

UNIT 4 REVISION CHECKLIST

Topic 4.1 Kinetics

Can you:

- a) Define the terms: rate of a reaction, rate constant, order of reaction and overall order of reaction
- b) Deduce the orders of reaction with respect to the reactants from initial rate data, presented graphically or in tabular form
- c) Calculate the value of a rate constant and its units from initial rate data
- d) Predict the effect of a change in temperature and pressure on the value of the rate constant

Topic 4.2 Equilibria

Can you:

- a) Derive an expression for the equilibrium constant K_c of a chemical reaction, and deduce its units
- b) Calculate the equilibrium constant of a reaction from equilibrium concentration data and vice versa
- c) Calculate the equilibrium constant of a reaction from initial concentration data and some information relating to the equilibrium composition
- d) Recall and explain that only temperature affects the value of the equilibrium constant

Topic 4.3 Acids and Bases

Can you:

- a) Define the terms acid and base in terms of Bronsted-Lowry theory
- b) Understand that acid-base reactions involve proton transfer and use the principle of acid-base conjugate pairs to explain acid-base reactions
- c) Explain the terms strong acid, weak acid, strong base and weak base
- d) Recall the expression for K_w (ionic product of water) and relate it to the auto-ionisation of water

- e) Deduce an expression for K_a of weak acids
- f) Define the terms pH and pK_a
- g) Calculate the pH of water and solutions of strong acids, weak acids or strong bases given the concentration and K_w or K_a , and vice versa, and explain the approximations involved
- h) Explain why pH is temperature dependent and explain the variation of dissociation with temperature on the basis of the enthalpy changes of dissociation
- i) Define the term buffer solution and explain using equations how a given buffer solution works
- j) Calculate the pH of a buffer solution consisting of a mixture of a weak acid and its conjugate base using K_a and the relative concentrations of acid and base, and vice versa
- k) Deduce the volume at which the end-point will be reached given information about the concentrations and volumes of the reacting species
- l) Sketch titration curves for strong and weak acids with strong and weak bases
- m) Understand that partially neutralised weak acids form a buffer solution, show how $pH = pK_a$ at half-neutralisation, and calculate the pH during titrations involving alkalis added to acids, including after excess alkali has been added
- n) Select a suitable indicator for a given titration given pK_{in} values, and explain the choice of indicator
- o) Recall that polybasic acids form more than one salt on neutralization and write equations to show the formation of each salt

Topic 4.4 Nomenclature and Isomerism

Can you:

- a) Name organic compounds involving all the functional groups introduced at AS level and also secondary and tertiary amines, quaternary ammonium salts, acid chlorides, acid anhydrides, amides, esters and N-substituted amides, and simple organic compounds involving two functional groups (such as amino acids)
- b) Define the terms chiral, optical isomer (enantiomer) and racemate, draw and recognise enantiomers and explain how they are distinguished, understand why some reactions produce racemates rather than single enantiomers, and explain why optical isomers of drugs may have very different effects

Topic 4.5 Compounds Containing the Carbonyl Group

- a) Write equations for the oxidation and reduction of alcohols, carbonyls and carboxylic acids and recall suitable reagents and conditions for these redox reactions
- b) Recall the reaction of carbonyls with HCN, and know the mechanism for nucleophilic addition limited to carbonyls with HCN and NaBH₄.
- c) Recall and write equations for the reaction of acid chlorides and acid anhydrides with water and ammonia
- d) Recall and write equations for the reaction of carboxylic acid, acid chlorides and acid anhydrides with alcohols, and of acid chlorides and acid anhydrides with primary amines, and know why acid anhydrides are preferred to acid chlorides when preparing aspirin
- e) Recall that esters can be hydrolysed under acidic and alkaline conditions and that this reaction is used in the manufacture of soap.
- f) Describe how to make biodiesel from naturally occurring vegetable oil
- e) Recall the mechanism of nucleophilic addition-elimination limited to acid chlorides with water, ammonia, primary amines and alcohols

Topic 4.6 Aromatic Chemistry

Can you:

- a) Describe the structure and bonding in benzene and explain its stability
- b) Write equations to show the nitration, acylation and alkylation of benzene, know the mechanism of electrophilic substitution limited to these reactions, know the necessary conditions and predict the major product formed when benzene is alkylated using alkenes and HCl
- c) Write an equation for the reduction of nitrobenzene to phenylamine and give the reagents and conditions for the reaction

Topic 4.7 Amines

Can you:

- a) Write equations for the formation of primary, secondary and tertiary amines and quaternary ammonium salts by reaction of a haloalkane with ammonia
- b) Write equations for the formation of primary amines from nitriles and know the advantages of this method for preparing primary amines
- c) Understand that amines are basic and write equations to show their basicity
- d) Explain why aromatic amines are less basic than aliphatic amines

Topic 4.8 Amino Acids

Can you:

- a) Name simple amino acids and draw their structures in high pH, low pH and as Zwitterions in the solid state
- b) Recall that amino acids can undergo condensation reactions with each other and draw the structures of possible condensation products
- c) Recall that amino acids can be separated by chromatography

Topic 4.9 Polymers

Can you:

- a) Recall that alkenes can form addition polymers and draw structures for polymers given the monomer and vice versa
- b) Recall that diacid chlorides or diacids can react with diols or diamines to form condensation polymers, draw the repeating units of polyesters and polyamides and know the structures of terylene and nylon 66
- c) Understand how condensation polymers can be hydrolysed and understand the advantages and disadvantages of this
- d) Understand that polyamides can form intermolecular and intramolecular hydrogen bonds and know the implications of this
- e) Explain the problems of polymer disposal and recycling

Topic 4.10 Organic Synthesis and Analysis

Can you:

- a) Describe tests for aldehydes, alkenes and carboxylic acids and understand the chemistry underlying them
- b) Describe how primary, secondary and tertiary alcohols could be distinguished
- c) Describe how acid chlorides and acid anhydrides can be distinguished
- d) Memorise a synthesis map showing the interconversion of all the different organic compounds and recall how one compound can be prepared from another using one or more steps

Topic 4.11 Structure Determination

Can you:

- a) Write equations to show the fragmentation of molecular ions in a mass spectrum and predict the structures of the most likely fragmentation products
- b) Use fragmentation patterns to deduce the structure of an organic compound given its molecular formula
- c) Understand that molecules containing Cl or Br will have more than one molecular ion peak
- d) Use data on infra-red absorption frequencies to deduce the functional groups present in an organic compound
- e) Explain why TMS is a useful reference in proton nmr spectroscopy and why CCl_4 and CDCl_3 are useful solvents
- f) Deduce the number of different proton environments and the number of protons in each environment from integrated proton nmr spectra
- g) Deduce the number of different carbon environments from carbon-13 nmr spectra
- g) Identify functional groups present in proton and carbon-13 nmr spectra from the chemical shift value
- i) Predict and justify splitting patterns, and recall that hydrogen atoms bonded to oxygen do not cause splitting
- j) Use integration factors, chemical shifts and splitting patterns to deduce structures of organic molecules
- k) Describe what happens during gas-liquid chromatography

If you can do all these things, you will get an A!