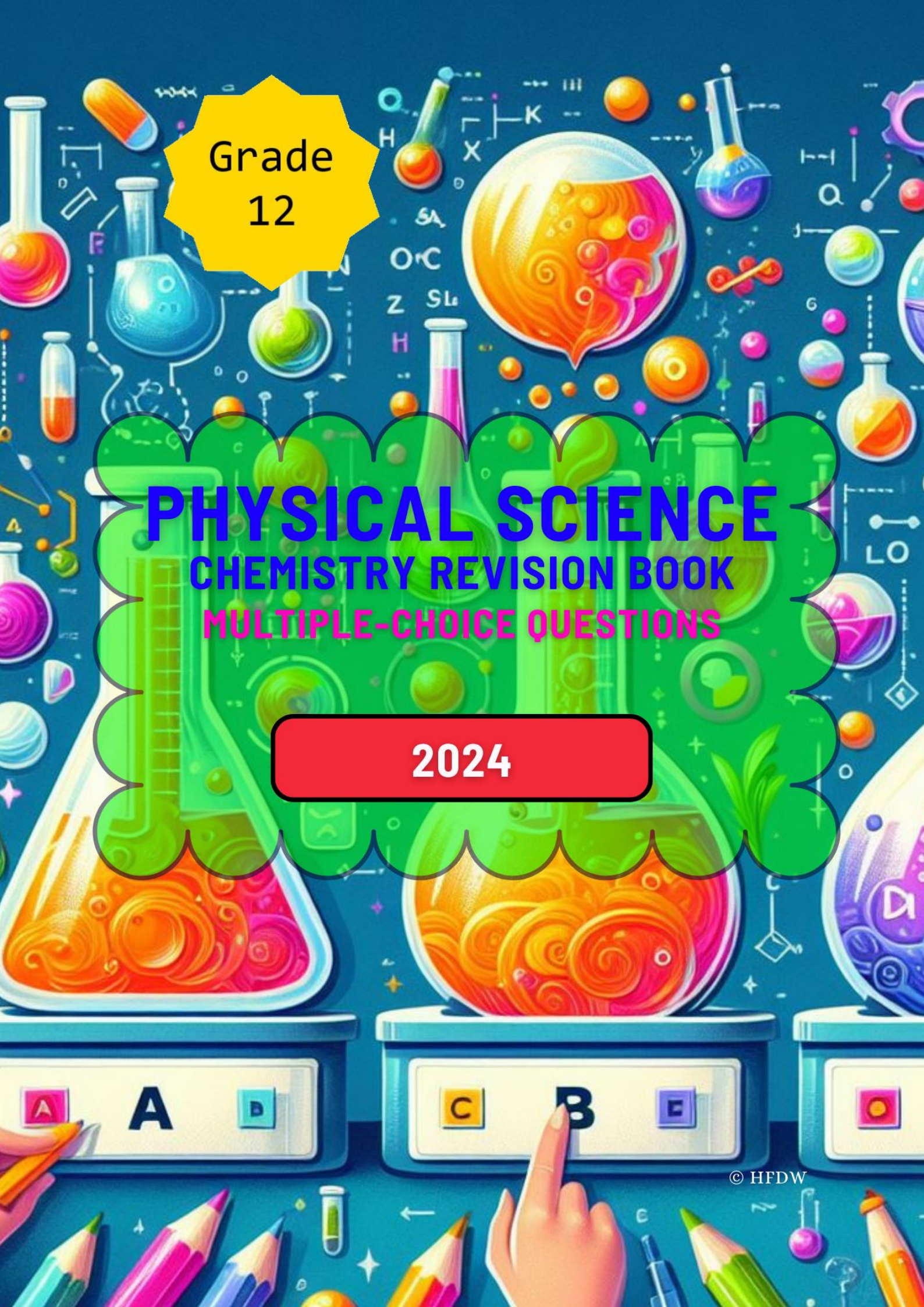
Grade
12
PHYSICAL SCIENCE
CHEMISTRY REVISION BOOK
MULTIPLE-CHOICE QUESTIONS
2024
A
B
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CREDITS

The following question papers were used to compile this book:

Department of Basic Education, *National Senior Certificate Physical Sciences Question Papers*, 2008 – 2023, Pretoria

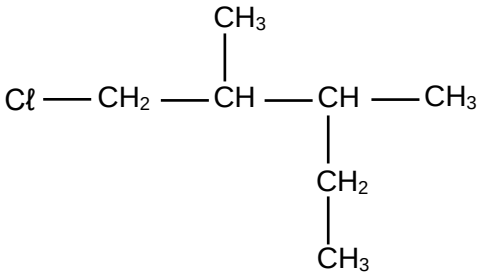
GENERAL GUIDELINES WHEN ANSWERING MULTIPLE CHOICE QUESTIONS

Don't be afraid of multiple-choice questions. Here are a few tips to answer them.

1. Do not spend more than about 30 minutes on the multiple-choice questions.
2. Start by carefully reading the sub-questions (1.1, 1.2, etc.) and pay attention to the keywords.
3. Aso pay attention to words that are in capital letters or otherwise emphasised. This is always important, even in the rest of the paper. The examiner wants you to focus on the emphasised words.
4. Decide whether you are required to recall or use a fact, phenomenon, definition, unit or formula.
5. Use the process of elimination. Eliminate all the answers you know are incorrect, then focus on the remaining answers. Not only does this strategy save time, it greatly increases your likelihood of selecting the correct answer. This is particularly helpful when the answers or options are very close to each other.
6. Never leave a multiple-choice question unanswered. If you do not know the answer, even after trying the process of elimination, then guess!
7. Answers supplied to the questions below demonstrate how to solve multiple choice questions that involve more than one step. A seemingly difficult chemistry multiple choice question might be very easy to solve if you follow the steps.

EXAMPLE 1

The condensed structural formula of an organic compound is given below.



Which ONE of the following is the correct IUPAC name of this compound?

A 1-chloro-2,3-dimethylbutane B 1-chloro-2,3-dimethylpentane
C 1-chloro-3-ethyl-2-methylbutane D 5-chloro-3,4-dimethylpentane

Solution:

- *All bonds are single bonds and the compound has a chlorine substituent – thus it is a chloroalkane/ haloalkane.*
- *Determine the longest chain that contains the halogen. The straight chain has 4 C atoms, but when counting 3 C atoms from the halogen and then 2 C atoms down, the longest chain has 5 C atoms. Therefore the compound is a pentane with a chloro and two methyl (1 C atom each) substituents i.e. chlorodimethylpentane.*
- *Answers A and C (both butane) are eliminated. The choice is now between B and D.*
- *Count from the side giving the substituents (halogen and alkyl) the lowest number. No preference is given to the halogen substituent.*
- *When C atoms are numbered from the C atom bonded to the chlorine, the compound is 1-chloro-2,3-dimethylpentane and from the other side it is 5-chloro-3,4-dimethylpentane. 1,2,3 is smaller than 5,3,4.*
- *Answer: B*

EXAMPLE 2

Consider the following hypothetical reaction that reached equilibrium in a closed container at 450 °C:

$$XY(s) \rightleftharpoons X(g) + Y(s) \qquad \Delta H > 0$$

Which ONE of the following changes will NOT affect the equilibrium position?

A Increase in temperature
B Increase in the amount of Y(s)
C Decrease in pressure at constant volume
D Increase in the volume of the container

Solution:

To make predictions on the effect on the equilibrium position, Le Chatelier's principal must be applied.
Analyse the reaction:

- *ΔH > 0: The reaction is endothermic reaction and the forward reaction will be favoured by an increase in T. T will affect the equilibrium position and thus A cannot be the answer.*
- *The reactant an one product are solids. Only one gas. An increase in p will favour the reverse reaction (1 mol gas to 0 mol gas) and a decrease in p will favour the forward reaction (0 mol gas to 1 mol gas). C cannot be the answer.*
- *Increasing the volume of the container will decrease p which will affect the equilibrium position. Therefore D cannot be the answer.*
- *Through elimination we found that the answer should be B. Adding more Y(s), a solid, at the same temperature, will not affect the equilibrium position.*

EXAMPLE 3

The following half-reactions take place in a galvanic cell:

$Co^{3+} + e^- \rightleftharpoons Co^{2+}$
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$

Which ONE of the following is the cell notation for this cell?

A $A\ell \mid A\ell^{3+} \parallel Co^{3+}, Co^{2+}$
B $A\ell \mid A\ell^{3+} \parallel Co^{3+}, Co^{2+} \mid Pt$
C $A\ell \mid A\ell^{3+} \parallel Co^{2+}, Co^{3+} \mid Pt$
D $Pt \mid Co^{2+}, Co^{3+} \parallel A\ell^{3+} \mid A\ell$

Solution:

- *Find the two half-reactions on Table 4B (Table of Standard Reduction Potentials). Aℓ is a stronger reducing agent than Co^{2+} (Table 4B – see direction of arrow indicating increasing strength of reducing agents). Therefore Aℓ / $A\ell^{3+}$ is the anode half-cell and must be written on the left in the cell notation. Therefore D is eliminated.*
- *Co^{3+} and Co^{2+} are both ions and thus in solution. Therefore an inactive electrode will be needed to connect the wire to. A is eliminated because there is no electrode in the cathode half-cell.*
- *To choose between B and C, you need to look at the reduction half-reaction taking place at the cathode: $Co^{3+} + e^- \rightarrow Co^{2+}$*
- *The ions should appear in the same sequence as in the reduction half-reaction i.e. first Co^{3+}, then Co^{2+}.*
- Answer: B

EXAMPLE 4

Which ONE of the following solutions can be stored in an aluminium container?
(Use the Table of Standard Reduction Potentials.)

A $CuSO_4(aq)$ B $ZnSO_4(aq)$
C $NaC\ell(aq)$ D $Pb(NO_3)_2(aq)$

Solution:

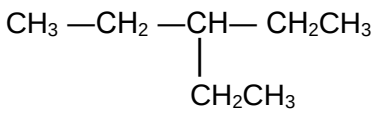
- To be safely stored in Aℓ container, the solution must not react with the container. Aℓ must not be oxidised to $A\ell^{3+}$ i.e. $A\ell \rightarrow A\ell^{3+} + 3e^-$.
- Find the Aℓ half-reaction in *Table 4B (Table of Standard Reduction Potentials).*
- The solutions to be stored contain the following ions: Cu^{2+}, Zn^{2+}, Na^+ and Pb^{2+}. Find the half-reactions for these ions in the table.
- *Oxidising agents are to the left of the table. The stronger oxidising agent (left bottom) will react with the stronger reducing agent (right top).*
  The sequence of the half-reactions in Table 4B is as follows:
  $Na^+ + e^- \rightleftharpoons Na$
  $A\ell^{3+} + 3e^- \rightleftharpoons A\ell$
  $Zn^{2+} + 2e^- \rightleftharpoons Zn$
  $Pb^{2+} + 2e^- \rightleftharpoons Pb$
  $Cu^{2+} + 2e^- \rightleftharpoons Cu$
- *Cu^{2+}, Pb^{2+} and Zn^{2+} are all stronger oxidising agents than $A\ell^{3+}$ and will oxidise Aℓ to $A\ell^{3+}$. Therefore solutions containing these three ions cannot be stored in an Aℓ container.*
- Na^+ is a weaker oxidising agent than $A\ell^{3+}$ and therefore will NOT oxidise *Aℓ to $A\ell^{3+}$. Only $NaC\ell(aq)$ can be stored in an* Aℓ container. Answer: C

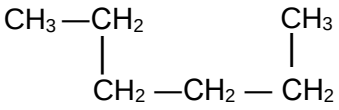
IMPORTANT:

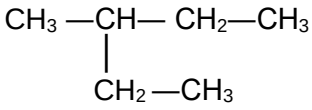
Always compare an oxidising agent to another oxidising agent, never to a reducing agent. When looking at the table, always compare species to the left of the double arrows in the Table of Standard Reduction Potentials with each other. Reducing agents (to the right of the double arrows) are compared to each other.

ORGANIC MOLECULES: NOMENCLATURE

1. Which of the following are structural isomers of hexane?

(i) 

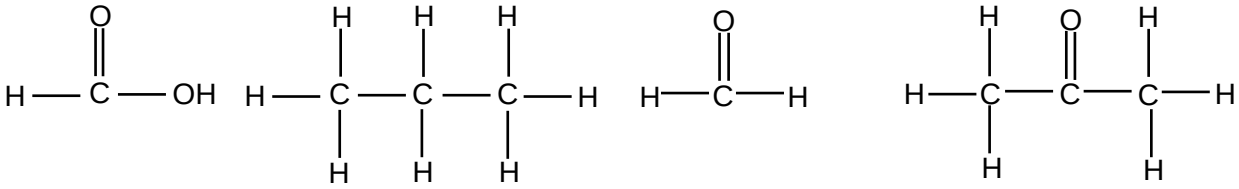
(ii) 

(iii) 

A (i) and (ii) only
B (ii) and (iii) only
C (i), (ii) and (iii)
D (i) and (iii) only (2)

Exemp 2008

2. The structural formulae for four compounds are shown below.

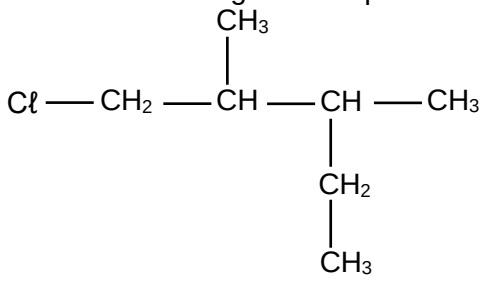


These compounds can be classified in the correct sequence as …

A Carboxylic acid, alkane, ketone, aldehyde
B Carboxylic acid, ketone, aldehyde, alkane
C Aldehyde, alkane, carboxylic acid, ketone
D Carboxylic acid, alkane, aldehyde, ketone (2)

Exemp 2008

3. The condensed structural formula of an organic compound is given below.

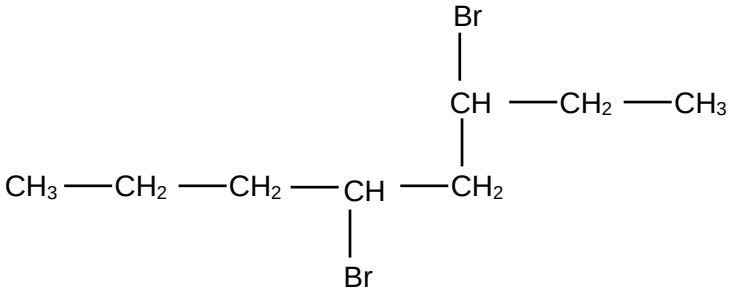


Which ONE of the following is the correct IUPAC name of this compound?

A 1-chloro-2,3-dimethylbutane
B 1-chloro-2,3-dimethylpentane
C 1-chloro-3-ethyl-2-methylbutane
D 1-chloro-2-ethyl-3-methylpentane (2)

Nov 2008

4. The condensed structural formula of an organic compound is shown below:

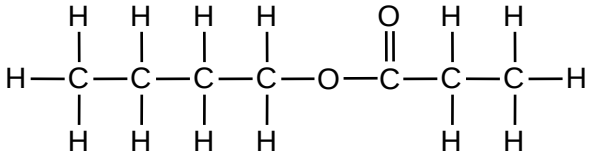


Which ONE of the following is the correct IUPAC name of this compound?

A 4,6-dibromooctane
B 4-bromo-5-bromo-5-propylpentane
C 3,5-dibromooctane
D 2-bromo-1-bromo-1-propylpentane (2)

Mar 2009

5. The structural formula of an ester is shown below.

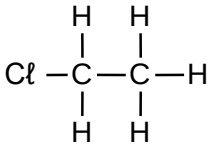
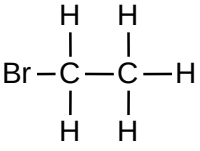
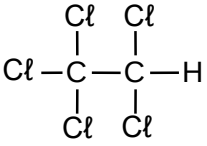
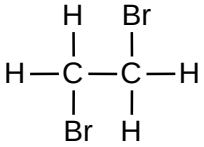


Which ONE of the following pairs of compounds can be used to prepare the above ester?

A Propanoic acid and butan-1-ol
B Propanoic acid and butan-2-ol
C Butanoic acid and propan-1-ol
D Butanoic acid and propan-2-ol

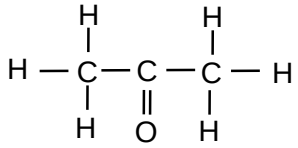
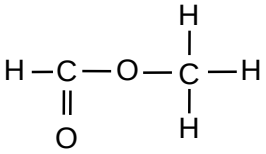
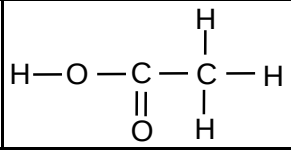
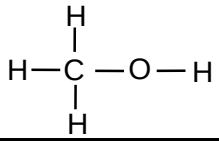
(2)
Nov 2009

6. Which ONE of the following compounds has structural isomers?

A		B	
C		D	

(2)
Nov 2009

7. Which ONE of the following compounds represents a ketone?

A		B	
C		D	

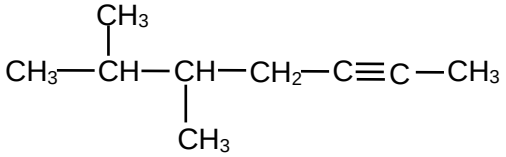
(2)
Nov 2010

8. Consider the compound with molecular formula C_4H_{10}. How many structural isomers does this compound have?

A 1 B 2
C 3 D 4

(2)
Nov 2010

9. The structural formula of an organic compound is given below.



The IUPAC name of this compound is ...

A 2,3-dimethylhept-5-yne. B 5,6-dimethylhept-2-yne.
C 2,3-methylhept-2-yne. D 5,6-dimethylhept-3-yne.

(2)
Mar 2011

10. Which ONE of the following hydrocarbons has NO structural isomers?

A Butane B Pentane
C Propane D But-1-ene (2)

FS Jun 2011

11. Which ONE of the following general formulae represents alkynes?

A C_nH_{2n+2} B C_nH_{2n-2}
C C_nH_{2n} D C_nH_{2n-1} (2)

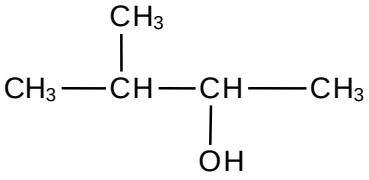
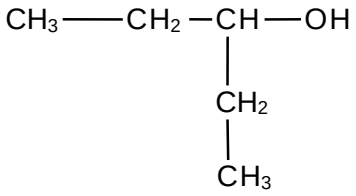
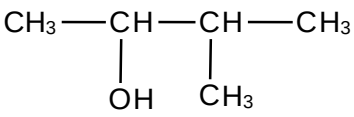
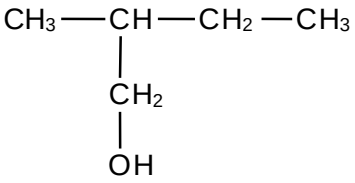
Nov 2011

12. Which ONE of the following homologous series does NOT contain a CARBONYL group ()?

A Aldehydes B Alcohols
C Carboxylic acids D Esters (2)

Nov 2011

13. The structures of four organic compounds are shown below.

I		**II**	
III		**IV**	

Which of the above compounds have the same IUPAC name?

A I and II only B III and IV only
C I and III only D II and IV only (2)

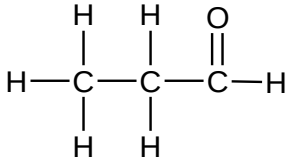
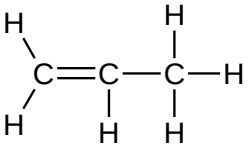
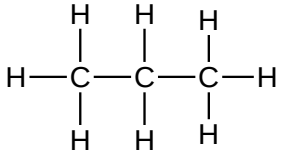
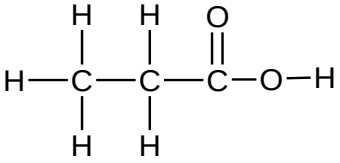
Nov 2011

14. Which ONE of the following compounds CANNOT be an alkene?

A C_2H_4 B C_3H_6
C C_3H_8 D C_4H_8 (2)

Mar 2012

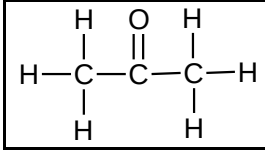
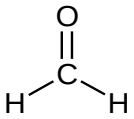
15. Which ONE of the compounds represented below is an UNSATURATED hydrocarbon?

A		B	
C		D	

(2)

Mar 2012

16. Consider the two organic compounds represented by **I** and **II**, as shown below.

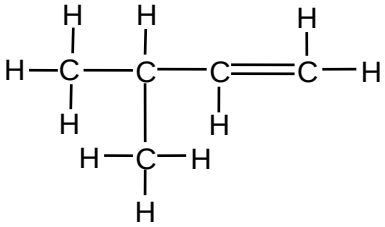
I	**II**
	

Which ONE of the following correctly represents the homologous series to which each belongs?

	I	**II**
A	aldehyde	alcohol
B	ketone	alcohol
C	ketone	aldehyde
D	aldehyde	ketone

(2)
Mar 2012

17. Consider the organic compound represented below.



The compound is ...

A saturated and branched.
B unsaturated and branched.
C saturated and straight-chained.
D unsaturated and straight-chained. (2)
Nov 2012

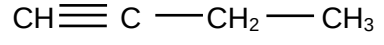
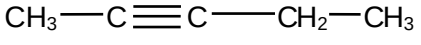
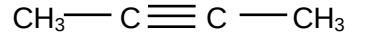
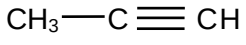
18. A structural isomer of butane is ...

A propane.
B 2-methylbutane.
C 2-methylpropane.
D 2,2-dimethylpropane. (2)
Nov 2012

19. The alcohols form a homologous series. This means that alcohols have ...

A similar chemical properties.
B similar physical properties.
C the same molecular formula.
D the same structural formula. (2)
Nov 2012

20. Consider the organic compounds (I to IV) shown below.

I		**II**	
III		**IV**	

Which of the compounds above are structural isomers?

A I and II
B I and III
C I and IV
D II and III (2)
Mar 2013

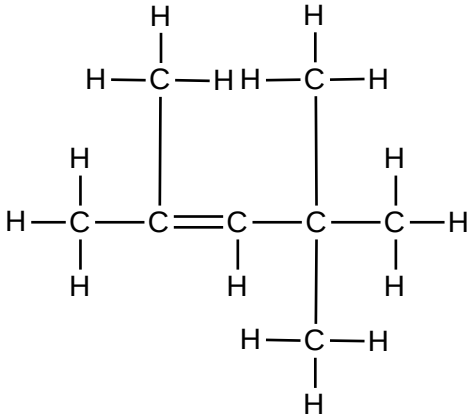
21. Which ONE of the following is the functional group of aldehydes?

