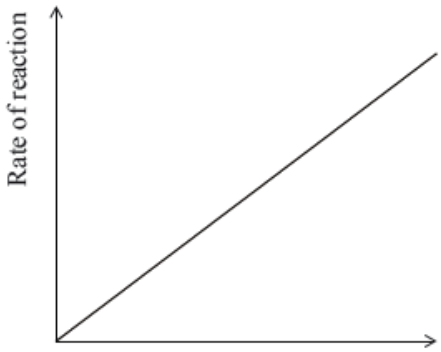
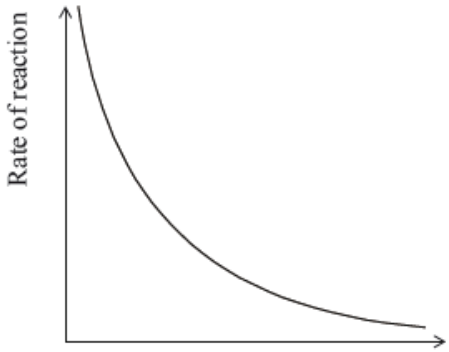
# HL Paper 1

Which graph represents a reaction that is first order with respect to reactant A.

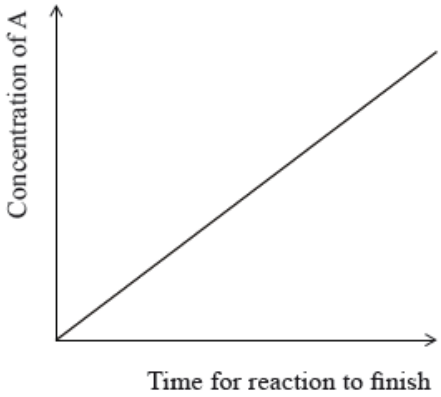
A.



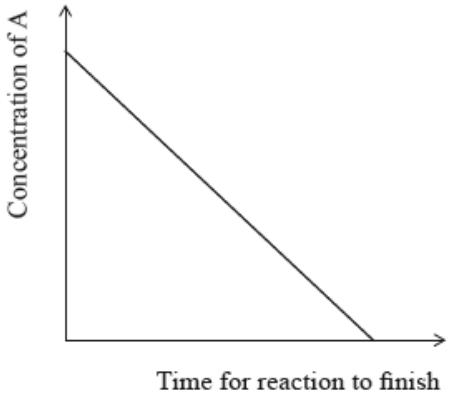

B.




C.




D.




# Markscheme

A

# Examiners report

[N/A]

Which is correct about reaction mechanisms?

A. A species that is zero order does not take part in the reaction.

B. A catalyst does not take part in the reaction.

C. Reactants in a fast step before the slow step are included in the rate expression.

D. Reactants in a fast step after the slow step are included in the rate expression.

# Markscheme

C

# Examiners report

[N/A]

---

What are correct labels for the Maxwell–Boltzmann energy distribution curves?

| | $x$-axis | $y$-axis |
|---|---|---|
| A. | progress of reaction | energy |
| B. | energy | progress of reaction |
| C. | probability density | kinetic energy |
| D. | kinetic energy | probability density |

# Markscheme

D

# Examiners report

[N/A]

---

What are the units of the rate constant for a zero-order reaction?

A. s

B. $\mathrm{s^{-1}}$

C. $\mathrm{mol^{-1}\,dm^{3}\,s^{-1}}$

D. $\mathrm{mol\,dm^{-3}\,s^{-1}}$

# Markscheme

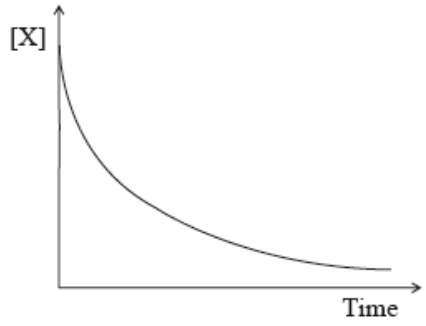
D

# Examiners report

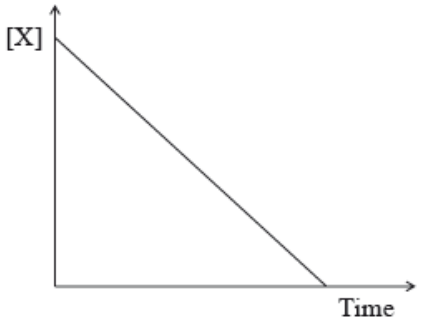
Over 34% confused the units with those of a first order reaction.

Which graph represents a reaction that is second order with respect to X for the reaction X $\rightarrow$ products?

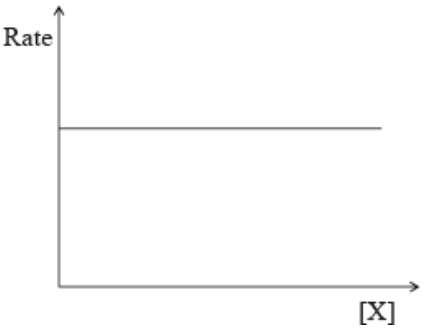
A.



