

A-Level Chemistry Practice Test 4

60 original multiple-choice questions in AQA / Edexcel / OCR exam style (AS + A2). Choose one answer for each question. The full answer key is on the last page — worked explanations for every question are free at QuaidianPoint.com.

Name: _____ Class: _____ Score: _____ / 60

Atomic Structure & Periodicity

Q1. Silicon has three isotopes: ^{28}Si (92.0% abundance), ^{29}Si (5.0% abundance) and ^{30}Si (3.0% abundance). What is the relative atomic mass of silicon?

- (A) 28.0
- (B) 29.0
- (C) 28.1
- (D) 28.5

Q2. The successive ionisation energies of an element are 580, 1820, 2740 and 11600 kJ mol⁻¹. To which group of the Periodic Table does the element belong?

- (A) Group 3
- (B) Group 2
- (C) Group 4
- (D) Group 5

Q3. What is the ground-state electronic configuration of a chromium atom?

- (A) [Ar] 3d⁴ 4s²
- (B) [Ar] 3d⁶
- (C) [Ar] 4s² 3d⁴
- (D) [Ar] 3d⁵ 4s¹

Q4. In a time of flight mass spectrometer, all the ions are accelerated so that they have the same kinetic energy. Which ion has the shortest time of flight?

- (A) An ion with $m/z = 64$
- (B) An ion with $m/z = 16$
- (C) An ion with $m/z = 32$
- (D) An ion with $m/z = 128$

Q5. Why is the first ionisation energy of aluminium lower than that of magnesium?

- (A) The outer electron in aluminium is in a 3p orbital, which is higher in energy and more shielded than the 3s orbital in magnesium
- (B) Aluminium has more protons than magnesium
- (C) Aluminium has a smaller atomic radius than magnesium
- (D) The outer electron in aluminium is in a 3s orbital

Amount of Substance

Q6. A 0.500 dm^3 sample of a gas with $M_r = 44$ is held at 200 kPa and 293 K . What is the mass of the gas? ($R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$)

- (A) 0.90 g
- (B) 3.62 g
- (C) 1.81 g
- (D) 0.45 g

Q7. A 25.0 cm^3 sample of sodium carbonate solution reacts exactly with 22.5 cm^3 of $0.200 \text{ mol dm}^{-3}$ hydrochloric acid. The equation is $\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$. What is the concentration of the sodium carbonate solution?

- (A) $0.0450 \text{ mol dm}^{-3}$
- (B) $0.180 \text{ mol dm}^{-3}$
- (C) $0.200 \text{ mol dm}^{-3}$
- (D) $0.0900 \text{ mol dm}^{-3}$

Q8. The theoretical yield of a synthesis is 10.7 g , but only 8.00 g of pure product is isolated. What is the percentage yield?

- (A) 133%
- (B) 75%
- (C) 25%
- (D) 85%

Q9. Complete combustion of 0.300 g of a compound containing only carbon, hydrogen and oxygen produces 0.440 g of CO_2 and 0.180 g of H_2O . What is the empirical formula of the compound?

- (A) CH_2O
- (B) $\text{C}_2\text{H}_4\text{O}$
- (C) CHO
- (D) CH_3O

Q10. How many molecules are there in 0.880 g of carbon dioxide? (M_r of $\text{CO}_2 = 44$; Avogadro constant = $6.02 \times 10^{23} \text{ mol}^{-1}$)

- (A) 1.20×10^{23}
- (B) 6.02×10^{21}
- (C) 1.20×10^{22}
- (D) 2.41×10^{22}

Q11. Which reaction has an atom economy of 100% ?

- (A) $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
- (B) $\text{C}_2\text{H}_4 + \text{HBr} \rightarrow \text{C}_2\text{H}_5\text{Br}$
- (C) $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
- (D) $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

Bonding & Structure

Q12. What is the shape of a PCl_5 molecule?

- (A) Square pyramidal
- (B) Octahedral
- (C) Tetrahedral
- (D) Trigonal bipyramidal

Q13. For magnesium chloride: enthalpy of formation = -641 kJ mol^{-1} ; enthalpy of atomisation of Mg = $+150 \text{ kJ mol}^{-1}$; first + second ionisation energies of Mg = $+2189 \text{ kJ mol}^{-1}$; enthalpy of atomisation of chlorine = $+121 \text{ kJ mol}^{-1}$ per mole of Cl atoms; electron affinity of Cl = -349 kJ mol^{-1} . What is the lattice enthalpy of MgCl_2 ?

