

APOLLO

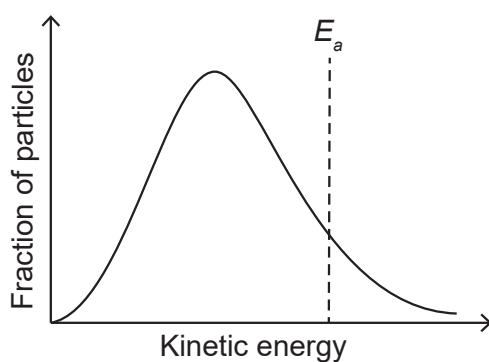
How fast? The rate of chemical change SL

Chemistry

First assessment 2025

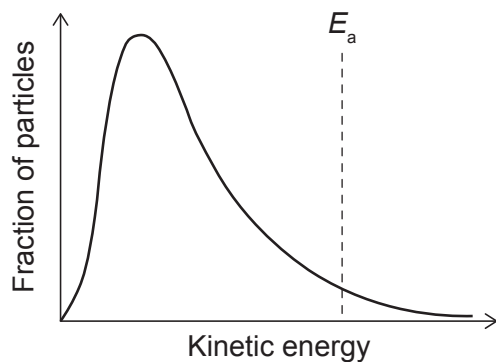
15 questions | questions

22. Consider the following Maxwell–Boltzmann energy distribution at a certain temperature.

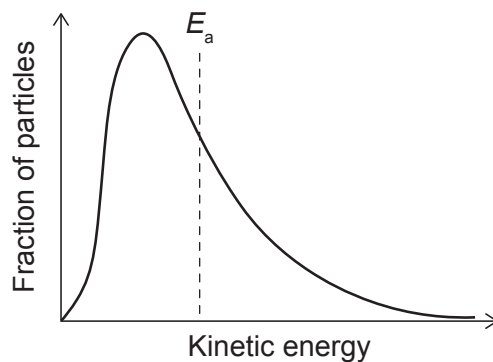


Which represents the distribution and value of activation energy at a lower temperature?

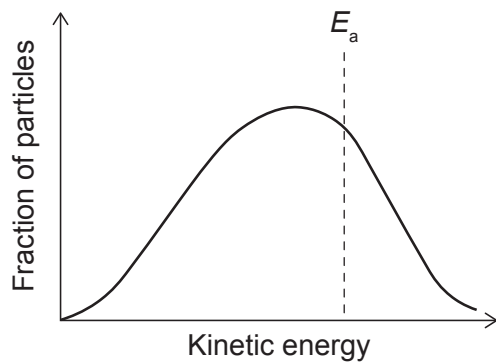
A.



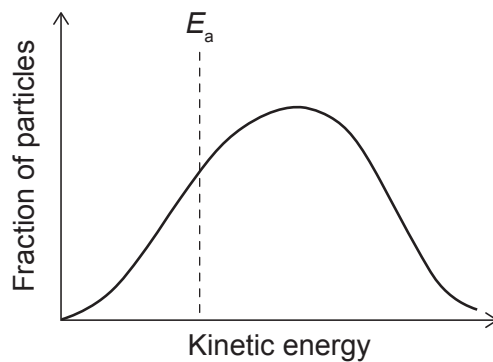
B.



C.

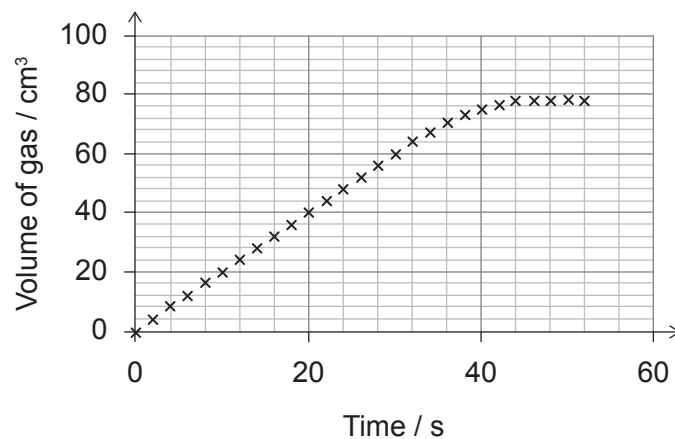


D.



Turn over

23. The volume of gas produced in a kinetics experiment is plotted against time.



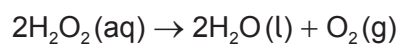
What is the average rate of gas production for the first 20 seconds?