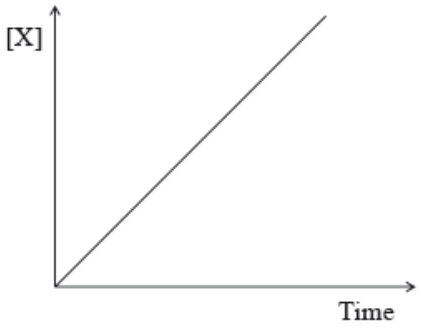

B.




C.




D.




# Markscheme

A

# Examiners report

One respondent stated that the graph in A looks more like a first order reaction than a second order reaction. In this question, C is ruled out as the rate-concentration plot would represent a clear zero-order reaction. B is also ruled out as a zero-order reaction will involve a straight line. D is also a straight line. Hence, by a process of elimination A must be the answer, as a second-order reaction will involve a curve for a concentration-time plot. It is true to say that a first-order reaction will also involve a curve for a concentration-time plot. In fact a first-order concentration-time curve is an exponential curve and a second-order concentration-time curve is a quadratic curve, which appears somewhat to have greater depth if the two are compared. It can be difficult to distinguish the two plots in fact based on experimental data, but this was not an issue for this question as second order was clearly mentioned in the question and B, C and D could be eliminated also. The question in fact was the fourth easiest question on the paper for candidates, with 86.42% of candidates getting the correct answer A.

---

The following experimental rate data were obtained for a reaction carried out at temperature *T*.

$$\mathrm{A(g) + B(g) \rightarrow C(g) + D(g)}$$

| Initial [A(g)] / mol dm$^{-3}$ | Initial [B(g)] / mol dm$^{-3}$ | Initial rate / mol dm$^{-3}$ s$^{-1}$ |
|---|---|---|
| $3.00\times10^{-1}$ | $2.00\times10^{-1}$ | $1.89\times10^{-2}$ |
| $3.00\times10^{-1}$ | $4.00\times10^{-1}$ | $1.89\times10^{-2}$ |
| $6.00\times10^{-1}$ | $4.00\times10^{-1}$ | $7.56\times10^{-2}$ |

What are the orders with respect to A(g) and B(g)?

| | Order with respect to A(g) | Order with respect to B(g) |
|---|---|---|
| A. | zero | second |
| B. | first | zero |
| C. | second | zero |
| D. | second | first |

# Markscheme

C

# Examiners report

[N/A]

---

Consider the following reaction.

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

A proposed reaction mechanism is:

$$\begin{aligned} &NO(g) + NO(g) \rightleftharpoons N_2O_2(g) && fast \\ &N_2O_2(g) + H_2(g) \rightarrow N_2O(g) + H_2O(g) && slow \\ &N_2O(g) + H_2(g) \rightarrow N_2(g) + H_2O(g) && fast \end{aligned}$$

What is the rate expression?

A. $\text{rate} = k[H_2][NO]^2$

B. $\text{rate} = k[N_2O_2][H_2]$

C. $\text{rate} = k[NO]^2[H_2]^2$

D. $\text{rate} = k[NO]^2[N_2O_2]^2[H_2]$

# Markscheme

A

# Examiners report

There were three G2 comments on this question. Two of these comments stated the question was very difficult and one comment stated that the first step should have had an equilibrium sign which is correct. The question itself was answered correctly by only 46.28% and was the third most difficult question on the entire paper.

---

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

$$\mathrm{Br_2(g) + 2NO(g) \rightarrow 2NOBr(g)}$$

Which rate equation is consistent with the experimental data?

| $[\mathrm{Br_2}]$ / mol $\mathrm{dm^{-3}}$ | [NO] / mol $\mathrm{dm^{-3}}$ | Rate / mol $\mathrm{dm^{-3}s^{-1}}$ |
|---|---|---|
| 0.10 | 0.10 | $1.0\times10^{-6}$ |
| 0.20 | 0.10 | $4.0\times10^{-6}$ |
| 0.20 | 0.40 | $4.0\times10^{-6}$ |

A. $\mathrm{rate} = k[\mathrm{Br_2}]^2[\mathrm{NO}]$

B. $\mathrm{rate} = k[\mathrm{Br_2}][\mathrm{NO}]^2$

C. $\mathrm{rate} = k[\mathrm{Br_2}]^2$

D. $\mathrm{rate} = k[\mathrm{NO}]^2$

# Markscheme

C

# Examiners report

[N/A]

---

Consider the following reaction.

$$\mathrm{5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)}$$

The rate expression for the reaction is found to be:

$$\mathrm{rate} = k[\mathrm{Br^-}][\mathrm{BrO_3^-}][\mathrm{H^+}]^2$$

Which statement is correct?

A. The overall order is 12.

B. Doubling the concentration of all of the reactants at the same time would increase the rate of the reaction by a factor of 16.

C. The units of the rate constant, $k$, are $\mathrm{mol\,dm^{-3}s^{-1}}$.

D. A change in concentration of $\mathrm{Br^-}$ or $\mathrm{BrO_3^-}$ does not affect the rate of the reaction.

# Markscheme

B

# Examiners report

[N/A]

---

The activation energy of a reaction may be determined by studying the effect of a particular variable on the reaction rate. Which variable must be changed?

A. pH

B. Concentration

C. Surface area

D. Temperature

# Markscheme

D

# Examiners report

[N/A]

---

Which statement about a reaction best describes the relationship between the temperature, $T$, and the rate constant, $k$?

