1. The reaction A + 2B → C has a rate law of the form

Rate = k [A] [B].

If the reaction proceeds by a two step process, then the rate-determining step might be

A A + B → intermediate

B B + B → intermediate

C A + B → C

D B + AB → C.

2. Which is a correct statement about a catalyst?

For a chemical reaction it

A does not alter the value of the rate constant

B alters the value of the equilibrium constant

C alters the mechanism

D has no effect on the value of the activation energy.

3. The rate of a particular chemical reaction is first order with respect to each of two reactants. The units of k, the rate constant, for the reaction are

A $mol\,l^{-1}s^{-1}$

B $l\,mol^{-1}s^{-1}$

C $l^2\,mol^{-2}s^{-2}$

D $mol^2\,l^{-2}s^{-1}$.

4. The reaction expressed by the stoichiometric equation

Q + R → X + Z
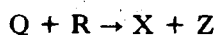
was found to be first order with respect to each of the reactants.

Which of the following statements is correct?

A Overall, the reaction is first order.

B If the initial concentrations of Q and R are halved, the rate of the reaction will be halved.

C The rate of the reaction decreases as the reaction proceeds.

D The rate of the reaction is independent of the concentration of either Q or of R.

5. For a given chemical change involving two reactants P and Q,
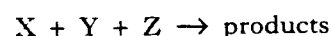
rate of reaction ∝ [P] [Q].

If the equation representing the overall reaction is

P + 2Q → S + T
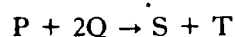
the mechanism could be

A   2Q → R + S   fast
     R + P → T   slow

B   P + Q → R + S   slow
     R + Q → T   fast

C   P → R + S   fast
     2Q + R → T   slow

D   P + Q → R + S   fast
     R + Q → T   slow

6. The following data refer to initial reaction rates obtained for the reaction

X + Y + Z → products

	RELATIVE CONCENTRATIONS			RELATIVE INITIAL RATE
	[X]	[Y]	[Z]	
Expt. 1	1·0	1·0	1·0	0·3
Expt. 2	1·0	2·0	1·0	0·6
Expt. 3	2·0	2·0	1·0	1·2
Expt. 4	2·0	1·0	2·0	0·6

These data fit the rate equation

A   Rate = k [X]

B   Rate = k [X] [Y]

C   Rate = k [X] [Y]^2

D   Rate = k [X] [Y] [Z].

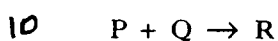7. For the reaction $A + B \rightarrow C$, the following data were obtained.

Experiment	Initial concentration of A, $mol\,l^{-1}$	Initial concentration of B, $mol\,l^{-1}$	Initial rate of formation of C/$mol\,l^{-1}s^{-1}$
1	0·050	0·050	0·015
2	0·050	0·100	0·060
3	0·100	0·100	0·060

The rate law for this reaction is

A   rate = $k[A]^2$

B   rate = $k[A][B]$

C   rate = $k[B]^2$

D   rate = $k[A][B]^2$

8. The reaction $A + 2B \rightarrow C$ has a rate law of the form

$$Rate = k[A][B]$$

If the reaction proceeds by a two step process, then the rate determining step might be

A $A + B \rightarrow$ intermediate

B $B + B \rightarrow$ intermediate

C $A + B \rightarrow C$

D $B + AB \rightarrow C$

9. The rate law for the reaction

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

can be expressed as either

Rate of production of $N_2 = k'[H_2][NO]^2$ or

Rate of production of $H_2O = k''[H_2][NO]^2$

Which of the following is true?

A $k' = k''$

B $k' = 2k''$

C $k'' = 2k'$

D   The order of the reaction is 4.

10. $$P + Q \rightarrow R$$

The rate equation for this reaction is Rate = $k[P][Q]^2$.

If the concentration of P and Q are both doubled, the rate will increase

A   2 times

B   4 times

C   6 times

D   8 times.

11. The following set of data was obtained for the kinetics of a reaction $A + B \rightarrow C$.

[A]/$mol\,l^{-1}$	[B]/$mol\,l^{-1}$	INITIAL RATE OF FORMATION OF C /$mol\,l^{-1}min^{-1}$
1·0	1·0	1·5
2·0	1·0	3·0
2·0	0·5	0·75

Which one of the following expresses the rate law for the reaction? The rate of formation of C is equal to

A $k[A][B]$

B $k[A][B]^2$

C $k[A]^2[B]$

D $k[A]^2[B]^2$

12. Which is a correct statement about a catalyst? For a chemical reaction, it

A   does not alter the value of the activation energy

B   alters the value of the equilibrium constant

C   does not affect the mechanism

D   alters the value of the rate constant.