A ─ COO ─ B ─ COOH
C ─ CHO D ─ OH (2)
Nov 2013

22. Which ONE of the compounds given below is an aldehyde?

A CH_3CHO B CH_3COCH_3
C CH_3COOH D CH_3OH (2)
Exemp 2014

23. Consider the structural formula of an organic compound below.



Which ONE of the following is the correct IUPAC name of this compound?

A 2,2,4-trimethylpent-2-ene B 2,2,4-trimethylpent-3-ene
C 2,4,4-trimethylpent-2-ene D 2,4,4-trimethylpent-3-ene (2)
Exemp 2014

24. Which ONE of the following compounds is a ketone?

A $CH_3COCH_2CH_3$ B $CH_3COOCH_2CH_3$
C $CH_3CH_2CH_2CHO$ D $CH_3CH(OH)CH_2CH_3$ (2)
Mar 2014

25. Which ONE of the following compounds is SATURATED?

A $CH_3CH(CH_3)CH_3$ B $CH_3CH_2CHCH_2$
C $CH_3CHCHCH_3$ D $CH_3C(CH_3)_2CHCH_2$ (2)
Mar 2014

26. Which ONE of the following statements is CORRECT?

Alkenes ...

A have the general formula C_nH_{2n+2}.
B are unsaturated hydrocarbons.
C readily undergo substitution reactions.
D have one triple bond between two carbon atoms. (2)
Nov 2014

27. Which ONE of the following compounds belongs to the same homologous series as but-2-yne?

A CH_3CCH B CH_2CHCH_2
C $CH_3CHCHCH_3$ D $CH_3CH_2CH_2CH_3$ (2)
Nov 2014

28. Which ONE of the following is the EMPIRICAL FORMULA of 1,2-dichloroethane?

A $CHC\ell$ B $CH_2C\ell$
C $CHC\ell_2$ D $C_2H_4C\ell_2$ (2)
Nov 2014

29. Which ONE of the following compounds is an aldehyde?

A Pentanal B Pentan-2-ol
C Pentan-2-one D Ethyl propanoate (2)
Mar 2015

30. Which ONE of the following compounds is an aldehyde?

A CH_3COCH_3 B CH_3CH_2CHO
C CH_3CH_2COOH D $CH_3CH_2CH_2OH$ (2)

Nov 2015

31. Which ONE of the following pairs of compounds are FUNCTIONAL isomers?

A Methanol and methanal
B Butane and 2-methylpropane
C Propan-1-ol and propan-2-ol
D Propanoic acid and methyl ethanoate (2)

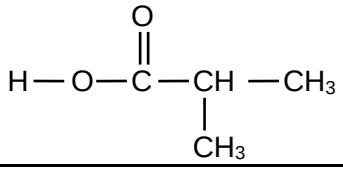
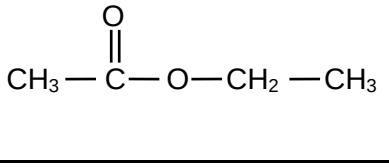
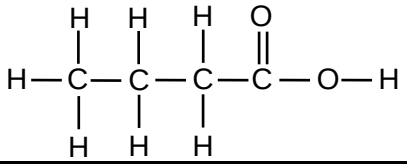
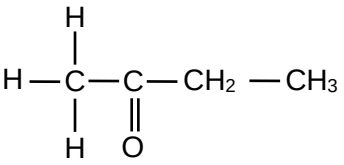
Mar 2016

32. A compound with the general formula C_nH_{2n+2} is an ...

A alkane. B alkene.
C alkyne. D alcohol. (2)

Jun 2016

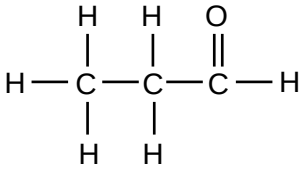
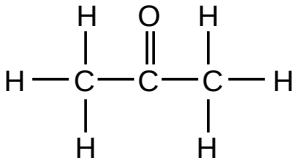
33. Which ONE of the following is a functional isomer of butanoic acid?

A		B	
C		D	

(2)

Jun 2016

34. Consider the two organic molecules **I** and **II** below.

I	**II**
	

Which ONE of the following represents the homologous series to which compound **I** and compound **II** belong?

	I	**II**
A	Ketones	Alcohols
B	Aldehydes	Ketones
C	Aldehydes	Alcohols
D	Ketones	Aldehydes

(2)

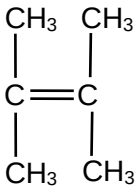
Nov 2016

35. A carbonyl group is the functional group of …

A alcohols. B ketones.
C haloalkanes. D carboxylic acids. (2)

Mar 2017

36. Consider the structure of an organic compound below.



The IUPAC name of this compound is …

A 2,3-dimethylbut-2-ene. B 2,2-dimethylbut-2-ene.
C 1,1,2-trimethylprop-1-ene. D 1,1,2,2-tetramethylethene. (2)

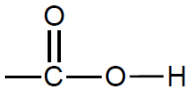
Mar 2017

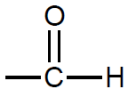
37. The IUPAC name of an organic compound with molecular formula $C_7H_{14}O_2$:

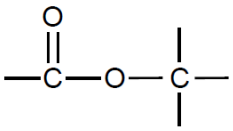
A Heptanal B Heptan-1-ol
C Heptan-2-ol D Heptanoic acid (2)

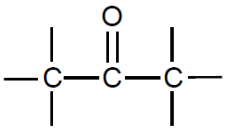
Nov 2017

38. Which ONE of the following structures is the functional group of aldehydes?

A 

B 

C 

D 

(2)

Nov 2017

39. Which ONE of the following is the general formula of alkynes?

A C_nH_{2n} B $C_{2n}H_{2n}$
C C_nH_{2n-2} D C_nH_{2n+2} (2)

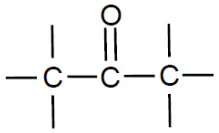
Mar 2018

40. An example of a saturated organic compound is …

A ethyne. B propene.
C but-2-ene. D 2-chloropropane. (2)

Jun 2018

41. Study the structural formula of the functional group below.

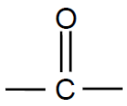
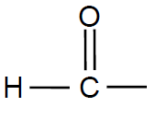
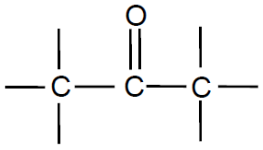
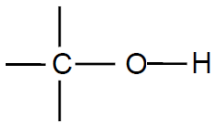


The structure above is the functional group of …

A esters. B ketones.
C aldehydes. D carboxylic acids. (2)

Jun 2018

41. Which ONE of the following is the structural formula of the functional group of the KETONES?

A		**B**	
C		**D**	

(2)

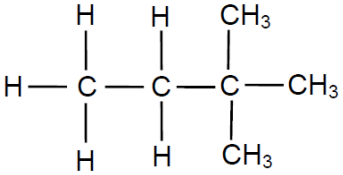
Nov 2018

43. Which ONE of the formulae below represents an ALKANE?

A C_2H_4 B C_5H_{10}
C $C_{14}H_{30}$ D C_8H_{14}

(2)
Nov 2018

44. Consider the organic compound below.



The IUPAC name of this compound is …

A 2,3-dimethyl butane. B 3,3-dimethyl butane.
C 2,2-dimethyl butane. D 1,1,1-trimethyl propane.

(2)
Nov 2018

45. Which ONE of the following is a SECONDARY alcohol?

A Ethanol B Butan-1-ol
C Butan-2-ol D 2-methylbutan-1-ol

(2)
Jun 2019

46. A FUNCTIONAL ISOMER of ethyl propanoate is …

A C_4H_9CHO. B $C_5H_{11}OH$.
C C_4H_9COOH. D $CH_3(CH_2)_3CHO$.

(2)
Jun 2019

47. Which ONE of the following combinations are BOTH UNSATURATED HYDROCARBONS?

A Ethane and ethene B Ethene and ethyne
C Ethane and ethanol D Ethanoic acid and ethene

(2)
Nov 2019

48. Which ONE of the following is the general formula for the alkanes?

A C_nH_{2n} B C_nH_{2n-2}
C C_nH_{2n+2} D $C_nH_{2n+2}O$

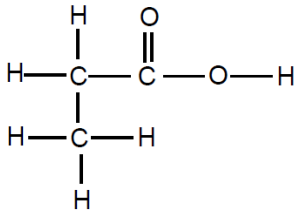
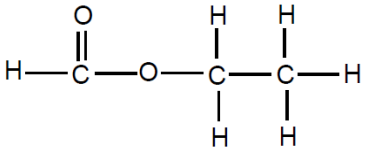
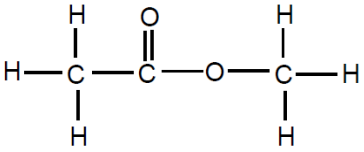
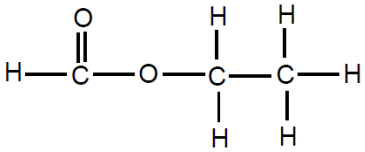
(2)
Nov 2020

49. The EMPIRICAL FORMULA of hexanoic acid is …

A $C_3H_6O_2$ B $C_6H_6O_2$
C $C_6H_{12}O_2$ D C_3H_6O

(2)
Nov 2020

50. Which ONE of the following is the CORRECT structural formula for METHYL ETHANOATE?

A		**B**	
C		**D**	

(2)
Nov 2020

51. To which homologous series does a compound with molecular formula $C_6H_{12}O_2$ belong?

A Ketones B Alcohols
C Aldehydes D Carboxylic acids (2)

Jun 2021

52. Which ONE of the following is an ALKANE?

A C_6H_8 B C_6H_{10}
C C_6H_{12} D C_6H_{14} (2)

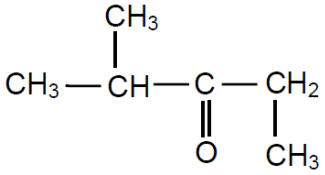
Sep 2021

53. Which formula shows the way in which atoms are bonded in a molecule but does not show all the bond lines?

A Empirical B Molecular
C Structural D Condensed structural (2)

Nov 2021

54. Consider the following compound:



Which ONE of the following is the IUPAC name of this compound?

A 2-methylpentan-3-one B 4-methylpentan-3-one
C 2,3-dimethylbutan-2-one D 2,2,4-trimethylpropan-2-one (2)

Nov 2021

55. Which ONE of the following terms describes hydrocarbons that contain only single bonds?

A Isomers B Saturated
C Unsaturated D Homologous series (2)

Nov 2022

56. For which ONE of the following molecular formulae are CHAIN isomers possible?

A C_4H_{10} B C_3H_8
C C_2H_6O D C_3H_8O (2)

Jun 2023

57. Which ONE of the following represents a straight chain SATURATED hydrocarbon?

A C_5H_8 B C_5H_{10}
C C_6H_{12} D C_6H_{14} (2)

Nov 2023

58. Which ONE of the following is a SECONDARY alcohol?

A $C(CH_3)_3OH$ B $CH_3(CH_2)_3OH$
C $CH_3(CH_2)_2CHO$ D $CH_3CH_2CH(OH)CH_3$ (2)

Nov 2023

ORGANIC MOLECULES: PHYSICAL PROPERTIES

1. The boiling points of branched alkanes are lower than those of straight chain alkanes containing the same number of carbon atoms because branched alkane chains have …

   A larger molecular mass.
   B shorter chain lengths.
   C more electrons.
   D smaller effective molecular surface areas. (2)

Nov 2008

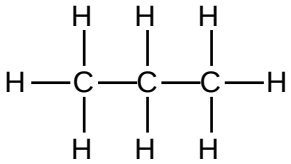
2. Which ONE of the following compounds will have the highest boiling point?

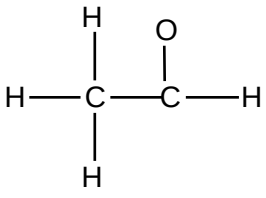
   A $CH_3CH_2CH_2CH_2CH_3$
   B $CH_3CH_2CH_2CH_2OCH_3$
   C $CH_3CH_2CH_2CH_2CH_2OH$
   D $CH_3CH_2CH_2C(=O)CH_3$

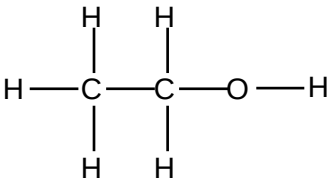
(2)

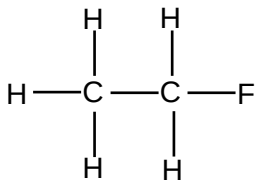
Exemp 2008

3. Consider the structural formula and IUPAC name of each compound shown below.


propane


ethanal


ethanol

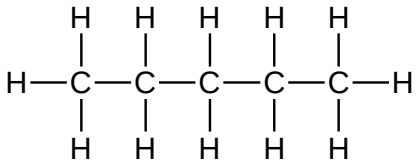
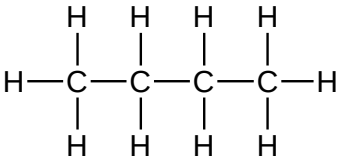
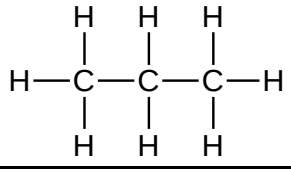
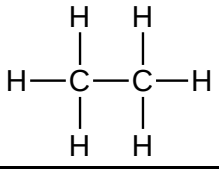

fluoroethane

Which ONE of these compounds has the highest vapour pressure at room temperature?

   A Propane
   B Ethanal
   C Ethanol
   D Fluoroethane (2)

Nov 2009

4. Which ONE of the following compounds has the highest boiling point?

A		B	
C		D	

(2)

FS Jun 2011

5. A scientist investigates a factor which influences the boiling points of alkanes. He determines the boiling points of the first six straight chain alkanes. Which ONE of the following is the independent variable in this investigation?

A Boiling point B Functional group
C Branching D Chain length (2)

Mar 2014

6. Which ONE of the following compounds has the highest boiling point?

A CH_3CH_3 B $CH_3CH_2CH_3$
C $CH_3CH_2CH_2CH_3$ D $CH_3CH_2CH_2CH_2CH_3$ (2)

Jun 2015

7. Which ONE of the following compounds has dipole-dipole forces between its molecules?

A Ethanal B Ethane
C Ethene D Ethyne (2)

Nov 2015

8. Which ONE of the following isomers has the LOWEST boiling point?

A $CH_3CH_2CH_2CH_2CH_2CH_3$ B $CH_3CH_2C(CH_3)_2CH_3$
C $CH_3CH(CH_3)CH_2CH_2CH_3$ D $CH_3CH_2CH(CH_3)CH_2CH_3$ (2)

Mar 2018

9. Which ONE of the following compounds has the HIGHEST vapour pressure?

A HCOOH B CH_3CHO
C CH_3CH_2OH D $CH_3CH_2CH_3$ (2)

Nov 2019

10. Which ONE of the following compounds has hydrogen bonds between molecules?

A Pentanal B Pentan-2-one
C Pentanoic acid D Methyl butanoate (2)

Jun 2021

11. Which ONE of the following compounds has hydrogen bonds between its molecules?

A $CH_3(CH_2)_2CH_3$ B $CH_3COCH_2CH_3$
C $CH_3COOCH_2CH_3$ D $CH_3CH(OH)CH_2CH_3$ (2)

Nov 2021

12. Which ONE of the following compounds has the LOWEST melting point?

A Hexane B Ethane
C Butane D Octane (2)

Jun 2022

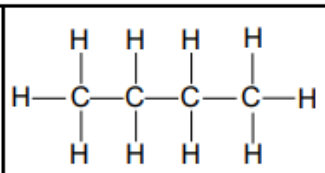
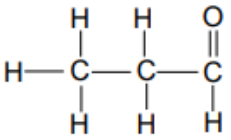
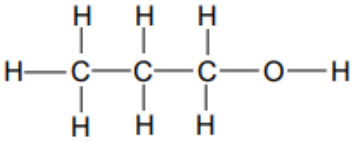
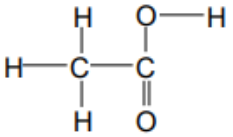
13. Which ONE of the following combinations correctly indicates the STRONGEST intermolecular forces found in ethanoic acid and methyl propanoate respectively?

	ETHANOIC ACID	**METHYL PROPANOATE**
A	Hydrogen bonds	Hydrogen bonds
B	Dipole-dipole forces	London forces
C	Hydrogen bonds	London forces
D	Hydrogen bonds	Dipole-dipole forces

(2)

Nov 2022

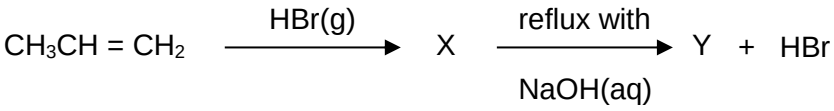
14. Which ONE of the following compounds has the LOWEST vapour pressure under the same conditions?

A		B	
C		D	

(2)
Jun 2023

ORGANIC MOLECULES: ORGANIC REACTIONS

1. A simple reaction scheme is shown below.



The formula for Y is …

A CH_3CH_2COOH B $CH_3CHOHCH_3$
C $CH_3CHBrCH_2OH$ D $CH_3CHOHCH_2Br$ (2)

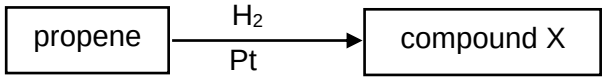
Exemp 2008

2. Which ONE of the following reaction types can be used to prepare ethene from octane?

A Addition B Hydrogenation
C Cracking D Substitution (2)

Nov 2009

3. Consider the flow diagram below:

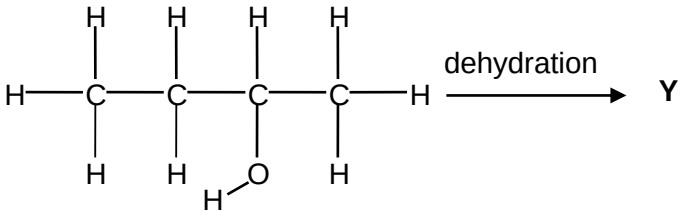


The IUPAC name for compound X is:

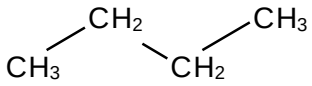
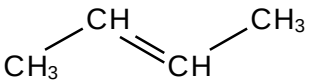
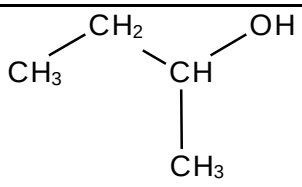
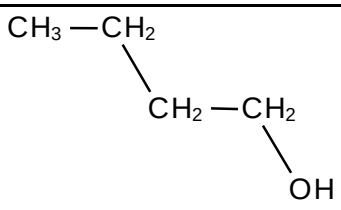
A propyne B propan-1-ol
C propane D propan-2-ol (2)

Mar 2010

4. During the dehydration of butan-2-ol, represented below, compound Y forms as one of the products.



Which ONE of the following is the correct condensed structural formula for compound **Y**?

A		B	
C		D	

(2)

Mar 2010

5. Which ONE of the following pairs of reactants can be used to prepare the ester ethyl butanoate in the laboratory?

A Ethanal and butanol
B Ethanoic acid and butanol
C Ethanol and butanoic acid
D Ethanal and butanoic acid (2)

Nov 2010

6. Which ONE of the following pairs of compounds correctly represents the products formed during the COMPLETE combustion of octane?

A CO and H_2O B CO and H_2
C CO_2 and H_2 D CO_2 and H_2O (2)

Mar 2011

7. Which ONE of the following pairs of reactants can be used to prepare the ester ethyl methanoate in the laboratory?

A Ethane and methanoic aid
B Methanol and ethanoic acid
C Ethanol and methanoic acid
D Ethene and methanol (2)

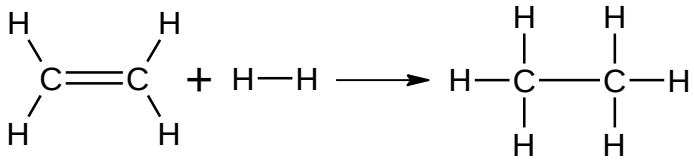
Mar 2011

8. The type of compound formed when but-1-ene reacts with water in the presence of a suitable catalyst is a/an ...

A alcohol. B alkane.
C haloalkane. D ester. (2)

Mar 2011

9. Consider the reaction represented below.

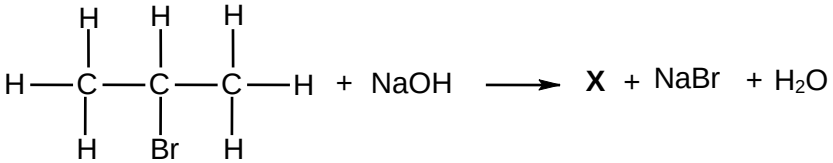


This reaction is an example of …

A addition. B oxidation.
C elimination. D substitution. (2)

Mar 2013

10. The equation below represents the reaction that takes place when an organic compound and concentrated sodium hydroxide are strongly heated.
X represents the major organic product formed.



Which ONE of the following is the correct IUPAC name for compound **X**?

A Prop-1-ene B Prop-2-ene
C Propan-1-ol D Propan-2-ol (2)

Nov 2013

11. The reaction represented by the equation below takes place in the presence of a catalyst.

$$C_{13}H_{28}(\ell) \rightarrow C_2H_4(g) + C_3H_6(g) + C_8H_{18}(\ell)$$

This reaction is an example of …

A Addition B Cracking
C Substitution D Polymerisation (2)

Exemp 2014

12. The following equation represents the cracking of a hydrocarbon at high temperature and pressure:

$$C_{11}H_{24} \rightarrow 2C_2H_4 + \mathbf{Y} + C_4H_{10}$$

Which ONE of the following is the IUPAC name of product Y?

