## Kinetics-Topic 17 (AHL)

**H** 90-42. The experimental rate law for the gas phase reaction given above has been found to be Rate=k[A][$B_2$]$^2$. The overall order of the reaction is

A. zero. B. first. C. second. D. third.

**H** 90-43. In the reaction of 90-42, if the concentration of A is tripled and the concentration of $B_2$ is doubled, the reaction rate would be increased by the factor

A. 6 B. 9 C. 12 D. 18

18. 90/44. For a given reaction in which the activation energies of the forward and reverse reactions are equal then

A. the equilibrium constant must equal one.
B. the rate law can be determined from the stoichiometric equation.
C. the overall order must be zero.
D. $\Delta H$ must be zero.

**H** 90-45. All of the following statements are true EXCEPT

A. chemical reactions involve collisions between the reactants (molecules).
B. a three-body collision is less likely than a two-body collision.
C. in reactions that are second order in one reactant and first order in another, the slow step usually involves a three-body collision.
D. after the addition of a catalyst, the collision rate between molecules is still the same.

**A** 91-29. The reaction $2ICl(g) + H_2(g) \rightarrow I_2(g) + 2HCl(g)$

is first order in both reactants. Which one of the following statements is true?

A. The rate of reaction will increase more if the ICl concentration is doubled than if the $H_2$ concentration is doubled.
B. The rate of reaction will increase more if the $H_2$ concentration is doubled than if the ICl concentration is doubled.
C. The rate of reaction will increase equally if the ICl or the $H_2$ concentration is doubled.
D. Reaction rates cannot be predicted, they can only be measured.

**H** 91-42. Two reactants P and Q are mixed and the reaction is timed until a colour change occurs. The data are

| **[P]** | **[Q]** | **Time(s)** |
|---|---|---|
| 0.100 | 0.140 | 25 |
| 0.050 | 0.140 | 50 |

0.100 0.070 100

What is the order of the reaction with respect to P?

A. 0.5 B. 1 C. 2 D. 3

16. 91/43. For the following reaction $H_2(g) + I_2(g) \rightarrow 2HI(g)$ the experimental rate law is Rate = $k[H_2][I_2]$
When time is given is seconds and the concentration is in mol $dm^{-3}$ , the units for the rate constant are
A. mol $dm^{-3}s^{-1}$ B. $mol^{-1}dm^3s^{-1}$ C. $s^{-1}$ D. $mol^{-1}dm^3s$

17. 91/44. For the reaction $I + I \rightarrow I_2$ at 25°C in $CCl_4$, k = $8.9 \times 10^9$ $dm^3$ $mol^{-1}s^{-1}$. This reaction is
A. first order and endothermic. B. first order and exothermic.
C. second order and endothermic. D. second order and exothermic.

**H** 91-45. In each of the following potential energy diagrams, the horizontal axis is the reaction coordinate and the vertical axis is potential energy in kJ. Which potential energy diagram best describes a reaction which has an activation energy of 40 kJ and a net energy change (reaction enthalpy) of -100 kJ?

(See hard copy)

A. Diagram I B. Diagram II C. Diagram III D. Diagram IV

**H** 92-46. Consider the following identical kinetic energy distribution curves for four different reactions. The reactions are occurring at the same temperature.

(See hard copy)

The reaction occurring most rapidly is probably

A. reaction I. B. reaction II. C. reaction III. D. reaction IV.

**H** 92-50. The radioactive isotope $^{131}_{53}I$ undergoes beta decay with a half-life of 8.04 days. If a 1.35 g sample of isotopically pure I-131 is isolated today, what will be the mass of the sample after 13.0 days?