A. As $T$ increases, $k$ decreases linearly.

B. As $T$ increases, $k$ decreases non-linearly.

C. As $T$ increases, $k$ increases linearly.

D. As $T$ increases, $k$ increases non-linearly.

# Markscheme

D

# Examiners report

[N/A]

---

Which step is the rate-determining step of a reaction?

A. The step with the lowest activation energy

B. The final step

C. The step with the highest activation energy

D. The first step

# Markscheme

C

# Examiners report

[N/A]

---

Consider the following proposed two-step reaction mechanism at temperature T.

Step 1: $2\mathrm{NO_2(g)} \xrightarrow{k_1} \mathrm{NO(g)} + \mathrm{NO_3(g)}$ *Slow*

Step 2: $\mathrm{NO_3(g)} + \mathrm{CO(g)} \xrightarrow{k_2} \mathrm{NO_2(g)} + \mathrm{CO_2(g)}$ *Fast*

Which statements are correct?

I. The overall reaction is $\mathrm{NO_2(g)} + \mathrm{CO(g)} \rightarrow \mathrm{NO(g)} + \mathrm{CO_2(g)}$.

II. Step 1 is the rate-determining step of the reaction.

III. The rate expression for Step 1 is rate $= k_1[\mathrm{NO_2}]^2$.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

# Markscheme

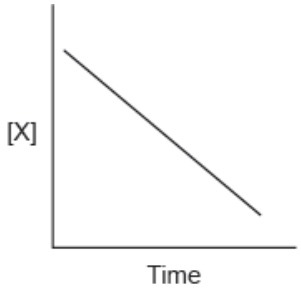
D

# Examiners report

This was reported to be “demanding (makes them think) but good”. It was the sixth hardest question with 63% scoring correctly. The most common error was not to recognize that the overall reaction equation is correct.

---

When X reacts with Y to give Z, the following graph is plotted. What can be deduced from the graph?




A. The concentration of X is directly proportional to time.

B. The reaction is first order overall.

C. The reaction is zero order with respect to X.

D. The reaction is first order with respect to X.

# Markscheme

C

# Examiners report

[N/A]

---

Which of the terms in the Arrhenius equation takes into account the orientation of the molecules?

$$k = Ae^{\frac{-E_a}{RT}}$$

A. *A*
B. $E_a$
C. *R*
D. *T*

# Markscheme

A

# Examiners report

[N/A]

---

Which combination shows a second-order rate expression with the correct rate constant units?

| | Rate expression | $k$ units |
|---|---|---|
| A. | rate $= k[NH_3][BF_3]$ | $mol\,dm^{-3}\,s^{-1}$ |
| B. | rate $= k[N_2O_5]$ | $s^{-1}$ |
| C. | rate $= k[N_2O_5]$ | $dm^3\,mol^{-1}\,s^{-1}$ |
| D. | rate $= k[CH_3COCH_3][H^+][I_2]^0$ | $dm^3\,mol^{-1}\,s^{-1}$ |

# Markscheme

D

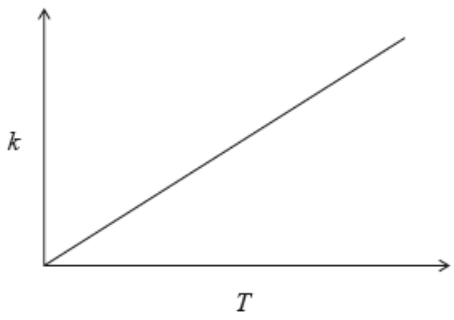
# Examiners report

[N/A]

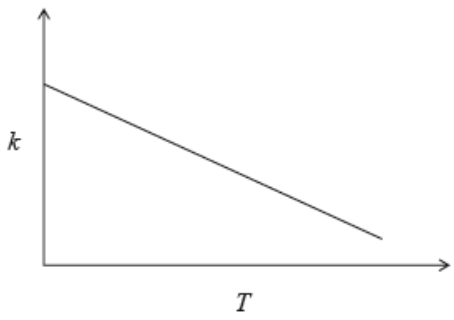
---

The rate constant for a reaction is determined at different temperatures. Which diagram represents the relationship between the rate constant, $k$ , and temperature, $T$ , in K ?

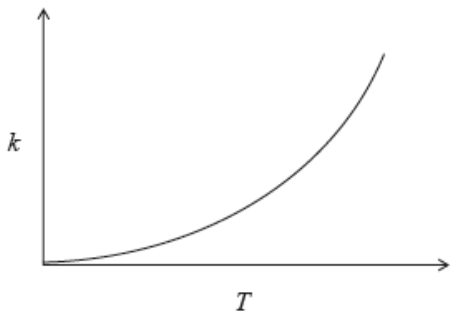
A.



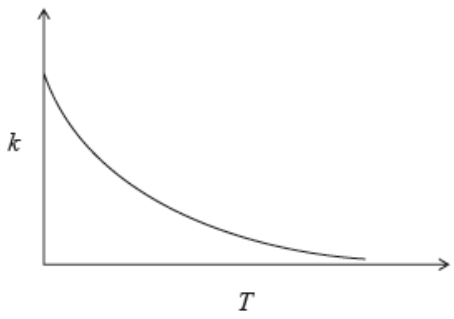

B.




C.