- (A) $-2524 \text{ kJ mol}^{-1}$
- (B) -641 kJ mol^{-1}
- (C) $-1883 \text{ kJ mol}^{-1}$
- (D) $+2524 \text{ kJ mol}^{-1}$

Q14. Which compound has the highest boiling point?

- (A) CH_3CH_3
- (B) CH_3OCH_3
- (C) $\text{CH}_3\text{CH}_2\text{OH}$
- (D) CH_3CHO

Q15. Why is the lattice enthalpy of NaF more exothermic than that of NaCl?

- (A) Fluorine has a more exothermic electron affinity than chlorine
- (B) The F^- ion is smaller than the Cl^- ion, so the ions are closer together and the electrostatic attraction is stronger
- (C) NaF contains more ions per formula unit than NaCl
- (D) The F^- ion has a greater charge than the Cl^- ion

Q16. Graphite conducts electricity along its layers because

- (A) the ions in graphite are free to move
- (B) every carbon atom forms four covalent bonds
- (C) the layers are held together by strong covalent bonds
- (D) each carbon atom forms only three bonds, leaving one delocalised electron per atom

Q17. Which compound forms hydrogen bonds between its molecules?

- (A) NH_3
- (B) CH_4
- (C) H_2S
- (D) PH_3

Energetics & Thermodynamics

Q18. When 0.0100 mol of ethanol is burned completely, the heat released raises the temperature of 100 g of water by 20.0 K . The specific heat capacity of water is $4.18 \text{ J g}^{-1} \text{ K}^{-1}$. What is the experimental enthalpy of combustion of ethanol?

- (A) $-83.6 \text{ kJ mol}^{-1}$
- (B) -418 kJ mol^{-1}
- (C) -836 kJ mol^{-1}
- (D) $-1672 \text{ kJ mol}^{-1}$

Q19. Standard enthalpies of combustion: C = -394 kJ mol^{-1} , H_2 = -286 kJ mol^{-1} , CH_4 = -890 kJ mol^{-1} . What is the standard enthalpy of formation of methane?

- (A) $+76 \text{ kJ mol}^{-1}$
- (B) -76 kJ mol^{-1}
- (C) -182 kJ mol^{-1}
- (D) -890 kJ mol^{-1}

Q20. Ammonium nitrate dissolves in water in an endothermic process, yet the dissolving happens spontaneously at room temperature. This shows that

- (A) the enthalpy change for dissolving must actually be negative
- (B) the process cannot involve an entropy change
- (C) enthalpy change is the only factor that decides feasibility
- (D) the entropy of the system increases enough to make ΔG negative

Q21. A reaction has $\Delta H = -100 \text{ kJ mol}^{-1}$ and $\Delta S = -200 \text{ J K}^{-1} \text{ mol}^{-1}$. What is the value of ΔG for this reaction at 298 K?

- (A) $-40.4 \text{ kJ mol}^{-1}$
- (B) $-159.6 \text{ kJ mol}^{-1}$
- (C) $+40.4 \text{ kJ mol}^{-1}$
- (D) -100 kJ mol^{-1}

Q22. The lattice enthalpy (for the dissociation of the lattice into gaseous ions) of KCl is $+701 \text{ kJ mol}^{-1}$. The enthalpies of hydration are $\text{K}^+ = -322 \text{ kJ mol}^{-1}$ and $\text{Cl}^- = -364 \text{ kJ mol}^{-1}$. What is the enthalpy of solution of KCl?

- (A) -15 kJ mol^{-1}
- (B) $+701 \text{ kJ mol}^{-1}$
- (C) $+15 \text{ kJ mol}^{-1}$
- (D) -701 kJ mol^{-1}

Q23. Bond enthalpies: $\text{C}=\text{C} = 612$, $\text{H}-\text{H} = 436$, $\text{C}-\text{C} = 348$, $\text{C}-\text{H} = 412 \text{ kJ mol}^{-1}$. What is the enthalpy change for the reaction $\text{C}_2\text{H}_4 + \text{H}_2 \rightarrow \text{C}_2\text{H}_6$?