- A. $2.0 \text{ cm}^3 \text{ s}^{-1}$
- B. $1.5 \text{ cm}^3 \text{ s}^{-1}$
- C. $1.0 \text{ cm}^3 \text{ s}^{-1}$
- D. $0.5 \text{ cm}^3 \text{ s}^{-1}$

19. Which are units for rate of reaction?

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

20. Which changes increase the rate of the reaction?



- I. Introducing a catalyst
 - II. Increasing concentration of $\text{H}_2\text{O}_2(\text{aq})$
 - III. Increasing pressure
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

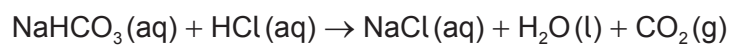
21. Why does rate of reaction increase with temperature?

- A. A higher proportion of collisions have the proper orientation
- B. A higher proportion of collisions have sufficient energy
- C. Activation energy decreases
- D. Activation energy increases

— 10 —

Turn over
2220-0210

19. Which apparatus can be used to monitor the progress of this reaction?



- I. A pH meter
 - II. A gas syringe
 - III. A colorimeter
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

Section B

Answer **all** questions. Answers must be written within the answer boxes provided.

2. In a separate experiment, the rate of a reaction was studied using colorimetry. During the reaction, the mixture changed colour from orange to green.

Before the investigation could be carried out, it was necessary to construct a calibration curve for the colorimeter.

- (a) Describe how a standard aqueous solution can be prepared.

[3]

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- (b) Describe how this solution can be used to construct a calibration curve.

[3]

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- (c) Explain how this curve can be used to determine the unknown concentration.

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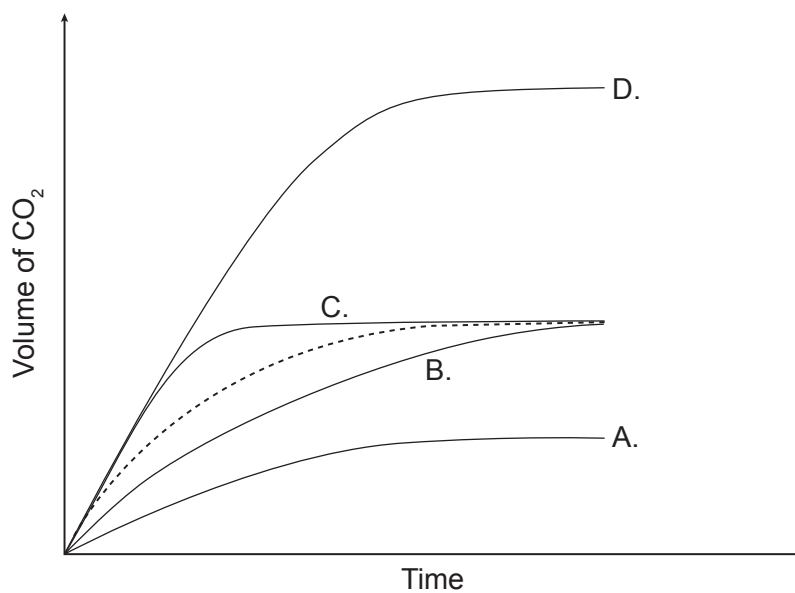
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- 22.** The dotted line represents the volume of carbon dioxide evolved when excess calcium carbonate is added into 100 cm^3 of 1.0 mol dm^{-3} of hydrochloric acid.

Which graph represents the production of carbon dioxide when excess calcium carbonate is added to the 200 cm^3 of 0.25 mol dm^{-3} of hydrochloric acid?



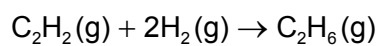
23. Which reaction has the lowest activation energy?

- A. $\text{Cl}_2(\text{g}) \rightarrow 2\text{Cl}(\text{g})$
- B. $\text{HCl}(\text{g}) \rightarrow \text{H}(\text{g}) + \text{Cl}(\text{g})$
- C. $\text{HCl}(\text{g}) \rightarrow \text{H}^+(\text{g}) + \text{Cl}^-(\text{g})$
- D. $2\text{H}(\text{g}) \rightarrow \text{H}_2(\text{g})$

— 10 —

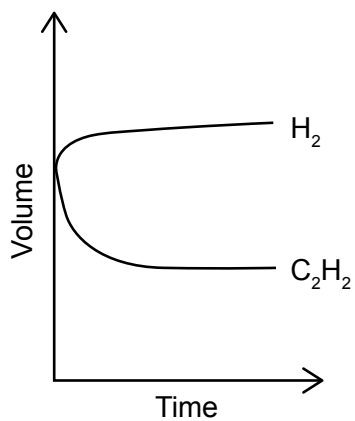
Turn over
0020-0210

19. The volume of ethyne as it reacts with hydrogen is shown in the graphs.

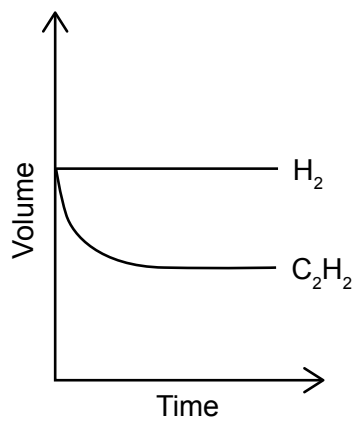


Which graph shows how the volume of hydrogen changes with time?