A. 0.220 g B. 0.268 g C. 0.440 g D. 0.835 g

**H** 92-47. A certain chemical reaction can be represented by the overall equation
$2A(g) + B(g) \rightarrow C(g)$
At a particular temperature the initial rate of this reaction was measured for various

initial concentrations of A and B, as shown below.

| Expt | Initial conc in mol $dm^{-3}$ A | B | Initial rate in mol C $hr^{-1}$ |
|---|---|---|---|
| 1 | 0.5 | 0.5 | 2.0 x 10-3 |
| 2 | 1.0 | 0.5 | 8.0 x 10-3 |
| 3 | 1.0 | 1.0 | 8.0 x 10-3 |
| 4 | 1.5 | 1.0 | 18.0 x 10-3 |

On the basis of the evidence provided, it appears that the mechanism of this reaction would involve two or more steps. In light of the experimental data, a possible rate determining step might be:

A. A + B → intermediate complex
B. A + A → intermediate complex
C. A + AB → C
D. A + B → C

19. 92/50. The radioactive isotope I-131 undergoes beta decay with a half-life of 8.04 days. If a 1.35 g sample of isotopically pure I-131 is isolated today, what will be the mass of the sample after 13.0 days?

A. 0.220 g B. 0.268 g C. 0.440 g D. 0.835 g

**A** 93-8. What fraction of a radioactive isotope will remain after 3 half-lives have elapsed?

A. ½ B. 1/3 C. 1/6 D. 1/8

**A** 93-27. Which of the following is needed to determine the rate law for a reaction?

I. An inspection of the balanced equation
II. Experimentation

A. I only B. II only C. Either I or II D. Both I and II

10. 93/47. For the reversible reaction $2NH_3(g)$ D $N_2(g) + 3H_2(g)$
$\Delta H$ = 92 kJ and the activation energy equals 335 kJ. The activation energy for the reverse reaction will be

A. -335 kJ B. 92 kJ C. 243 kJ D. 427 kJ

**Questions 93/45 and 93/46 are about the reaction of hydrogen with nitrogen(II) oxide, which may be represented by the equation**

**$2H_2(g) + 2NO(g) \rightarrow 2H_2O(g) + N_2(g)$**

**The reaction is known to follow the rate law: Rate = $k[NO]^2[H_2]$**

**H** 93-45. The overall order for this reaction is

A. 1 B. 2 C. 3 D. 4

15. 93/46. At 800°C the instantaneous rate of reaction is 3.5 mol $dm^{-3}s^{-1}$ when the concentration of nitrogen(II)oxide and hydrogen are each 0.30 mol $dm^{-3}$. The numerical value of the specific rate constant is

A. 1.2 B. 3.5 C. $3.9 \times 10^1$ D. $1.3 \times 10^2$

**A** 94-9. How many half-lives must pass before a radioactive isotope is reduced to 1/16 of its original quantity?

A. 4 B. 8 C. 16 D. 32

**A** 94-28. The reaction between gaseous $CS_2$ and $H_2$ represented below is first order with respect to $H_2$ and second order with respect to $CS_2$. How will changes in the concentrations of $H_2$ and $CS_2$ affect the reaction rate?

$$CS_2(g) + 4H_2(g) \rightarrow 2H_2S(g) + CH_4(g)$$

A. Changing the $CS_2$ concentration will affect the reaction rate more than changing the $H_2$ concentration will.
B. Changing the $H_2$ concentration will affect the reaction rate more than changing the $CS_2$ concentration will.
C. Changing the $H_2$ and $CS_2$ concentrations will have equal effects on the reaction rate.
D. It is impossible to predict how the reaction rate will be affected from this information.

**A** 94-29. Which statement about activation energies is true?

A. The activation energy for a reaction can be calculated from the heats of formation of the reactants and products
B. The activation energy depends on concentration
C. Activation energy decreases as the temperature is raised
D. Reaction rates increase when activation energies are lowered

8. 94/43. Which one of the following factors does not affect the rate of a chemical reaction?

A. The enthalpy change of the reaction
B. The nature of the reactants
C. The concentration of the reactants
D. The presence of a catalyst

**H** 94-44. In a school laboratory, the reaction

$2I^-(aq) + H_2O_2(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(l)$

was studied in the presence of $S_2O_3^{2-}(aq)$ and starch solution. This is known as an 'iodine-clock reaction', because its end point is marked by the sudden appearance of a blue colour. The time taken to produce the blue colour was observed for various concentrations of reactants.

| Experiment Number | $I^-$ | $H_2O_2$ | $H^+$ | Time |
|---|---|---|---|---|
| I | 0.100 M | 0.140 M | 0.0010 M | 25 s |
| II | 0.050 M | 0.140 M | 0.0010 M | 50 s |
| III | 0.100 M | 0.070 M | 0.0010 M | 100 s |