- (A) $+124 \text{ kJ mol}^{-1}$
- (B) -124 kJ mol^{-1}
- (C) -348 kJ mol^{-1}
- (D) -62 kJ mol^{-1}

Kinetics & Rate Equations

Q24. Initial rate experiments show that doubling [A] increases the rate by a factor of 4, while doubling [B] has no effect on the rate. What is the rate equation for the reaction?

- (A) $\text{Rate} = k[\text{A}][\text{B}]$
- (B) $\text{Rate} = k[\text{A}]$
- (C) $\text{Rate} = k[\text{A}]^2[\text{B}]$
- (D) $\text{Rate} = k[\text{A}]^2$

Q25. What are the units of the rate constant for a third-order reaction?

- (A) $\text{mol}^{-2} \text{ dm}^6 \text{ s}^{-1}$
- (B) $\text{mol}^{-1} \text{ dm}^3 \text{ s}^{-1}$
- (C) s^{-1}
- (D) $\text{mol dm}^{-3} \text{ s}^{-1}$

Q26. A first-order reaction has a half-life of 600 s. What is the value of the rate constant?

- (A) $1.16 \times 10^{-2} \text{ s}^{-1}$
- (B) $5.78 \times 10^{-4} \text{ s}^{-1}$
- (C) $1.16 \times 10^{-3} \text{ s}^{-1}$
- (D) $1.67 \times 10^{-3} \text{ s}^{-1}$

Q27. A reaction has an activation energy of 50.0 kJ mol^{-1} . Its rate constant at 300 K is $2.00 \times 10^{-3} \text{ s}^{-1}$. What is the rate constant at 320 K ? ($R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$)

- (A) $2.9 \times 10^{-3} \text{ s}^{-1}$
- (B) $7.0 \times 10^{-3} \text{ s}^{-1}$
- (C) $4.0 \times 10^{-3} \text{ s}^{-1}$
- (D) $1.4 \times 10^{-2} \text{ s}^{-1}$

Q28. A catalyst increases the rate of a reaction because it

- (A) increases the average energy of the reactant particles
- (B) shifts the position of equilibrium towards the products
- (C) increases the energy of every collision
- (D) provides an alternative pathway with a lower activation energy, so a greater proportion of collisions are successful

Equilibria (K_c & K_p)

Q29. At equilibrium for the reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$, the concentrations are $[\text{H}_2] = 0.10 \text{ mol dm}^{-3}$, $[\text{I}_2] = 0.10 \text{ mol dm}^{-3}$ and $[\text{HI}] = 0.80 \text{ mol dm}^{-3}$. What is the value of K_c ?

- (A) 64
- (B) 0.80
- (C) 8.0
- (D) 16

Q30. In the Haber process equilibrium $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$, the equilibrium partial pressures are $\text{N}_2 = 20 \text{ kPa}$, $\text{H}_2 = 60 \text{ kPa}$ and $\text{NH}_3 = 20 \text{ kPa}$. What is the value of K_p ?

- (A) $3.70 \times 10^{-3} \text{ kPa}^{-2}$
- (B) $1.11 \times 10^{-4} \text{ kPa}^{-2}$
- (C) $9.26 \times 10^{-5} \text{ kPa}^{-2}$
- (D) $2.78 \times 10^{-4} \text{ kPa}^{-2}$

Q31. A catalyst is added to a reaction mixture that has already reached equilibrium. What happens?

- (A) The value of K_c increases
- (B) The position of equilibrium and the value of K_c are unchanged
- (C) The equilibrium shifts towards the products
- (D) The value of K_c decreases

Q32. In the equilibrium $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$, the equilibrium concentrations are $[\text{PCl}_5] = 1.20 \text{ mol dm}^{-3}$, $[\text{PCl}_3] = 0.80 \text{ mol dm}^{-3}$ and $[\text{Cl}_2] = 0.80 \text{ mol dm}^{-3}$. What is the value of K_c ?

- (A) 0.42 mol dm^{-3}
- (B) 1.88 mol dm^{-3}
- (C) 0.96 mol dm^{-3}
- (D) $0.533 \text{ mol dm}^{-3}$

Q33. At equilibrium in the esterification $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} \rightleftharpoons \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$, a mixture contains 0.20 mol of ethanoic acid, 0.20 mol of ethanol, 0.80 mol of ethyl ethanoate and 0.80 mol of water, all in the same volume. What is the value of K_c ?