D.




# Markscheme

C

# Examiners report

This question could be answered if students knew that the relationship between $k$ and $T$ is exponential (as stated in A.S. 16.3.1), but it was not necessary that students recalled the Arrhenius equation. Candidates found the question difficult, having only 46% correct answers.

---

Consider the following reaction between nitrogen monoxide and oxygen.

$$2\mathrm{NO(g)} + \mathrm{O_2(g)} \rightarrow 2\mathrm{NO_2(g)}$$

The reaction occurs in two steps:

Step 1: $\mathrm{NO(g)} + \mathrm{NO(g)} \rightleftharpoons \mathrm{N_2O_2(g)}$ *fast*

Step 2: $\mathrm{N_2O_2(g)} + \mathrm{O_2(g)} \rightarrow 2\mathrm{NO_2(g)}$ *slow*

What is the rate expression for this reaction?

A. Rate $= k[\mathrm{NO}]^2$

B. Rate $= k[\mathrm{NO}][\mathrm{O_2}]$

C. Rate $= k[\mathrm{NO}]^2[\mathrm{O_2}]$

D. Rate $= k[\mathrm{NO}][\mathrm{O_2}]^2$

# Markscheme

C

# Examiners report

There were two comments. One suggested a “quantum change in difficulty” and the other commented that “students are not normally taught how to eliminate the intermediate from the rate expression for the slow step”. In the event, 82.71% of the candidates scored correctly, the sixth “easiest” question on the paper.

---

Which statement is correct?

A. The value of the rate constant, *k*, is independent of temperature and is deduced from the equilibrium constant, $K_c$.

B. The value of the rate constant, *k*, is independent of temperature and the overall reaction order determines its units.

C. The value of the rate constant, *k*, is temperature dependent and is deduced from the equilibrium constant, $K_c$.

D. The value of the rate constant, *k*, is temperature dependent and the overall reaction order determines its units.

# Markscheme

D

# Examiners report

[N/A]

---

Consider the following reaction mechanism.

$$\begin{array}{lll} \text{Step 1} & \mathrm{H_2O_2 + I^- \rightarrow H_2O + IO^-} & \text{slow} \\ \text{Step 2} & \mathrm{H_2O_2 + IO^- \rightarrow H_2O + O_2 + I^-} & \text{fast} \end{array}$$

Which statement correctly identifies the rate-determining step and the explanation?

A. Step 2 because it is the faster step

B. Step 1 because it is the slower step

C. Step 1 because it is the first step

D. Step 2 because it is the last step

# Markscheme

B

# Examiners report

[N/A]

---

What are the units for the rate constant, *k*, in the expression?

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

A. mol$^2$ dm$^{-6}$ s$^{-1}$

B. mol$^{-1}$ dm$^3$ s$^{-1}$

C. mol dm$^{-3}$ s$^{-1}$

D. mol$^{-2}$ dm$^6$ s$^{-1}$

# Markscheme

D

# Examiners report

[N/A]

---

Consider the following reaction.

$$\mathrm{2P + Q \rightarrow R + S}$$

This reaction occurs according to the following mechanism.

$$\begin{aligned} \mathrm{P} + \mathrm{Q} &\rightarrow \mathrm{X} \quad && slow \\ \mathrm{P} + \mathrm{X} &\rightarrow \mathrm{R} + \mathrm{S} \quad && fast \end{aligned}$$

What is the rate expression?

A. rate $= k[\mathrm{P}]$

B. rate $= k[\mathrm{P}][\mathrm{X}]$

C. rate $= k[\mathrm{P}][\mathrm{Q}]$

D. rate $= k[\mathrm{P}]^2[\mathrm{Q}]$

# Markscheme

C

# Examiners report

[N/A]

---

What is the effect of increasing temperature on the rate constant, *k*?

A. The rate constant does not change.

B. The rate constant decreases linearly.

C. The rate constant increases exponentially.

D. The rate constant increases proportionally with temperature.

# Markscheme

C

# Examiners report

[N/A]

---

What happens when the temperature of a reaction increases?

A. The activation energy increases.

B. The rate constant increases.

C. The enthalpy change increases.

D. The order of the reaction increases.

# Markscheme

B

# Examiners report

[N/A]

---

For the gas phase reaction:

$$\mathrm{A(g)} + \mathrm{B(g)} \rightarrow \mathrm{C(g)}$$

the experimentally determined rate expression is: rate $= k[\mathrm{A}][\mathrm{B}]^2$

By what factor will the rate change if the concentration of A is tripled and the concentration of B is halved?

A. 0.75

B. 1.5

C. 6

D. 12

# Markscheme

A

# Examiners report

[N/A]

---

Carbon monoxide and nitrogen dioxide react to form carbon dioxide and nitrogen monoxide according to the following equation.

$$\mathrm{CO(g)} + \mathrm{NO_2(g)} \rightarrow \mathrm{CO_2(g)} + \mathrm{NO(g)}$$

The reaction occurs in a series of steps. The equation for the rate-determining step is given below.

$\mathrm{2NO_2(g)} \rightarrow \mathrm{NO_3(g)} + \mathrm{NO(g)}$

What is the rate expression for this reaction?