A Prop-1-ene B Propane
C Ethene D Ethane (2)

Nov. 2014

13. When 2-chlorobutane is strongly heated in the presence of concentrated sodium hydroxide, the major product formed is …

A but-1-ene. B but-2-ene.
C butan-1-ol. D butan-2-ol. (2)

Nov. 2014

14. Consider the reaction represented by the equation below:

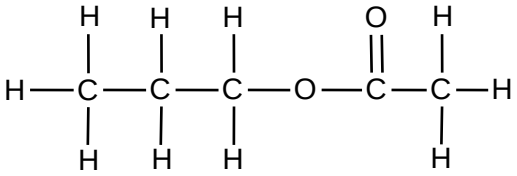
$$CH_3CHCH_2 + H_2 \rightarrow CH_3CH_2CH_3$$

This reaction is an example of …

A hydration. B dehydration.
C substitution. D hydrogenation. (2)

Mar 2015

15. Consider the structural formula of a compound below.



Which ONE of the following pairs of reactants can be used to prepare this compound in the laboratory?

A Propanoic acid and ethanol B Propanoic acid and methanol
C Ethanoic acid and propan-1-ol D Methanoic acid and propan-1-ol (2)

Mar 2015

16. The addition of hydrogen to an alkene is known as ...

A hydration. B cracking.
C hydrogenation. D hydrohalogenation. (2)

Jun 2015

17. Which ONE of the following is a product formed during the hydrolysis of bromoethane?

A Water B Ethene
C Ethanol D Bromine (2)

Nov. 2015

18. In the flow diagram below **P** and **Q** represent two organic compounds.

$$CH_2{=}CH_2 \xrightarrow{HBr} \mathbf{P} \xrightarrow[\text{heat}]{NaOH(aq)} \mathbf{Q} \text{ (major product)}$$

Compound **Q** is:

A CH_2CH_2 B CH_3CH_3
C CH_3CH_2Br D CH_3CH_2OH (2)

Jun 2016

19. What product will be formed when an alkene reacts with water vapour (H_2O) in the presence of an acid catalyst?

A Ester B Alkane
C Alcohol D Aldehyde (2)

Nov 2016

20. Which ONE of the following represents a SUBSTITUTION REACTION?

A $CH_2 = CH_2 + HBr \rightarrow CH_3CH_2Br$
B $CH_2 = CH_2 + H_2O \rightarrow CH_3CH_2OH$
C $CH_3CH_2OH \rightarrow CH_2 = CH_2 + H_2O$
D $CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$ (2)

Nov 2016

21. Consider the reaction represented below.

$$CH_3CH_2CH_2CH_2CH_3 \longrightarrow CH_3CHCH_2 + \mathbf{X}$$

Which ONE of the following CORRECTLY gives the type of reaction that takes place and the IUPAC name of product **X**?

	Type of reaction	Product X
A	Elimination	Ethane
B	Elimination	Ethene
C	Addition	Ethane
D	Addition	Ethene

(2)
Mar 2017

22. Which ONE of the following organic reactions will take place only when exposed to light?

A $CH_2CH_2 + H_2 \rightarrow CH_3CH_3$
B $CH_3CH_3 \rightarrow CH_2CH_2 + H_2$
C $CH_2CH_2 + C\ell_2 \rightarrow CH_2C\ell CH_2C\ell$
D $CH_3CH_3 + C\ell_2 \rightarrow CH_3CH_2C\ell + HC\ell$ (2)
Jun 2017

23. The complete combustion of ethane is represented by the balanced equation below.

$$2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$$

The maximum volume of gas that can be produced by the complete combustion of 100 cm^3 of ethane is:

A 200 cm^3 B 400 cm^3
C 500 cm^3 D 600 cm^3 (2)
Jun 2017

24. Which ONE of the following equations represents a cracking process?

A $5CH_2 = CH_2 \rightarrow —(CH_2CH_2)_5—$
B $CH_3(CH_2)_5CH = CH_2 + H_2 \rightarrow CH_3(CH_2)_6CH_3$
C $CH_3(CH_2)_6CH_3 \rightarrow CH_3(CH_2)_4CH_3 + CH_2 = CH_2$
D $CH_3(CH_2)_7OH \rightarrow CH_3(CH_2)_5CH = CH_2 + H_2O$ (2)
Nov 2017

25. The type of reaction that takes place when a carboxylic acid and an alcohol react in the presence of an acid:

A Addition B Hydrolysis
C Substitution D Esterification (2)
Mar 2018

26. When ethene reacts with hydrogen gas in the presence of a catalyst, the product is …

A ethane. B ethyne.
C ethanol. D ethanal. (2)
Jun 2018

27. Which ONE of the following will RAPIDLY decolourise bromine water?

A CH_3CHCH_2 B $CH_3CH_2CH_3$
C CH_3COOCH_3 D CH_3CH_2COOH (2)
Jun 2019

28. Which functional groups are involved in the formation of esters?

A Formyl and carbonyl B Hydroxyl and carbonyl
C Hydroxyl and carboxyl D Carbonyl and carboxyl (2)
Jun 2021

29. Esters are formed by a reaction between two organic compounds, **X** and **Y**, each with a different functional group. The functional groups of these compounds are:

	Compound X	**Compound Y**
A	Hydroxyl group	Carboxyl group
B	Hydroxyl group	Carbonyl group
C	Hydroxide ion	Carboxyl group
D	Hydroxide ion	Carbonyl group

(2)
Sep 2021

30. When butane is subjected to high temperatures and pressures, the following reaction takes place:

Butane $\rightarrow$ methane + **Y**

Which ONE of the following represents **Y**?

A $CHCCH_3$ B CH_2CHCH_3
C $CH_3CH_2CH_3$ D $CH_3CHCHCH_3$ (2)
Sep 2021

31. When $CH_2 = CH_2$ is converted to CH_3CH_3, the type of reaction is …

A hydration. B hydrolysis.
C halogenation. D hydrogenation. (2)
Jun 2022

32. Which ONE of the following compounds in solution will change the colour of bromothymol blue?

A CH_3CH_2CHO B CH_3CH_2COOH
C $CH_3CH_2COCH_3$ D $CH_3CH_2COOCH_3$ (2)
Jun 2022

33. A test tube contains a liquid hydrocarbon. When bromine water (Br_2) is added to the test tube, the mixture decolourises IMMEDIATELY.
Which ONE of the following combinations correctly identifies the COMPOUND and the TYPE OF REACTION that takes place in the test tube?

	COMPOUND	**TYPE OF REACTION**
A	Hexane	Addition
B	Hexane	Substitution
C	Hex-2-ene	Addition
D	Hex-2-ene	Substitution

(2)
Nov 2022

34. The type of organic compound formed when a haloalkane is heated in the presence of a concentrated strong base is an …

A alkane. B alkene.
C alkyne. D alcohol. (2)
Jun 2023

35. Which ONE of the following is a HYDROLYSIS reaction?

A $CH_3CH_2Br + H_2O \rightarrow CH_3CH_2OH + HBr$
B $CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$
C $CH_2CH_2 + H_2O \rightarrow CH_3CH_2OH$
D $CH_2CH_2 + H_2 \rightarrow CH_3CH_3$ (2)
Nov 2023

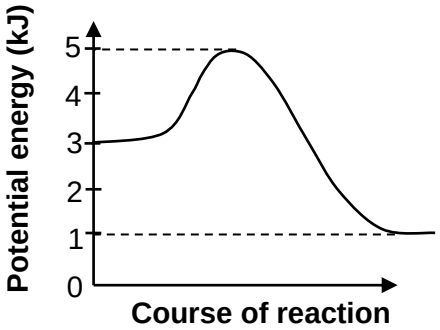
REACTION RATE AND ENERGY IN CHEMICAL REACTIONS

1. Which ONE of the following statements about the rate of reaction is INCORRECT?

   A Meat decays quicker in a warm environment than in a fridge.
   B Most industrial processes are cheaper to run when a catalyst is used.
   C Zinc reacts faster with excess dilute hydrochloric acid than with concentrated hydrochloric acid that is not in excess.
   D Potatoes cook faster when sliced than when cooked whole. (2)

Nov 2008

2. The graph below represents the relationship between potential energy and course of reaction for a certain chemical reaction.

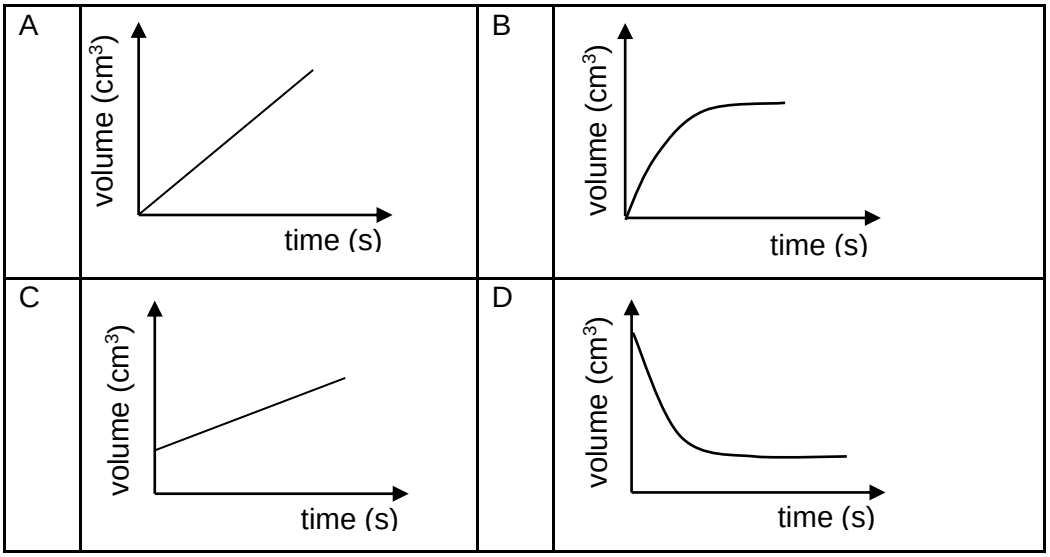


The activation energy for the forward reaction is …

A 1 kJ. B 2 kJ.
C 3 kJ. D 4 kJ. (2)

Nov 2010

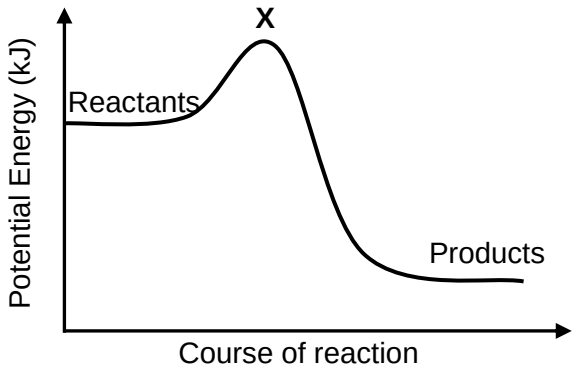
3. One of the products formed in a chemical reaction is a gas. Which ONE of the following graphs of volume versus time best represents the formation of this gas until the reactants are used up?



(2)

Nov 2010

4. Consider the following potential energy diagram for a chemical reaction.

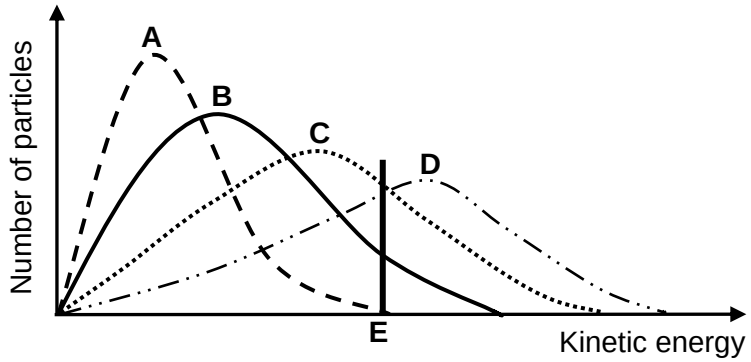


Which ONE of the statements below is CORRECT?

A The reaction is endothermic.
B The heat of reaction (ΔH) increases when the reactants are heated.
C An increase in concentration of reactants lowers the activation energy.
D Position **X** on the graph represents the activated complex. (2)

FS Jun 2011

5. The Maxwell-Boltzmann energy distribution curves below show the number of particles as a function of their kinetic energy for a reaction at four different temperatures. The minimum kinetic energy needed for effective collisions to take place is represented by **E**.

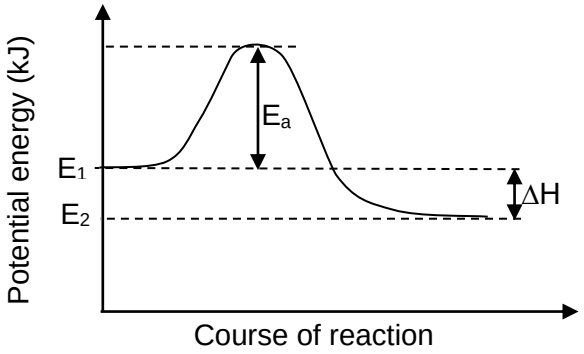


Which ONE of these curves represents the reaction with the highest rate?

A A B B
C C D D (2)

Nov 2011

6. A certain chemical reaction is represented by the potential energy diagram below.



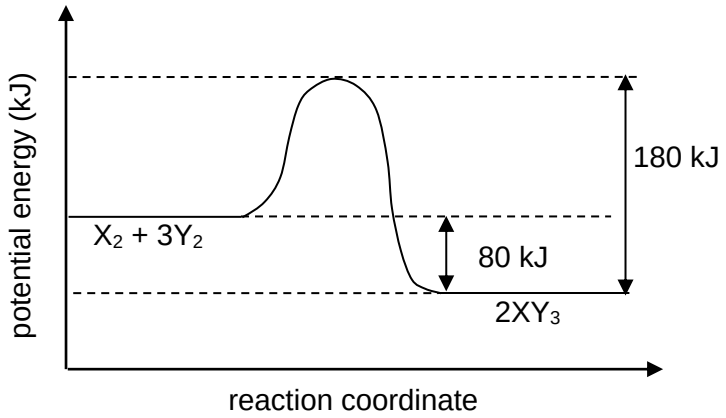
Which ONE of the following quantities will change when a catalyst is added?

A E_2 B E_1
C E_a D ΔH (2)

Nov 2011

7. The diagram below shows the change in potential energy for a hypothetical reaction, represented by the following equation:

$$X_2(g) + 3Y_2(g) \rightarrow 2XY_3(g)$$



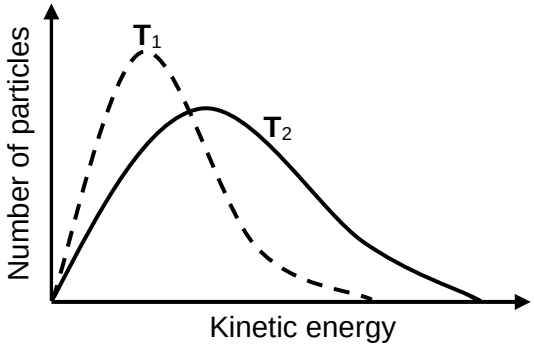
The activation energy for the forward reaction is …

A - 80 kJ
B 80 kJ
C 100 kJ
D 180 kJ

(2)

Mar 2012

8. The energy distribution diagrams for particles in a fixed mass of gas at two different temperatures, T_1 and T_2, are shown below.



Which ONE of the following is the correct interpretation of the diagrams as the temperature of the gas changes from **T_1** to **T_2**?

	Activation energy (E_A)	**Number of effective collisions**
A	Remains the same	Increases
B	Decreases	Decreases
C	Decreases	Increases
D	Remains the same	Decreases

(2)

Nov 2012

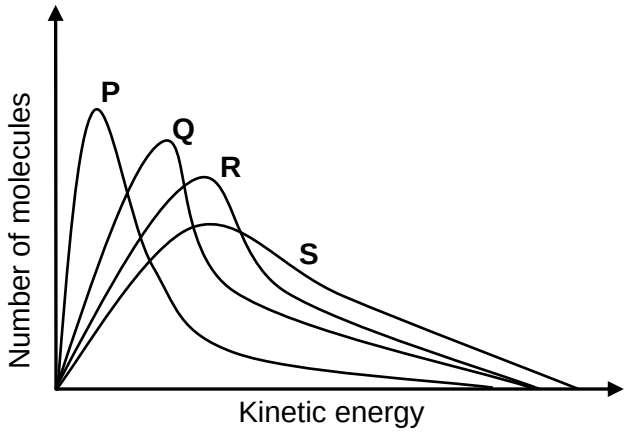
9. Activation energy can best be described as the minimum energy required to …

A cause effective collisions.
B make reactant molecules collide.
C increase the kinetic energy of reactant molecules.
D change the orientation of reactant molecules.

(2)

Mar 2013

10. The graphs below represent the molecular distribution for a reaction at different temperatures.



Which ONE of the graphs above represents the reaction at the highest temperature?

A P B Q
C R D S (2)

Nov 2013

11. The temperature of a substance is a measure of the ... of the particles.

A average potential energy B average kinetic energy
C total kinetic energy D total potential energy (2)

Mar 2014

12. In a chemical reaction, the difference between the potential energy of the products and the potential energy of the reactants is equal to the …

A enthalpy of the reaction.
B rate of the reaction.
C enthalpy change of the reaction.
D total potential energy of the particles. (2)

Mar 2014

13. The rate of a chemical reaction can be expressed in …

A grams per mole.
B energy consumed per mole.
C volume of gas per unit time.
D moles of product formed per litre of solution. (2)

Exemp 2014

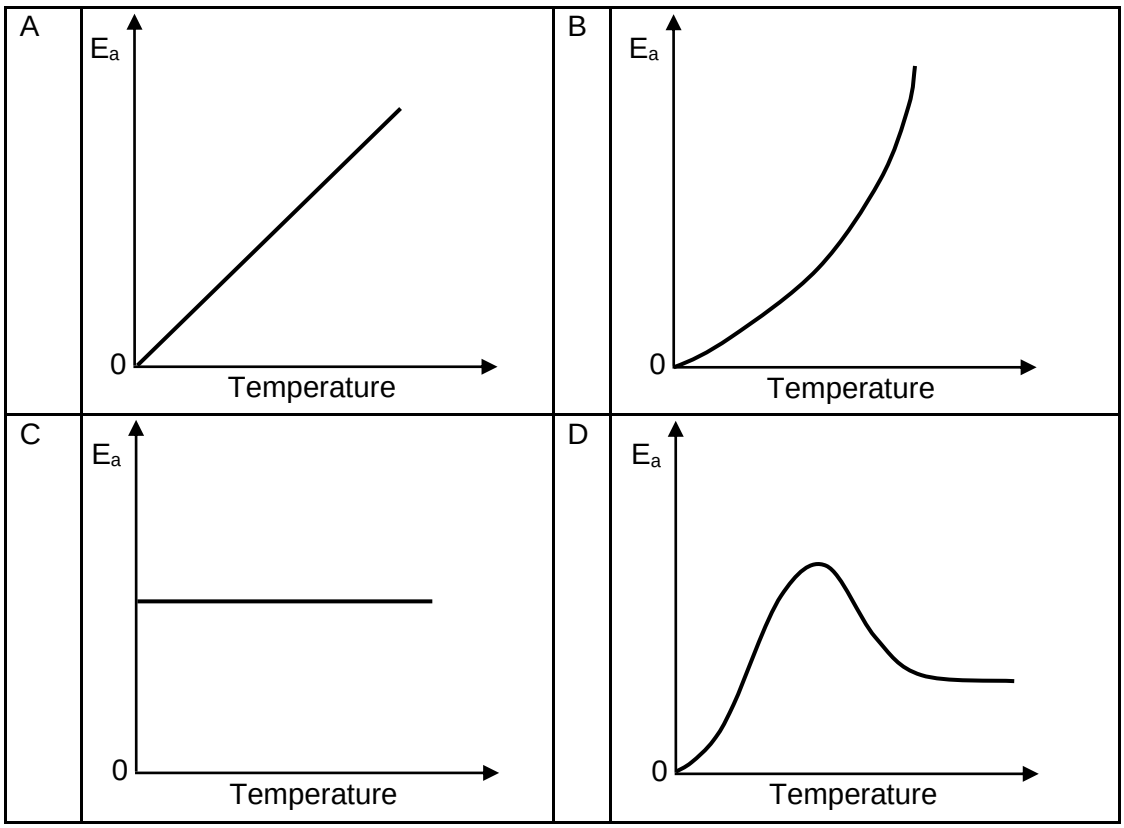
14. Which ONE of the following describes the effect of a positive catalyst on the net activation energy and the heat of reaction (ΔH) of a specific reaction?

	NET ACTIVATION ENERGY	**ΔH**
A	Increases	No effect
B	Decreases	Increases
C	No effect	Decreases
D	Decreases	No effect

(2)

Nov. 2014

15. Which ONE of the following graphs shows the relationship between activation energy (E_a) of a reaction and temperature?



(2)
Exemp 2014

16. Consider the reaction represented by the balanced equation below:

$$A_2(g) + B_2(g) \rightarrow 2AB(g)$$

The activation energy for the forward reaction is 180 kJ and that for the reverse reaction is 200 kJ. The heat of reaction (ΔH) is ...

A + 20 kJ. B - 20 kJ.
C + 380 kJ. D - 380 kJ. (2)
Mar 2015

17. When a catalyst is used in a chemical reaction, it increases the …

A rate of the reaction. B amount of products obtained.
C concentration of the products. D concentration of the reactants. (2)
Jun 2015

18. Consider the reaction represented by the balanced equation below:

$$2SO_3(g) \rightarrow 2SO_2(g) + O_2(g) \qquad \Delta H = 198\ kJ{\cdot}mol^{-1}$$

Which ONE of the following is TRUE for this reaction?

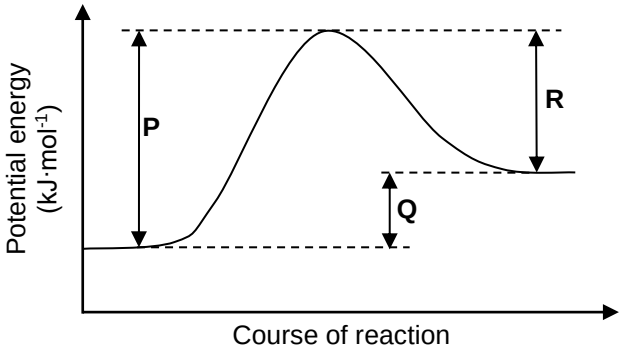
When 2 moles of $SO_2(g)$ are formed ...

A 198 kJ of energy are absorbed. B 198 kJ of energy are released.
C 396 kJ of energy are absorbed. D 396 kJ of energy are released. (2)
Jun 2015

19. The rate of a chemical reaction is most correctly defined as the ...

A time taken for a reaction to occur.
B speed at which a reaction takes place.
C change in the amount of reactants or products.
D change in the concentration of reactants or products per unit time. (2)
Nov 2015

20. The energy changes represented by **P**, **Q** and **R** on the potential energy graph below take place during a reversible chemical reaction.