13. The gas phase reaction $H_2 + I_2 \rightarrow 2HI$ is first order with respect to both reactants. If the concentrations of both H_2 and I_2 are doubled, the reaction rate will be changed by a factor of

A   0·5

B   2

C   3

D   4.

14. The following reaction is first order with respect to each of the reactants.
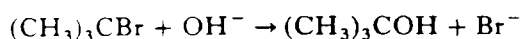
$$A + B \rightarrow C + D$$
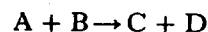
Which of the following is correct?

A   The rate of the reaction is independent of the concentration of either A or of B.

B   The overall reaction is first order.

C   If the initial concentrations of A and B are both doubled, the rate of the reaction will be doubled.

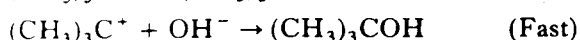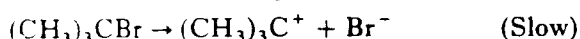D   As the reaction proceeds, its rate will decrease.

15 The order of a reaction

A will depend on the stoichiometry of the overall reaction

B is the sequence of steps in the mechanism

C can only be obtained by experiment

D controls the speed of the overall reaction.

16 Two mechanisms have been proposed for the hydrolysis of 2-bromo-2-methylpropane.

One of these has only one step

$$(CH_3)_3CBr + OH^- \rightarrow (CH_3)_3COH + Br^-$$

The other has two steps

$$(CH_3)_3CBr \rightarrow (CH_3)_3C^+ + Br^- \qquad \text{(Slow)}$$

$$(CH_3)_3C^+ + OH^- \rightarrow (CH_3)_3COH \qquad \text{(Fast)}$$

The reaction is observed to follow first order kinetics. The rate expression is

A Rate = $k[(CH_3)_3CBr]$

B Rate = $k[(CH_3)_3CBr][OH^-]$

C Rate = $k[(CH_3)_3C^+]$

D Rate = $k[(CH_3)_3C^+][OH^-]$.

17 The following data refer to initial reaction rates obtained with initial concentrations of reactants expressed in arbitrary but consistent units for the reaction
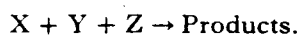
$$X + Y + Z \rightarrow \text{Products.}$$

	[X]	[Y]	[Z]	Initial Rate
Experiment 1	1·0	1·0	1·0	0·3
Experiment 2	1·0	2·0	1·0	0·6
Experiment 3	2·0	2·0	1·0	1·2
Experiment 4	2·0	1·0	2·0	0·6

These data fit the rate equation

A Rate = k[X][Y][Z]

B Rate = k[X][Y]^2

C Rate = k[X][Y]

D Rate = k[X].

18 In the reaction X + 2Y → Products, the reaction occurs in two stages:

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

$$Z + Y \xrightarrow{\text{fast}} \text{Products}$$
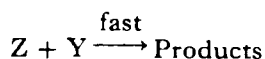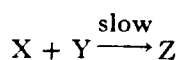
Which one of the following statements is correct?

A The rate of the reaction = $k[X][Y]^2$.

B The overall order of reaction is 3.

C The order with respect to Y is 2.

D The reaction is first order for both X and Y.

19 The rate of a chemical reaction may **not** be expressed in terms of the

A equilibrium constant for the observed reaction

B rate at which the product concentration increases

C rate constant for the observed reaction

D rate at which the reactant concentration decreases.

20. Two colourless substances P and Q react to give a coloured substance R. The times (t) taken for various initial concentrations of P and Q to produce a certain colour intensity are as follows.

Experiment	Initial concentration of P/mol l^{-1}	Initial concentration of Q/mol l^{-1}	t/s
1	0·05	0·05	46
2	0·05	0·10	23
3	0·10	0·05	46

The rate equation for this reaction is

A Rate = k[P]

B Rate = k[Q]

C Rate = k[Q]^2

D Rate = k[P][Q]

21 The reaction between nitrogen monoxide (NO) and hydrogen to give nitrogen and water occurs by the following steps

$$2NO + H_2 \xrightarrow{\text{slow}} N_2 + H_2O_2$$

$$H_2O_2 + H_2 \xrightarrow{\text{fast}} 2H_2O$$
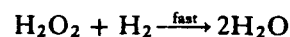
The overall order of this reaction will be

A 1

B 2

C 3

D 4.

22 An investigation of the oxidation of bromide ions by bromate(V) ions in acid solution (all concentrations molar) according to
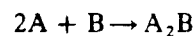
$$BrO_3^- + 5Br^- + 6H^+ \rightarrow 3Br_2 + 3H_2O$$
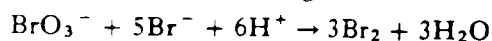
involved the preparation and reaction of several mixtures of equal total volume.

