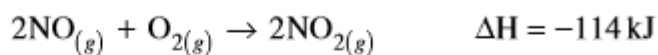


Multiple Choice Section: (10 marks, 1 mark each)

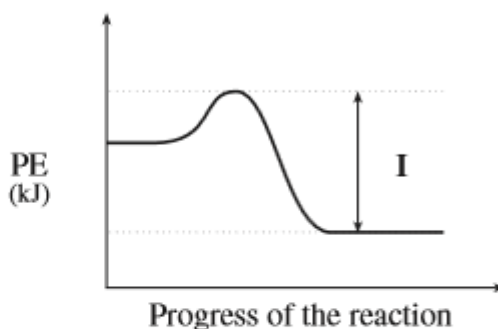
1. Consider the following reaction:



How could the rate of this reaction be increased?

- A. Reduce the pressure.
- B. Increase the volume.
- C. Remove some $\text{NO}_{2(g)}$.
- D. Increase the temperature.

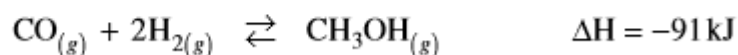
2. Consider the following PE diagram:



Which of the following describes the energy value indicated by I?

- A. heat of reaction
- B. activation energy for the reverse reaction
- C. activation energy for the forward reaction
- D. potential energy of the reaction intermediate

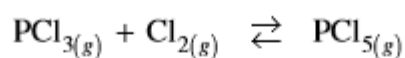
3. Consider the following equilibrium:



Which of the following factors will increase the yield of methanol, CH_3OH ?

- A. Removing CH_3OH from the system
- B. Increasing the temperature
- C. Increasing the volume
- D. Decreasing the partial pressure of hydrogen

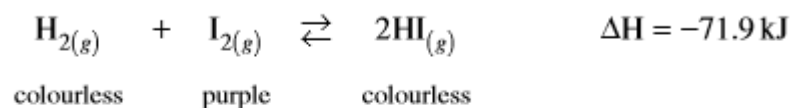
4. Consider the following equilibrium:



If the volume of the system is decreased, how will the reaction rates in the new equilibrium compare with the rates in the original equilibrium?

	Forward Rate	Reverse Rate
A.	increases	increases
B.	increases	decreases
C.	decreases	decreases
D.	decreases	increases

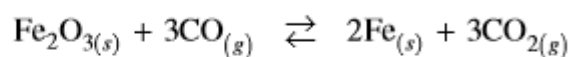
5. Consider the following equilibrium:



Which of the following would allow you to conclude that the system has reached equilibrium?

- A. The pressure remains constant.
- B. The reaction rates become zero.
- C. The colour intensity remains constant.
- D. The system shifts completely to the right.

6. Consider the following equilibrium:



Identify the equilibrium constant expression.

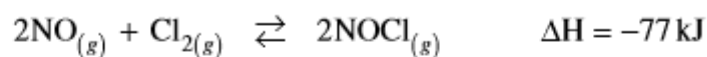
A. $K_{eq} = \frac{[\text{CO}_2]^3}{[\text{CO}]^3}$

B. $K_{eq} = \frac{[\text{CO}_2]}{[\text{CO}]}$

C. $K_{eq} = \frac{[\text{CO}_2]^3 [\text{Fe}]^2}{[\text{Fe}_2\text{O}_3][\text{CO}]^3}$

D. $K_{eq} = \frac{[\text{Fe}_2\text{O}_3][\text{CO}]^3}{[\text{CO}_2]^3 [\text{Fe}]^2}$

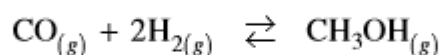
7. Consider the following equilibrium system:



In which direction will the equilibrium shift and what happens to the value of K_{eq} when the temperature of the system is increased?

	Shift	K_{eq}
A.	right	increases
B.	right	decreases
C.	left	increases
D.	left	decreases

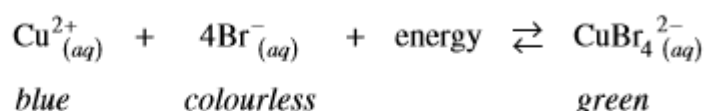
8. Consider the following equilibrium:



At equilibrium it was found that $[\text{CO}] = 0.105 \text{ mol/L}$, $[\text{H}_2] = 0.250 \text{ mol/L}$ and $[\text{CH}_3\text{OH}] = 0.00261 \text{ mol/L}$. Which of the following is the equilibrium constant value?

