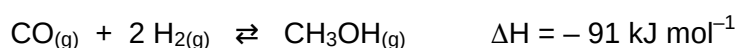


Name: **ANSWERS**

Mark = ____ / 43

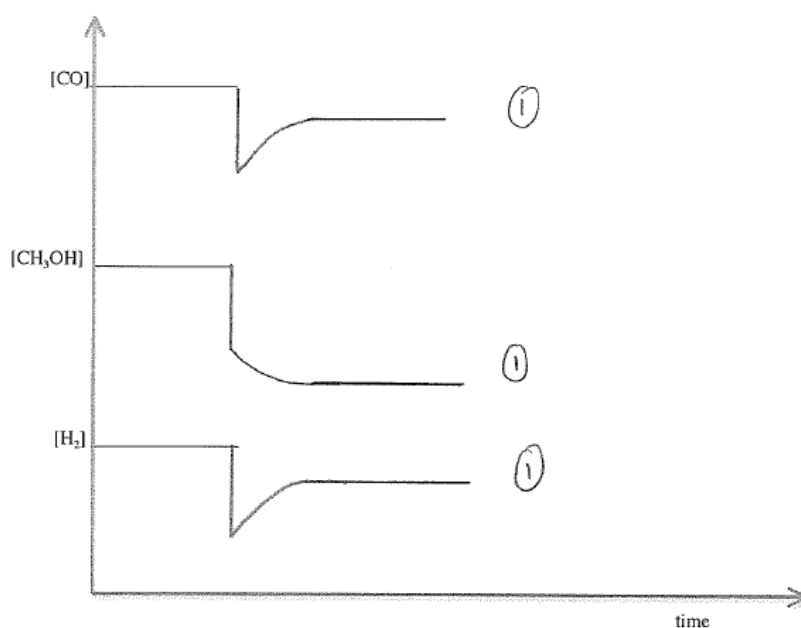
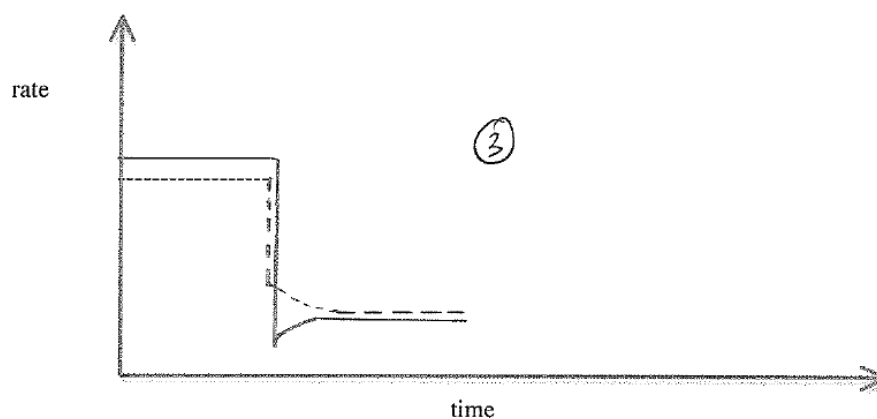
Part 1: Multiple Choice Section**10 marks**1. **C** 2. **D** 3. **C** 4. **D** 5. **C** 6. **D** 7. **B** 8. **D** 9. **A** 10. **B****Part 2: Short Answer Section****33 marks**

1. Consider an equilibrium mixture due to the reaction:



Draw (i) rate-time and (ii) concentration-time sketches to show the return to equilibrium when there is an increase in the volume of the cylinder containing the equilibrium mixture.

[————— forward reaction - - - - - reverse reaction]

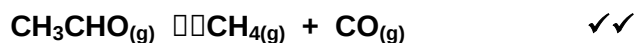


[3 + 3 = 6 marks]

2. Gaseous ethanal, CH_3CHO can decompose to form methane gas, CH_4 , and carbon monoxide gas, CO . The activation energy for this process is 191 kJ for each mole of

ethanal decomposed. The reaction releases 10 kJ of energy for each mole of carbon atoms involved in the reaction.