Which ONE of the following changes will decrease both **P** and **R**, but leave **Q** unchanged?

A A decrease in volume
B The addition of a catalyst
C A decrease in temperature
D A decrease in concentration (2)

Nov 2015

21. The equation below represents the decomposition of calcium carbonate.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

Which ONE of the following factors will increase the initial rate of decomposition of calcium carbonate?

A Pressure
B Temperature
C Concentration
D Mass of $CaCO_3(s)$ (2)

Mar 2016

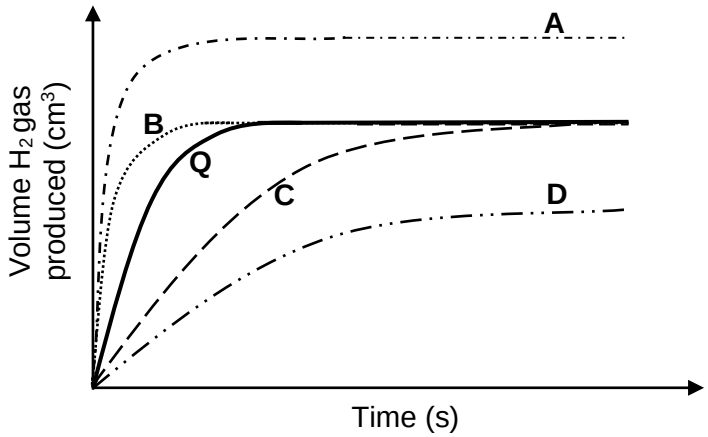
22. The activation energy for a certain reaction is 50 $kJ \cdot mol^{-1}$. Energy is absorbed when this reaction takes place. Which ONE of the following is CORRECT for the REVERSE reaction?

	ACTIVATION ENERGY (E_A)	**HEAT OF REACTION (ΔH)**
A	$E_A > 50\ kJ \cdot mol^{-1}$	$\Delta H > 0$
B	$E_A > 50\ kJ \cdot mol^{-1}$	$\Delta H < 0$
C	$E_A < 50\ kJ \cdot mol^{-1}$	$\Delta H < 0$
D	$E_A < 50\ kJ \cdot mol^{-1}$	$\Delta H > 0$

(2)

Mar 2016

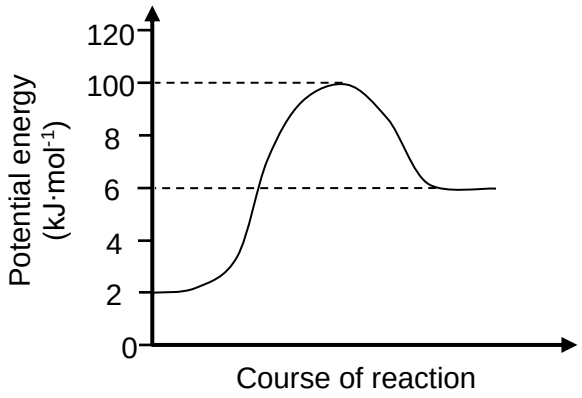
23. Graph **Q** (the solid line) below was obtained for the reaction of 100 cm^3 of a 0,1 $mol \cdot dm^{-3}$ HCℓ solution with excess magnesium powder. Which graph (**A**, **B**, **C** or **D**) most probably represents the reaction of 100 cm^3 of a 0,1 $mol \cdot dm^{-3}$ CH_3COOH solution with excess magnesium powder?



(2)

Jun 2016

24. Consider the following potential energy diagram for a chemical reaction:

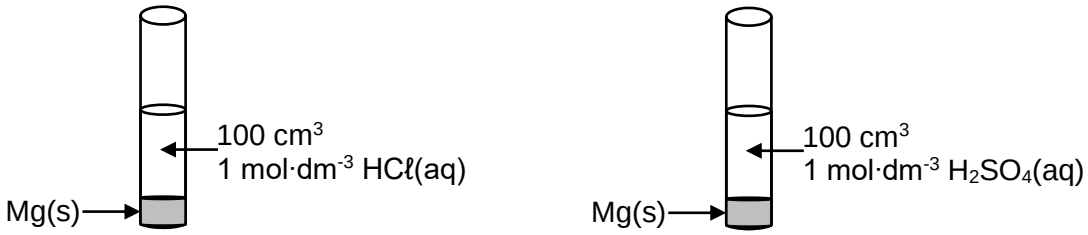


Which ONE of the following shows the values of the total energy change and the activation energy for this reaction?

	Energy change (kJ·mol^{-1})	**Activation energy (kJ·mol^{-1})**
A	80	40
B	60	100
C	40	80
D	– 40	80

(2)
Jun 2016

25. Equal amounts of magnesium (Mg) powder react respectively with equal volumes and equal concentrations of HCℓ(aq) and H_2SO_4(aq), as shown below.



Test tube X **Test tube Y**

The magnesium is in EXCESS.

Consider the following statements regarding these two reactions:

I: The initial rate of the reaction in test tube **X** equals the initial rate of the reaction in test tube **Y**.
II: After completion of the reactions, the mass of magnesium that remains in test tube **X** will be greater than that in test tube **Y**.
III: The amount of hydrogen gas formed in **X** is equal to the amount of hydrogen gas formed in **Y**.

Which of the above statements is/are TRUE?

A **I** only B **II** only
C **III** only D **I** and **III** only (2)
Nov 2016

26. A potential energy diagram can be used to show the activation energy (E_A) and the heat of reaction (ΔH) of a reaction.
Which ONE of the following combinations of values of E_A and ΔH CANNOT be obtained for any reaction?

	E_A (kJ·mol^{-1})	ΔH (kJ·mol^{-1})
A	50	-100
B	50	+100
C	100	+50
D	100	-50

(2)
Mar 2017

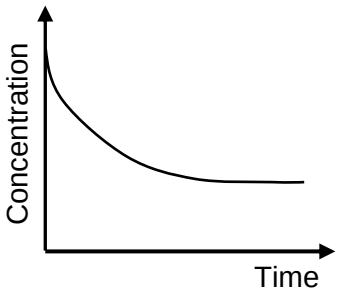
27. The energy change during a chemical reaction is known as …

A bond energy. B heat of reaction.
C activation energy. D activated complex. (2)
Jun 2017

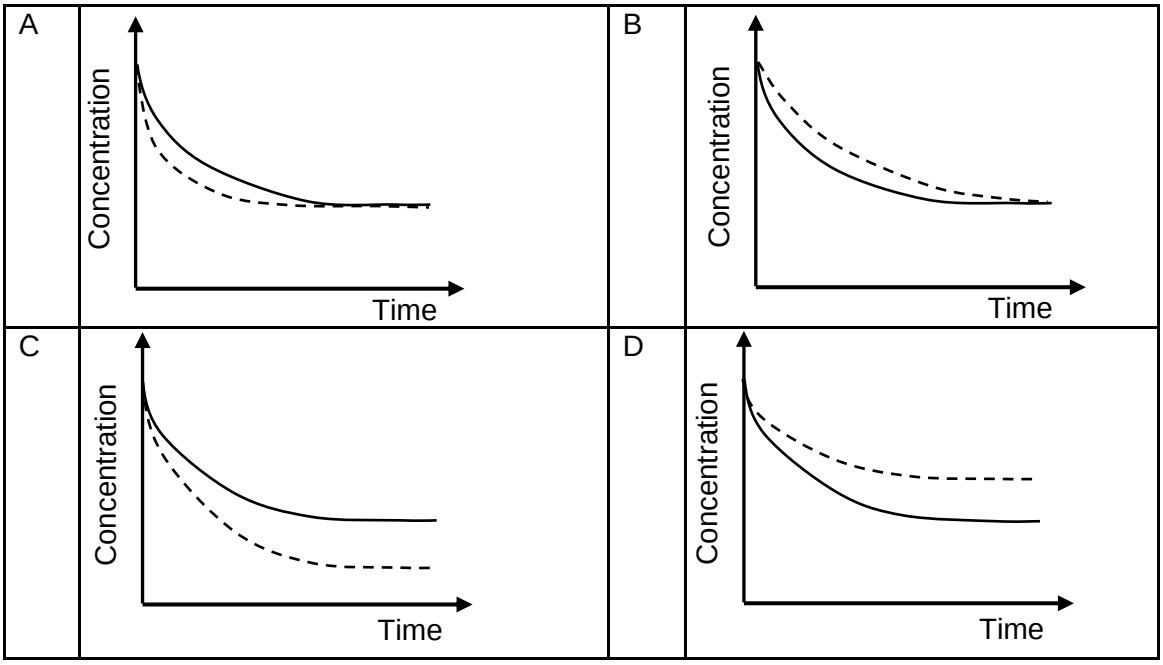
28. Activation energy can best be described as the minimum energy required to …

A cause effective collisions.
B make reactant molecules collide.
C change the orientation of reactant molecules.
D increase the kinetic energy of reactant molecules. (2)
Nov 2018

29. The graph below represents the change in concentration of a reactant against time for a chemical reaction.

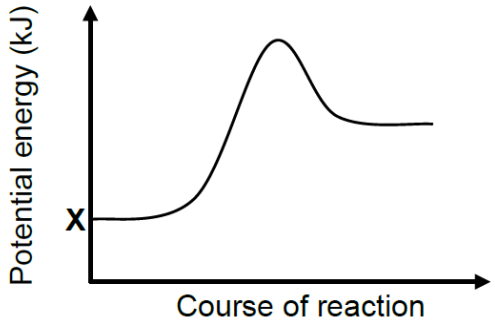


In which ONE of the following graphs does the dotted line show the effect of a catalyst on this reactant?



(2)
Mar 2017

30. The potential energy diagram for a chemical reaction is shown below.



Consider the following statements regarding the graph above:

I: **X** represents the potential energy of the products formed during the reverse r reaction.

II: The graph could be a representation of the change in potential energy for the following reaction: $CaCO_3(s) \rightleftharpoons Ca^{2+}(aq) + CO_3^{2-}(aq)$ $\Delta H > 0$

III: The graph could be a representation of the change in potential energy for the combustion of methane.

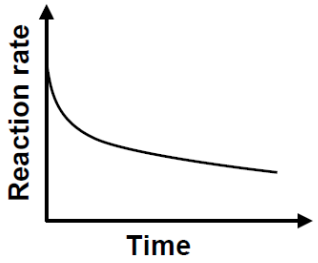
Which of the statements above are TRUE?

A **I** and **II** only B **II** and **III** only
C **I** and **III** only D **I, II** and **III** (2)

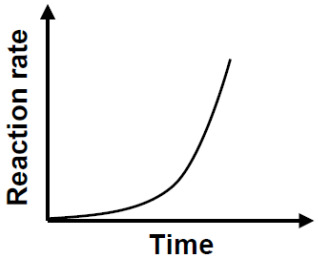
Nov 2017

31. Which ONE of the reaction rate versus time graphs below best represents the reaction between magnesium and EXCESS dilute hydrochloric acid?

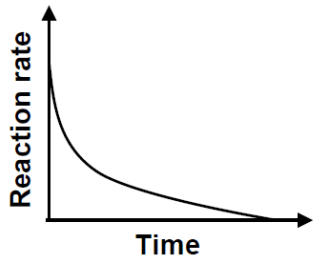
A



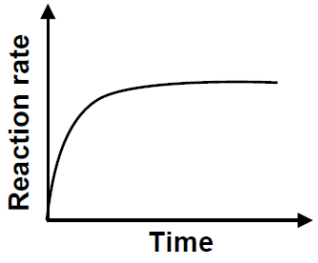
B



C



D



(2)

Mar 2018

32. Study the following hypothetical reaction:

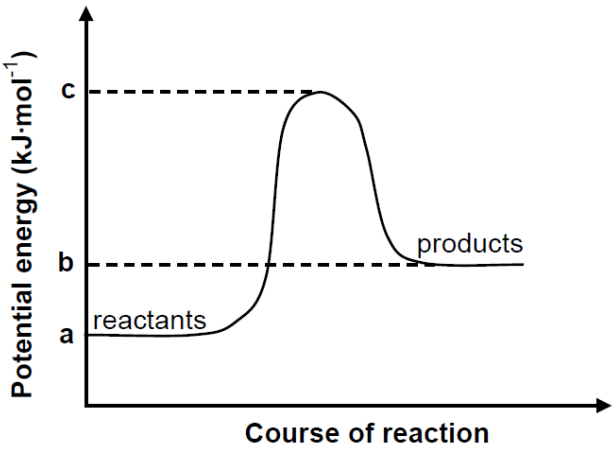
$$2P(g) + 3Q(g) \rightarrow 4R(g) + 2Z(g)$$

The rate of the reaction in terms of the number of moles of substance **P** used up, is 1×10^{-3} mol·dm^{-3}·s^{-1}. What is the rate (in mol·dm^{-3}·s^{-1}) at which product **R** is formed?

A 1×10^{-3} B $4(1 \times 10^{-3})$
C $\frac{1 \times 10^{-3}}{2}$ D $2(1 \times 10^{-3})$ (2)

Jun 2018

33. The potential energy graph for a hypothetical chemical reaction is shown below.



What type of reaction is taking place and what are the correct methods to calculate ΔH and E_a?

	TYPE OF REACTION	ΔH	E_a
A	Exothermic	b − a	c − b
B	Endothermic	b − a	c − a
C	Endothermic	a − b	a − c
D	Exothermic	a − b	b − c

(2)
Jun 2018

34. Activation energy can best be described as the minimum energy required to …

A cause effective collisions.
B make reactant molecules collide.
C change the orientation of reactant molecules.
D increase the kinetic energy of reactant molecules. (2)
Nov 2018

35. Consider the balanced equation for a chemical reaction below.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

The activation energy of the forward and reverse reactions are 156 kJ·mol^{-1} and 175 kJ·mol^{-1} respectively. The heat of reaction, in kJ·mol^{-1}, for this reaction is …

A –19. B +19.
C +331. D –331. (2)
Jun 2019

36. Which ONE of the following sets of values for activation energy (**E_a**) and heat of reaction (**ΔH**) is possible for a reaction?

	ACTIVATION ENERGY (Ea) (kJ·mol^{-1})	HEAT OF REACTION (ΔH) (kJ·mol^{-1})
A	100	+100
B	50	+100
C	50	+50
D	100	-50

(2)
Nov 2019

37. Zinc (Zn) granules react as follows with EXCESS hydrochloric acid solution, HCℓ(aq):

$$Zn(s) + HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$$

Which ONE of the following combinations of volume and concentration of HCℓ(aq) will result in the highest INITIAL reaction rate for the same mass of zinc granules used? (Assume that the zinc granules are completely covered by the acid in all cases.)

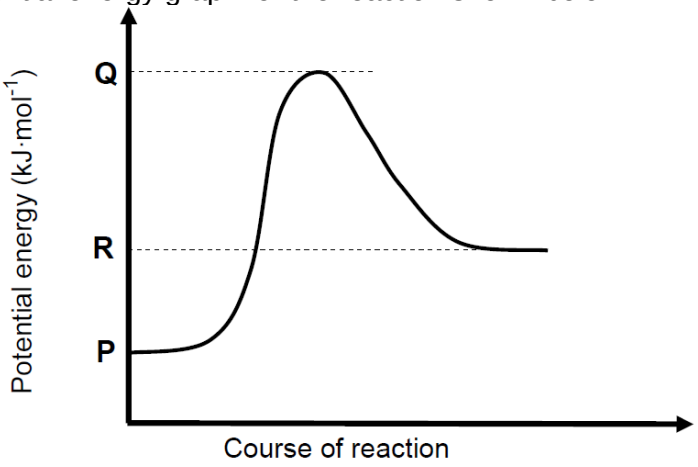
	VOLUME HCℓ(aq) (cm^3)	**CONCENTRATION HCℓ(aq) ($mol \cdot dm^{-3}$)**
A	50	0,5
B	100	1,0
C	200	0,1
D	200	0,5

(2)
Nov 2020

38. The role of a catalyst in a chemical reaction is to increase the …

A yield. B activation energy.
C heat of reaction. D rate of the reaction. (2)
Nov 2020

39. Consider the potential energy graph for the reaction shown below.



The activation energy for the FORWARD reaction in terms of **P**, **Q** and **R** is:

A **Q** B **R – P**
C **Q – R** D **Q – P** (2)
Jun 2021

40. 2 g piece of magnesium reacts with EXCESS hydrochloric acid according to the following balanced equation:

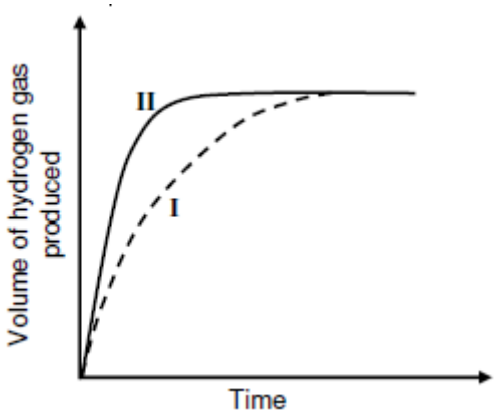
$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

Which ONE of the following changes will INCREASE the YIELD of $H_2(g)$?

A Crush the piece of magnesium.
B Use a 3 g piece of magnesium.
C Use a greater volume of the acid.
D Use a higher concentration of the acid. (2)
Nov 2021

41. A hydrochloric acid solution, HCℓ(aq), of concentration 1 mol·dm^{-3} is added to EXCESS POWDERED magnesium at 25 °C.

Curve **I** below represents the volume of hydrogen gas produced during the reaction.
Curve **II** was obtained at different conditions using the SAME VOLUME of hydrochloric acid solution.



Which ONE of the following represents the conditions used to obtain curve **II**?

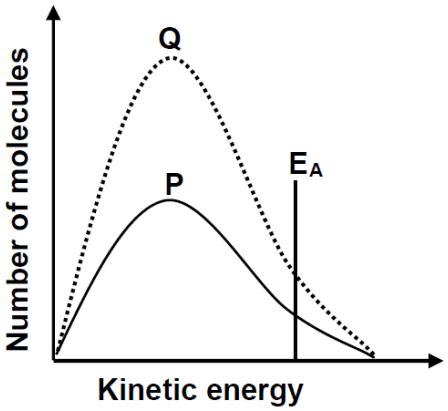
	STATE OF DIVISION OF Mg	CONCENTRATION ACID (mol·dm^{-3})	TEMPERATURE (°C)
A	Ribbon	0,5	25
B	Ribbon	2	25
C	Powder	1	20
D	Powder	1	30

(2)
Sep 2021

42. Which ONE of the following statements is TRUE for an EXOTHERMIC reaction?

A More energy is absorbed than released.
B More energy is released than absorbed.
C Heat of reaction (ΔH) is positive.
D Energy of the products is greater than the energy of the reactants. (2)
Sep 2021

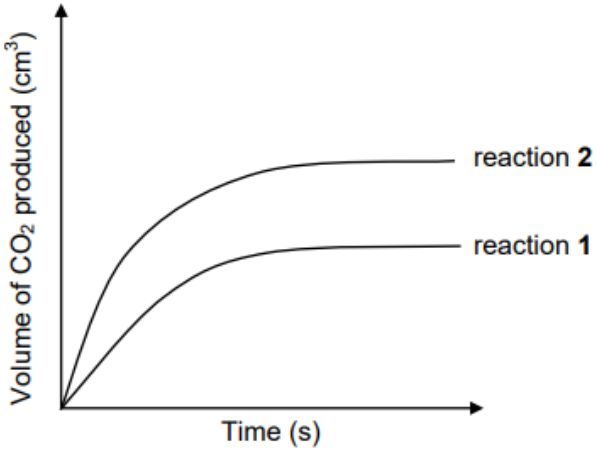
43. The Maxwell-Boltzmann distribution curve **P** represents the number of molecules against kinetic energy for a certain reaction.
Curve **Q** is obtained after a change was made to one reaction condition.



Which ONE of the following changes resulted in curve **Q**?

A Addition of a catalyst
B Increase in temperature
C Increase in activation energy
D Increase in the concentration of the reactants (2)
Nov 2021

44. Two DIFFERENT samples of IMPURE $CaCO_3$ of EQUAL masses react with 0,1 mol·dm^{-3} H_2SO_4. Assume that the impurities do not react. The graph below shows the volume of $CO_2(g)$ produced for each reaction.



When compared to reaction **2**, which ONE of the following statements BEST explains the curve obtained for reaction **1**?

A The temperature is higher in reaction **1**.
B The surface area is greater in reaction **2**.
C The amount of impurities is greater in reaction **2**.
D The amount of impurities is greater in reaction **1**. (2)

Jun 2022

45. The equation below represents a hypothetical reaction.

$$A(g) + B(g) \rightleftharpoons C(g) \quad \Delta H = -50 \text{ kJ·mol}^{-1}$$

The activation energy for the REVERSE reaction is 110 kJ·mol^{-1}.
Which ONE of the following is the activation energy (in kJ·mol^{-1}) for the FORWARD reaction?

A 50 B 60
C 110 D 160 (2)

Jun 2022

46. Which ONE of the following statements is the CORRECT definition for the rate of a reaction?

A The time taken for the reaction to take place
B The speed at which the reaction takes place
C The rate of change in concentration of the products or reactants
D The rate of change in concentration of the products or reactants per unit time (2)

Nov 2022

47. Consider the balanced equation for the reaction between magnesium powder and EXCESS dilute hydrochloric acid, HCℓ(aq):

$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

Which ONE of the following will NOT increase the rate of this reaction?

A Increasing the volume of HCℓ(aq)
B Increasing the temperature of HCℓ(aq)
C Increasing the concentration of HCℓ(aq)
D Adding more magnesium powder (2)

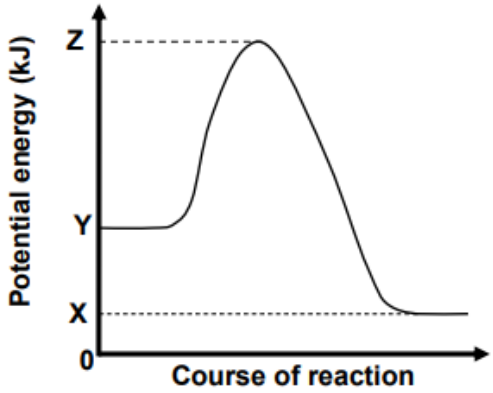
Nov 2022

48. EXCESS HCℓ(aq) of concentration 0,1 mol·dm^{-3} reacts with 2 g of Mg under different conditions. Which ONE of the following combinations of conditions will produce the largest volume of H_2(g) in the FIRST MINUTE of the reaction?