A. rate $= k[\mathrm{CO(g)}][\mathrm{NO_2(g)}]$

B. rate $= k[\mathrm{NO_2(g)}]^2$

C. rate $= k[\mathrm{NO_3(g)}][\mathrm{NO(g)}]$

D. rate $= k[\mathrm{CO_2(g)}][\mathrm{NO(g)}]$

# Markscheme

B

# Examiners report

[N/A]

---

Which is true of an Arrhenius plot of $\ln k$ (*y*-axis) against $\frac{1}{T}$?

A. The graph goes through the origin.

B. The activation energy can be determined from the gradient.

C. The intercept on the *x*-axis is the activation energy.

D. The intercept on the *y*-axis is the frequency factor, A.

# Markscheme

B

# Examiners report

[N/A]

---

The rate expression for a reaction is:

$$\text{rate} = k[\text{X}][\text{Y}]$$

Which statement is correct?

A. As the temperature increases the rate constant decreases.

B. The rate constant increases with increased temperature but eventually reaches a constant value.

C. As the temperature increases the rate constant increases.

D. The rate constant is not affected by a change in temperature.

# Markscheme

C

# Examiners report

[N/A]

---

Which statement describes the characteristics of a transition state relative to the potential energy of the reactants and products?

A. It is an unstable species with lower potential energy.

B. It is an unstable species with higher potential energy.

C. It is a stable species with lower potential energy.

D. It is a stable species with higher potential energy.

# Markscheme

B

# Examiners report

[N/A]

---

The following data were obtained for the reaction between gases A and B.

| Experiment | Initial [A] / mol dm$^{-3}$ | Initial [B] / mol dm$^{-3}$ | Initial rate / mol dm$^{-3}$ min$^{-1}$ |
|---|---|---|---|
| 1 | $1.0\times10^{-3}$ | $1.0\times10^{-3}$ | $2.0\times10^{-4}$ |
| 2 | $2.0\times10^{-3}$ | $1.0\times10^{-3}$ | $2.0\times10^{-4}$ |
| 3 | $2.0\times10^{-3}$ | $2.0\times10^{-3}$ | $4.0\times10^{-4}$ |

Which relationship represents the rate expression for the reaction?

A. $\text{rate} = k[\text{B}]^2$

B. $\text{rate} = k[\text{A}]^2$

C. $\text{rate} = k[\text{A}]$

D. $\text{rate} = k[\text{B}]$

# Markscheme

D

# Examiners report

[N/A]

---

Which is the first step in the CFC-catalysed destruction of ozone in UV light?

A. $CCl_2F_2 \rightarrow CClF_2^+ + Cl^-$

B. $CCl_2F_2 \rightarrow \bullet CClF_2 + Cl\bullet$

C. $CCl_2F_2 \rightarrow CCl_2F^+ + F^-$

D. $CCl_2F_2 \rightarrow \bullet CCl_2F + F\bullet$

# Markscheme

B

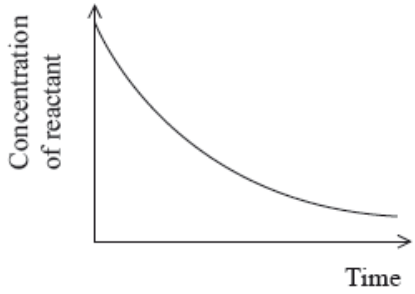
# Examiners report

[N/A]

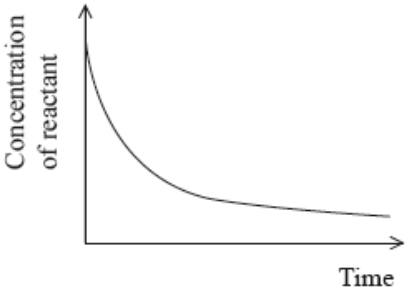
---

Which graph best represents a second-order reaction?

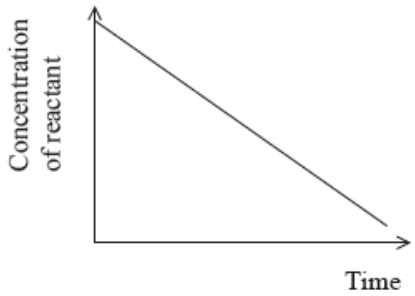
A.



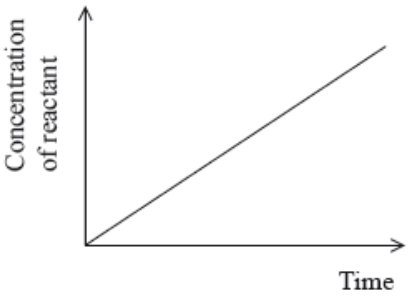

B.




C.




D.




# Markscheme

B

# Examiners report

One respondent stated that graphs A and B look too similar so students might not be able to clearly see that the answer is B. The initial gradient of curve B is clearly greater so candidates should have recognized the faster decrease in initial concentration for a second order reaction. Curve A clearly shows a constant half-life so candidates should have recognized that it refers to a first order reaction. 60.65% of the candidates chose the correct answer B.

---

Consider the rate expression:

$$\text{Rate} = k[\text{X}][\text{Y}]$$

Which change decreases the value of the rate constant, $k$?

