**Kinetics Review**

1. Which of the following is (are) important in determining whether a reaction occurs?

I. Energy of the molecules

II. Orientation of the molecules

A. I only

B. II only

C. Both I and II

D. Neither I nor II

1. Consider the reaction between solid CaCO3 and aqueous HCl. The reaction will be speeded up by an increase in which of the following conditions?

I. Concentration of the HCl

II. Size of the CaCO3 particles

III. Temperature

A. I only

B. I and III only

C. II and III only

D. I, II and III

1. Which step in a multi-step reaction is the rate determining step?

A. The first step

B. The last step

C. The step with the lowest activation energy

D. The step with the highest activation energy

1. Excess magnesium was added to a beaker of aqueous hydrochloric acid on a balance. A graph of the mass of the beaker and contents was plotted against time (line 1).



 What change in the experiment could give line 2?

I. The same mass of magnesium but in smaller pieces

II. The same volume of a more concentrated solution of hydrochloric acid

III. A lower temperature

A. I only

B. II only

C. III only

D. None of the above

1. The rate of a reaction between two gases increases when the temperature is increased and a catalyst is added. Which statements are both correct for the effect of these changes on the reaction?

|  |  |  |
| --- | --- | --- |
|  | Increasing the temperature  | Adding a catalyst  |
| A. | Collision frequency increases  | Activation energy increases  |
| B. | Activation energy increases  | Activation energy does not change  |
| C. | Activation energy does not change  | Activation energy decreases  |
| D. | Activation energy increases  | Collision frequency increases  |

1. The rate expression for a reaction is shown below.

rate = *k*[A]2[B]2

 Which statements are correct for this reaction?

I. The reaction is second order with respect to both A and B.

II. The overall order of the reaction is 4.

III. Doubling the concentration of A would have the same effect on the rate of reaction as doubling the concentration of B.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

1. Which of the quantities in the enthalpy level diagram below is (are) affected by the use of a catalyst?



A. I only

B. III only

C. I and II only

D. II and III only

1. Values of a rate constant, *k*, and absolute temperature, *T*, can be used to determine the activation energy of a reaction by a graphical method. Which graph produces a straight line?

A. *k* versus *T*

B. *k* versus 

C. ln *k* versus *T*

D. ln *k* versus 

1. For a given reaction, why does the rate of reaction increase when the concentrations of the reactants are increased?

A. The frequency of the molecular collisions increases.

B. The activation energy increases.

C. The average kinetic energy of the molecules increases.

D. The rate constant increases.

1. Which statement is correct for the reaction below?

 4P + Q → 2R + 2S

A. The rate of formation of R is one half the rate of the disappearance of Q.

B. The rate of disappearance of Q is one quarter of the rate of disappearance of P.

C. The rates of formation of R and S are not equal.

D. The rate of formation of S is double the rate of disappearance of P.

1. In the Haber process for the synthesis of ammonia, what effects does the catalyst have?

|  |  |  |
| --- | --- | --- |
|  | **Rate of formation of NH3(g)** | **Amount of formed NH3(g)** |
| A. | Increases | Increases |
| B. | Increases | Decreases |
| C. | Increases | No change |
| D. | No change | Increases |

1. Consider the following statements.

I. The rate constant of a reaction increases with increase in temperature.

II. Increase in temperature decreases the activation energy of the reaction.

III. The term *A* in the Arrhenius equation () relates to the energy requirements of the collisions.

 Which statement(s) is/are correct?

A. I only

B. II only

C. I and III only

D. II and III only

1. For the chemical reaction

2NO(g) + O2(g) → 2NO2(g)

 the following reaction mechanism has been proposed.

 NO (g) + NO(g)  N2O2 (g) fast
N2O2 (g) + O2 (g) → 2NO2 (g) slow

 What could be the rate expression for this reaction?

A. rate = k[NO][O2]

B. rate = k[NO]2

C. rate = k[N2O2][O2]

D. rate = k[NO]2[O2]

1. The rate expression for a particular reaction is

Rate = *k*[P][Q]

 Which of the units below is a possible unit for *k*?

A. mol–2 dm6 min–1

B. mol–1 dm3 min–1

C. mol dm3 min–1

D. mol–2 dm–6 min–1

1. What is the definition of *half-life* for a first order reaction?

A. The time required for the quantity of a reactant to decrease by half.

B. Half the time required for a reactant to be completely used up.

C. Half the time required for a reaction to reach its maximum rate.

D. The time required for a reaction to reach half of its maximum rate.

1. Gaseous hydrogen iodide, HI, decomposes into its elements when heated. The decomposition was investigated in a series of experiments carried out at the same temperature. The following data was obtained.

|  |  |  |
| --- | --- | --- |
| **Experiment number** | Initial (HI) / mol dm−3 | **Initial rate of reaction / mol dm−3 s−1** |
| 1 | 2.2 × 10−3 | 1.1 × 10−6 |
| 2 | 6.6 × 10−3 | 9.9 × 10−6 |
| 3 | 2.2 × 10−2 | 1.1 × 10−4 |
| 4 | 4.4 × 10−3 | to be determined |

(a)Write the equation for the decomposition of hydrogen iodide.

 (1)

(b)Deduce the order of the reaction and explain your answer.

(2)

(c)State the rate expression for the reaction.

 (1)

(d) Determine the initial rate of reaction in experiment 4.

 (1)

(e)Define the term *molecularity* and deduce its value in this reaction.

 (2)

1. The following reaction is described as first order with respect to N2O5.

2N2O5(g) → 4NO2(g) + O2 (g)

 (a) Write the rate expression for the reaction.

 (1)

(b) One possible mechanism for this reaction is given below.

N2O5(g) → NO(g) + NO3(g) Step 1

N2O5(g) + NO3(g) → 2NO2(g) + O2(g) Step 2

 Describe the rate expression that would result if the rate determining step in the mechanism is

(i) Step 1. **(1)**

(ii) Step 2.

 (2)

 Outline your reasoning.

(c) Explain what is meant by the term *half-life* for this reaction.

 (1)

(d) State what is characteristic about the half-life of a first order reaction.

 (1)

1. When excess lumps of magnesium carbonate are added to dilute hydrochloric acid the following reaction takes place.

MgCO3(s) + 2HCl(aq) → MgCl2(aq) + CO2(g) + H2O(l)

(a) Outline **two** ways in which the rate of this reaction could be studied. In each case sketch a graph to show how the value of the chosen variable would change with time.

(4)

(b) State and explain **three** ways in which the rate of **this** reaction could be increased.

(6)

(c) State and explain whether the total volume of carbon dioxide gas produced would increase, decrease or stay the same if

(i) more lumps of magnesium carbonate were used.

(2)

(ii) the experiments were carried out at a higher temperature. **(2)**

1. The oxidation of nitrogen monoxide takes place as follows:

 2NO(g) + O2(g)  2NO2(g)

The following experimental data was obtained at 101.3 kPa and 298 K.

|  |  |  |  |
| --- | --- | --- | --- |
| Experiment | Initial [NO] / mol dm–3 | Initial [O2] / mol dm–3 | Initial rate / mol dm–3 s–1 |
| 1 | 3.50×10–2 | 1.75×10–2 | 3.75×10–3 |
| 2 | 3.50×10–2 | 3.50×10–2 | 7.50×10–3 |
| 3 | 7.00×10–2 | 7.00×10–2 | 6.00×10–2 |

(a) Deduce the order of reaction with respect to O2 **[1]**

(b) Deduce the order of reaction with respect to NO. **[1]**

(c) State the rate expression for the reaction. **[1]**

(d) Calculate the value of the rate constant and state the units. **[2]**