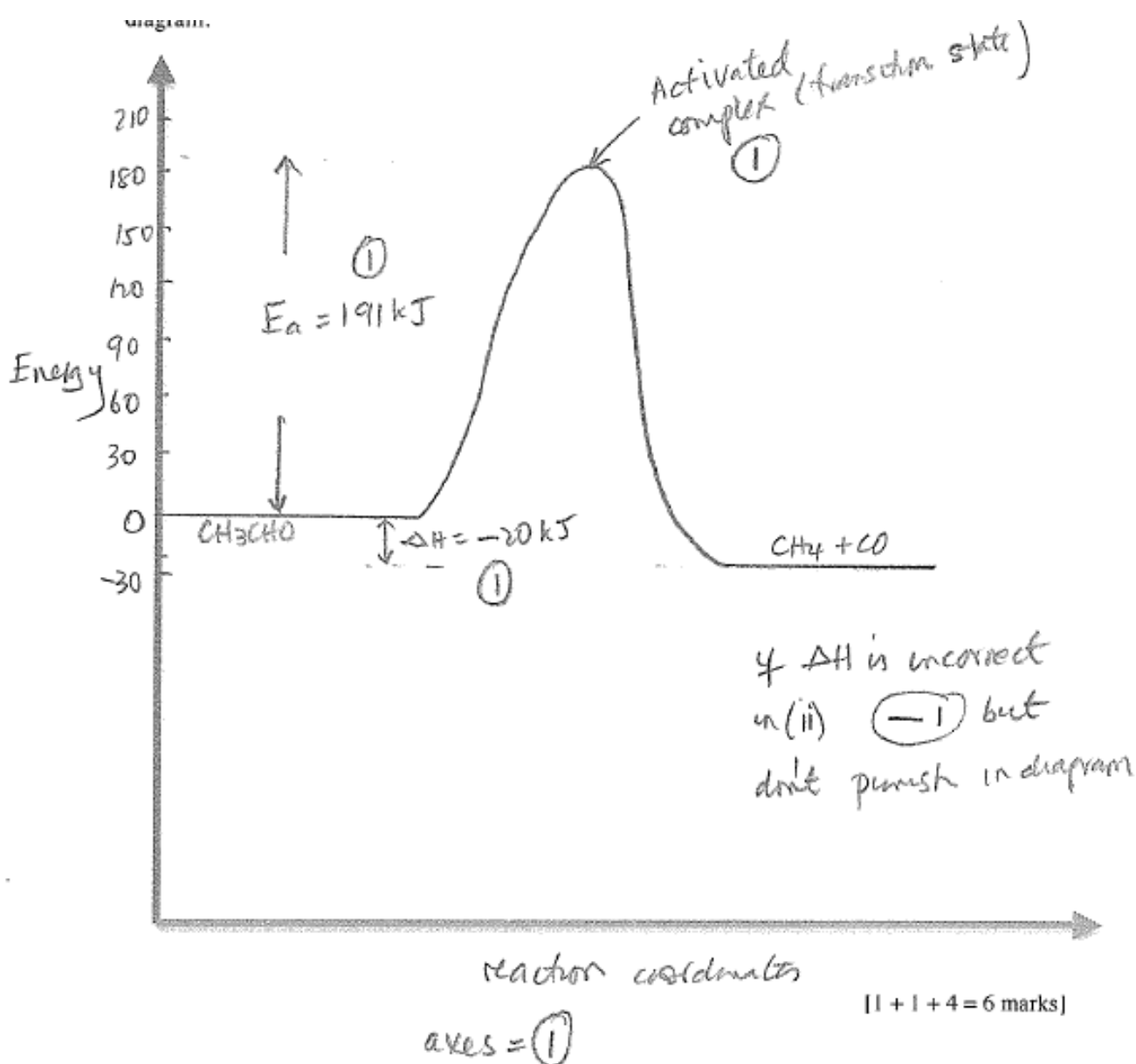
- (a) Write an equation for the decomposition of ethanal including state symbols.



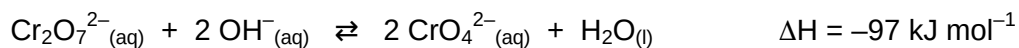
- (b) Give the value, including the sign, of the heat of reaction for the reaction you have represented in part (a), above.

- 20 kJ ✓

- (c) Sketch an energy profile diagram for the reaction. Your sketch should indicate intervals labelled as " ΔH " and "activation energy". Show the magnitude of these quantities. Label the axes and include the terms "activated complex" (or transition state) and "reaction coordinate" in the appropriate places in your diagram.



