

question 1 (MC):

Find the correct stoichiometric coefficients for the following reaction equation: $v \text{ NH}_4\text{Cl} + w \text{ Ca(OH)}_2 \longrightarrow x \text{ CaCl}_2 + y \text{ H}_2\text{O} + z \text{ NH}_3$

- a. v: 2 / w: 1 / x: 1 / y: 2 / z: 2
- b. v: 1 / w: 1 / x: 1 / y: 1 / z: 1
- c. v: 3 / w: 1 / x: 1 / y: 2 / z: 4
- d. v: 2 / w: 1 / x: 1 / y: 1 / z: 2

question 2 (MC):

In the periodic table, the atomic radius increases from...

- a. ...top left to bottom right.
- b. ...bottom left to top right.
- c. ...bottom right to top left.
- d. ...top right to bottom left.

question 3 (MC):

What is the geometry of HClO_4 ?

- a. trigonal planar
- b. trigonal bipyramidal
- c. distorted tetrahedral
- d. square planar

question 4 (MC):

Which is the correct electron configuration for Mn?

- a. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^7 / 3d^7 4s^0$
- b. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5 / 3d^5 4s^2$
- c. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3 / 3s^3 4s^2$
- d. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^5 / 3d^5 4s^0$

question 5 (MC):

Which electrode gives the highest cell potential when paired with a standard silver electrode ($\text{Ag} | \text{Ag}^+$)?

- a. $\text{Cu}_2^+ | \text{Cu}$
- b. standard hydrogen electrode
- c. $\text{Fe}_2^+ | \text{Fe}$
- d. $\text{Fe}_3^+ | \text{Fe}$

question 6 (MC):

Choose the statement in which the acids are correctly ordered according to their acidity.

- a. $\text{HF} < \text{HI} < \text{HCl}$
- b. $\text{HF} < \text{HCl} < \text{HI}$
- c. $\text{HF} \approx \text{HCl} \approx \text{HI}$
- d. $\text{HI} < \text{HCl} < \text{HF}$

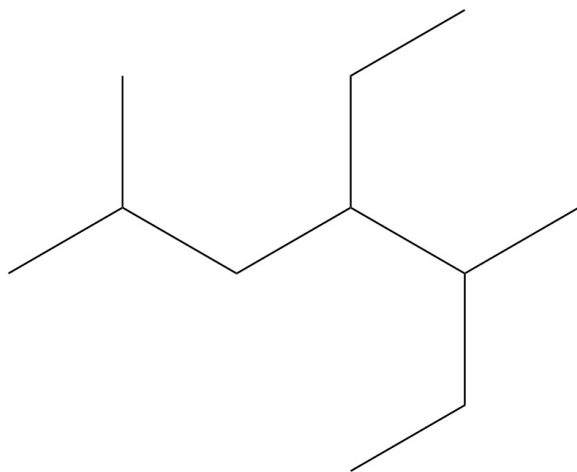
question 7 (MC):

What is the pH of 3.6 mmol L^{-1} hydrobromic acid?

- a. 4.44
- b. 1.44
- c. 2.44
- d. 0.56

question 8 (MC):

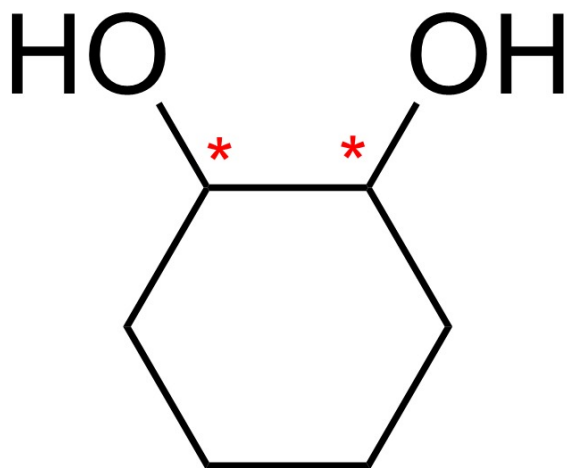
What is the IUPAC name of the following molecule?



- a. 4,5-diethyl-2-methylhexane
- b. 2,3-diethyl-5-methylhexane
- c. 4-ethyl-2,5-dimethylheptane
- d. 4-ethyl-3,6-dimethylheptane

question 9 (MC):

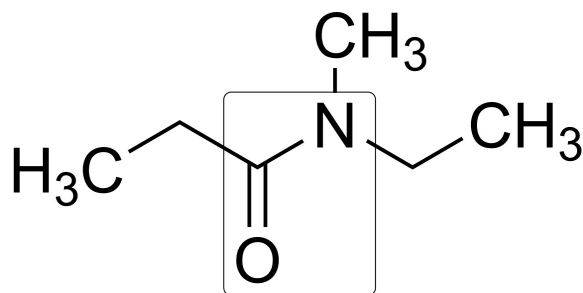
How many stereoisomers does the following molecule have? Asterisks denote a stereogenic center.