The order of the reaction wlth respect to $I^-$ is

A. 0 B. 1/2 C. 1 D. 2

**H** 94-45. For the reaction $CH_3COCH_3(aq) + I_2(aq) \rightarrow CH_3COCH_2I(aq) + HI(aq)$ it is found experimentally that doubling the concentration of $CH_3COCH_3$ doubles the reaction rate, tripling the concentration of $H^+$ triples the rate, and halving the concentration of $I_2$ has no effect on the rate. It may be concluded that

A. iodine is acting as a catalyst in the reaction
B. the slowest step in the reaction involves iodine.
C. the rate of the reaction is independent of the pH of the solution.
D. the rate determining step involves $CH_3COCH_3$ but not iodine.

**H** 94-46. A proposed mechanism for the decomposition of $N_2O_5$ is

$N_2O_5(g) \rightarrow NO_2(g) + NO_3(g)$ (slow)
$NO_2(g) + NO_3(g) \rightarrow NO_2(g) + O_2(g) + NO(g)$ (fast)
$NO(g) + N_2O_5(g) \rightarrow 3NO_2(g)$ (fast)

The stoichiometric equation for the decomposition of $N_2O_5$ must therefore be

A. $N_2O_5(g) \rightarrow NO_2(g) + NO_3(g)$
B. $N_2O_5(g) \rightarrow NO_2(g) + O_2(g) + NO(g)$
C. $N_2O_5(g) + NO_2(g) + NO_3(g) \rightarrow 4NO_2(g) + O_2(g)$
D. $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$

**A** 95-28. Which species might be behaving as a catalyst based on the equations below?

$O_3 + Cl \rightarrow ClO + O_2$
$ClO + O \rightarrow Cl + O_2$

A. $O_2$ B. Cl C. ClO D. O

**A** 95-29. Which of the following can be used to determine the order of a reaction?

I. Studies of reaction rate as a function of reactant concentration
II. Consideration of the balanced equation for the reaction
III. Knowledge of the activation energy for the reaction

A. I only B. II only C. Either I or II D. I, II or III

**H** 95-42. An energy diagram for a chemical reaction is shown below. Which letter correctly represents the activation energy for the catalysed reaction in the forward direction?

(See hard copy)

A. W B. X C. Y D. Z

**H** 95-43. Which one of the following graphs represents the plot of ln[X] against time, t, for the first-order reaction, $X \rightarrow Y$?

(See hard copy)

9. 95/44. The conversion of NO to $NO_2$ was studied at 250°C in the gas phase. The following kinetic data were obtained.

| [NO] mol $dm^{-3}$ | [$O_2$] mol $dm^{-3}$ | Initial Rate (mol $dm^3$ $s^{-1}$) |
|---|---|---|
| $1.6 \times 10^{-1}$ | $2.4 \times 10^{-1}$ | $1.5 \times 10^{-4}$ |
| $3.2 \times 10^{-1}$ | $2.4 \times 10^{-1}$ | $6.0 \times 10^{-4}$ |
| $3.2 \times 10^{-1}$ | $4.8 \times 10^{-1}$ | $1.2 \times 10^{-3}$ |

The values for the order of the reaction with respect to NO and $O_2$ are

| | NO | $O_2$ | | NO | $O_2$ |
|---|---|---|---|---|---|
| A. | 2 | 1 | B. | 2 | 2 |
| C. | 1 | 2 | D. | 1 | 1 |

11. 95/45. Some information regarding the catalysed and uncatalysed decomposition of HI is given below.

| Reaction | $E_{activation}$(kJ $mol^{-1}$) | Rate |
|---|---|---|
| 2 HI --> $H_2 + I_2$ | 190 | $R_1$ |
| 2 HI --> $H_2 + I_2$ (catalysed) | 95 | $R_2$ |

Based on this information, which of the following statements is true?

A. $R_1 = 2R_2$ at all temperatures. B. $R_1 = R_2^2$ at all temperatures.
C. An increase of 10°C will cause the rates of both reactions to double.
D. $R_1$ increases more rapidly with temperature than $R_2$ does.