	STATE OF DIVISION OF Mg	TEMPERATURE OF HCℓ(aq) (°C)
A	Powder	20
B	Granules	20
C	Powder	50
D	Granules	50

(2)
Jun 2023

49. The potential energy diagram for a chemical reaction is shown below.



Which ONE of the following combinations is CORRECT for the FORWARD reaction?

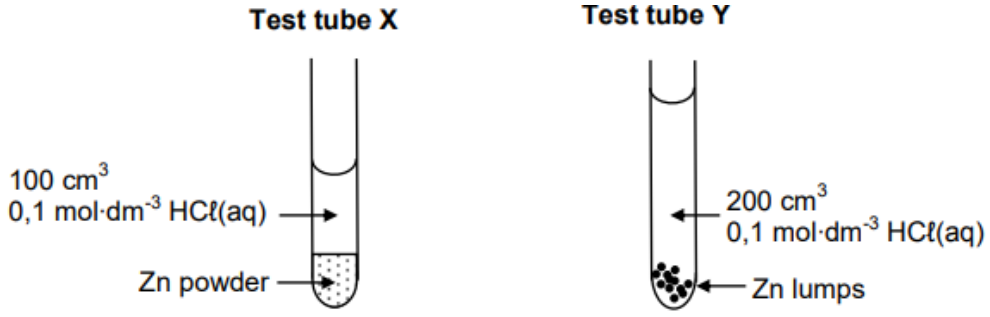
	ΔH	ACTIVATION ENERGY	POTENTIAL ENERGY OF THE ACTIVATED COMPLEX
A	Y - X	Z + Y	Z
B	Y - X	Z - Y	Z + Y
C	X - Y	Z - Y	Z
D	X - Y	Z	Z - Y

(2)
Jun 2023

1.4 Hydrochloric acid reacts with EXCESS zinc:

$$Zn(s) + 2HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$$

Different reaction conditions are shown in the diagrams below. The mass of zinc used is the same in both test tubes.



How will the INITIAL rate of reaction and FINAL VOLUME of H_2(g) produced in test tube **Y** compare with that in test tube **X**?

	INITIAL RATE OF REACTION IN Y	FINAL VOLUME OF H_2(g) IN Y
A	Higher	Equal
B	Lower	More
C	Lower	Equal
D	Higher	More

(2)
Nov 2023

CHEMICAL EQUILIBRIUM

1. In which ONE of the following equilibrium reactions is the yield of products favoured by increasing the pressure of the reaction mixture?

   A $2NO(g) + C\ell_2(g) \rightleftharpoons 2NOC\ell(g)$
   B $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$
   C $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$
   D $PC\ell_5(g) \rightleftharpoons PC\ell_3(g) + C\ell_2(g)$ (2)

   Exemp 2008

2. The following reaction is in equilibrium in a closed container:

   $$PC\ell_5(g) \rightleftharpoons PC\ell_3(g) + C\ell_2(g) \qquad \Delta H < 0$$

   Which ONE of the following statements regarding the equilibrium is TRUE?

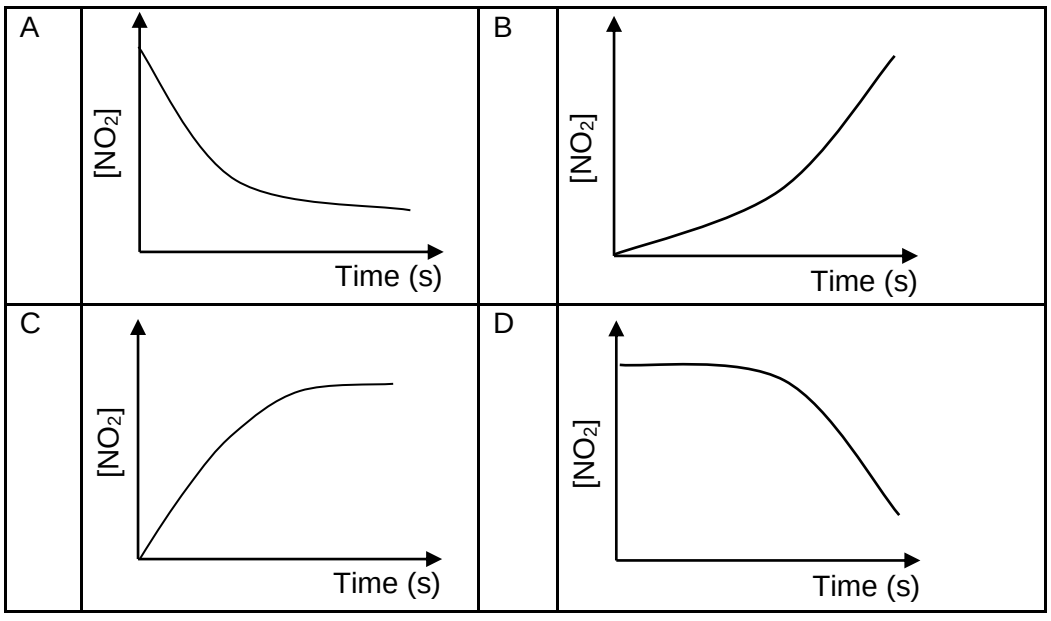
   A Addition of a catalyst favours the forward reaction.
   B Increasing the temperature has no effect on the yield of products.
   C An increase in the concentration of $PC\ell_5(g)$ causes an increase in the concentration of the products.
   D Increasing the temperature causes the value of the equilibrium constant to increase. (2)

   Exemp 2008

3. $N_2O_4(g)$ is placed in an evacuated, sealed container.
   The following reaction takes place in the container at constant temperature:

   $$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

   The concentration of the product is measured over time. Which ONE of the following graphs correctly illustrates the relationship between the nitrogen dioxide (NO_2) concentration and time?



   (2)

   Mar 2009

4. When the equilibrium constant of a reversible reaction has a value much greater than 1 ($K_c > 1$), it indicates that …

   A a higher concentration of products than reactants will be formed.
   B a lower concentration of products than reactants will be formed.
   C the reaction will reach equilibrium quickly.
   D the reaction will take a long time to reach equilibrium. (2)

   Nov 2009

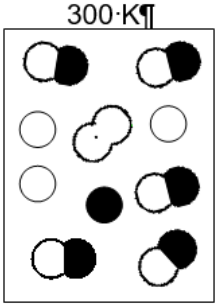
5. The following hypothetical reaction is at equilibrium at 300 K:

$$A_2(g) + B(g) \rightleftharpoons A(g) + AB(g)$$

The diagram below shows the molecules involved in this chemical equilibrium at 300 K.

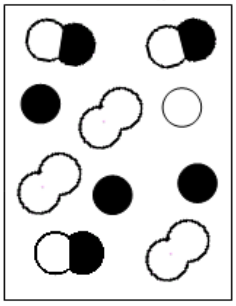
The white circles represent atoms of A and the black circles represent atoms of B.

300·K¶



The temperature is increased to 500 K. The diagram below represents the same equilibrium mixture at 500 K.

500·K¶



Which ONE of the following statements is CORRECT?

A The forward reaction is exothermic.
B The concentration of AB is lower at a lower temperature.
C The forward reaction is endothermic.
D The concentration of B is higher at a lower temperature. (2)

Mar 2009

6. Diagrams **P**, **Q** and **R** represent different reaction mixtures of the following hypothetical reaction that is at equilibrium in a closed container at a certain temperature.

$$X(g) + Y_2(g) \rightleftharpoons XY(g) + Y(g) \qquad \Delta H > 0$$

KEY **X:** ◯ **Y:** ●

Diagram P

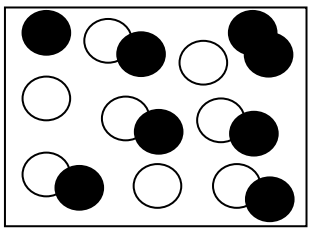


Diagram Q

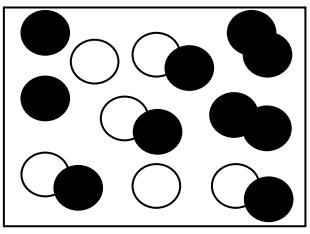
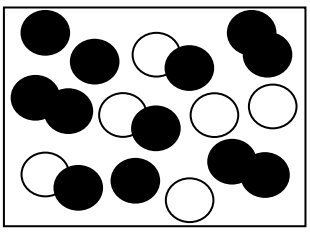


Diagram R



If at equilibrium $\mathbf{K_c = 2}$, which diagram(s) correctly represent(s) the mixture at equilibrium?

A **P** only
B **Q** only
C **R** only
D **P**, **R** and **Q** (2)

Nov 2009

7. Consider the following hypothetical reaction that reached equilibrium in a closed container at 450 °C:

$$XY(s) \rightleftharpoons X(g) + Y(s) \qquad \Delta H > 0$$

Which ONE of the following changes will NOT affect the equilibrium position?

A Increase in temperature
B Increase in the amount of Y(s)
C Decrease in pressure at constant volume
D Increase in the volume of the container (2)

Mar 2010

8. The reaction represented by the equation below reaches equilibrium.

$$Co(H_2O)_6^{2+}(aq) + 4C\ell^-(aq) \rightleftharpoons CoC\ell_4^{2-}(aq) + 6H_2O(\ell) \qquad \Delta H > 0$$

pink blue

Which ONE of the following changes to the reaction mixture will change its colour from blue to pink?

A Add a catalyst.
B Place the reaction mixture in a container with hot water.
C Add a few drops of concentrated hydrochloric acid to the reaction mixture.
D Add water to the reaction mixture. (2)

Nov 2010

9. A chemical reaction reaches equilibrium. Which ONE of the following statements regarding this equilibrium is TRUE?

A The concentrations of the individual reactants and products are constant.
B The concentrations of the individual reactants and products are equal.
C The concentrations of the individual reactants are zero.
D The concentrations of the individual products increase until the reaction stops. (2)

Mar 2011

10. The equation below represents a chemical reaction at equilibrium in a closed container.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H < 0$$

Which ONE of the following changes will increase the yield of HI(g) in the above reaction?

A Increase the temperature
B Decrease the temperature
C Increase the pressure by decreasing the volume
D Decrease the pressure by increasing the volume (2)

Mar 2011

11. The balanced equation below represents a reaction at equilibrium in a closed container:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H < 0$$

Which ONE of the following conditions of temperature and pressure will BOTH favour the forward reaction?

	TEMPERATURE	**PRESSURE**
A	Low	High
B	High	High
C	High	Low
D	Low	Low

(2)

FS Jun 2011

12. The reaction represented by the equation below reaches equilibrium.

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell)$$
yellow orange

Which ONE of the following changes to the reaction mixture will change its colour from yellow to orange?

A Add a catalyst.
B Add water to the reaction mixture.
C Add a few drops of sodium hydroxide solution to the reaction mixture.
D Add a few drops of concentrated hydrochloric acid to the reaction mixture. (2)

Nov 2011

13. The following hypothetical reaction reaches equilibrium in a closed container at a certain temperature:

$$X_2(g) + Y_2(g) \rightleftharpoons 2XY(g) \qquad \Delta H < 0$$

Which ONE of the following changes will increase the AMOUNT of XY(g)?

A Decrease in temperature
B Increase in temperature
C Increase in pressure
D Decrease in pressure (2)

Mar 2012

14. Consider the chemical reaction represented by the equation below.

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$

Which ONE of the following changes will increase the rate of production of $CO_2(g)$?

A Increase in pressure
B Increase in mass of $CaCO_3$
C Increase in volume of $HC\ell(aq)$
D Increase in concentration of $HC\ell(aq)$ (2)

Mar 2012

15. The expression for the equilibrium constant (K_C) of a hypothetical reaction is given as follows:

$$K_C = \frac{[D]^2[C]}{[A]^3}$$

Which ONE of the following equations for a reaction at equilibrium matches the above expression?

A $3A(s) \rightleftharpoons C(g) + 2D(g)$

B $3A(\ell) \rightleftharpoons C(aq) + 2D(aq)$

C $3A(aq) + B(s) \rightleftharpoons C(g) + D_2(g)$

D $3A(aq) + B(s) \rightleftharpoons C(aq) + 2D(aq)$ (2)

Nov 2012

16. The reaction represented by the balanced equation below reaches equilibrium in a closed container.

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \qquad \Delta H < 0$$

Which ONE of the following changes will INCREASE the yield of $N_2O_4(g)$?

A Add a catalyst.
B Remove NO_2 gas from the container.
C Increase the temperature of the system.
D Decrease the temperature of the system. (2)

Nov 2012

17. Which ONE of the following CORRECTLY describes the effect of an INCREASE IN TEMPERATURE on a reaction at equilibrium?

	Reaction favoured	Reaction rate
A	Exothermic	Increases
B	Exothermic	Decreases
C	Endothermic	Increases
D	Endothermic	Decreases

(2)
Mar 2013

18. Each of the reactions represented below is at equilibrium in a closed container. In which ONE of these reactions will an INCREASE IN PRESSURE (by decreasing the volume) favour the formation of products?

A $N_2O_4(g) \rightleftharpoons 2NO_2(g)$
B $PC\ell_5(g) \rightleftharpoons PC\ell_3(g) + C\ell_2(g)$
C $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
D $NO_2(g) + CO(g) \rightleftharpoons NO(g) + CO_2(g)$ (2)
Mar 2013

19. The reaction represented below reaches equilibrium in a closed container.

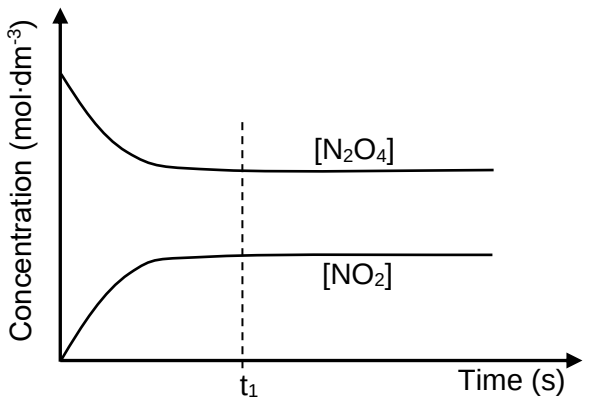
$$CuO(s) + H_2(g) \rightleftharpoons Cu(s) + H_2O(g) \quad \Delta H < 0$$

Which ONE of the following changes will increase the yield of products?

A Increase temperature.
B Decrease temperature.
C Increase pressure by decreasing the volume.
D Decrease pressure by increasing the volume. (2)
Nov 2013

20. The graph below represents the decomposition of $N_2O_4(g)$ in a closed container according to the following equation:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

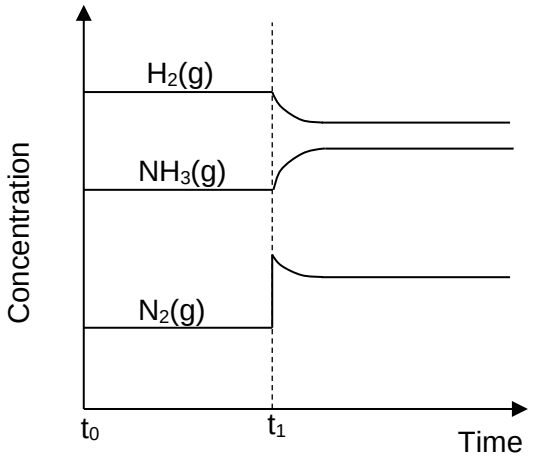


Which ONE of the following correctly describes the situation at t_1?

A The N_2O_4 gas is used up.
B The NO_2 gas is used up.
C The rate of the forward reaction equals the rate of the reverse reaction.
D The concentrations of the reactant and the product are equal. (2)
Nov 2013

21. The graph below shows a change made to a chemical equilibrium in a closed container at time t_1. The equation for the reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$



Which ONE of the following is the change made at time t_1?

A Addition of a catalyst
B Increase in temperature
C Increase in the concentration of $N_2(g)$
D Increase in pressure by decreasing the volume (2)

Mar 2014

22. Initially, a certain amount of $IC\ell(g)$ is sealed in an empty flask at a certain temperature. The reaction that takes place is:

$$2IC\ell(g) \rightleftharpoons I_2(g) + C\ell_2(g)$$

Which of the following statements describe(s) the change(s) occurring as the system proceeds towards equilibrium?

(I) The rate of the backward reaction increases.
(II) Concentration of $IC\ell(g)$ increases.
(III) Concentration of $C\ell_2(g)$ increases.

A (I) only
B (II) only
C (I) and (III) only
D (II) and (III) only (2)

Exemp 2014

23. A hypothetical reaction reaches equilibrium at 10 °C in a closed container according to the following balanced equation:

$$A(g) + B(g) \rightleftharpoons AB(g) \qquad \Delta H < 0$$

The temperature is now increased to 25 °C. Which ONE of the following is correct as the reaction approaches a new equilibrium?

	REACTION RATE	YIELD OF PRODUCTS
A	Increases	Remains the same
B	Increases	Decreases
C	Increases	Increases
D	Decreases	Decreases

(2)

Nov. 2014

24. The following reaction reaches equilibrium in a closed container at a certain temperature:

$$2O_3(g) \rightleftharpoons 3O_2(g)$$

The pressure is now decreased by increasing the volume of the container at constant temperature.

Which ONE of the following is correct as the reaction approaches a new equilibrium?

	NUMBER OF MOLES OF $O_3(g)$	NUMBER OF MOLES OF $O_2(g)$	CONCENTRATION OF $O_2(g)$
A	Increases	Decreases	Decreases
B	Decreases	Increases	Increases
C	Decreases	Increases	Decreases
D	Increases	Decreases	Increases

(2)
Nov.2014

25. Consider the equilibrium constants for the same reaction at two different temperatures below.

298 K: $K_c = 0,03$

318 K: $K_c = 0,005$

Which ONE of the following is CORRECT?

	HEAT OF REACTION	YIELD OF PRODUCTS AS THE TEMPERATURE INCREASES
A	$\Delta H > 0$	Increases
B	$\Delta H < 0$	Decreases
C	$\Delta H > 0$	Decreases
D	$\Delta H < 0$	Remains the same

(2)
Mar 2015

26. The reaction of an acid-base indicator, represented as HIn(aq), with $H_2O(\ell)$ reaches equilibrium according to the following balanced equation:

$$\underset{\text{yellow}}{HIn(aq)} + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + \underset{\text{purple}}{In^-(aq)} \qquad \Delta H > 0$$

At equilibrium the colour of the solution is purple. Which ONE of the following will change the colour of the solution from purple to yellow?

A Add NaOH(aq) B Add HCℓ(aq)
C Add water D Increase the temperature (2)
Mar 2015

27. The equilibrium constant, K_c, for the reaction $A(g) \rightleftharpoons B(g)$ is 1×10^{-4}.

Which ONE of the following statements is always CORRECT for this reaction?

The mixture at equilibrium consists of ...

A equal amounts of A(g) and B(g). B very little of A(g).
C mostly A(g). D mostly B(g). (2)
Jun 2015

28. The reaction represented by the balanced equation below reaches equilibrium in a closed container.

$$C\ell_2(g) + H_2O(\ell) \rightleftharpoons C\ell^-(aq) + C\ell O^-(aq) + 2H^+(aq)$$

Which ONE of the following reagents will favour the forward reaction when added?

A Hydrogen B Sodium chloride
C Hydrogen chloride D Sodium hydroxide (2)

Nov 2015

29. The balanced equations for three reactions at equilibrium in a closed container are given below.

(i) $C_2H_4(g) + H_2(g) \rightleftharpoons C_2H_6(g)$
(ii) $Fe_3O_4(s) + 4H_2(g) \rightleftharpoons 3Fe(s) + 4H_2O(g)$
(iii) $SO_3(g) + NO(g) \rightleftharpoons NO_2(g) + SO_2(g)$

In which reaction(s) will the equilibrium position shift when the volume of the reaction vessel is decreased at constant temperature?

A (i) only B (i) and (ii) only
C (i) and (iii) only D (i), (ii) and (iii) (2)

Mar 2016

30. Chromate ions and dichromate ions are in equilibrium with each other in an aqueous solution according to the following balanced equation:

$$\underset{\text{yellow}}{2CrO_4^{2-}(aq)} + 2H^+(aq) \rightleftharpoons \underset{\text{orange}}{Cr_2O_7^{2-}(aq)} + H_2O(\ell)$$

Which ONE of the following reagents should be added to change the colour of the solution to yellow?

A HNO_3 B $HC\ell$
C NaOH D CH_3COOH (2)

Jun 2016

31. A catalyst is added to a reaction mixture at equilibrium. Which ONE of the following statements about the effect of the catalyst is FALSE?

A The rate of the forward reaction increases.
B The rate of the reverse reaction increases.
C The equilibrium position shifts to the right.
D The equilibrium position remains unchanged. (2)

Nov 2016

32. Initially, 2 mol CO(g) and 2 mol H_2(g) are sealed in a container. The reaction reaches equilibrium according to the following balanced equation:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

At equilibrium the amount of CH_3OH(g) in the mixture will be …

A 1 mol. B 2 mol.
C less than 1 mol. D greater than 1 mol. (2)

Mar 2017

33. The reaction below reaches equilibrium in a closed container.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + \text{energy}$$

Consider the following statements regarding the equilibrium above:

I: When one N_2 molecule combines with three H_2 molecules, two NH_3 molecules decompose at the same time.
II: An iron oxide catalyst increases the amount of ammonia produced in this reaction.
III: When the temperature increases, the equilibrium constant (K_c) for this reaction will increase.

Which of the above statements is/are CORRECT?

A **I** only B **I** and **II** only
C **I** and **III** only D **I, II** and **III** (2)

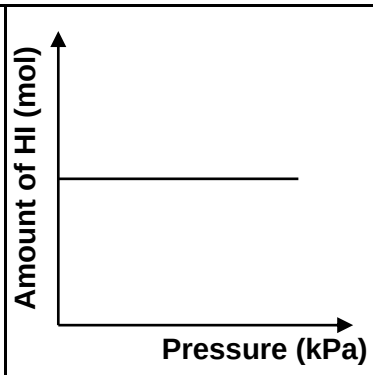
Jun 2017

34. The reaction between hydrogen gas and iodine gas reaches equilibrium in a closed container according to the following balanced equation:

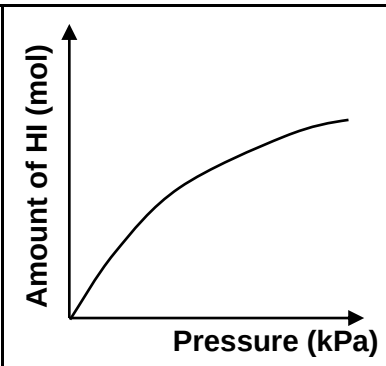
$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Which ONE of the graphs below shows the relationship between the amount of HI(g) at equilibrium and the pressure in the container at constant temperature?