- (A) 16
- (B) 4.0
- (C) 0.25
- (D) 2.0

Redox & Electrode Potentials

Q34. What is the average oxidation state of sulfur in $\text{Na}_2\text{S}_2\text{O}_3$?

- (A) +4
- (B) 0
- (C) +2
- (D) +6

Q35. E° values: $\text{Mg}^{2+}/\text{Mg} = -2.37 \text{ V}$; $\text{Ag}^+/\text{Ag} = +0.80 \text{ V}$. What is the standard cell potential of a cell combining these two half-cells?

- (A) +1.57 V
- (B) +3.17 V
- (C) -3.17 V
- (D) +2.37 V

Q36. Standard electrode potentials: $\text{Cu}^{2+}/\text{Cu} = +0.34 \text{ V}$; $\text{Fe}^{2+}/\text{Fe} = -0.44 \text{ V}$; $\text{Zn}^{2+}/\text{Zn} = -0.76 \text{ V}$; $\text{Mg}^{2+}/\text{Mg} = -2.37 \text{ V}$. Which metal is the strongest reducing agent?

- (A) Zn
- (B) Fe
- (C) Cu
- (D) Mg

Q37. $E^\circ(\text{Cu}^+/\text{Cu}) = +0.52 \text{ V}$ and $E^\circ(\text{Cu}^{2+}/\text{Cu}^+) = +0.15 \text{ V}$. What happens when Cu^+ ions are in aqueous solution?

- (A) They disproportionate into Cu and Cu^{2+}
- (B) They are stable and no reaction occurs
- (C) They are oxidised by water to Cu^{2+}
- (D) They are all reduced to Cu by water

Q38. A current of 0.50 A is passed for 30 minutes through silver nitrate solution. What mass of silver is deposited at the cathode? ($F = 96500 \text{ C mol}^{-1}$; Ar of Ag = 108)

- (A) 0.50 g
- (B) 2.01 g
- (C) 1.01 g
- (D) 0.25 g

Acids, Bases & Buffers

Q39. What is the pH of a $0.0500 \text{ mol dm}^{-3}$ solution of propanoic acid? ($K_a = 1.3 \times 10^{-5} \text{ mol dm}^{-3}$)

- (A) 2.79
- (B) 3.09
- (C) 3.39
- (D) 4.89

Q40. Equal volumes (25.0 cm^3) of $0.100 \text{ mol dm}^{-3}$ hydrochloric acid and $0.0500 \text{ mol dm}^{-3}$ sodium hydroxide solution are mixed. What is the pH of the resulting solution?

- (A) 1.00
- (B) 2.30
- (C) 0.60
- (D) 1.60

Q41. A buffer solution is made by mixing 0.300 mol of ethanoic acid with 0.200 mol of sodium ethanoate in the same volume of solution. The pK_a of ethanoic acid is 4.76. What is the pH of the buffer?

- (A) 4.58
- (B) 4.76
- (C) 4.94
- (D) 4.40

Q42. At 50°C , the ionic product of water, K_w , is $5.5 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$. What is the pH of pure water at this temperature?

- (A) 7.00
- (B) 7.37
- (C) 6.63
- (D) 13.26

Q43. Which salt forms an acidic solution when dissolved in water?

- (A) Sodium ethanoate
- (B) Ammonium chloride
- (C) Potassium nitrate
- (D) Sodium carbonate

Inorganic Chemistry

Q44. Which Group 2 carbonate is the most stable to thermal decomposition?

- (A) MgCO_3
- (B) CaCO_3
- (C) SrCO_3
- (D) BaCO_3

Q45. Concentrated sulfuric acid is added to solid sodium bromide and the mixture is warmed. What is observed?

- (A) Orange fumes of bromine are produced
- (B) White fumes of hydrogen bromide only are produced
- (C) No reaction occurs
- (D) Brown fumes of nitrogen dioxide are produced

Q46. Zinc is added to acidified potassium dichromate(VI) solution and the mixture is shaken. What colour change is seen?

- (A) Colourless to orange
- (B) Green to orange
- (C) Orange to green
- (D) Blue to green

Q47. Which ligand is bidentate?

- (A) NH_3
- (B) $\text{C}_2\text{O}_4^{2-}$ (ethanedioate)
- (C) Cl^-
- (D) H_2O

Q48. A solution is warmed with sodium hydroxide solution and a gas is produced that turns damp red litmus paper blue. Which ion was present in the solution?