- a. 1 (the molecule does not exhibit optical isomerism)
- b. 2
- c. 3
- d. 4

question 10 (MC):

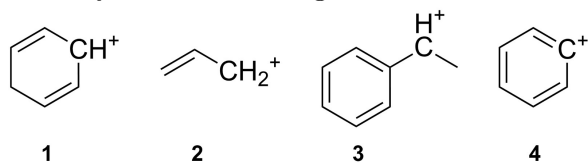
What is the functional group shown in the box below?



- a. Amine
- b. Amide
- c. Ketone
- d. Ester

question 11 (MC):

What is the correct ordering in terms of stability for the following carbocations?



- a. $4 < 2 < 1 < 3$
- b. $2 < 4 < 1 < 3$
- c. $2 < 1 < 3 < 4$
- d. $3 < 1 < 2 < 4$

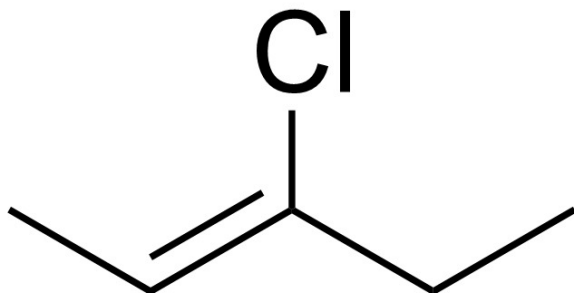
question 12 (MC):

What is the mass of water produced by the combustion of 5 g glucose ($C_6H_{12}O_6$)?

- a. 1.5 g
- b. 3 g
- c. 5 g
- d. 7 g

question 13 (MC):

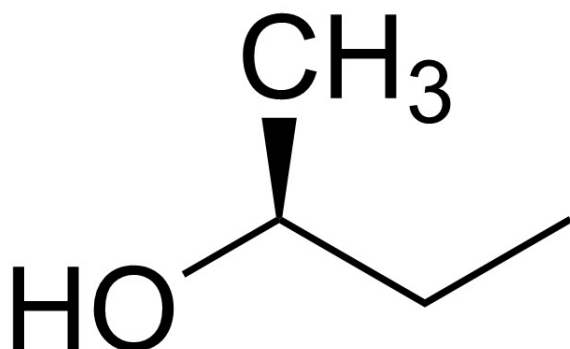
Is the following molecule the Z or the E geometric isomer?



- a. E
- b. Z
- c. The molecule does not exhibit geometric isomerism.

question 14 (MC):

Is the following molecule the R or the S optical isomer?



- a. R
- b. S
- c. The molecule does not exhibit optical isomerism.

question 15 (MC):

What is the relationship between the following molecules?



- a. Enantiomers
- b. Diastereomers

- c. Conformers
- d. They are the same molecule.

question 16 (MC):

What is a property of an ideal gas for a given quantity of molecules?

- a. Pressure is proportional to the volume when the temperature is kept constant
- b. Volume is proportional to the temperature when the pressure is kept constant
- c. Pressure is inversely proportional to the temperature when the volume is kept constant

question 17 (MC):

This reaction takes place in a closed container under standard conditions. What is the change in Gibbs free energy? $4 \text{ CuO (s)} \longrightarrow 2 \text{ Cu}_2\text{O (s)} + \text{O}_2 \text{ (g)}$

@ 25°C	CuO(s)	Cu ₂ O(s)	O ₂ (g)
$\Delta_f H^\circ$ [kJ/mol]	-157.3	-168.6	0
S° [J/(mol·K)]	42.6	93.1	205.1

- a. $\Delta G = -357.9 \text{ J/mol}$
- b. $\Delta G = 226139 \text{ J/mol}$
- c. $\Delta G = 66150 \text{ J/mol}$
- d. $\Delta G = 66.15 \text{ kJ/mol}$

question 18 (MC):

You try to identify the concentration of Chlorophyll a in a pure solution. The absorbance of light at a wavelength of 663 nm is 0.146 after running it through a sample of width 0.01 cm. The molar extinction coefficient is $7.81 \times 10^4 \text{ L}/(\text{mol cm})$. What is the concentration of Chlorophyll a of your sample?

- a. $0.000187 \text{ mol L}^{-1}$
- b. $0.0000187 \text{ mol L}^{-1}$
- c. $11'402 \text{ mol L}^{-1}$
- d. $1.1402 \text{ mol L}^{-1}$

question 19 (MC):

Which of the following isotopes has the most neutrons?