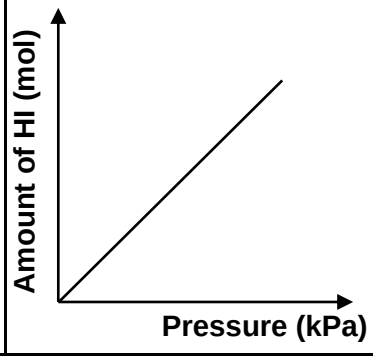
A



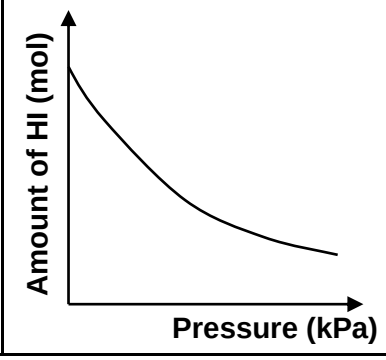
B



C



D



(2)
Nov 2016

35. Which ONE of the descriptions below is TRUE for a chemical reaction in equilibrium?

	CONCENTRATIONS OF REACTANTS AND PRODUCTS	FORWARD AND REVERSE REACTION RATES
A	Remain constant	Equal
B	Remain constant	Not equal
C	Equal	Equal
D	Not equal	Not equal

(2)
Jun 2017

36. A certain chemical reaction reaches equilibrium at 25 °C.
The equilibrium constant, K_c, for the reaction at this temperature is $1,0 \times 10^{-4}$.

Which ONE of the following statements regarding this reaction at equilibrium is CORRECT?

A The concentration of the products is equal to that of the reactants.
B The concentration of the products is higher than that of the reactants.
C The concentration of the products is lower than that of the reactants.
D The rate of the forward reaction is lower than the rate of the reverse reaction. (2)
Nov 2017

37. Which ONE of the following will NOT affect the equilibrium position of reversible chemical reactions?

A Temperature
B Catalyst
C Pressure
D Concentration (2)
Mar 2018

38. Consider the following chemical reaction at equilibrium in a closed container:

$$2HgO(s) \rightleftharpoons 2Hg(\ell) + O_2(g)$$

More HgO(s) is now added to the container at constant temperature. How will the number (in moles) of $O_2(g)$ and the value of K_c be affected at equilibrium?

	NUMBER OF MOLES OF O_2	**K_c**
A	Increases	Increases
B	Increases	Remains the same
C	Remains the same	Remains the same
D	Remains the same	Increases

(2)
Nov 2017

39. Study the following reaction at equilibrium at a certain temperature.

$$2SO_3(g) \rightleftharpoons O_2(g) + 2SO_2(g) \qquad \Delta H > 0$$

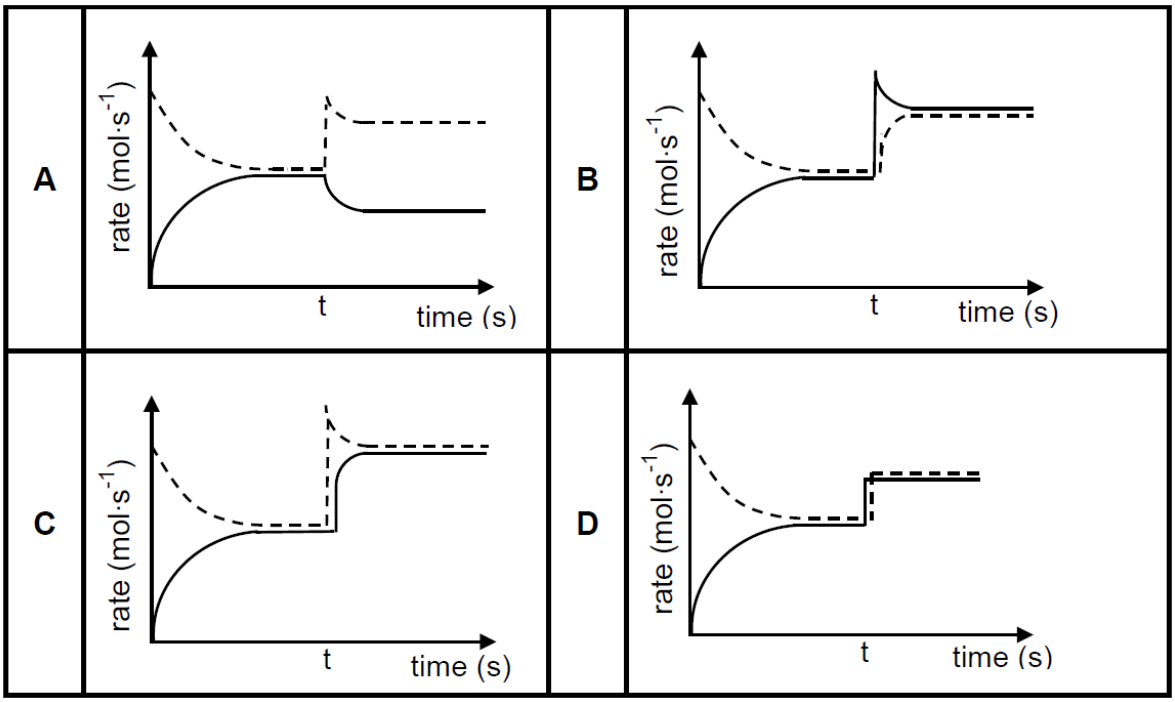
Which ONE of the following factors will change the K_c value?

A Adding more $SO_2(g)$.
B Adding a catalyst.
C Increasing the temperature.
C Increasing the pressure by decreasing the volume. (2)
Jun 2018

40. Initially, a certain amount of P(g) was placed in an empty container. The hypothetical reaction reaches equilibrium in a closed container according to the following balanced equation:

$$P(g) \rightleftharpoons 2Q(g) \qquad \Delta H < 0$$

At time t, the temperature is increased.
Which graph below best illustrates the resulting changes in the rates of the forward and reverse reactions after the temperature is increased?



(2)
Nov 2018

41. Which statement is CORRECT for a system in DYNAMIC EQUILIBRIUM?

A All reactants are used up.
B The forward reaction is equal to the reverse reaction.
C All substances in the reaction are of equal concentration.
D The concentration of the reactants and products remain constant. (2)

Nov 2018

42. The reaction given below reaches equilibrium in a closed container. The K_c value is 0,04 at a certain temperature.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H < 0$$

Which ONE of the following factors will change the K_c value to 0,4?

A Increase in pressure B Decrease in pressure
C Increase in temperature D Decrease in temperature (2)

Jun 2019

43. Which ONE of the following statements best describes a state of dynamic equilibrium?

A The limiting reagent has been used up.
B The forward and reverse reactions have stopped.
C The rates of the forward and reverse reactions are equal.
D The concentration of products equals the concentration of reactants. (2)

Jun 2019

44. Consider the following balanced equation for a system at equilibrium:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

How will the addition of a catalyst to the equilibrium mixture affect the YIELD and REACTION RATE?

	YIELD	**REACTION RATE**
A	Increases	Increases
B	Remains the same	Remains the same
C	Remains the same	Increases
D	Decreases	Increases

(2)

Nov 2019

45. A hypothetical reaction reaches equilibrium at a certain temperature in a closed container according to the following balanced equation:

$$A(g) + 2B(g) \rightleftharpoons 3C(s) \quad \Delta H < 0$$

Which ONE of the following changes to the equilibrium conditions will result in an INCREASE in the equilibrium constant, K_c?

A Increase in temperature
B Decrease in temperature
C Increase in pressure at constant temperature
D Decrease in pressure at constant temperature (2)

Nov 2019

46. Consider the equilibrium represented by the balanced equation below:

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell) \qquad \Delta H < 0$$

Which ONE of the following changes to the equilibrium will favour the forward reaction?

	TEMPERATURE	**pH**
A	Decrease	Increase
B	Decrease	Decrease
C	Increase	Increase
D	Increase	Decrease

(2)

Nov 2020

47. The equation below represents a reaction at equilibrium.

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell)$$
yellow orange

Which ONE of the following will change the colour of the mixture from yellow to orange?

A Addition of sodium hydroxide pellets
B Addition of concentrated hydrochloric acid
C Increase in pressure at constant temperature
D Decrease in pressure at constant temperature (2)

Jun 2021

48. A reaction reaches equilibrium in a closed container according to the following balanced equation:

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

Which ONE of the following changes will INCREASE the value of the equilibrium constant?

A Removing $NH_3(g)$
B Heating the container
C Cooling the container
D Increasing the volume of the container (2)

Jun 2021

49. In which ONE of the following reactions at equilibrium will the YIELD of the product increase when the VOLUME of the container is increased at constant temperature?

A $N_2O_4(g) \rightleftharpoons 2NO_2(g)$
B $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
C $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
D $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ (2)

Sep 2021

50. The expression for the equilibrium constant (K_c) of a hypothetical reaction is given as follows:

$$K_c = \frac{[X]^3}{[Y]^2[Z]}$$

Which ONE of the following equations for a reaction at equilibrium matches the above expression?

A $Z(g) + 2Y(g) \rightleftharpoons 3X(s)$
B $Z(aq) + 2Y(aq) \rightleftharpoons 3X(\ell)$
C $Z(g) + Y_2(g) \rightleftharpoons 3X(aq) + Q(s)$
D $Z(aq) + 2Y(aq) \rightleftharpoons 3X(aq) + Q(s)$ (2)

Nov 2021

51. A reaction reaches equilibrium at 25 °C in a flask according to the following balanced equation:

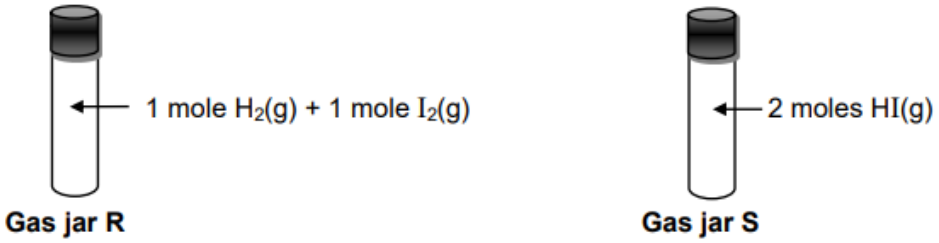
$$Co(H_2O)_6^{2+}(aq) + 4C\ell^-(aq) \rightleftharpoons CoC\ell_4^{2-}(aq) + 6H_2O(\ell) \qquad \Delta H > 0$$
pink blue

Which ONE of the following will change the colour of the mixture from pink to blue?

A Adding water
B Cooling the flask
C Adding NaOH(aq)
D Adding $NH_4C\ell(aq)$ (2)

Jun 2022

52. Two identical sealed gas jars, **R** and **S**, initially contain gases as shown below.



Equilibrium is reached in both gas jars at 500 °C according to the following balanced equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Which ONE of the following statements is TRUE at equilibrium?

A **S** will contain 1 mole of $I_2(g)$.
B **R** will contain a larger amount of $I_2(g)$ than **S**.
C **R** and **S** will contain the same amount of HI(g).
D **S** will contain a larger amount of HI(g) than **R**. (2)

Nov 2022

53. Consider the following reaction that reaches equilibrium in a beaker:

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell)$$

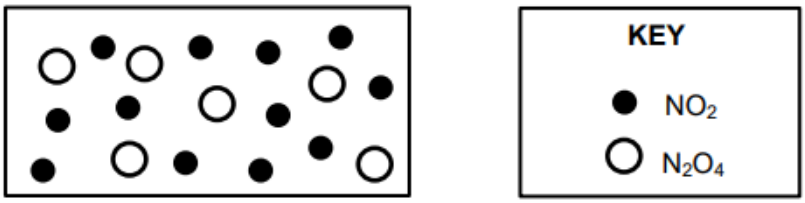
A few drops of concentrated NaOH(aq) are now added to the beaker.
Which ONE of the following combinations correctly identifies the DISTURBANCE ON THE SYSTEM and the SYSTEM'S RESPONSE to the disturbance?

	DISTURBANCE ON THE SYSTEM	SYSTEM'S RESPONSE
A	$[H^+]$ decreases	Forward reaction favoured
B	$[H^+]$ decreases	Reverse reaction favoured
C	$[CrO_4^{2-}]$ decreases	Reverse reaction favoured
D	$[CrO_4^{2-}]$ increases	Forward reaction favoured

(2)

Jun 2023

54. The diagram below represents a mixture of $NO_2(g)$ and $N_2O_4(g)$ molecules at equilibrium in a 1 dm^3 container at T °C.



The balanced equation for this reaction is:

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

Which ONE of the following is TRUE for the value of the equilibrium constant, K_c, for the reaction at T °C?

A $K_c = 24$ B $K_c > 1$
C $K_c = 1$ D $0 < K_c < 1$ (2)

Nov 2023

55. A reaction is at equilibrium in a closed container according to the following balanced equation:

$$4CuO(s) \rightleftharpoons 2Cu_2O(s) + O_2(g)$$

The volume of the container is now increased while the temperature remains constant.
A new equilibrium is reached.
Which ONE of the following combinations is CORRECT for the new equilibrium?

	CONCENTRATION OF O_2	**NUMBER OF MOLES OF O_2**	**EQUILIBRIUM CONSTANT (K_c)**
A	Decreases	Remains the same	Increases
B	Remains the same	Decreases	Remains the same
C	Remains the same	Increases	Remains the same
D	Decreases	Increases	Remains the same

(2)
Nov 2023

ACIDS AND BASES

1. Consider the ionisation reaction below:

$$H_3PO_4(aq) + HCO_3^-(aq) \rightleftharpoons H_2PO_4^-(aq) + H_2CO_3(aq) \qquad K_a >> 1$$

The strongest base in the above reaction is:

A $H_2PO_4^-$ B HCO_3^-
C H_3PO_4 D H_2CO_3 (2)

Exemp 2014

2. Which ONE of the following represents the products formed during the hydrolysis of ammonium chloride?

A $NH_3(aq)$ and $H_3O^+(aq)$ B $NH_4^+(aq)$ and $C\ell^-(aq)$
C $HC\ell(aq)$ and $OH^-(aq)$ D $C\ell^-(aq)$ and $H_3O^+(aq)$ (2)

Nov.2014

3. Which ONE of the following is a CORRECT description for a 0,1 mol·dm^{-3} hydrochloric acid solution?

A Dilute strong acid B Dilute weak acid
C Concentrated weak acid D Concentrated strong acid (2)

Mar 2015

4. Which ONE of the following weak acids, each of concentration 0,1 mol·dm^{-3}, has the lowest $H_3O^+(aq)$ concentration?

	ACID	K_a VALUE
A	$H_2SO_3(aq)$	$1,2 \times 10^{-2}$
B	$H_2CO_3(aq)$	$4,2 \times 10^{-7}$
C	$(COOH)_2(aq)$	$5,6 \times 10^{-2}$
D	$H_2S(aq)$	$1,0 \times 10^{-7}$

(2)

Jun 2015

5. Consider the reaction represented by the balanced equation below.

$$H_3PO_4(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + H_2PO_4^-(aq)$$

Which ONE of the following is a conjugate acid-base pair?

A $H_3O^+(aq)$ and $H_2O(\ell)$ B $H_3PO_4(aq)$ and $H_2O(\ell)$
C $H_3PO_4(aq)$ and $H_3O^+(aq)$ D $H_3O^+(aq)$ and $H_2PO_4^-(aq)$ (2)

Nov 2015

6. Which ONE of the following compounds will react with sodium hydroxide (NaOH) in a neutralisation reaction?

A CH_3CHO B CH_3COOH
C CH_3COCH_3 D CH_3CH_2OH (2)

Mar 2016

7. Consider the reactant **Y** in the following reaction:

$$\mathbf{Y} + H_2O \rightleftharpoons H_3O^+ + H_2PO_4^-$$

The formula of **Y** is:

A PO_4^{3-} B $H_2PO_4^-$
C HPO_4^{2-} D H_3PO_4 (2)

Mar 2016

8. Which ONE of the following is a product in ALL neutralisation reactions?

A H^+ B H_2O
C OH^- D $NaC\ell$ (2)

Jun 2016

9. Which ONE of the following pairs is NOT a conjugate acid-base pair?

A H_3O^+ and OH^- B NH_4^+ and NH_3
C $H_2PO_4^-$ and HPO_4^{2-} D H_2CO_3 and HCO_3^- (2)

Nov 2016

10. A solution has a pH = 1. This solution …

A contains no OH^- ions.
B neutralises a hydrochloric acid solution of pH = 1.
C contains a higher concentration of H_3O^+ ions than OH^- ions.
D contains a higher concentration of OH^- ions than H_3O^+ ions. (2)

Mar 2017

11. Which ONE of the following pairs represents the conjugate acid and the conjugate base of HPO_4^{2-}?

	CONJUGATE ACID	CONJUGATE BASE
A	PO_4^{3-}	$H_2PO_4^-$
B	$H_2PO_4^-$	PO_4^{3-}
C	$H_2PO_4^-$	H_3PO_4
D	$H_2PO_4^-$	PO_4^{3-}

(2)

Jun 2017

12. Which ONE of the following solutions, each of concentration 0,1 mol·dm^{-3}, has the highest pH?

A $HNO_3(aq)$ B $NH_4C\ell(aq)$
C $Na_2CO_3(aq)$ D $CH_3COOH(aq)$ (2)

Nov 2017

13. The following equilibrium exists in pure water at 25 °C.

$$2H_2O(\ell) \rightleftharpoons H_3O^+(aq) + OH^-(aq) \qquad \Delta H > 0$$

At this temperature, the pH = 7 and $K_w = 1 \times 10^{-14}$.
The temperature of the water is now increased to 90 °C.
Which ONE of the following is TRUE at the new temperature?

A pH = 7 B $[H_3O^+] = [OH^-]$
C $[H_3O^+][OH^-] = 10^{-14}$ D $[H_3O^+] = 10^{-7}$ mol·dm^{-3} (2)

Mar 2018

14. A hydrochloric acid solution is titrated against an ammonia solution.

The balanced equation for the reaction is:

$$HC\ell(aq) + NH_4OH(aq) \rightarrow NH_4C\ell(aq) + H_2O(\ell)$$

Which ONE of the following gives the pH of the solution at the end point and the reason for this pH?

	pH	REASON
A	3	$H_3O^+(aq)$ is formed during the ionisation of $HC\ell(aq)$.
B	5	$H_3O^+(aq)$ is formed during hydrolysis of $NH_4^+(aq)$.
C	7	Neutralisation takes place at the end point.
D	9	$OH^-(aq)$ is formed during hydrolysis of $NH_4^+(aq)$.

(2)

Mar 2018

15. Which ONE of the following represents the products formed during the hydrolysis of $NH_4^+(aq)$?

A $NH_3(aq) + H_2O(\ell)$ B $NH_3(aq) + H_3O^+(aq)$
C $NH_3(aq) + OH^-(aq)$ D $NH_3(aq) + OH^-(aq) + H_2O(\ell)$ (2)

Jun 2018

16. Reactions **I** and **II** below have equilibrium constants (K_c) greater than 1.

I: $H_3X + HCO_3^- \rightleftharpoons H_2X^- + H_2CO_3$ $K_c > 1$

II: $H_3O^+ + H_2X^- \rightleftharpoons H_2O + H_3X$ $K_c > 1$

Based on the reactions above, the ACIDS in order of INCREASING STRENGTH (weakest to strongest) are …

A H_3X, H_2X^-, H_3O^+ B H_2CO_3, H_3X, H_2O
C H_3X, H_2CO_3, H_3O^+ D H_3X, H_3O^+, H_2CO_3 (2)

Nov 2018

17. During a titration to determine the concentration of an acid using a standard base, a learner pipettes the base into a conical flask. She then uses a small amount of water to rinse the inside of the flask so that all the base is part of the solution in the flask.

How will the extra water added to the flask affect the results of this titration?
The concentration of the acid …

A cannot be determined. B will be lower than expected.
C will be higher than expected. D will be the same as expected. (2)

Jun 2019

18. A hydrochloric acid solution, HCℓ(aq), and an acetic acid solution, $CH_3COOH(aq)$, of EQUAL CONCENTRATIONS are compared.

How do the $H_3O^+(aq)$ concentration of HCℓ(aq) and the pH of HCℓ(aq) compare to that of $CH_3COOH(aq)$?

	$[H_3O^+]$ of HCℓ(aq)	**pH of HCℓ(aq)**
A	Higher than	Higher than
B	Higher than	Lower than
C	Equal to	Equal to
D	Higher than	Equal to

(2)

Nov 2019

19. The conjugate base of HPO_4^{2-} is …

A OH^- B PO_4^{3-}
C $H_2PO_4^-$ D H_3PO_4 (2)

Nov 2020

20. Sulphuric acid ionises in water according to the following equations:

$$H_2SO_4(\ell) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + HSO_4^-(aq)$$
$$HSO_4^-(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + SO_4^{2-}(aq)$$

Consider the following statements regarding the ionisation above:

I: $H_2O(\ell)$ acts as a base in both reactions.
II: $HSO_4^-(aq)$ acts as an ampholyte.
III: $SO_4^{2-}(aq)$ is the conjugate base of H_2SO_4.

Which of the statements above is/are TRUE?

A **I** only B **I** and **II**
C **I** and **III** D **I**, **II** and **III** (2)

Jun 2021

21. Consider the equation below.

$$H_3PO_4(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + H_2PO_4^-(aq)$$

Which ONE of the following is a conjugate acid-base pair?

