International Chemistry Competition

Edition of 2026

Final Round – Solutions

Q2. How many valence electrons does a neutral carbon atom possess?

Answer: 4

Q3. What is the pH of a 1.0×10^{-3} mol/L aqueous solution of HCl?
Answer: 3.0

Q4. What is the oxidation state of manganese in $KMnO_4$?

Answer: 7

Q5. What is the mass, in g, of 0.500 mol of NaCl (using $M(\text{NaCl}) = 58.5$ g/mol)?
Answer: 29.25

Q6. When 0.400 mol of $KClO_3$ decomposes according to

$$2\,KClO_3 \rightarrow 2\,KCl + 3\,O_2,$$

how many moles of O_2 are produced?

Answer: 0.6

Q7. What volume, in L, does 2.00 mol of an ideal gas occupy at standard temperature and pressure?

Answer: 44.8

Q9. How many moles of iron are present in $11.16\,\text{g}$ of Fe (use $M(\text{Fe}) = 55.8\,\text{g/mol}$)?
Answer: 0.200

Q10. How many nitrogen atoms make up the central catenated chain in the radical anion $[\mathbf{1}]^{\bullet-}$ reported in the Pre-Final research paper?

Answer: 4

Q14. Which class of nitrogen-centred radical species is liberated upon decomposition of the $\{N_4\}^{\bullet-}$ chain, allowing the molecule to act as a storable nitrogen-transfer reagent according to the Pre-Final research paper?

Answer: nitrene

Q16. The ground-state electron configuration of the iron(II) cation Fe^{2+} is ...

A. [Ar] $3d^4\,4s^2$

B. [Ar] $3d^5\,4s^1$

C. [Ar] $3d^6$

D. [Ar] $3d^8$

Answer: C – [**Ar**] $3d^6$

Q17. Which of the following species is isoelectronic with a neutral atom of neon Ne?

A. O

B. F^-

C. Na

D. Cl^-

Answer: B – F^-

Q18. According to VSEPR theory, the molecular geometry of NH_3 around the central nitrogen atom is ...

A. linear

B. trigonal planar

C. trigonal pyramidal

D. tetrahedral

Answer: C – trigonal pyramidal

Q19. The strongest intermolecular force present in liquid hydrogen fluoride HF is ...

A. London dispersion

B. dipole-dipole interaction

C. hydrogen bonding

D. ion-dipole interaction

Answer: C – hydrogen bonding

Q21. Which of the following molecules is nonpolar overall even though it contains polar covalent bonds?

A. H_2O

B. NH_3

C. HF

D. CO_2

Answer: D – CO_2

Q22. In the combustion reaction

$$\mathrm{CH_4} + 2\,\mathrm{O_2} \rightarrow \mathrm{CO_2} + 2\,\mathrm{H_2O},$$

1.0 mol of $\mathrm{CH_4}$ is mixed with 1.0 mol of $\mathrm{O_2}$. The limiting reagent is ...

A. $\mathrm{CH_4}$

B. $\mathrm{O_2}$

C. $\mathrm{CO_2}$

D. $\mathrm{H_2O}$

Answer: B – $\mathrm{O_2}$

Q23. A compound contains 40.0% carbon, 6.7% hydrogen, and 53.3% oxygen by mass. Its empirical formula is ...

A. CHO

B. CH_2O

C. $C_2H_4O_2$

D. C_2H_6O

Answer: B – CH_2O

Q24. For the esterification equilibrium

$$\text{isoamyl alcohol} + \text{acetic acid} \rightleftharpoons \text{isoamyl acetate} + H_2O,$$

which modification most effectively increases the yield of the ester?

A. continuously adding water to the reaction mixture

B. continuously removing water from the reaction mixture

C. strongly cooling the reaction vessel

D. removing the sulfuric acid catalyst

Answer: B – continuously removing water from the reaction mixture

Q26. Which of the following processes is exothermic?

A. melting of ice at $0\,^{\circ}\mathrm{C}$

B. boiling of liquid water at $100\,^{\circ}\mathrm{C}$

C. sublimation of solid carbon dioxide

D. combustion of methane to CO_2 and H_2O

Answer: D – combustion of methane to CO_2 and H_2O

Q27. For the general gas-phase equilibrium

$$a\,\mathrm{A} + b\,\mathrm{B} \rightleftharpoons c\,\mathrm{C} + d\,\mathrm{D},$$

the correct expression for the equilibrium constant K_c is ...