- (A) CO_3^{2-}
- (B) SO_4^{2-}
- (C) NO_3^-
- (D) NH_4^+

Organic Chemistry I

Q49. Which pair of products could be formed when decane, $\text{C}_{10}\text{H}_{22}$, is cracked?

- (A) $\text{C}_8\text{H}_{18} + \text{C}_2\text{H}_4$
- (B) $\text{C}_9\text{H}_{20} + \text{CH}_4$
- (C) $\text{C}_5\text{H}_{12} + \text{C}_5\text{H}_{12}$
- (D) $\text{C}_7\text{H}_{16} + \text{C}_3\text{H}_8$

Q50. The hydrolysis of 2-bromo-2-methylpropane by aqueous alkali is first order in the halogenoalkane and zero order in hydroxide ions. This is because

- (A) the hydroxide ion attacks the carbon atom at the same time as the bromide leaves
- (B) a primary carbocation intermediate is formed
- (C) the rate-determining step is the slow ionisation of the molecule to form a stable tertiary carbocation
- (D) the reaction is an elimination, not a substitution

Q51. Which species can act as a nucleophile?

- (A) H^+
- (B) NH_3
- (C) BF_3
- (D) NO_2^+

Q52. Which alkene shows cis-trans (E/Z) isomerism?

- (A) Ethene
- (B) Propene
- (C) 2-Methylpropene
- (D) But-2-ene

Q53. Propan-1-ol is distilled with acidified potassium dichromate(VI) as it forms. What is the organic product collected?

- (A) Propanal
- (B) Propanone
- (C) Propanoic acid
- (D) Propene

Q54. Butan-2-ol is dehydrated by heating with concentrated sulfuric acid. Counting E/Z isomers as separate products, how many different alkenes are formed?

- (A) 1
- (B) 2
- (C) 3
- (D) 4

Organic Chemistry II & Analysis

Q55. Which compound forms a silver mirror when warmed with Tollens' reagent?

- (A) Propanone
- (B) Ethanal
- (C) Ethanol
- (D) Ethanoic acid

Q56. Propanoic acid is warmed with methanol in the presence of a concentrated sulfuric acid catalyst. What is the main organic product?

- (A) Ethyl propanoate
- (B) Methyl ethanoate
- (C) Propyl methanoate
- (D) Methyl propanoate

Q57. What are the correct reagents and conditions for the bromination of benzene?

- (A) Br₂ with an FeBr₃ catalyst
- (B) Br₂ in ultraviolet light
- (C) Concentrated HBr, heated
- (D) Aqueous bromine, no catalyst

Q58. Propanenitrile is reduced using hydrogen and a nickel catalyst. What is the product?

- (A) Ethylamine
- (B) Propanamide
- (C) Propylamine
- (D) Propanoic acid

Q59. In a strongly acidic solution, glycine (aminoethanoic acid) exists mainly as

- (A) a zwitterion with -NH₃⁺ and -COO⁻ groups
- (B) a positive ion with -NH₃⁺ and -COOH groups
- (C) a negative ion with -NH₂ and -COO⁻ groups
- (D) a neutral molecule with -NH₂ and -COOH groups

Q60. How many peaks are there in the carbon-13 NMR spectrum of benzene?

- (A) 6
- (B) 3
- (C) 2
- (D) 1

Answer Key

Q1: C	Q11: B	Q21: A	Q31: B	Q41: A	Q51: B
Q2: A	Q12: D	Q22: C	Q32: D	Q42: C	Q52: D
Q3: D	Q13: A	Q23: B	Q33: A	Q43: B	Q53: A
Q4: B	Q14: C	Q24: D	Q34: C	Q44: D	Q54: C
Q5: A	Q15: B	Q25: A	Q35: B	Q45: A	Q55: B
Q6: C	Q16: D	Q26: C	Q36: D	Q46: C	Q56: D
Q7: D	Q17: A	Q27: B	Q37: A	Q47: B	Q57: A
Q8: B	Q18: C	Q28: D	Q38: C	Q48: D	Q58: C
Q9: A	Q19: B	Q29: A	Q39: B	Q49: A	Q59: B
Q10: C	Q20: D	Q30: C	Q40: D	Q50: C	Q60: D

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