CHEMISTRY ONLINE TUITION

CHEMISTRY

PHYSICAL CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	RATE EQUATIONS
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	10
TOTAL MARKS	23

Rate Equations - 1

1. The rate of the reaction between substance A and substance B was studied in a series of experiments carried out at the same temperature.

In each experiment the initial rate was measured using different concentrations of A and B.

These results were used to deduce the order of reaction with respect to A and the order of reaction with respect to B.

(a) What is meant by the term order of reaction with respect to A?

(1)

(b) When the concentrations of A and B were both doubled, the initial rate increased by a factor of 4.
Deduce the overall order of the reaction.

(1)

(c) In another experiment, the concentration of A was increased by a factor of three and the concentration of B was halved.

This caused the initial rate to increase by a factor of nine.

Deduce the order of reaction with respect to A and the order with respect to B.

Write a rate equation for the reaction and suggest suitable units for the rate constant.

(4)

2. The rate expression for the reaction between X and Y is rate = k $[X]^2[Y]$
   Which statement is correct?

   A. The rate constant has units mol^{-1} dm^3 s^{-1}
   B. The rate of the reaction is halved if the concentration of X is halved and the concentration of Y is doubled.
   C. The rate increases by a factor of 16 if the concentration of X is tripled and the concentration of Y is doubled.
   D. The rate constant is independent of temperature.

   (1)

3. The following data were obtained in a series of experiments on the rate of the reaction between NO and O_2 at a constant temperature.

Experiment	Initial concentration of NO/mol dm^{-3}	Initial concentration of O_2/mol dm^{-3}	Initial rate/mol dm^{-3} s^{-1}
1	5.0×10^{-2}	2.0×10^{-2}	6.5×10^{-4}
2	6.5×10^{-2}	3.4×10^{-2}	To be calculated

   The rate equation for this reaction is rate = k$[NO]^2$ $[O_2]$

(a) Use the data from experiment 1 to calculate a value for the rate constant, k, at this temperature, and state its units.

(2)

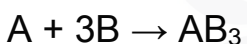**(b)** Calculate a value for the initial rate in experiment 2.

(2)

4. What are the units of the rate constant for a third order reaction?

A. $mol\ dm^{-3}\ s^{-1}$
B. $mol^{-1}\ dm^{3}\ s^{-1}$
C. $mol^{2}\ dm^{-6}\ s^{-1}$
D. $mol^{-2}\ dm^{6}\ s^{-1}$

(1)

5. Compound A reacts with compound B as shown by the overall equation

$A + 3B \rightarrow AB_3$

The rate equation for the reaction is rate = $k[A][B]^2$

A suggested mechanism for the reaction is

Step 1 $A + B \rightarrow AB$
Step 2 $AB + B \rightarrow AB_2$
Step 3 $AB2 + B \rightarrow AB_3$
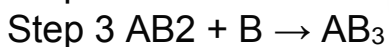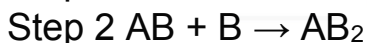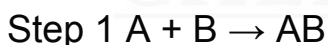
Deduce which one of the three steps is the rate-determining step.
Explain your answer.

I am Sorry !!!!!

(2)

6. The results of an investigation of the reaction between P and Q are shown in this table

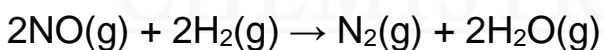| Experiment	[P] / mol dm^{-3}	Initial Initial [Q] / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
1	0.200	0.500	0.400
2	0.600	To be calculated	0.800

The rate equation is: rate = k [P] [Q]^2

What is the initial concentration of Q in experiment 2?

A. 0.167
B. 0.333
C. 0.408
D. 0.612

(1)

7. In the presence of the catalyst rhodium, the reaction between NO and H_2 occurs according to the following equation.

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

The kinetics of the reaction were investigated and the rate equation was found to be rate = k[NO]$_2$ [H$_2$]

The initial rate of reaction was 6.2×10^{-6} mol dm^{-3} s^{-1}

When the initial concentration of NO was 2.9×10^{-2} mol dm^{-3} and the initial concentration of H_2 was 2.3×10^{-2} mol dm^{-3}.

(a) Calculate the value of the rate constant under these conditions and give its units.

(3)

(b) Calculate the initial rate of reaction if the experiment is repeated under the same conditions but with the concentrations of NO and of H_2 both doubled from their original values.

(1)

8. Solutions of two compounds, W and X, react together in the presence of a soluble catalyst, Y, as shown in the equation $2W + X \rightarrow Z$

When the concentrations of W, X and Y are all doubled, the rate of reaction increases by a factor of four.

Which is a possible rate equation for this reaction?

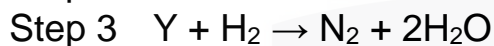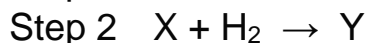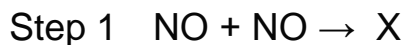**A.** rate = k $[W]^2$ $[X]$
B. rate = k $[W]^2$ $[Y]$
C. rate = k $[X]$ $[Y]$
D. rate = k $[X]$ $[Z]$

(1)

9. Using the rate equation and the overall equation, the following three-step mechanism for the reaction was suggested.

X and Y are intermediate species.

Step 1 $NO + NO \rightarrow X$
Step 2 $X + H_2 \rightarrow Y$
Step 3 $Y + H_2 \rightarrow N_2 + 2H_2O$

Suggest which one of the three steps is the rate-determining step.

Explain your answer.

(2)

10. The rate equation for the acid-catalysed reaction between iodine and propanone is:

rate = $k\,[H^+]\,[C_3H_6O]$

The rate of reaction was measured for a mixture of iodine, propanone and sulfuric acid at pH = 0.70

In a second mixture the concentration of the sulfuric acid was different but the concentrations of iodine and propanone were unchanged.

The new rate of reaction was a quarter of the original rate.
What was the pH of the second mixture?

A. 1.00
B. 1.30
C. 1.40
D. 2.80

(1)

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