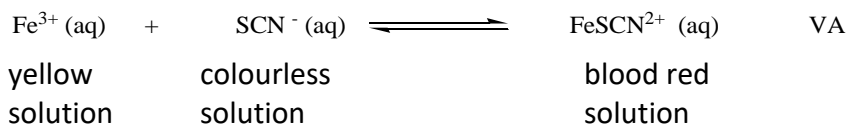
Questions for equilibrium V step 4

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

V 4 d) Which direction did equilibrium (V) A shift?

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

Equilibrium V continued



Questions for equilibrium V step 5

	[Fe ³⁺]	[SCN ⁻]	[FeSCN ²⁺]	[Ag ⁺]	[AgSCN]
V 5 a) Solution colour (without ppt) after adding AgNO ₃ _____ Which chemicals are predominant in VA?					
V 5 b) Ppt colour after adding AgNO ₃ _____ Which chemicals are predominant in VB?					
V 5 c) Which ion visibly decrease on addition of AgNO ₃ ?					

V 5 d) Which direction did equilibrium (V) A shift?

V 5 e) Which direction did equilibrium (V) B shift?

V 5 f) Explain why the colour and precipitate changed. Use Le Chatelier's principle.