A $H_3O^+(aq)$ and $H_2O(\ell)$ B $H_3PO_4(aq)$ and $H_2O(\ell)$
C $H_3PO_4(aq)$ and $H_3O^+(aq)$ D $H_3O^+(aq)$ and $H_2PO_4^-(aq)$ (2)

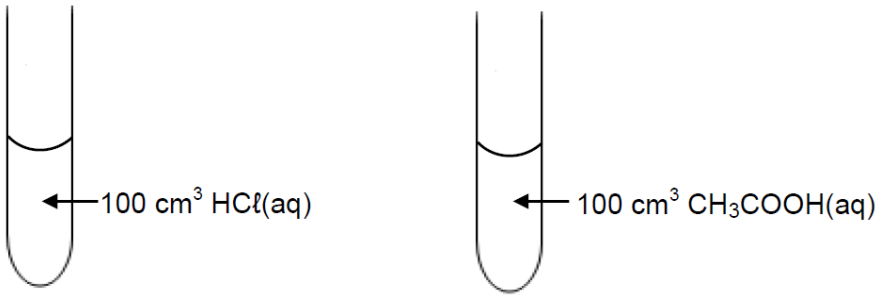
Sep 2021

22. Which ONE of the following is the conjugate base of $H_2PO_4^-$?

A PO_4^{3-} B HPO_4^{2-}
C H_3PO_4 D $H_4PO_4^+$ (2)

Nov 2021

23. Two dilute acids of equal concentrations are added to separate test tubes as shown below.



Consider the following statements regarding these acids:

I: The pH of each is less than 7.
II: Both will react at the same rate with 5 g of magnesium powder.
III: Both will neutralise the same number of moles of NaOH(aq).

Which of the statements above is/are TRUE?

A **I** only B **I, II** and **III**
B **I** and **III** only D **II** and **III** only (2)

Nov 2021

24. Dilute nitric acid is added to distilled water at 25 °C.
How will this affect the hydronium ion concentration $[H_3O^+]$ and the ionisation constant (K_w) of water at 25 °C?

	$[H_3O^+]$	K_w
A	Increases	Increases
B	Increases	Decreases
C	Increases	Remains the same
D	Remains the same	Remains the same

(2)

Jun 2022

25. Consider the ionisation reactions **I** and **II**.

I $H_2PO_4^- + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + \mathbf{X}$

II $\mathbf{X} + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + \mathbf{Y}$

Which ONE of the following combinations represents the formulae of **X** and **Y** respectively?

	X	**Y**
A	HPO_4^{2-}	PO_4^{3-}
B	HPO_4^{2-}	H_3PO_4
C	H_3PO_4	PO_4^{3-}
D	HPO_4^{2-}	$H_2PO_4^-$

(2)

Jun 2022

26. Which ONE of the following salts, when dissolved in water, will NOT change the pH of the water?

A Na_2CO_3 B $(COO)_2Na_2$
C $NH_4C\ell$ D $NaC\ell$ (2)

Nov 2022

27. A dilute acid is titrated against a potassium hydroxide solution, KOH(aq). At the equivalence point the pH is 7. Which ONE of the following combinations correctly identifies the acid and the MOST SUITABLE indicator for this titration?

	X	Y
A	$(COOH)_2$(aq)	Phenolphthalein
B	$(COOH)_2$(aq)	Bromothymol blue
C	HCℓ(aq)	Phenolphthalein
D	HCℓ(aq)	Bromothymol blue

(2)
Nov 2022

28. According to the Lowry-Brønsted theory, a conjugate base is formed when a/an …

A proton is added to the acid.
B electron is added to the acid.
C proton is removed from the acid.
D electron is removed from the acid. (2)
Jun 2023

29. Consider the statements below regarding an alkaline substance.
An alkaline substance:
(i) Reacts with an acid to form a neutral solution
(ii) Turns red litmus blue
(iii) Forms a salt when it reacts with an acid

Which of the statements above are ALWAYS TRUE?

A (i), (ii) and (iii) B (i) and (ii) only
C (i) and (iii) only D (ii) and (iii) only (2)
Jun 2023

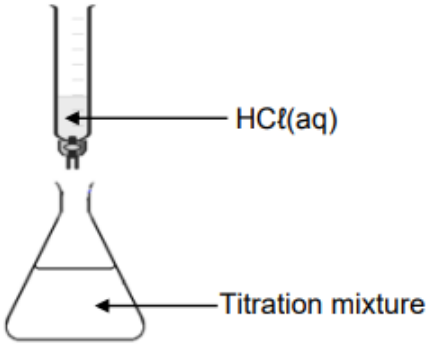
30. Nitric acid, HNO_3(aq), and ethanoic acid, CH_3COOH(aq), of equal volumes and concentrations are compared.

Consider the following statements regarding these solutions:
(i) They have different pH values.
(ii) Both have the same electrical conductivity.
(iii) Both solutions require the same number of moles of KOH(aq) for complete neutralisation.

Which of the above statement(s) is/are TRUE?

A (i) only B (i) and (ii) only
C (i) and (iii) only D (ii) and (iii) only (2)
Nov 2023

1.8 The apparatus in the diagram below is used for the titration between HCℓ(aq) and KOH(aq).



In a titration, the learner accidentally exceeds the endpoint. Which ONE of the following will be TRUE for the titration mixture?

A $[H^+] > [OH^-]$ and pH < 7 B $[H^+] < [OH^-]$ and pH < 7
C $[H^+] < [OH^-]$ and pH > 7 D $[H^+] > [OH^-]$ and pH > 7 (2)
Nov 2023

GALVANIC CELLS AND REDOX REACTIONS

1. Which ONE of the following containers can be used to store an iron(II) sulphate solution?

   A Al B Mg
   C Ni D Zn (2)

   Exemplar 2008

2. Which statement is CORRECT for a Zn-Cu galvanic cell that operates under standard conditions?

   A The concentration of the Zn^{2+} ions in the zinc half-cell gradually decreases.
   B The concentration of the Cu^{2+} ions in the copper half-cell gradually increases.
   C Negative ions migrate from the zinc half-cell to the copper half-cell.
   D The intensity of the colour of the electrolyte in the copper half-cell gradually decreases. (2)

   Exemp 2008

3. Which one of the following solutions can be stored in an aluminium container? (Use the Table of Standard Reduction Potentials.)

   A $CuSO_4(aq)$ B $ZnSO_4(aq)$
   C $NaC\ell(aq)$ D $Pb(NO_3)_2(aq)$ (2)

   Exemp 2008

4. The most common filling for tooth cavities is 'dental amalgam' – a solid solution of tin and silver in mercury. If you bite on a piece of aluminium foil that is in contact with a dental filling in your mouth, you may feel a painful sensation because …

   A the aluminium foil is hard.
   B a temporary galvanic cell has been set up whilst the aluminium and fill are in contact.
   C electrons are being transferred to the aluminium.
   D a temporary electrolytic cell has been set up whilst the aluminium and fill are in contact. (2)

   Mar 2009

5. The reactions below occur in two different electrochemical cells **X** and **Y**.

   Cell X: $CuC\ell_2(aq) \rightarrow Cu(s) + C\ell_2(g)$

   Cell Y: $Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$

   Which ONE of the following correctly describes the substance that forms at the CATHODE of each of these cells?

	Cell X	**Cell Y**
A	$C\ell_2(g)$	Cu(s)
B	Cu(s)	Cu(s)
C	$C\ell_2(g)$	$ZnSO_4(aq)$
D	Cu(s)	$ZnSO_4(aq)$

   (2)

   Nov 2009

6. Which ONE of the following statements regarding the anode of a standard galvanic cell in operation is correct?

   A The anode accepts electrons.
   B The mass of the anode decreases.
   C The concentration of the electrolyte in the half-cell containing the anode initially decreases.
   D The anode is the positive terminal of the cell. (2)

   Nov 2010

7. Consider the reaction represented by the following equation:

$$2Ag^+(aq) + Cu(s) \rightarrow 2Ag + Cu^{2+}(aq)$$

Which ONE of the following represents the oxidising agent in the above reaction?

A Ag^+ B Ag
C Cu D Cu^{2+} (2)

Nov 2010

8. When the net (overall) cell reaction in a galvanic (voltaic) cell reaches equilibrium, the emf of the cell is equal to ...

A +2,00 V. B +1,00 V.
C 0,00 V. D -1,00 V. (2)

Mar 2011

9. Four statements regarding a galvanic cell are given below.

Which ONE of these statements is TRUE?

A The anode is positive and oxidation takes place.
B The cathode is negative and reduction takes place.
C The cell reaction is endothermic.
D The cell reaction is exothermic. (2)

FS Jun 2011

10. Which ONE of the following containers can be used to store a zinc(II) sulphate solution?

A Ca B Ni
C Mn D Mg (2)

FS Jun 2011

11. When a metallic atom becomes an ion, it …

A loses electrons and is oxidised.
B loses electrons and is reduced.
C gains electrons and is oxidised.
D gains electrons and is reduced. (2)

Nov 2011

12. Consider the two half-reactions below that occur in a battery.

$$Zn(s) + 2OH^-(aq) \rightarrow ZnO(s) + H_2O(\ell) + 2e^-$$

$$Ag_2O(s) + H_2O(\ell) + 2e^- \rightarrow 2Ag(s) + 2OH^-(aq)$$

Which ONE of the following statements is CORRECT?

A Ag(s) is reduced.
B Zn(s) is the anode.
C $Ag_2O(s)$ is the negative electrode.
D Electrons are transferred from Ag(s) to Zn(s). (2)

Nov 2011

13. The oxidation number of copper (Cu) in the compound $CuSO_4$ is ...

A - 2 B - 4
C + 2 D + 4 (2)

Nov 2011

14. The gain of electrons by a substance in a chemical reaction is known as …

A oxidation. B reduction.
C electrolysis. D oxidation and reduction. (2)

Mar 2012

15. Which ONE of the following statements regarding a copper-silver galvanic cell is TRUE?

A Silver is formed at the anode. B Copper is formed at the anode.
C Silver is formed at the cathode. D Copper is formed at the cathode. (2)

Mar 2012

16. In a redox reaction, an oxidising agent is ...

A reduced because it loses electrons.
B reduced because it gains electrons.
C oxidised because it loses electrons.
D oxidised because it gains electrons. (2)

Nov 2012

17. In a galvanic (voltaic) cell, electrons move from the ...

A anode to the cathode through the salt bridge.
B cathode to the anode through the salt bridge.
C anode to the cathode in the external circuit.
D cathode to the anode in the external circuit. (2)

Nov 2012

18. When a galvanic (voltaic) cell delivers current, the salt bridge …

A allows electrons to move in the cell.
B ensures electrical neutrality in the cell.
C prevents the two solutions from mixing.
D allows electrons to travel from the cathode to the anode. (2)

Mar 2013

19. Which ONE of the following metals is the strongest reducing agent?

A Ag B Zn
C Cu D Aℓ (2)

Mar 2013

20. Which ONE of the following is the strongest oxidising agent?

A $F_2(g)$ B $F^-(aq)$
C Li(s) D $Li^+(aq)$ (2)

Nov 2013

21. Which ONE of the following statements about a galvanic cell in operation is CORRECT?

A ΔH for the cell reaction is positive.
B The overall cell reaction is non-spontaneous.
C The emf is negative.
D ΔH for the cell reaction is negative. (2)

Nov 2013

22. The function of the salt bridge in a galvanic cell in operation is to ...

A allow anions to travel to the cathode.
B maintain electrical neutrality in the half-cells.
C allow electrons to flow through it.
D provide ions to react at the anode and cathode. (2)

Nov 2013

23. Which ONE of the following CANNOT act as a reducing agent?

A Mg B Br^-
C Fe^{2+} D MnO_4^- (2)

Exemp 2014

24. Consider the galvanic cell represented below.

$$Mg(s) \mid Mg^{2+}(aq) \parallel H^+(aq) \mid H_2(g) \mid Pt$$

Which ONE of the following half-reactions takes place at the cathode?

A $H_2(g) \rightarrow 2H^+(aq) + 2e^-$ B $Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$
C $Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$ D $2H^+(aq) + 2e^- \rightarrow H_2(g)$ (2)

Mar 2014

25. Consider an electrochemical cell based on the following reaction:

$$Sn^{4+}(aq) + Sn(s) \rightarrow 2Sn^{2+}(aq)$$

Which ONE of the following statements regarding this cell is CORRECT?

A Sn is the anode of the cell. B Sn is the cathode of the cell.
C $Sn^{4+}(aq)$ is the reducing agent. D Sn is the oxidising agent. (2)

Mar 2014

26. Consider the reaction represented by the balanced equation below:

$$Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$$

In the above reaction, Cu(s) is the ...

A oxidising agent and is reduced. B oxidising agent and is oxidised.
C reducing agent and is reduced. D reducing agent and is oxidised. (2)

Nov. 2014

27. Which ONE of the following metals will NOT react spontaneously with sulphuric acid?

A Zn B Mg
C Cu D Fe (2)

Mar 2015

28. A galvanic cell consists of the following half-cells:

$$Pt(s)\,|C\ell_2(g)\,|C\ell^-(aq) \quad \text{AND} \quad Cu^{2+}(aq)\,|Cu(s)$$

Which ONE of the following statements is TRUE while the cell is functioning?

A Cu(s) is oxidised. B $C\ell^-(aq)$ is reduced.
C $C\ell_2(g)$ acts as reducing agent. D Cu(s) acts as oxidising agent. (2)

Jun 2015

29. The following half-reactions take place in a galvanic cell:

$$Co^{3+} + e^- \rightleftharpoons Co^{2+}$$
$$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$$

Which ONE of the following is the cell notation for this cell?

A $A\ell \mid A\ell^{3+} \parallel Co^{3+}, Co^{2+}$ B $A\ell \mid A\ell^{3+} \parallel Co^{3+}, Co^{2+} \mid Pt$
C $A\ell \mid A\ell^{3+} \parallel Co^{2+}, Co^{3+} \mid Pt$ D $Pt \mid Co^{2+}, Co^{3+} \parallel A\ell^{3+} \mid A\ell$ (2)

Nov 2015

30. Chlorine gas ($C\ell_2$) is bubbled through a potassium iodide solution (KI).
The reducing agent in this reaction is:

A Potassium ions B Chlorine gas
C Iodide ions D Chloride ions (2)

Nov 2015

31. Consider the cell notation of the galvanic cell below.

$$Zn\,|\,Zn^{2+}\,\|\,Cu^{2+}\,|\,Cu$$

Which ONE of the following statements regarding this cell is TRUE?

A Copper is formed at the cathode. B Copper is formed at the anode.
C Zinc is formed at the anode. D Zinc is formed at the cathode. (2)

Mar 2016

32. Which ONE of the following is a NON-SPONTANEOUS redox reaction?
Refer to the Table of Standard Reduction Potentials (Table 4A or 4B).

A $Zn(s) + 2HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$
B $Cu(s) + FeC\ell_2(aq) \rightarrow CuC\ell_2(aq) + Fe(s)$
C $2AgNO_3(aq) + Cu(s) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$
D $2A\ell(s) + 3Ni(NO_3)_2(aq) \rightarrow 2A\ell(NO_3)_3(aq) + 3Ni(s)$ (2)

Jun 2016

33. In a chemical reaction an oxidising agent will …

A lose protons. B gain protons.
C lose electrons. D gain electrons. (2)

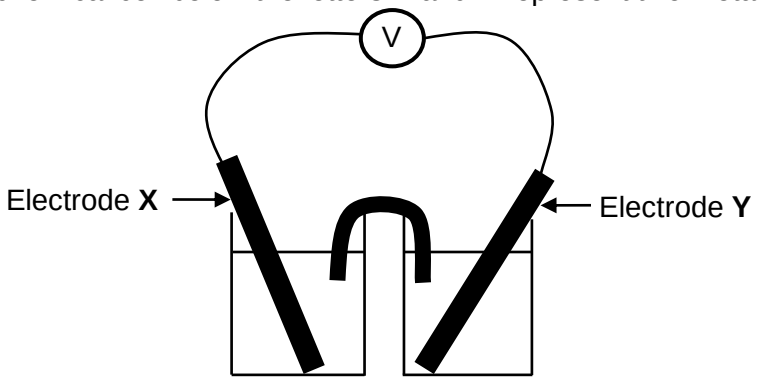
Nov 2016

34. Which ONE of the equations below represents the half-reaction occurring at the CATHODE of an electrochemical cell that is used to electroplate an object?

A $Ag \rightarrow Ag^+ + e^-$ B $Cr^{3+} + 3e^- \rightarrow Cr$
C $Cr^{3+} + e^- \rightarrow Cr^{2+}$ D $Cu^{2+} + e^- \rightarrow Cu^+$ (2)

Nov 2016

35. In the electrochemical cell below the letters **X** and **Y** represent two metal electrodes.



When the cell is functioning, ELECTRODE **X** GAINS MASS.

Which ONE of the following is the CORRECT cell notation for this cell?

A $Y(s) \mid Y^{2+}(aq) \parallel X^{+}(aq) \mid X(s)$
B $X(s) \mid X^{+}(aq) \parallel Y^{2+}(aq) \mid Y(s)$
C $X^{+}(aq) \mid X(s) \parallel Y(s) \mid Y^{2+}(aq)$
D $Y^{2+}(aq) \mid Y(s) \parallel X(s) \mid X^{+}(aq)$ (2)

Jun 2016

36. The following equation represents the reaction taking place in an electrochemical cell:

$$Ni(s) + Pb^{2+}(aq) \rightarrow Ni^{2+}(aq) + Pb(s)$$

The flow of electrons through the external circuit of this cell is from …

A Pb at the anode to Ni at the cathode.
B Pb at the cathode to Ni at the anode.
C Ni at the cathode to Pb at the anode.
D Ni at the anode to Pb at the cathode. (2)

Mar 2017

37. Which ONE of the half-cells below will result in the HIGHEST emf when it is used as a cathode, together with a zinc half-cell as anode, in a standard galvanic cell?

A $Cu^{2+}(aq) \mid Cu(s)$
B $Fe^{2+}(aq) \mid Fe(s)$
C $Ag^{+}(aq) \mid Ag(s)$
D $Sn^{2+}(aq) \mid Sn(s)$ (2)

Jun 2017

38. The cell notation for a galvanic cell is as follows:

$$Ni(s) \mid Ni^{2+}(1\ mol{\cdot}dm^{-3}) \parallel Pb^{2+}(1\ mol{\cdot}dm^{-3}) \mid Pb(s)$$

Which ONE of the following statements is CORRECT for this cell?

A Ni is oxidised.
B Pb(s) is reduced.
C Ni^{2+}(aq) is the oxidising agent.
D Pb^{2+}(aq) is the reducing agent. (2)

Nov 2017

39. A decrease in the oxidation number of an atom during a chemical reaction is known as …

A redox.
B oxidation.
C reduction.
D electrolysis. (2)

Mar 2018

40. The two half-reactions below are used to construct a galvanic cell.

$$X^{+}(aq) + e^{-} \rightleftharpoons X(s) \qquad E^{\theta}_{reduction} = + 0,15\ V$$

$$Y^{2+}(aq) + 2e^{-} \rightleftharpoons Y(s) \qquad E^{\theta}_{reduction} = - 0,15\ V$$

Which ONE of the statements below is CORRECT when the cell is in operation?

A $X^{+}(aq)$ is reduced.
B Y(s) is reduced.
C $X(s) \mid X^{+}(aq)$ is the negative electrode.
D Electrons flow from X(s) to Y(s) in the external circuit. (2)

Mar 2018

41. Potassium nitrate is used as an electrolyte in the salt bridge of a copper-zinc cell.
Which ONE of the following CORRECTLY shows the direction of migration of potassium and nitrate ions in the cell?

	POTASSIUM IONS TO THE:	**NITRATE IONS TO THE:**
A	Anode	Cathode
B	Negative electrode	Positive electrode
C	Zinc electrode	Copper electrode
D	Copper electrode	Zinc electrode

(2)
Jun 2018

42. Consider the cell notation for a galvanic cell below.

$$Ni(s) \mid Ni^{2+}(aq) \parallel H^+(aq) \mid H_2(g) \mid Pt(s)$$

Which ONE of the following half-reactions takes place at the ANODE of this cell?

A $2H^+(aq) + 2e^- \rightarrow H_2(g)$
B $H_2(g) \rightarrow 2H^+(aq) + 2e^-$
C $Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$
D $Ni(s) \rightarrow Ni^{2+}(aq) + 2e^-$

(2)
Nov 2018

43. The standard reduction potentials for two substances used to set up a galvanic cell are as follows:

$Sn^{2+} + 2e^- \rightleftharpoons Sn$ $\quad E^{\theta}_{reduction} = -0,14\ V$
$Cu^{2+} + 2e^- \rightleftharpoons Cu$ $\quad E^{\theta}_{reduction} = 0,34\ V$

Which ONE of the following combinations gives the substances formed at each electrode when the cell is functioning?

	Cathode	**Anode**
A	Cu^{2+}	Sn
B	Sn	Cu^{2+}
C	Sn^{2+}	Cu
D	Cu	Sn^{2+}

(2)
Jun 2019

44. Two hypothetical half-reactions and their respective reduction potentials are shown below:

$B^+(aq) + e^- \rightleftharpoons B(s)$ $\quad E^{\theta}_{reduction} = -1,5\ V$
$A^{2+}(aq) + 2e^- \rightleftharpoons A(s)$ $\quad E^{\theta}_{reduction} = 2,5\ V$

A galvanic cell is set up using the above substances.

Which ONE of the following statements is CORRECT for this galvanic cell?

A B(s) is the reducing agent.
B A(s) is the oxidising agent.
C The mass of B(s) will increase.
D The mass of A(s) will decrease.

(2)
Nov 2019

45. Which ONE of the following reactions will proceed spontaneously under standard conditions?

A $Ni^{2+}(aq) + H_2(g) \rightarrow Ni(s) + 2H^+(aq)$
B $Br_2(\ell) + 2C\ell^-(aq) \rightarrow 2Br^-(aq) + C\ell_2(g)$
C $2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(s)$
D $2Cu^+(aq) + Pb^{2+}(aq) \rightarrow 2Cu^{2+}(aq) + Pb(s)$

(2)
Nov 2020

46. Which ONE of the following reactions, when used in a voltaic cell, will give a positive reading on the voltmeter?

A $Mg^{2+}(aq) + Zn(s) \rightarrow Mg(s) + Zn^{2+}(aq)$
B $Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$
C $Co^{2+}(aq) + Sn^{2+}(aq) \rightarrow Co(s) + Sn^{4+}(aq)$
D $3Ni^{2+}(aq) + 2Fe(s) \rightarrow 3Ni(s) + 2Fe^{3+}(aq)$ (2)

Jun 2021

47. Consider the balanced equation for the reaction below:

$$2Cr^{2+}(aq) + Sn^{4+}(aq) \rightarrow 2Cr^{3+}(aq) + Sn^{2+}(aq)$$

The OXIDISING AGENT is:

A $Cr^{2+}(aq)$ B $Cr^{3+}(aq)$
C $Sn^{2+}(aq)$ D $Sn^{4+}(aq)$ (2)

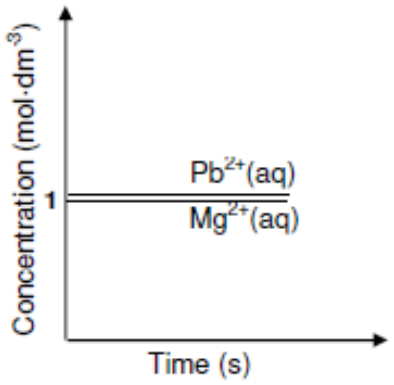
Sep 2021

48. An electrochemical cell is set up at standard conditions. The cell notation for the cell is given below.

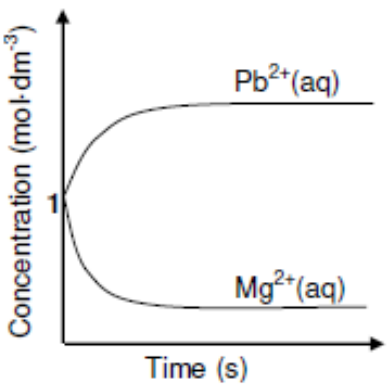
$$Mg(s) \mid Mg^{2+}(aq) \parallel Pb^{2+}(aq) \mid Pb(s)$$

The cell is now connected in a circuit. Which ONE of the graphs below BEST represents the concentrations of the electrolytes after a long time?