Mixture	BrO_3^-/cm^3	Br^-/cm^3	H^+/cm^3	H_2O/cm^3	Relative Rate
(1)	10	50	60	80	1
(2)	10	100	60	30	2
(3)	10	50	120	20	4
(4)	20	50	60	70	4

If the rate $= k[BrO_3^-]^x[Br^-]^y[H^+]^z$, what values of x, y and z are consistent with experimental data?

	x	y	z
A	1	1	1
B	1	2	1
C	2	2	2 ·
D	2	1	2

23 A suggested mechanism for the reaction

$$2A + B \rightarrow A_2B$$

is a two-step process

$$A + B \rightarrow AB \text{ (slow)}$$
$$AB + A \rightarrow A_2B \text{ (fast)}$$
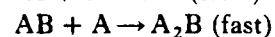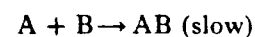
This mechanism is consistent with the rate expression

A   rate $= k[A]^2[B]$

B   rate $= k[A][B]$

C   rate $= k[A][AB]$

D   rate $= k[AB]$

24 For the reaction

$$(CH_3)_3CI(g) \rightarrow (CH_3)_2C{=}CH_2(g) + HI(g)$$
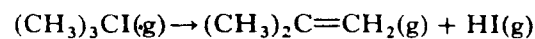
the rate $= k[(CH_3)_3CI]$

If all concentrations are in $mol\,l^{-1}$, the units of k will be

A s^{-1}

B $mol\,l^{-1}s^{-1}$

C $l\,mol^{-1}s^{-1}$

D $l^2\,mol^{-2}s^{-1}$

25 Various experiments are carried out to study the kinetics of the reaction $X + 2Y \rightarrow$ Products. The boxes in the grid below contain possible graphs of the results.
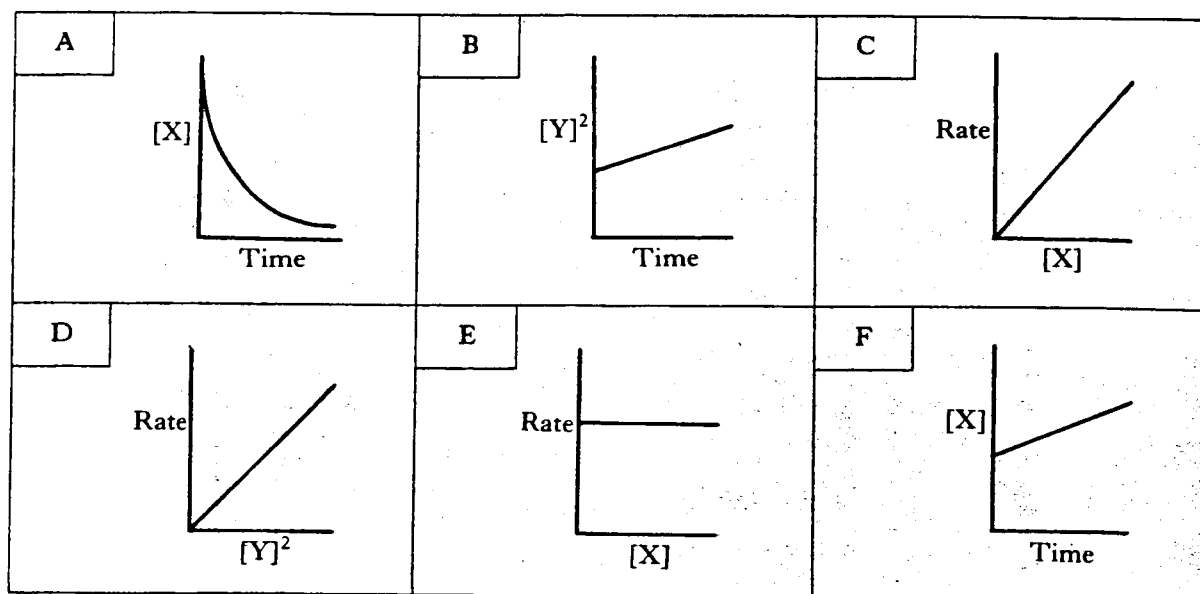
Identify

(a)   the graph(s) which would be obtained if the **overall** rate expression was

$$Rate = k[Y]^2.$$

(b)   the graph(s) which would be obtained if the mechanism for the reaction was

$$X + Y \rightarrow XY \qquad \text{(slow)}$$
$$XY + Y \rightarrow \text{Products} \quad \text{(fast)}.$$

(c)   the graph(s) which would be obtained from a zero order reaction.

Advanced Higher

Unit 2f — Kinetics

1	A
2	C
3	B
4	C
5	B
6	B
7	C
8	A
9	A
10	D
11	B
12	D

13	D
14	D
15	C
16	A
17	C
18	D
19	A
20	B
21	C
22	D
23	B
24	A

25 a. A a D   (2×1)

    b. C a A   (2×1)

    c. E   (1)