A. $\dfrac{[\mathrm{A}]^a[\mathrm{B}]^b}{[\mathrm{C}]^c[\mathrm{D}]^d}$

B. $\dfrac{[\mathrm{C}]^c[\mathrm{D}]^d}{[\mathrm{A}]^a[\mathrm{B}]^b}$

C. $\dfrac{[\mathrm{C}][\mathrm{D}]}{[\mathrm{A}][\mathrm{B}]}$

D. $\dfrac{[\mathrm{A}][\mathrm{B}]}{[\mathrm{C}][\mathrm{D}]}$

Answer: B – $\dfrac{[\mathbf{C}]^c[\mathbf{D}]^d}{[\mathbf{A}]^a[\mathbf{B}]^b}$

Q28. For the equilibrium

$$\mathrm{N_2}(g) + 3\,\mathrm{H_2}(g) \rightleftharpoons 2\,\mathrm{NH_3}(g),$$

an increase in the total pressure at constant temperature causes the equilibrium to ...

A. shift to the left

B. shift to the right

C. remain unchanged

D. stop completely

Answer: B – shift to the right

Q29. The conjugate base of the hydrogen carbonate ion HCO_3^- is ...

A. OH^-

B. H_2O

C. CO_3^{2-}

D. H_2CO_3

Answer: C – CO_3^{2-}

Q30. Which of the following is classified as a strong acid in dilute aqueous solution?

A. HF

B. HCl

C. H_2CO_3

D. CH_3COOH

Answer: B – HCl

Q31. In the reaction

$$2\,\mathrm{Mg}(s) + \mathrm{O}_2(g) \rightarrow 2\,\mathrm{MgO}(s),$$

the oxidising agent is ...

A. Mg

B. Mg^{2+}

C. O_2

D. MgO

Answer: C – O_2

Q32. In a galvanic cell operating spontaneously, the half-reaction occurring at the cathode is always ...

A. an oxidation

B. a reduction

C. a disproportionation

D. a precipitation

Answer: B – a reduction

Q33. The role of a catalyst in a chemical reaction is best described as ...

A. decreasing the enthalpy change ΔH of the reaction

B. shifting the equilibrium toward the products

C. lowering the activation energy E_a

D. increasing the equilibrium constant K

Answer: C – lowering the activation energy E_a

Q35. A first-order reaction has a rate constant $k = 0.693\,\text{min}^{-1}$.
Its half-life $t_{1/2}$ is closest to ...

A. $0.5\,\text{min}$

B. $1.0\,\text{min}$

C. $2.0\,\text{min}$

D. $10.0\,\text{min}$

Answer: B – $1.0\,\text{min}$

Q36. The functional group −COOR, where R is an organyl group, is characteristic of which class of organic compounds?

A. alcohols

B. aldehydes

C. ketones

D. esters

Answer: D – esters

Q37. The acid-catalysed condensation of a carboxylic acid with an alcohol to give an ester and water is known as the ... reaction.

A. Wittig

B. Diels-Alder

C. Fischer esterification

D. Friedel-Crafts acylation

Answer: C – Fischer esterification

Q39. The hybridization of the central carbon atom in methane CH_4 is ...

A. sp

B. sp^2

C. sp^3

D. sp^3d

Answer: C – sp^3

Q41. How many chemically distinct ^{1}H NMR signals are expected in a high-resolution spectrum of pure ethanol?

A. 1

B. 2

C. 3

D. 4

Answer: C – 3

Q42. An aqueous solution of $Cu(NO_3)_2$, which contains the hexaaquacopper(II) complex $[Cu(H_2O)_6]^{2+}$, is characteristically which colour?

A. yellow

B. blue

C. red

D. green

Answer: B – blue

Q43. In the synthesis described in the Pre-Final research paper, the cryptand ’crypt’ is added in order to ...

A. reduce the aryl azide starting material

B. sequester the potassium cation

C. act as a radical-trapping agent

D. serve as the polar reaction solvent

Answer: B – sequester the potassium cation

Q44. According to the Pre-Final research paper, which of the substituted $[\mathrm{K(crypt)}][\{\mathrm{N_4R_2}\}^{\bullet-}]$ salts shows the longest solution-state half-life and was therefore selected for further reactivity studies?

A. R $=$ 4-F-$\mathrm{C_6H_4}$

B. R $=$ 4-Cl-$\mathrm{C_6H_4}$

C. R $=$ 4-Br-$\mathrm{C_6H_4}$

D. R $=$ $\mathrm{C_6H_5}$

Answer: C – R $=$ 4-Br-$\mathrm{C_6H_4}$

Q45. In the radical anion $[\mathbf{1}]^{\bullet-}$ described in the Pre-Final research paper, the largest individual spin density on the $\{\mathrm{N}_4\}$ chain is located on ...