A. Increase in the reaction temperature

B. Decrease in the reaction temperature

C. Increase in the concentration of X and Y

D. Decrease in the concentration of X and Y

# Markscheme

B

# Examiners report

[N/A]

---

The rate expression for the reaction X (g) + 2Y (g) → 3Z (g) is

$$\text{rate} = k[\text{X}]^0\,[\text{Y}]^2$$

By which factor will the rate of reaction increase when the concentrations of X and Y are both increased by a factor of 3?

A. 6

B. 9

C. 18

D. 27

# Markscheme

B

# Examiners report

[N/A]

---

The table gives rate data for the reaction in a suitable solvent.

$$C_4H_9Br + OH^- \rightarrow C_4H_9OH + Br^-$$

| Initial $[C_4H_9Br]$ / mol $dm^{-3}$ | Initial $[OH^-]$ / mol $dm^{-3}$ | Initial rate of reaction / mol $dm^{-3}$ $s^{-1}$ |
|---|---|---|
| 0.02 | 0.02 | $2.0 \times 10^{-3}$ |
| 0.04 | 0.02 | $4.0 \times 10^{-3}$ |
| 0.02 | 0.04 | $2.0 \times 10^{-3}$ |
| 0.04 | 0.04 | $4.0 \times 10^{-3}$ |

Which statement is correct?

A. The rate expression is rate = $k$ $[C_4H_9Br]$ $[OH^-]$.

B. The rate increases by a factor of 4 when the $[OH^-]$ is doubled.

C. $C_4H_9Br$ is a primary halogenoalkane.

D. The reaction occurs via $S_N1$ mechanism.

# Markscheme

D

# Examiners report

[N/A]

---

Which pair of statements explains the increase in rate of reaction when the temperature is increased or a catalyst is added?

| | Increasing temperature | Adding a catalyst |
|---|---|---|
| A. | average kinetic energy of particles increases | activation energy increases |
| B. | enthalpy change of reaction decreases | average kinetic energy of particles increases |
| C. | average kinetic energy of particles increases | activation energy decreases |
| D. | activation energy increases | enthalpy change of reaction decreases |

# Markscheme

C

# Examiners report

[N/A]

---

X and Y react according to the equation $2\mathrm{X} + \mathrm{Y} \rightarrow \mathrm{Z}$. The reaction can be described by the following mechanism:

$\mathrm{X} + \mathrm{X} \rightarrow \mathrm{X_2}$ slow

$\mathrm{X_2} + \mathrm{Y} \rightarrow \mathrm{Z}$ fast

What is the order of the reaction with respect to X and Y?

| | X | Y |
|---|---|---|
| A. | First | Zero |
| B. | First | First |
| C. | Second | Zero |
| D. | Second | First |

# Markscheme

C

# Examiners report

[N/A]

---

What happens to the rate constant, *k*, and the activation energy, $E_\mathrm{a}$, as the temperature of a chemical reaction is increased?

| | Value of *k* | Value of $E_\mathrm{a}$ |
|---|---|---|
| A. | increases | increases |
| B. | unchanged | increases |
| C. | decreases | unchanged |
| D. | increases | unchanged |

# Markscheme

D

# Examiners report

[N/A]

---

The hydrolysis of tertiary bromoalkanes with a warm dilute aqueous sodium hydroxide solution proceeds by a two-step $\mathrm{S_N1}$ mechanism.

Step I: $\mathrm{R-Br} \rightarrow \mathrm{R^+Br^-}$

Step II: $\mathrm{R^+ + OH^- \rightarrow R - OH}$

Which description of this reaction is consistent with the above information?

| | Step I | Step II | Rate expression |
|---|---|---|---|
| A. | fast | slow | rate = $k$[R–Br] |
| B. | slow | fast | rate = $k$[R–Br] |
| C. | fast | slow | rate = $k$[R–Br][$OH^-$] |
| D. | slow | fast | rate = $k$[R–Br][$OH^-$] |

# Markscheme

B

# Examiners report

[N/A]

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Which statement about a first-order reaction is correct?

A. The reactant concentration decreases linearly with time.

B. The reactant concentration decreases exponentially with time.

C. The rate of reaction remains constant as the reaction proceeds.

D. The rate of reaction increases exponentially as the reaction proceeds.

# Markscheme

B

# Examiners report

Students found this question to be somewhat difficult with 42.15% correct answers. However, almost 40% of the candidates chose A, namely that for a first-order reaction, the reactant concentration decreases linearly with time (rather than exponentially); this suggests the importance of reading the statements more thoroughly.

---

The rate information below was obtained for the following reaction at a constant temperature.

$$\mathrm{2NO_2(g) + F_2(g) \rightarrow 2NO_2F(g)}$$

| $[NO_2]$ / mol dm$^{-3}$ | $[F_2]$ / mol dm$^{-3}$ | Rate / mol dm$^{-3}$ s$^{-1}$ |
|---|---|---|
| $2.0\times10^{-3}$ | $1.0\times10^{-2}$ | $4.0\times10^{-4}$ |
| $4.0\times10^{-3}$ | $1.0\times10^{-2}$ | $8.0\times10^{-4}$ |
| $4.0\times10^{-3}$ | $2.0\times10^{-2}$ | $1.6\times10^{-3}$ |

What are the orders of the reaction with respect to $NO_2$ and $F_2$?