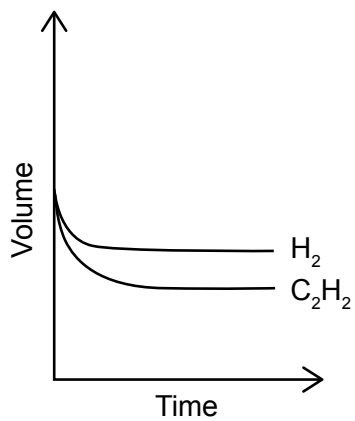
A.



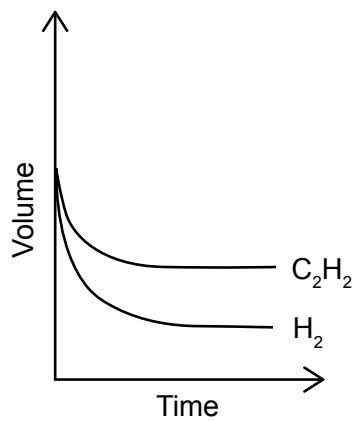
B.



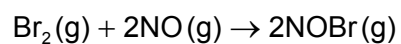
C.



D.



20. Which conditions would increase the rate of reaction between bromine and nitrogen(II) oxide?



- I. Increasing temperature
 - II. Increasing pressure
 - III. Increasing volume
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

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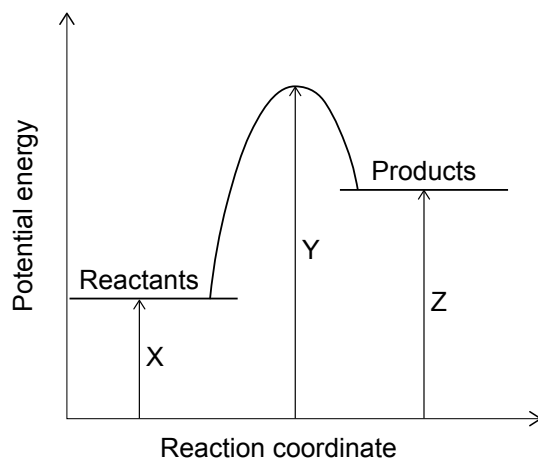
Turn over

0020-0222

21. Which statement about catalysts is correct?

- A. Catalysts increase the kinetic energy of reacting particles.
- B. Catalysts affect endothermic reactions more than exothermic reactions.
- C. Catalysts increase reaction rate and are used up in a reaction.
- D. Catalysts alter the mechanism of a reaction.

22. The diagram shows the energy profile of a reaction.



Which combination is correct?

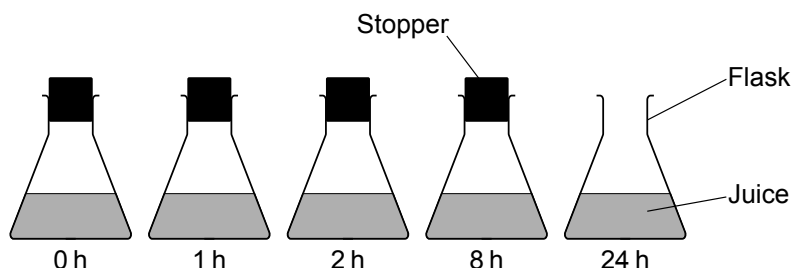
	Activation energy of forward reaction	Activation energy of reverse reaction
A.	X	Z
B.	$Y - X$	$Y - Z$
C.	Y	Y
D.	$Y - X$	$Z - X$

- 23.** What is the main reason for an increase in rate of reaction when the temperature is raised?
- A. A greater proportion of collisions are successful.
 - B. Particles collide more frequently.
 - C. The bonds in the reactants are weakened.
 - D. The activation energy of the reaction decreases.

Section B

Answer **all** questions. Answers must be written within the answer boxes provided.

2. A student investigates the effect of exposure to the air on the ascorbic acid (vitamin C) concentration in a specific orange juice. Equal volumes of orange juice are sealed into identical flasks and placed in a refrigerator for two weeks. The samples in the refrigerator are exposed to the air by removing the stopper for a different number of hours each day as shown.



