IB CHEM 2

HL Kinetics Problem Set

1. The rate constant, k, is commonly described by the Arrhenius equation:
$k = A*exp[-E_a/RT]$

Which of the following statements are correct?

I. A greater E_a value results in a smaller k value.

II. Reactions of less complex molecules usually have a greater value of A.

III. The slope (gradient) of ln k versus 1/T equals E_a.

A. I and II only

B. I and III only

C. II and III only

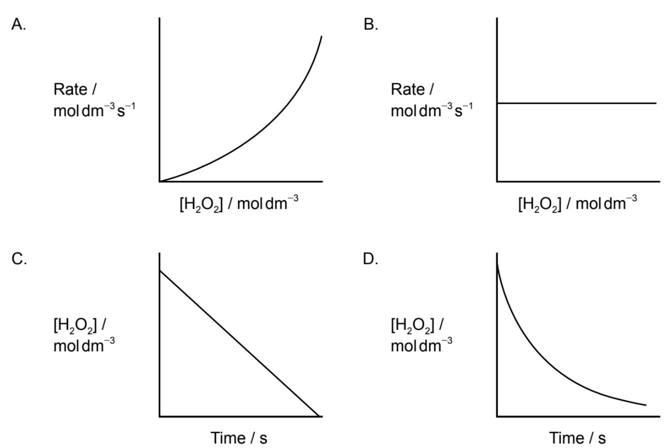
D. I, II and III

2. Decomposition of hydrogen peroxide in an aqueous solution proceeds as follows.

$$2H_2O_2 (aq) \rightarrow 2H_2O(l) + O_2 (g)$$

The rate expression for the reaction was found to be: rate = k $[H_2O_2]$.

Which graph is consistent with the given rate expression?



3. Bromine and nitrogen(II) oxide react according to the following equation.

$$Br_2\ (g) + 2NO\ (g) \rightarrow 2NOBr\ (g)$$

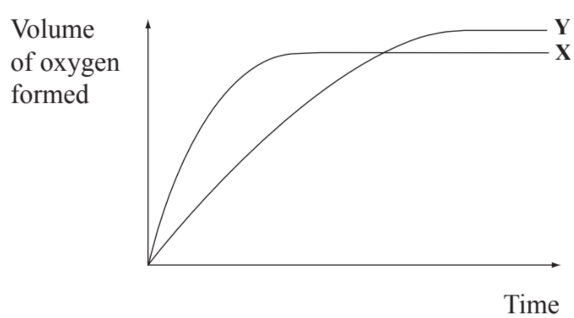
Which rate equation is consistent with the experimental data?

$[Br_2]$ / mol dm^{-3}	[NO] / mol dm^{-3}	Rate / mol dm^{-3}s^{-1}
0.10	0.10	1.0×10^{-6}
0.20	0.10	4.0×10^{-6}
0.20	0.40	4.0×10^{-6}

A. rate = k $[Br_2]^2$ [NO]
B. rate = k $[Br_2]$ $[NO]^2$
C. rate = k $[Br_2]^2$
D. rate = k $[NO]^2$

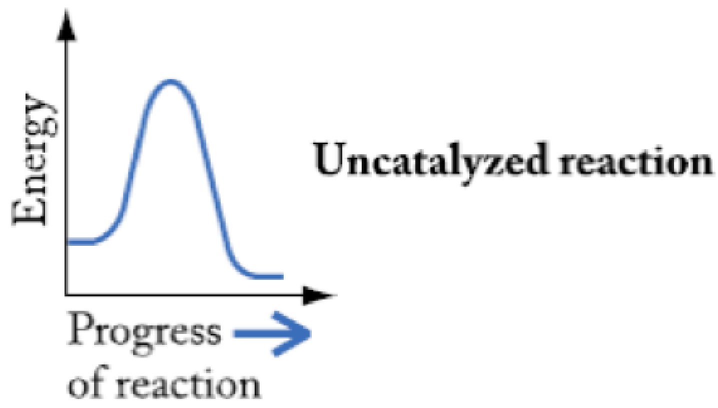
4. Curve X on the graph below shows the volume of oxygen formed during the catalytic decomposition of a 1.0 mol dm^{-3} solution of hydrogen peroxide.

$$2H_2O_2(aq) \rightarrow O_2(g) + 2H_2O(l)$$



Which change would produce the curve Y?
A. Adding water
B. Adding some 0.1 mol dm^{-3} hydrogen peroxide solution
C. Using a different catalyst
D. Lowering the temperature

5. The energy coordinate diagram for a hypothetical reaction is given below. Answer the following questions based on the diagram:



a. Is the reaction endothermic or exothermic? Explain. [2]

b. Does it require high activation energy or low activation energy? [1]

c. Draw the diagram for what the reaction energy would like if you added a catalyst to the reaction mixture. [2]

d. Explain how the catalyst changes activation energy with respect to its purpose in the reaction. [2]

6. Therapeutic hypothermia techniques involve lowering the body temperature to limit tissue damage in stroke victims or those resuscitated from cardiac arrest. The average pulse rate of an adult human at 37˚C is about 75 beats min^{-1}. If the effective activation energy for the beating of the heart muscle is about 30 kJ, estimate the heart rate of a patient at 22˚C. [4]

7. The rate constant for the reaction NO_2 (g) + O_3 (g) → NO_3 (g) + O_2 (g) was determined over a temperature range of 40K with the following results

T (K)	k (1/M*s)
203	4.14E+05
213	7.30E+05
223	1.22E+05
233	1.96E+06
243	3.02E+06

a. Calculate the activation energy for this reaction. [3]

b. Calculate the rate constant for the reaction at 300K? [2]

8. The reaction described in question 4 was conducted in a lab. The following kinetics data were obtained for the reaction:

Expt	**Conc of**	**Conc of**	**Init**
#	**NO (M)**	**H_2 (M)**	**Rate (M/s)**
1	**0.100**	**0.100**	**0.00123**
2	**0.100**	**0.200**	**0.00246**
3	**0.200**	**0.100**	**0.00492**

a. Based on the data provided, what is the rate law for this reaction? Support your answer. [2]

b. Based on the data above, calculate the rate constant. [2]

c. What order kinetics would this reaction follow? Support your answer. [2]

d. Calculate the rate when [NO] = 0.0500 M and [H_2] = 0.1500 M. [2]

e. How would the rate expression change if you conducted the experiment with a large excess of H_2 (g)? What order kinetics would this follow? [2]