NB. ‘Half a question’ (out of 12.5 marks)

Answer part (a) and EITHER part (b) OR part (c) of this question.

(a) (i) Draw a curly arrow mechanism and sketch an energy profile diagram for the reaction of benzene with a nitronium ion (NO2⁺) giving nitrobenzene via an S₄Ar pathway. Clearly indicate the relative energies of the starting material, transition state(s), intermediate(s) and product in your diagram.

(ii) Using the reaction of chlorobenzene with acetyl chloride (MeCOCl) and aluminium trichloride (AlCl₃) as an example, explain the directing effect of the chlorine substituent on this S₄Ar reaction. Refer to Hammond’s postulate and the structure of the Wheland intermediate in your answer. Also explain why only mono-substitution occurs.

(b) Draw the expected major product of the following reaction and provide a mechanism. Justify any regiochemistry.

(c) Draw the expected major product of the following reaction and provide a mechanism. Justify any regiochemistry.