ORDERS OF REACTION and MECHANISMS

1. This question is about the reaction:

   A + B = C + D

   The reaction is believed to happen in two steps:

Step 1:	A = C + X	(slow reaction)
Step 2:	B + X = D	(fast reaction)

   a) Step 1 is described as *rate determining*. Explain what that means.

   b) Explain what *molecularity* means and give the molecularity of the two steps.

   c) The reaction is found to be first order with respect to A and zero order with respect to B. Explain the difference between the terms *molecularity* and *order*.

2. In a reaction between E and F, the reaction was found experimentally to be second order *overall*. Which of the following mechanisms is consistent with this. Explain your answer.

   Mechanism 1:

Step 1:	E = G + Y	(slow reaction)
Step 2:	Y + F = Z	(fast reaction)
Step 3:	Z + F = H	(fast reaction)

   Mechanism 2:

Step 1:	E + F = Y	(slow reaction)
Step 2:	Y + F = G + H	(fast reaction)

   Mechanism 3:

Step 1:	2F = G + Y	(slow reaction)
Step 2:	Y + E = H	(fast reaction)

3. You won't need to be able to do this unless your examiners ask difficult questions about reactions in which the slow step isn't the first one. I suggest you don't even attempt to do it unless you are confident about equilibrium constants.

   First example: $A + B \underset{}{\overset{\text{fast}}{\rightleftharpoons}} X$

   $A + X \xrightarrow{\text{slow}} C$

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a) Write the rate equation for the reaction based on what is present in the rate determining step.

b) Write an expression for the equilibrium constant for the first step of the reaction, and rearrange it to give an expression for the concentration of X.

c) By combining the answers to (a) and (b), show that the mechanism is consistent with the reaction being second order with respect to A and first order with respect to B.

Second example: $A + B \underset{}{\overset{\text{fast}}{\rightleftharpoons}} X + Y$

$C + X \xrightarrow{\text{slow}} Z$

d) Write the rate equation for the reaction based on what is present in the rate determining step.

e) Write an expression for the equilibrium constant for the first step of the reaction, and rearrange it to give an expression for the concentration of X, pointing out any assumptions you make.

f) By combining the answers to (d) and (e), show that the mechanism is consistent with the rate equation:

$$\text{Rate} = k[A]^{1/2}[B]^{1/2}[C]$$