3. Consider the following equilibrium:



Two test tubes were set up, each containing some of the equilibrium mixture. A different change was imposed on each test tube.

Predict what would be observed and give reasons why.

Imposed change	Observations	Explanation using Le Chatelier's Principle
Temperature is decreased	more yellow / less orange ✓	<p>According to LCP, a decrease in temperature favours a shift in direction of exothermic reaction ✓</p> <p>∴ a shift to the right ✓</p> <p>∴ at new equilibrium: $\uparrow [\text{CrO}_4^{2-}]$, more yellow $\downarrow [\text{Cr}_2\text{O}_7^{2-}]$, less orange ✓</p>
A little concentrated sulfuric acid is added	more orange / less yellow ✓	<p>Addition of H^+, causes $\downarrow [\text{OH}^-]$ (i.e. $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$) ✓</p> <p>By LCP, there will be a shift to the left ✓</p> <p>∴ at new equilibrium: $\downarrow [\text{CrO}_4^{2-}]$, less yellow $\uparrow [\text{Cr}_2\text{O}_7^{2-}]$, more orange ✓</p>

[4 + 4 = 8 marks]

4. The following equilibrium has a value for K of 0.042 at 25°C.



If 0.20 mol PCl_3 , 0.20 mol Cl_2 and 0.50 mol PCl_5 were mixed in a 1.0 L container at 25°C, the reaction will shift left in order to establish equilibrium. Explain why.

$$K \text{ (or } Q) = \frac{[\text{Cl}_2][\text{PCl}_3]}{[\text{PCl}_5]}$$

$$\therefore Q = \frac{(0.2)(0.2)}{(0.5)} = 0.08 \quad \checkmark$$

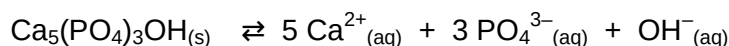
$$Q = 0.08 > 0.042 = K \quad \checkmark$$

\therefore system will shift left in approaching equilibrium
i.e. $\downarrow[\text{Cl}_2]$; $\downarrow[\text{PCl}_3]$; $\uparrow[\text{PCl}_5]$ \checkmark

[3 marks]

5. Tooth decay is the result of the dissolving of tooth enamel, $\text{Ca}_5(\text{PO}_4)_3\text{OH}_{(s)}$.

In the mouth the following equilibrium is established:



When sugar ferments on teeth it produces acidic compounds. Explain, in terms of the above equilibrium, the effect of these compounds on tooth enamel.

Sugars cause $\uparrow[\text{H}^+]$

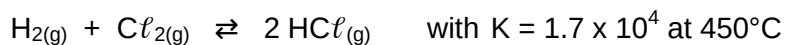
As $[\text{H}^+]\uparrow$, $[\text{OH}^-]\downarrow$ (i.e. $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$) \checkmark

By LCP, there will be a shift to the right \checkmark

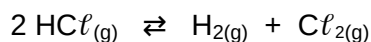
$\therefore \downarrow m(\text{Ca}_5(\text{PO}_4)_3\text{OH})$, leading to greater tooth decay \checkmark

[3 marks]

6. Consider the reaction:



(a) Determine K of the following at 450°C:



Reverse reaction

$$\therefore K = \frac{1}{1.7 \times 10^4} = 5.88 \times 10^{-5}$$

✓ ✓

[2 marks]

(b) If the pressure of the system $\text{H}_{2(g)} + \text{Cl}_{2(g)} \rightleftharpoons 2 \text{HCl}_{(g)}$ was increased by decreasing its volume at 450°C, then:

- (i) in which direction would the system shift? **No shift** ✓
- (ii) the value of K would **stay the same / remain unchanged** ✓

[2 marks]

(c) At 678°C, $K = 1.34 \times 10^5$ for $\text{H}_{2(g)} + \text{Cl}_{2(g)} \rightleftharpoons 2 \text{HCl}_{(g)}$.

Is the forward reaction for this system exothermic or endothermic? Explain.

By LCP, $\uparrow T$ causes a shift in endothermic direction ✓

From data: as $T \uparrow$, $K \uparrow$, indicating a shift to right ✓

\therefore forward reaction is endothermic ✓

[3 marks]

End of Test