A. the terminal nitrogens (N1 and N1’)

B. the internal nitrogens (N2 and N2’)

C. the aromatic carbon atoms of the aryl rings

D. the potassium counter-cation

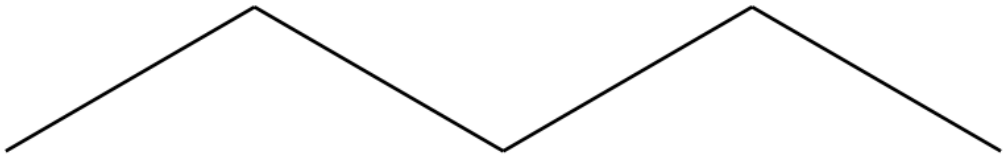
Answer: A – the terminal nitrogens (N1 and N1’)

Q111. Give the common one-word name of the alcohol whose structural formula is drawn here:



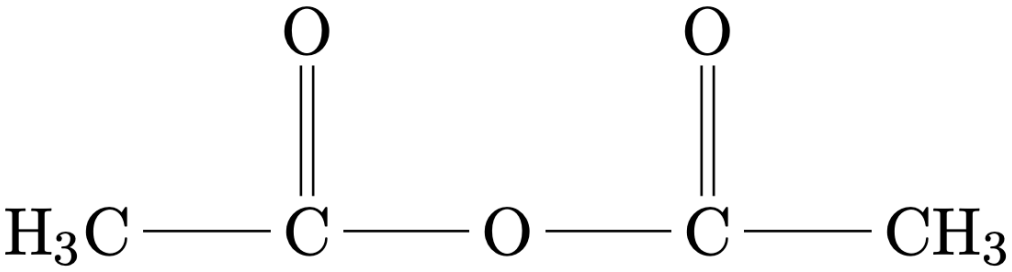
Answer: ethanol

Q112. How many carbon atoms are present in the hydrocarbon whose skeletal formula is drawn here:



Answer: 5

Q116. The molecule whose structural formula is drawn below is most accurately named ...?



A. ethyl acetate

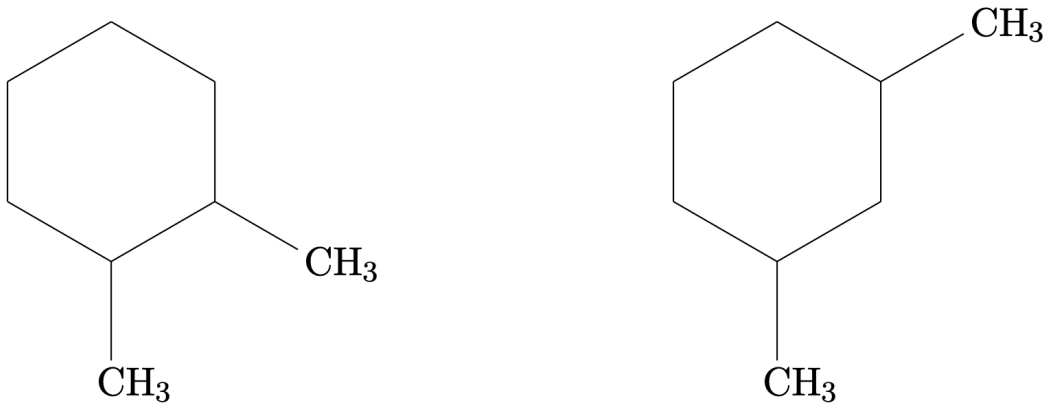
B. acetic anhydride

C. dimethyl ether

D. dimethyl carbonate

Answer: B – acetic anhydride

Q117. The two molecules drawn below are best described as ... ?



A. identical molecules drawn in two orientations

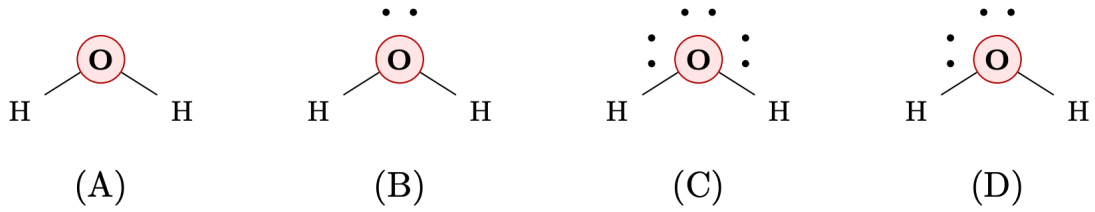
B. constitutional (structural) isomers

C. non-superimposable mirror images (enantiomers)

D. cis-trans (geometrical) isomers

Answer: B – constitutional (structural) isomers

Q118. The image below shows four candidate electron-dot (Lewis) diagrams for the bonding in H_2O. Which one correctly represents the molecule?



A. diagram (A)

B. diagram (B)

C. diagram (C)

D. diagram (D)

Answer: D – diagram (D)

Q1113. The figure below shows the combustion equation for propane. Which values balance the equation?

$$\mathrm{C_3H_8} + a\,\mathrm{O_2} \rightarrow b\,\mathrm{CO_2} + c\,\mathrm{H_2O}$$

A. $a = 4,\ b = 3,\ c = 4$

B. $a = 5,\ b = 3,\ c = 4$

C. $a = 4,\ b = 4,\ c = 3$

D. $a = 3,\ b = 3,\ c = 4$

Answer: B – $a = 5,\ b = 3,\ c = 4$