A. $NO_2$ is first order and $F_2$ is second order

B. $NO_2$ is second order and $F_2$ is first order

C. $NO_2$ is first order and $F_2$ is first order

D. $NO_2$ is second order and $F_2$ is second order

# Markscheme

C.

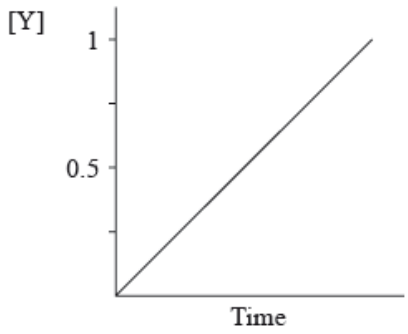
# Examiners report

[N/A]

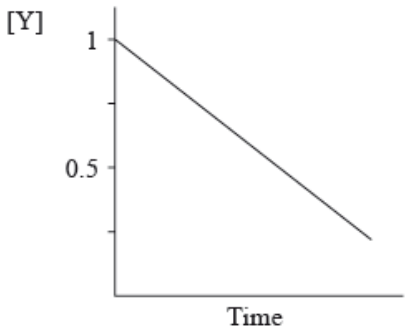
---

Experimental data shows that a reaction in which Y is a reactant is first order with respect to Y. Which graph shows this first-order relationship?

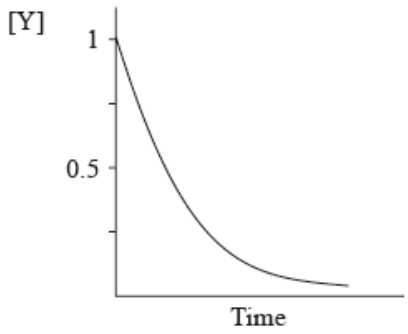
A.



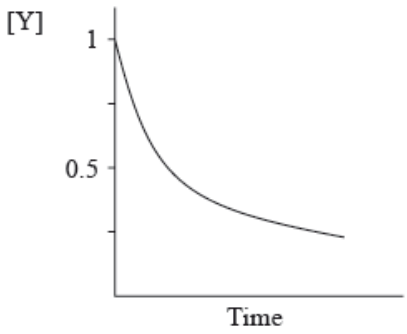

B.




C.




D.




# Markscheme

C

# Examiners report

The graph in C showed a constant *half-life* and so represented a 1st order relationship.

---

The reaction between $NO_2$ and $F_2$ gives the following rate data at a certain temperature.

| $[NO_2]$ / mol dm$^{-3}$ | $[F_2]$ / mol dm$^{-3}$ | Rate / mol dm$^{-3}$ min$^{-1}$ |
|---|---|---|
| 0.15 | 0.20 | 0.10 |
| 0.30 | 0.20 | 0.40 |
| 0.15 | 0.40 | 0.20 |

What is the overall order of reaction?

A. 3

B. 2

C. 1

D. 0

# Markscheme

A

# Examiners report

[N/A]

---

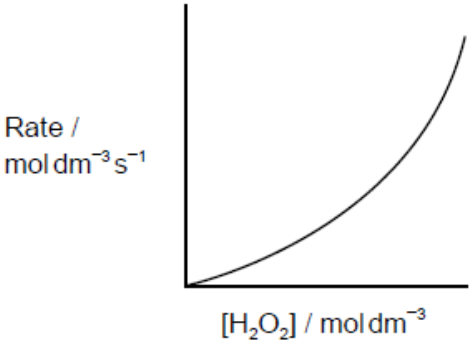
Decomposition of hydrogen peroxide in an aqueous solution proceeds as follows.

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

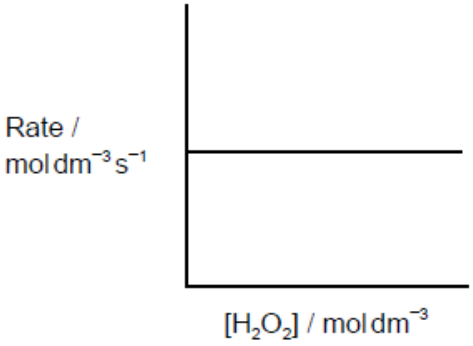
The rate expression for the reaction was found to be: rate = $k$ $[H_2O_2]$.

Which graph is consistent with the given rate expression?

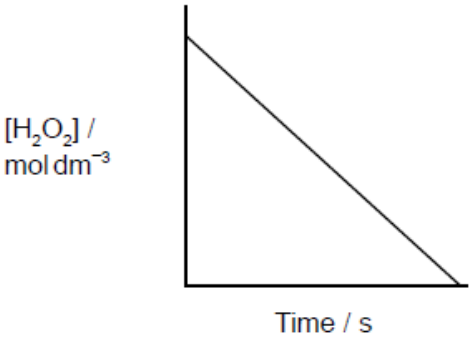
A.



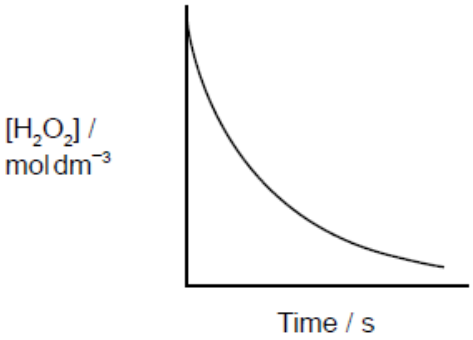

B.




