Kinetics Written Response Key:

1.

1. (4 marks)

Solid sodium bicarbonate and acetic acid were reacted in an open flask as follows:

$$NaHCO_3(s) + CH_3COOH(aq) \rightarrow NaCH_3COO(aq) + H_2O(\ell) + CO_2(g)$$

The following data was recorded:

Time (s)	Mass of Flask and Contents (g)
0.00	203.00 g
30.0	202.95 g
60.0	202.93 g
90.0	202.92 g

Calculate the overall rate of reaction in grams of $NaHCO_3$ per minute.

Solution:

For Example:

$$\text{rate} = \frac{0.08\,\text{g } CO_2}{90\,\text{s}} \times \frac{60\,\text{s}}{\text{min}} = 0.053\,\text{g } CO_2/\text{min} \qquad \leftarrow \text{2 marks}$$

$$\text{rate} = \frac{0.053\,\text{g } CO_2}{\text{min}} \times \frac{1\,\text{mol } CO_2}{44\,\text{g } CO_2} \times \frac{1\,\text{mol } NaHCO_3}{1\,\text{mol } CO_2} \times \frac{84\,\text{g } NaHCO_3}{\text{mol}}$$

$$= 0.1\,\text{g } NaHCO_3/\text{min} \qquad \leftarrow \text{2 marks}$$

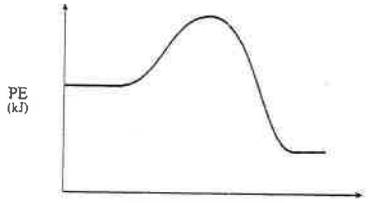
2.

1. (4 marks)

A catalyzed decomposition of ozone (O_3) occurs in a series of steps as illustrated below:

Step 1	O_3 + sunlight $\rightarrow O_2 + O$
Step 2	$O_3 + NO \rightarrow NO_2 + O_2$
Step 3	$NO_2 + O \rightarrow NO + O_2$
Overall Reaction	
Catalyst	

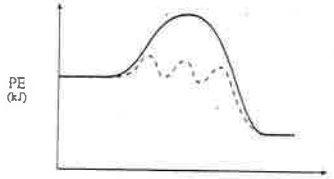
Write the equation for the overall reaction and then identify the catalyst in the spaces above.
The PE diagram below represents the uncatalyzed decomposition of ozone. On the PE diagram, sketch a curve that could represent the mechanism for the catalyzed decomposition.



Solution:
For Example:

Overall reaction: $2O_3 \rightarrow 3O_2$ ← 1 mark

Catalyst: NO ← 1 mark



← ½ mark ($E_{a(\text{catalyzed})} < E_{a(\text{uncatalyzed})}$)

← ½ mark (three humps)

← 1 mark ($PE_{(\text{reactants})}$ and $PE_{(\text{products})}$ unchanged)

3.

1. Consider the reaction: $2Zn(s) + O_2(g) \rightarrow 2ZnO(s)$

State two different methods that would increase the rate of this reaction.
Explain each in terms of collision theory. (4 marks)

Method 1: _____

Explanation: _____

Method 2: _____

Explanation: _____

For Example:

Method: Increase surface area of Zn.
Explanation: There are more sites for successful collisions between reactants.

Method: Increase temperature.
Explanation: A larger fraction of collisions has sufficient energy to react.

← 4 marks

4.

1. Consider the following reaction mechanism:

Step 1	$Cl_2 \rightarrow 2Cl$	(fast)
Step 2	$Cl + CO \rightarrow COCl$	(slow)
Step 3	$COCl + Cl_2 \rightarrow COCl_2 + Cl$	(fast)

Identify a reaction intermediate in the reaction mechanism and write the equation for the overall reaction. Explain why increasing the $[CO]$ will increase the reaction rate, but increasing the $[Cl_2]$ will not. (5 marks)

Solution:

For Example:

Reaction Intermediate: COCl **OR** Cl ← 1 mark

Overall Reaction Equation: $2Cl_2 + CO \rightarrow COCl_2 + 2Cl$ ← 2 marks

Explanation: The slowest step is Step 2, so increasing $[CO]$ will speed up Step 2. Increasing $[Cl_2]$ will not speed up the slowest step so does not increase the reaction rate. ← 2 marks