A



B



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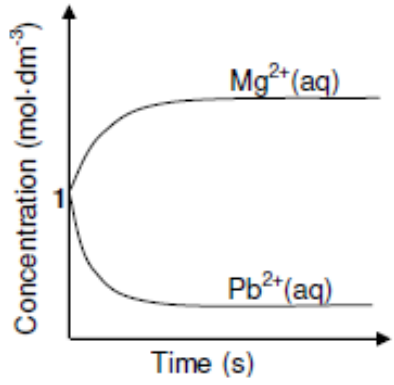
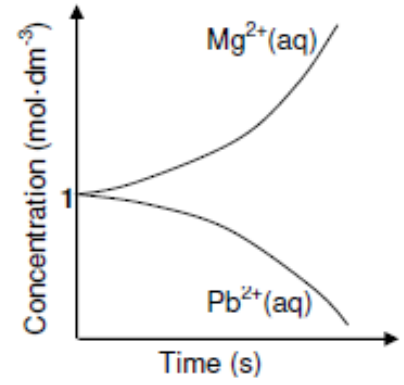


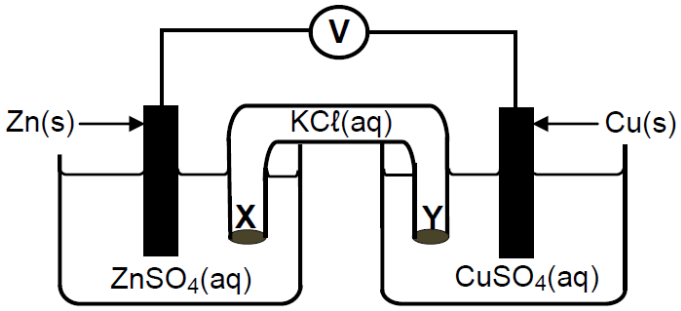
D



(2)

Sep 2021

49. The diagram below represents a voltaic cell.



Which ONE of the following correctly describes the movement of ions in the cell?

	TYPE OF IONS	DIRECTION OF MOVEMENT
A	$C\ell^-(aq)$	**Y to X**
B	$SO_4^{2-}(aq)$	**X to Y**
C	$Cu^{2+}(aq)$	**Y to X**
D	$K^+(aq)$	**Y to X**

(2)
Nov 2021

50. An electrochemical cell was set up using a $Hg(\ell)|Hg^{2+}(aq)$ half-cell and another half-cell under standard conditions. Which ONE of the following half-cells, when connected to the $Hg(\ell)|Hg^{2+}(aq)$ half-cell, will result in the HIGHEST cell potential?

A $A\ell(s)|A\ell^{3+}(aq)$ B $Zn(s)|Zn^{2+}(aq)$
C $Co(s)|Co^{2+}(aq)$ D $Pt(s)|H_2(g)|H^+(aq)$ (2)
Jun 2022

51. Which ONE of the following statements is TRUE for an oxidising agent?

A It gains electrons.
B It causes another species in the reaction to be reduced.
C Its oxidation number does not change during a chemical reaction.
D Its oxidation number increases during a chemical reaction. (2)
Nov 2022

52. Which ONE of the following metals will reduce $Cd^{2+}(aq)$ to Cd(s), but will NOT reduce $Mn^{2+}(aq)$ to Mn(s)?

A Zn B Ag
C Ni D Mg (2)
Nov 2022

53. Consider the cell notation for a galvanic cell.

$$Pt \mid H_2(g) \mid OH^-(aq) \mid H_2(\ell) \parallel Ag^+(aq) \mid Ag(s)$$

Which ONE of the following equations represents the half-reaction taking place at the positive electrode?

A $Ag^+(aq) + e^- \rightarrow Ag(s)$
B $Ag(s) \rightarrow Ag^+(aq) + e^-$
C $2H_2(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$
D $H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(\ell) + 2e^-$ (2)
Jun 2023

54. The following hypothetical standard reduction potentials relate to a galvanic cell:

$X^{2+}(aq) + 2e^- \rightarrow X(s)$ $E^\ominus = +0,10\ V$
$Y^+(aq) + e^- \rightarrow Y(s)$ $E^\ominus = -0,10\ V$

Consider the following statements for this galvanic cell:
(i) The emf of the cell is 0,20 V under standard conditions.
(ii) Electrode Y is the anode.
(iii) X is oxidised.
Which of the above statement(s) is/are TRUE for this galvanic cell?

A (i) only B (i) and (ii) only
C (i) and (iii) only D (ii) and (iii) only (2)
Nov 2023

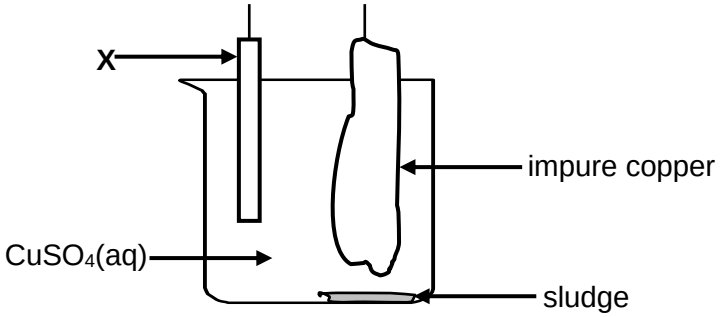
ELECTROLYTIC CELLS

1. Which ONE of the following half-reactions occurs at the cathode during the electrolysis of an aqueous $CuC\ell_2$ solution?

A $C\ell_2 + 2e^- \rightarrow 2C\ell^-$ B $Cu^+ + e^- \rightarrow Cu$
C $2C\ell^- \rightarrow C\ell_2 + 2e^-$ D $Cu^{2+} + 2e^- \rightarrow Cu$ (2)

Exemp 2008

2. The diagram below represents a cell that may be used for refining copper.
The impure copper contains silver metal and zinc metal.



Which ONE of the following half-reactions will take place at electrode **X**?

A $Ag^+ + e^- \rightarrow Ag$ B $Cu \rightarrow Cu^{2+} + 2e^-$
C $Cu^{2+} + 2e^- \rightarrow Cu$ D $Zn^{2+} + 2e^- \rightarrow Zn$ (2)

Nov 2009

3. The following characteristics may be used to describe an electrochemical cell (electrolytic or galvanic):

I The chemical reaction is self-sustaining.
II The reaction requires energy from an electrical source.
III The anode is the positive electrode of the cell.

Which of these characteristics are specific to an electrolytic cell?

A Only **I** B Only **II**
C **I** and **III** D **II** and **III** (2)

Mar 2010

4. The net (overall) cell reaction taking place in a certain cell is represented as follows:

$$2H_2O(\ell) + \text{electrical energy} \rightarrow 2H_2(g) + O_2(g)$$

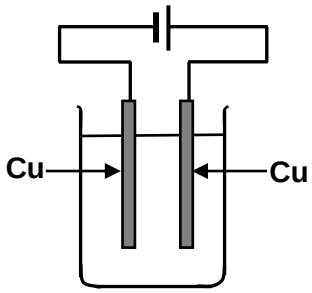
Which ONE of the following statements best describes this cell?

The cell is a/an …

A electrolytic cell in which an exothermic reaction occurs.
B electrolytic cell in which an endothermic reaction occurs.
C galvanic (voltaic) cell in which an exothermic reaction occurs.
D galvanic (voltaic) cell in which an endothermic reaction occurs. (2)

Mar 2011

5. Copper is purified through electrolysis as represented in the simplified diagram below.



Which ONE of the following statements is CORRECT for this process?

A Cu is oxidised at the negative electrode.
B Cu is reduced at the positive electrode.
C Cu^{2+} ions are reduced at the positive electrode.
D Cu^{2+} ions are reduced at the negative electrode. (2)

Mar 2011

6. Which ONE of the following half-reactions occurs at the cathode during the electrolysis of an aqueous $CuC\ell_2$ solution?

A $C\ell_2 + 2e^- \rightarrow 2C\ell^-$ B $2C\ell^- \rightarrow C\ell_2 + 2e^-$
C $Cu^{2+} + 2e^- \rightarrow Cu$ D $Cu \rightarrow Cu^{2+} + 2e^-$ (2)

FS Jun 2011

7. Which ONE of the following substances can be used as an electrolyte?

A Mercury
B Molten copper
C Sugar dissolved in distilled water
D Table salt dissolved in distilled water (2)

Mar 2012

8. Which ONE of the following half-reactions occurs at the CATHODE during the electrolysis of a solution of $CuC\ell_2$?

A $Cu \rightarrow Cu^{2+} + 2e^-$ B $2C\ell^- \rightarrow C\ell_2 + 2e^-$
C $Cu^{2+} + 2e^- \rightarrow Cu$ D $C\ell_2 + 2e^- \rightarrow 2C\ell^-$ (2)

Mar 2013

9. The major product formed at the ANODE during electrolysis of a concentrated sodium chloride solution is ...

A hydrogen. B oxygen.
C chlorine. D hydroxide ions. (2)

Nov 2013

10. A sample of silver contains impurities of gold. During purification by electrolysis, the impure silver is made into an electrode.

Which ONE of the following is the best choice of anode and cathode for this process?

	Cathode	Anode
A	Pure gold	Impure silver
B	Impure silver	Pure gold
C	Pure silver	Impure silver
D	Impure silver	Pure silver

(2)

Exemp 2014

11. Which ONE of the following statements regarding an electrolytic cell is CORRECT?

A An electric current causes a chemical change to occur.
B Reduction occurs at the anode.
C A spontaneous chemical reaction produces an electric current.
D Electrons flow to the electrode where oxidation occurs. (2)

Mar 2014

12. Which ONE of the following is formed at the cathode during the electrolysis of a concentrated sodium chloride solution?

A Chlorine B Hydrogen
C Sodium chloride D Oxygen (2)

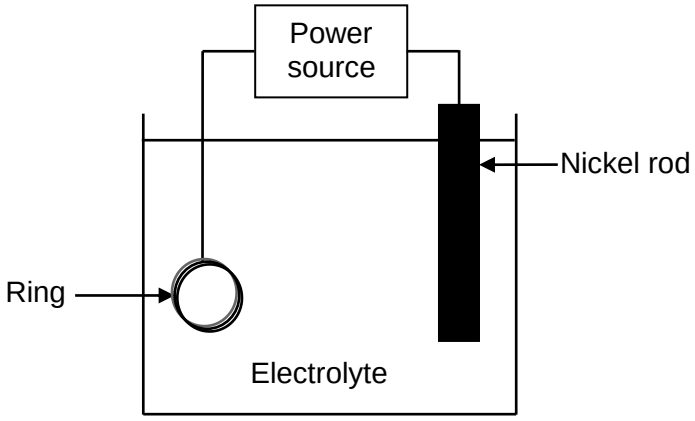
Mar 2014

13. An electrochemical cell is used to electroplate an iron spoon with nickel. Which ONE of the following half-reactions takes place at the positive electrode of this cell?

A $Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$ B $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$
C $Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$ D $Ni(s) \rightarrow Ni^{2+}(aq) + 2e^-$ (2)

Nov. 2014

14. A learner wants to electroplate a copper ring with nickel. He uses the experimental set-up shown in the simplified diagram below.



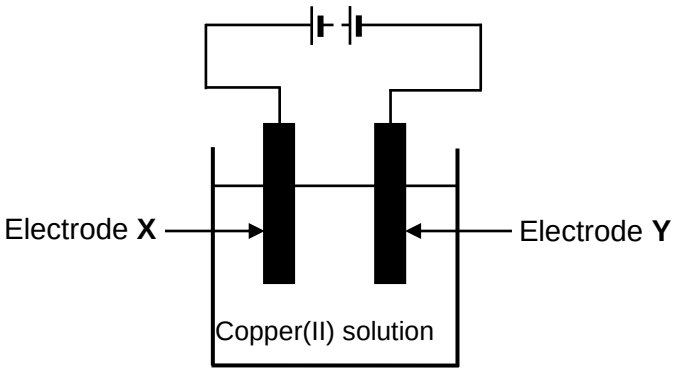
Which ONE of the following is CORRECT?

	ANODE	CATHODE	ELECTROLYTE
A	Copper ring	Nickel rod	$CuSO_4$
B	Nickel rod	Copper ring	$CuSO_4$
C	Copper ring	Nickel rod	$NiSO_4$
D	Nickel rod	Copper ring	$NiSO_4$

(2)

Mar 2015

15. The simplified diagram below shows a cell that can be used to purify copper.

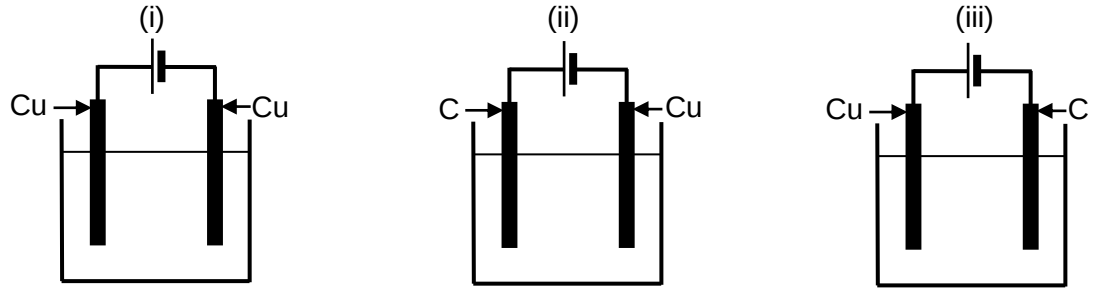


The purification failed. Which ONE of the following is the most likely reason for the failure?

A A DC source is used.
B Electrode **X** is the anode.
C Electrode **Y** is the impure copper.
D Electrode Y is a carbon rod. (2)

Jun 2015

16. In each of the electrolytic cells below, copper(II) sulphate is used as the electrolyte. The electrodes are either carbon (C) or copper (Cu).



In which cell(s) will the concentration of the electrolyte remain constant during electrolysis?

A (i) only
B (i) and (ii) only
C (i) and (iii) only
D (ii) and (iii) only (2)

Mar 2016

17. Consider the following balanced equation of a chemical reaction:

$$2NaC\ell + 2H_2O \rightarrow C\ell_2 + H_2 + 2NaOH$$

Which ONE of the following statements about the reaction is correct?

The reaction takes place in a/an …

A galvanic cell and absorbs energy.
B galvanic cell and releases energy.
C electrolytic cell and absorbs energy.
D electrolytic cell and releases energy. (2)

Mar 2017

18. Which ONE of the following combinations CORRECTLY shows the products formed during the electrolysis of a CONCENTRATED sodium chloride solution?

	CATHODE	ANODE
A	Hydrogen	Sodium
B	Hydrogen	Chlorine
C	Chlorine	Sodium
D	Chlorine	Hydrogen

(2)

Nov 2017

19. Which ONE of the following shows the electrode where the electrons are gained in an **electrolytic cell** and the chemical change that occurs at this electrode?

	ELECTRODE WHERE ELECTRONS ARE GAINED	CHEMICAL CHANGE
A	Anode	Oxidation
B	Anode	Reduction
C	Cathode	Oxidation
D	Cathode	Reduction

(2)

Jun 2018

20. Which ONE of the following is applicable to an ELECTROLYTIC CELL?

A Reduction takes place at the anode.
B Oxidation takes place at the cathode.
C It uses alternating current.
D A battery is used for the cell to function. (2)

Nov 2018

21. Which ONE of the following half-reactions takes place at the POSITIVE ELECTRODE of an electrochemical cell used to electroplate an iron rod with silver?

A $Ag^+ + e^- \rightarrow Ag$
B $Fe^{2+} + 2e^- \rightarrow Fe$
C $Ag \rightarrow Ag^+ + e^-$
D $Fe \rightarrow Fe^{2+} + 2e^-$

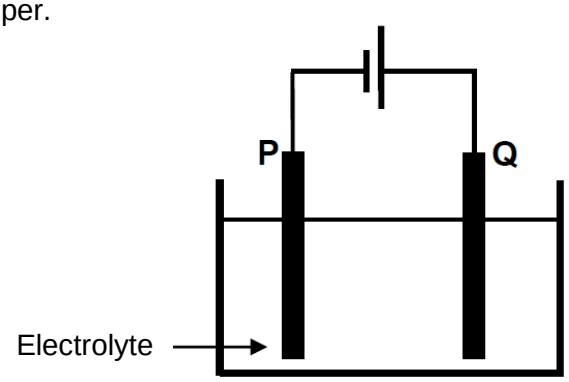
(2)
Jun 2019

22. In an electrolytic cell …

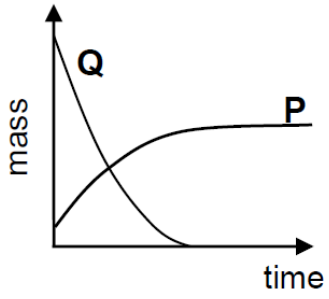
A the anode is the positive electrode.
B oxidation takes place at the cathode.
C electrons flow from the cathode to the anode.
D the mass of the anode increases.

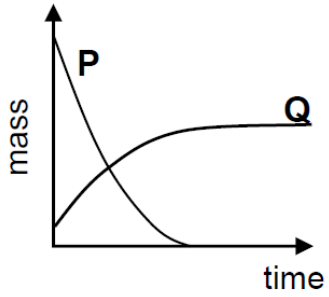
(2)
Nov 2019

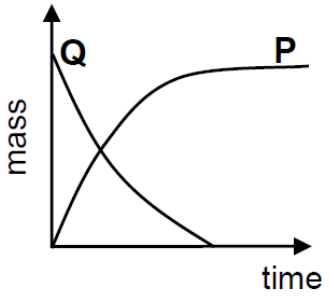
23. The simplified diagram below represents an electrochemical cell used for the PURIFICATION of copper.

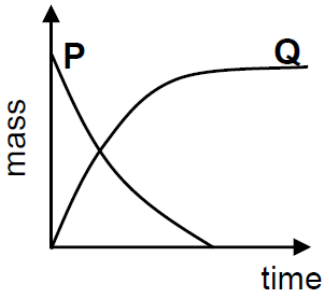


Which ONE of the graphs below represents the CHANGE IN MASS of electrodes **P** and **Q** during the purification process?

A


B


C


D


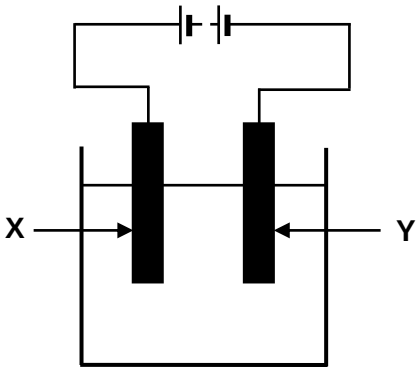
(2)
Nov 2020

24. Which ONE of the following statements is CORRECT for an ELECTROLYTIC CELL?

A The anode is the positive electrode.
B The cathode is the positive electrode.
C Oxidation takes place at the cathode.
D Reduction takes place at the anode.

(2)
Jun 2021

25. The electrolytic cell illustrated below is used to electroplate a nickel rod with copper.

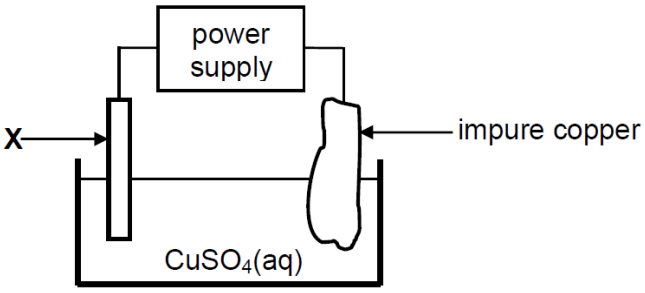


Which ONE of the following correctly shows the formula of the electrolyte and the letter that represents the nickel rod?

	ELECTROLYTE	NICKEL ROD
A	$NiSO_4(aq)$	X
B	$CuSO_4(aq)$	X
C	$NiSO_4(aq)$	Y
D	$CuSO_4(aq)$	Y

(2)
Sep 2021

26. The diagram below represents a cell that is used for the refining of copper.



Which ONE of the following statements is TRUE?

A **X** is made of platinum.
B The mass of **X** increases.
C **X** is the electrode where oxidation takes place.
D **X** is connected to the positive terminal of the power supply. (2)
Nov 2021

27. The following reaction takes place in an electrochemical cell:

$$CuC\ell_2(aq) \rightarrow Cu(s) + C\ell_2(g)$$

Which ONE of the following is CORRECT for this cell?
A It is a galvanic cell.
B A power source is needed.
C The reaction is spontaneous.
D Copper acts as the oxidising agent. (2)
Jun 2022

28. A concentrated solution of sodium chloride, $NaC\ell(aq)$, undergoes electrolysis.
Which ONE of the combinations correctly shows the products formed at each electrode?

	CATHODE	ANODE
A	Na	$C\ell_2$
B	H_2	OH^-
C	$C\ell_2$	H_2 and OH^-
D	H_2 and OH^-	$C\ell_2$

(2)
Jun 2023

29. Which ONE of the half-reactions below will be the MAIN reaction at the ANODE during the electrolysis of CONCENTRATED $CuC\ell_2(aq)$?

A $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$
B $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$
C $2H_2O(\ell) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$
D $2C\ell^-(aq) \rightarrow C\ell_2(g) + 2e^-$ (2)

Nov 2023