- (a) Identify **two** variables that are controlled. [1]

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- (b) The concentration of ascorbic acid is determined by titration with a standard iodine solution. Every few days, 10.00 cm^3 of orange juice is removed from each sample, diluted to 100.0 cm^3 , and titrated.

- (i) Suggest why the juice is diluted before titration. [1]

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- (ii) Identify a possible systematic error with this method regarding the sample that is exposed for zero hours. [1]

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- (iii) Suggest how an additional flask could be set up to verify whether the systematic error in (ii) has occurred. [1]

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12EP07

Turn over

(Question 2 continued)

- (c) The following data are collected during a titration.

Final burette reading = $16.10 \pm 0.05 \text{ cm}^3$ Initial burette reading = $1.10 \pm 0.05 \text{ cm}^3$

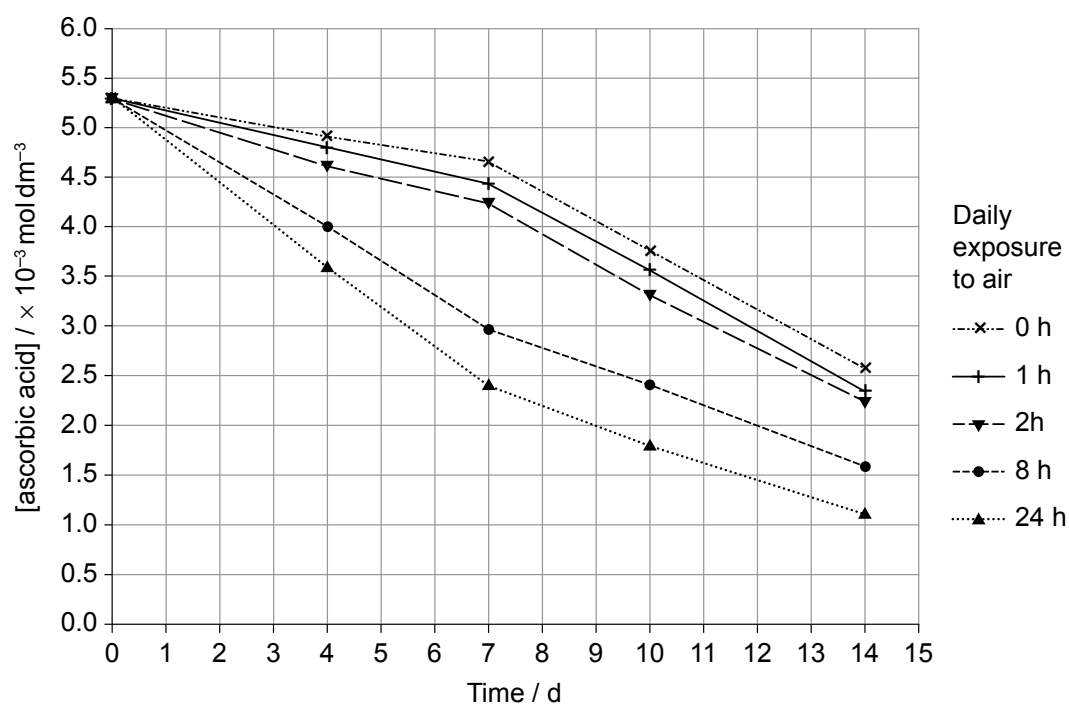
Calculate the percentage uncertainty of the titre.

[1]

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- (d) The following graph shows the student's results.



- (i) Calculate the average rate of decrease in ascorbic acid concentration for the 24 h sample over the period of 14 days, including units.

[2]

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12EP08

(Question 2 continued)

- (ii) The student's hypothesis is: "A lower ascorbic acid concentration will be found in juice exposed to the air for longer, due to oxidation of ascorbic acid by oxygen."

Discuss whether or not the data support the hypothesis.

[2]

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- (iii) State the implications of the results of the experiment for avoiding loss of vitamin C in the storage of orange juice.

[1]

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- (e) Suggest an extension to the investigation that would generate further recommendations for the storage of orange juice.

[1]

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12EP09

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References:

- 1(c)** National Center for Biotechnology Information, 2020. *PubChem Compound Summary for CID 24526, Chlorine* [online] Available at: <<https://pubchem.ncbi.nlm.nih.gov/compound/Chlorine>> [Accessed 23 September 2020].
- 1(e)** Norlex, 2020. *Chlorine for water disinfection*. [online] Available at: <<https://norlexpools.com/guidance/about-the-right-water-balance/safe>> [Accessed 23 September 2020]
- 1(f)(ii)** ResearchGate, 2015. *Distributions of chloramines as a function of pH*. [image online] Available at: <https://www.researchgate.net/figure/Distribution-of-chloramines-as-a-function-of-pH_fig8_273449675> [Accessed 23 September 2020]



12EP10

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12EP11

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12EP12