- a. ^{197}Au
- b. ^{197}Hg
- c. ^{203}Rn
- d. ^{200}Po

question 20 (MC):

After Thorium-232 undergoes one alpha decay and two beta-minus (β^-) decays, what is the resulting isotope?

- a. Radium-228
- b. Uranium-228
- c. Thorium-228
- d. Radon-228

question 21 (MC):

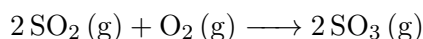
Upon adding a catalyst, which of the following is true?

- a. The Gibbs free energy for the neat reaction decreases
- b. The net reaction order decreases

- c. The net reaction becomes exothermic
- d. The net reaction rate increases

question 22 (MC):

What shifts the equilibrium of the following exothermic reaction towards the reactants?



- a. Increasing the pressure
- b. Increasing the temperature
- c. Decreasing the volume
- d. Remove the catalyst

question 23 (MC):

The solubility product of AgBr is $K_S = 4.9 \cdot 10^{-9}$. How much AgBr can be dissolved in 100 mL water?

- a. $7.0 \cdot 10^{-5} \text{ g}$
- b. $7.0 \cdot 10^{-6} \text{ g}$
- c. $1.3 \cdot 10^{-2} \text{ g}$
- d. $1.3 \cdot 10^{-3} \text{ g}$

question 24 (MC):

Which of the following molecules is/are polar? H_2O , CO_2 , CCl_4

- a. H_2O and CO_2
- b. H_2O and CCl_4
- c. H_2O
- d. all

question 25 (MC):

Which of the following statements about all salts is true?

- a. A salt needs to have the same number of cations and anions.
- b. Due to the strong forces acting between cations and anions, salts are poorly soluble in water.
- c. The ions in a salt are arranged in a regularly ordered lattice.
- d. Due to the presence of ions, salt crystals usually conduct electricity.

question 26 (MC):

What type of intermolecular force is primarily responsible for the high boiling point of water compared to other molecules with similar molecular weight?

- a. van-der-Waals forces
- b. Dipole-dipole interactions
- c. Hydrogen bonding
- d. Ion-dipole interactions

question 27 (MC):

Which of the following substituents has the most electron-withdrawing properties?

- a. $-\text{OH}$
- b. $-\text{CH}_3$
- c. $-\text{COOH}$
- d. $-\text{NH}_2$

question 28 (MC):

Choose the correct oxidation numbers for the elements in thiosulfuric acid ($\text{H}_2\text{S}_2\text{O}_3$). (Hint: One of the protons is NOT bound to an oxygen atom.)

- a. H: +I / S: +II / O: -II

- b. H: +I / S: -II / O: 0

- c. H: +I / one S: +V / second S: -I / O: -II

- d. H: +I / one S: +VI / second S: -II / O: -II

question 29 (MC):

If you titrate a dilute solution of acetic acid with sodium hydroxide, which statement about the solution at the equivalence point is true?

- a. The solution is still acidic.
- b. The solution has a pH value of 7.
- c. The solution is weakly alkaline.
- d. The solution is strongly alkaline.

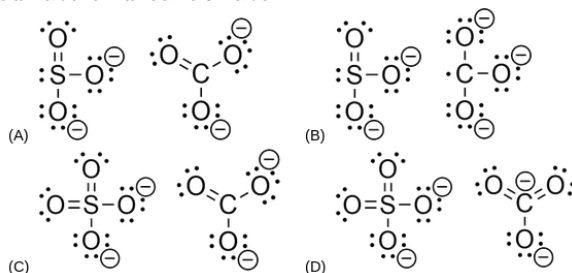
question 30 (MC):

Which statement is correct?

- a. A weak base acts as a buffer in aqueous solution at neutral pH.
- b. A weak base acts as a buffer in aqueous solution, independent of the pH of the solution.
- c. In an aqueous solution of a weak base, only a small fraction of the base is deprotonated.
- d. In an aqueous solution of a weak base, only a small fraction of the base is protonated.

question 31 (MC):

Which are the correct Lewis structures for sulfate and carbonate?



- a. A
- b. B
- c. C
- d. D

question 32 (MC):

You have a 100 mL sample of a solution containing 10 mmol L^{-1} lactic acid ($pK_a = 3.90$). You add 10 mL of a 0.025 mol L^{-1} sodium hydroxide solution. Calculate the pH after addition of the base.

- a. 4.38
- b. 2.80
- c. 7.50
- d. 3.42

question 33 (MC):

Choose the correct statement.

- a. A Lewis base is an electron donor while a Lewis acid is an electron acceptor.
- b. A Lewis acid is an electron donor while a Lewis base is an electron acceptor.
- c. A Lewis base is an electron donor while a Lewis acid is a proton acceptor.
- d. A Lewis base is an electron donor while a Lewis acid is a proton donor.