

# EQUILIBRIUM

Date: \_\_\_\_\_

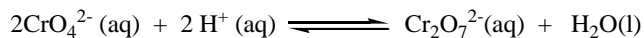
Name: \_\_\_\_\_

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 <sub>4</sub> <sup>2-</sup> ]	[H <sup>+</sup> ]	[Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup> ]
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 <b>effect</b> 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 <sub>4</sub> <sup>2-</sup> ]	[H <sup>+</sup> ]	[Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup> ]
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 <b>effect</b> 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 changed. Use Le Chatelier's principle.

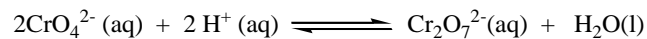
### Questions for test tube 4, equilibrium I step 4

		[CrO <sub>4</sub> <sup>2-</sup> ]	[H <sup>+</sup> ]	[Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup> ]
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 <b>effect</b> of the addition of the NaOH on the other ions. Do they increase or decrease?			

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

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

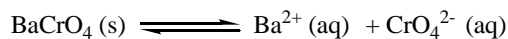
### Equilibrium I



yellow  
solution

orange  
solution

### Equilibrium II



#### Questions for equilibrium II step 2

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

#### Questions for equilibrium II step 3

		$\text{BaCrO}_4$	$[\text{Ba}^{2+}]$	$[\text{CrO}_4^{2-}]$	$[\text{H}^+]$	$[\text{Cr}_2\text{O}_7^{2-}]$
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  $\text{BaCrO}_4$  to re-form?

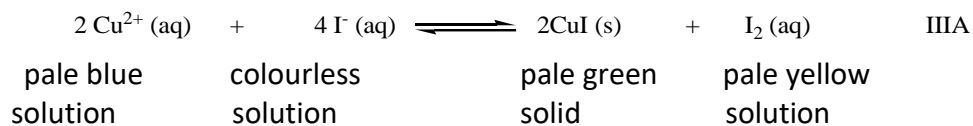
		$\text{BaCrO}_4$	$[\text{Ba}^{2+}]$	$[\text{CrO}_4^{2-}]$	$[\text{H}^+]$	$[\text{Cr}_2\text{O}_7^{2-}]$
II 4 b)	On addition of the above, with which ion does it react?					
II 4 c)	Therefore, which species have increased, and which decreased?					

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



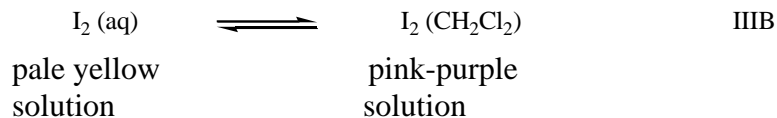
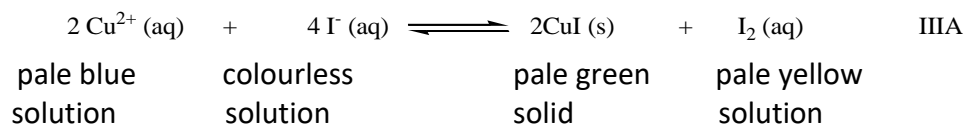
### Questions for equilibrium III step 1

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	

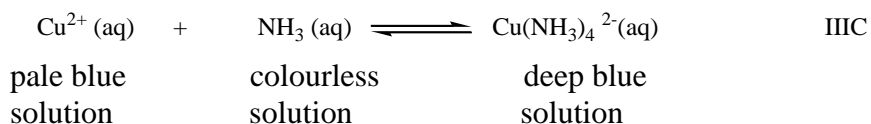
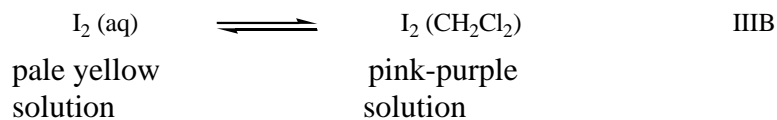
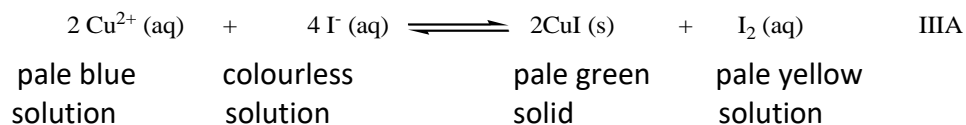
After the addition of $\text{CH}_2\text{Cl}_2$ , which species increased and which decreased:	$[\text{Cu}^{2+}]$	$[\text{I}^{-}]$	CuI	$[\text{I}_2 (\text{aq})]$	$[\text{I}_2 (\text{CH}_2\text{Cl}_2)]$
III 2 c) In equilibrium (III) A?					
III 2 d) In equilibrium (III) B?					