C.




D.




# Markscheme

D

# Examiners report

[N/A]

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The data shows the effect of changing reactant concentrations on the rate of the following reaction at 25°C.

$$F_2\,(g) + 2ClO_2\,(g) \rightarrow 2FClO_2\,(g)$$

| Initial [$F_2$(g)] / mol dm$^{-3}$ | Initial [$ClO_2$(g)] / mol dm$^{-3}$ | Initial rate of reaction / mol dm$^{-3}$ s$^{-1}$ |
|---|---|---|
| 0.100 | 0.010 | $1.20 \times 10^{-3}$ |
| 0.100 | 0.030 | $3.60 \times 10^{-3}$ |
| 0.150 | 0.010 | $1.80 \times 10^{-3}$ |

Which is correct for the order of reaction with respect to the fluorine concentration and the overall order of reaction?

# Markscheme

D

| | Order with respect to $[F_2(g)]$ | Overall order |
|---|---|---|
| A. | 2 | 1 |
| B. | 2 | 2 |
| C. | 1 | 1 |
| D. | 1 | 2 |

# Examiners report

[N/A]

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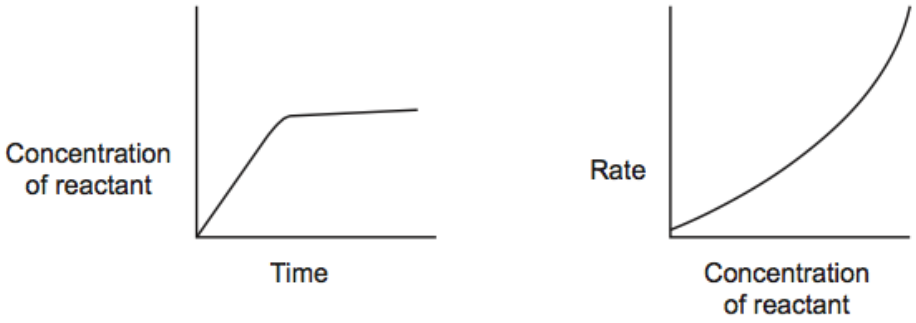
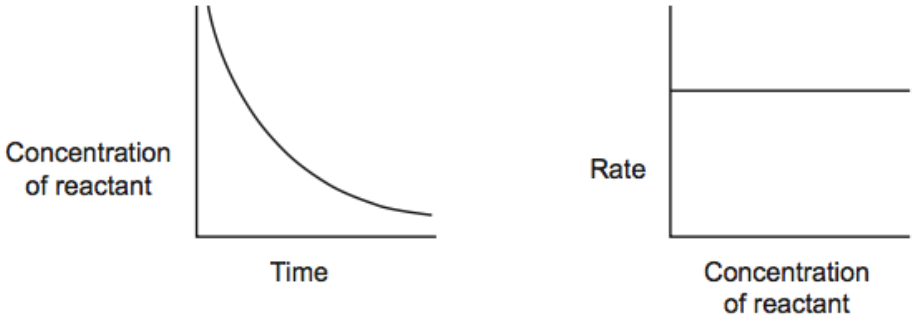
Which pair of graphs represents the same order of reaction?

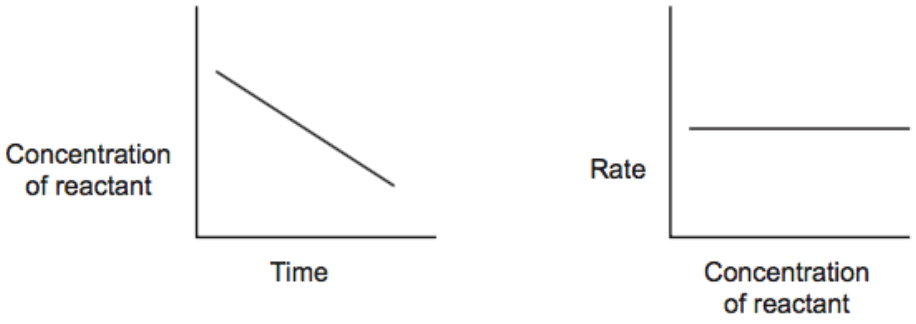
A.



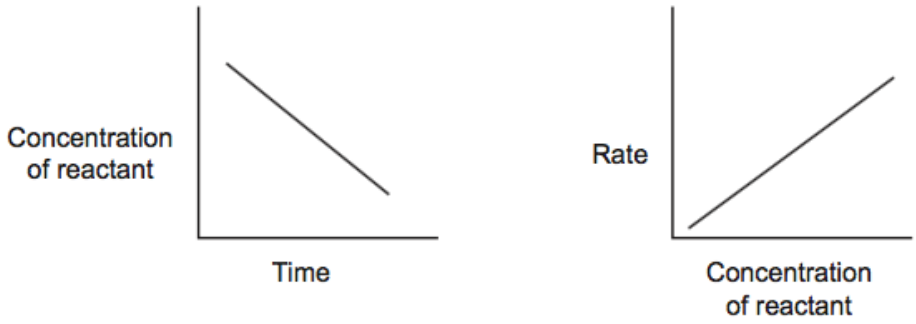

B.




C.



D.




# Markscheme

C

# Examiners report

[N/A]