- A. 9.94×10^{-2}
- B. 0.398
- C. 2.51
- D. 10.0

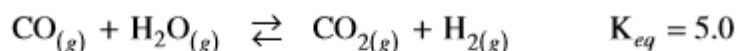
9. Consider the following equilibrium:



Which of the following will cause this equilibrium to change from blue to green?

- A. adding $\text{NaBr}_{(s)}$
- B. adding $\text{NaNO}_{3(s)}$
- C. adding a catalyst
- D. decreasing the temperature

10. Consider the following equilibrium:

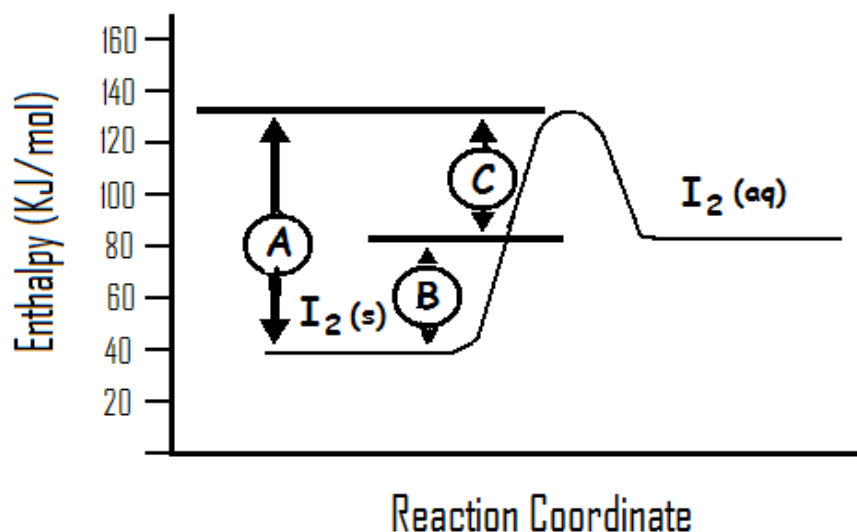


At equilibrium, the $[\text{CO}] = 0.20 \text{ mol/L}$, $[\text{H}_2\text{O}] = 0.30 \text{ mol/L}$, and $[\text{H}_2] = 0.90 \text{ mol/L}$. Calculate the equilibrium $[\text{CO}_2]$.

- A. 0.013 mol/L
- B. 0.066 mol/L
- C. 0.33 mol/L
- D. 1.0 mol/L

Short Answer Questions:[36 marks for this section]

1. The potential energy diagram below refers to the reaction: $\text{I}_2(\text{s}) \rightleftharpoons \text{I}_2(\text{aq})$



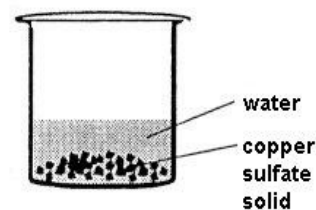
Circle which of the following statement(s) is/are FALSE?

[2 marks]

- (a) 'A' is the activation energy for the reaction: $\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{aq})$
- (b) ΔH for the reaction is positive and has the value 'B'
- (c) At equilibrium the rate of reaction, $\text{I}_2(\text{aq}) \rightarrow \text{I}_2(\text{s})$, is faster than that of $\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{aq})$
- (d) An increase in temperature will alter the equilibrium position and increase the solubility of I_2

2. Consider the system shown in the diagram, where a solute solution equilibrium has been established in a beaker. Briefly explain the following:

- a) What is happening on a macroscopic level?[2 marks]



- b) What is happening on a microscopic level?

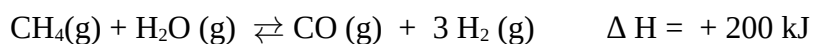
[2 marks]

c) State two ways by which the equilibrium could be altered.

[2 marks]

3. The following equilibrium is being investigated.

[6 marks]



Four identical sealed boxes are set up at 300°C and 1.00 atmosphere each containing the equilibrium mixture. Each of the boxes is treated as described below, and time allowed for a new equilibrium to be established. Write what happens in each case as a result of changes.

	What happens to the total pressure? Write 'increase', 'decrease' or 'no change'	What happens to the partial pressure of CO? Write 'increase', 'decrease' or 'no change'	What happens to the equilibrium position? Write 'move to the right', move to the left' or 'no change'.
The system is heated above 300°C			
More CH ₄ (g) at 300°C is injected into the box			
Ne (g) at 300°C is injected into the box.			
The volume of the box is halved.			