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 $\text{NH}_3$ 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?						

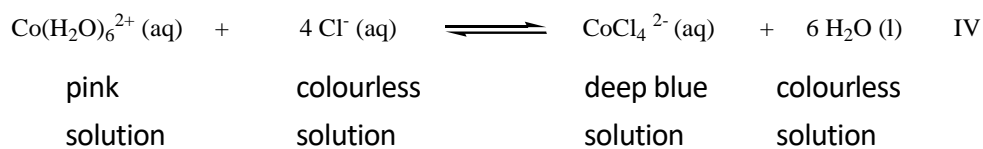
III 3 f) Which direction did equilibrium (III) A shift?

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

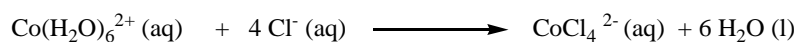


### Questions for equilibrium IV step 3

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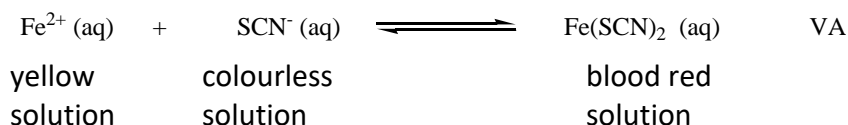
		$[\text{Co(H}_2\text{O)}_6^{2+}]$	$[\text{Cl}^-]$	$[\text{CoCl}_4^{2-}]$
IV 3 a)	Colour after cooling _____ Which chemical is predominant?			
IV 3 b)	Show the <b>effect</b> of the cooling above on all chemicals present. Do they increase or decrease?			
IV 3 c)	Colour after heating _____ Which chemical is predominant?			
IV 3 d)	Show the <b>effect</b> 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 <sup>3+</sup> ]	[SCN <sup>-</sup> ]	[Fe(SCN) <sub>2</sub> ]
V 3 a)	Colour after adding FeCl <sub>3</sub> _____ Which ion is predominant?			
V 3 b)	Which ion in the table does FeCl <sub>3</sub> directly contribute to the equilibrium?			
V 3 c)	Show the <b>effect</b> of the addition of FeCl <sub>3</sub> 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

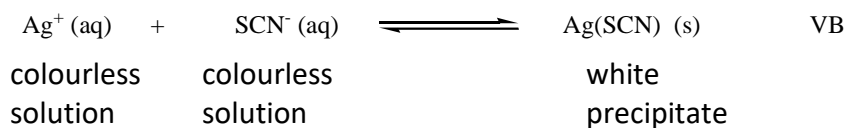
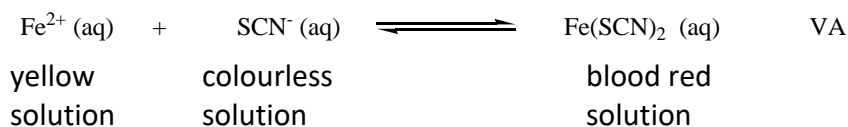
		[Fe <sup>3+</sup> ]	[SCN <sup>-</sup> ]	[Fe(SCN) <sub>2</sub> ]
V 4 a)	Colour after adding NH <sub>4</sub> SCN _____ Which ion (s) is/are predominant?			
V 4 b)	Which ion in the table does NH <sub>4</sub> SCN directly contribute to the equilibrium?			
V 4 c)	Show the <b>effect</b> of the addition of NH <sub>4</sub> 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 <sup>3+</sup> ]	[SCN <sup>-</sup> ]	[Fe(SCN) <sub>2</sub> ]	[Ag <sup>+</sup> ]	[AgSCN]
V 5 a)	<b>Solution</b> colour (without ppt) after adding AgNO <sub>3</sub> _____ Which chemicals are predominant in VA?					
V 5 b)	<b>Ppt</b> colour after adding AgNO <sub>3</sub> _____ Which chemicals are predominant in VB?					
V 5 c)	Which ion <b>visibly</b> decrease on addition of AgNO <sub>3</sub> ?					

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.