**A** 96-29. The reaction between NO and $H_2$ that occurs according to the equation

$$2NO + 2H_2 \rightarrow 2H_2O + N_2$$

is second order in NO and first order in $H_2$. Which one of the following statements is true?

A. Doubling the concentration of the NO will have more effect on the reaction rate than doubling the concentration of the $H_2$.
B. Doubling the concentration of the $H_2$ will have more effect on the reaction-rate than doubling the concentration of the NO.

C. Doubling the concentration of the $H_2$ will affect the reaction rate just as much as doubling the concentration of the NO.

D. the effect of doubling the concentration of either NO or $H_2$ cannot be predicted from this information.

**A** 97-9. A certain radioactive element has a half-life of 2 hours. How many grams of a 32 gram sample remain after 5 half-lives?

A. 1.0 g B. 2.0 g C. 3.2 g D. 6.4 g

**A** 97-28. The reaction between $S_2O_8^{2-}$ and $I^-$ ions is first order in each reactant and occurs according to the equation,

$$S_2O_8^{2-}(aq) + 3I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_3^-(aq)$$

How will doubling the concentration of $S_2O_8^{2-}$ and $I^-$ ions affect the rate of this reaction?

A. Doubling the $S_2O_8^{2-}$ concentration will alter the rate more than doubling the $I^-$ concentration.

B. Doubling the $I^-$ concentration will alter the rate more than doubling the $S_2O_8^{2-}$ concentration.

C. The reaction rate change will be the same when the $I^-$ or the $S_2O_8^{2-}$ concentration is doubled.

D. No conclusions can be made about the effect of concentration on the reaction rate from this information.

4.

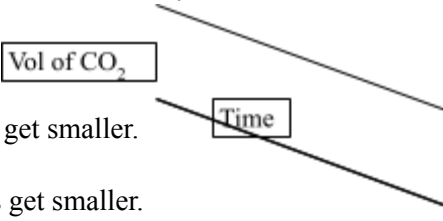
5. 98/24. Reaction rates typically increase with an increase in temperature. This increase is best explained by an increase in the

A average energy of the particles B. number of collisions between particles

C. number of particles with the energy required to react D. activation energy of the reaction

1. 99/22. The reaction between excess calcium carbonate and hydrochloric acid can be followed by measuring the volume of carbon dioxide produced with time.

The results of one such reaction are shown at the right. How does the rate of this reaction change with time and what is the main reason for this change.




A. The rate increases with time because the calcium carbonate particles get smaller.

B. The rate increases with time because the acid becomes more dilute.

C. The rate decreases with time because the calcium carbonate particles get smaller.

D. The rate decreases with time because the acid becomes more dilute.

E. 99/23. Most reactions occur in a series of steps, one of which is the rate determining step. The rate determining step is so called because it is the

A. first step B. last step C. fastest step D. slowest step

3. 99/24. The reaction between nitrogen dioxide and carbon monoxide is given by $NO_2(g) + CO(g) \rightarrow NO(g) CO_2(g)$.

According to the following experimental data, what is the rate equation?

| $[NO_2]$ / mol $dm^{-3}$ | $[CO]$ / mol $dm^{-3}$ | Rate / mol $dm^{-3}$ $s^{-1}$ |
|---|---|---|

| | | |
|---|---|---|
| 0.10 | 0.10 | $1.0 \times 10^{-6}$ |
| 0.30 | 0.10 | $9.0 \times 10^{-6}$ |
| 0.30 | 0.30 | $9.0 \times 10^{-6}$ |

A. Rate = $k[NO^2][CO]$ . Rate = $k[CO]^2$ C. Rate = $k[NO_2]^2$ D. Rate = $k[NO_2]^3$

1. 00/21. Some collisions between reactant molecules do not form products. This is most likely because
   2. the molecules do not collide in the proper ratio B. the molecules do not have enough energy
   C. the concentration is too low D. the reaction is at equilibrium
7. 00/22. Doubling which one of the following will double the rate of a first order reaction?
   8. concentration of the reactant B. size of solid particles
   C. volume of solution in which the reaction is carried out D. activation energy