4. Consider the following equilibrium system:



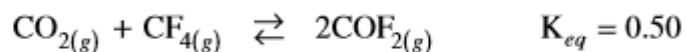
A closed container was initially filled with equal moles of H_2 and Br_2 .

When equilibrium is reached, the $[\text{HBr}]$ is 0.329 mol/L .

What is the equilibrium concentration of H_2 gas?

[4 marks]

5. Consider the following:



In a reaction container the initial concentrations are:

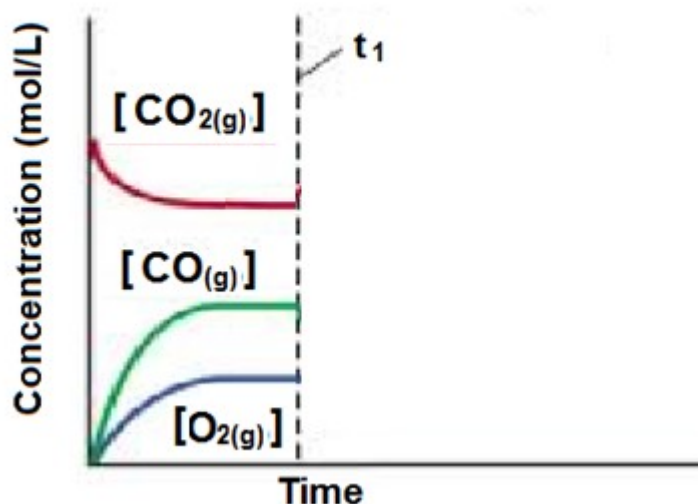
$$[\text{CO}_2] = 0.50 \text{ mol/L}, [\text{CF}_4] = 0.50 \text{ mol/L}, [\text{COF}_2] = 0.30 \text{ mol/L}$$

Calculate Q and state which way the reaction will shift (left toward the reactants or right toward the products or will not shift since it is at equilibrium) as a result of your calculation of Q .

[2 marks]

Reaction will _____ [1 mark]

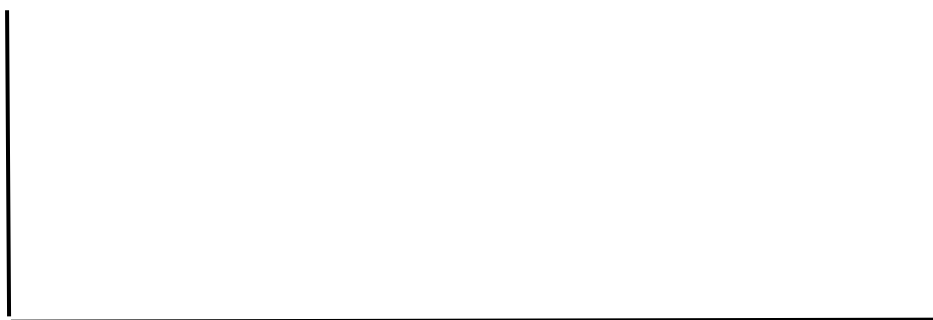
6. Refer to the diagram below then answer the questions below.



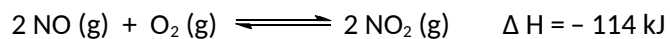
a) Draw on the above diagram what you would expect would happen to the concentration of the reactants and products if the temperature of the closed system was significantly decreased at time t_1 . [2 marks]

b) Describe the changes you just drew on the graph above and why they occurred. [3 marks]

c) Using the above concentration versus time graph draw a rate versus time graph that would correspond to this concentration versus time graph, including the changes at t_1 . [3 marks]



7. One step in the synthesis of nitric acid involves the following reversible reaction.



Assume this reaction has reached equilibrium in a closed container at constant temperature and pressure.

(a) What happens (increase, decrease, no change) to the equilibrium yield of $\text{NO}_2 \text{(g)}$ if the following occur? (3 marks)

Change	Effect
The volume of the container is increased	
More oxygen is added to the container	
A suitable catalyst is added.	

(b) What happens initially (increase, decrease, no change) to the rate of forward reaction if the following changes are made. (3 marks)

Change	Effect
The temperature of the container is increased	
More $\text{NO}_2 \text{(g)}$ is added to the container	
A suitable catalyst is added.	