

## Review Questions- G12-Edexcel-Unit-4

### Unit 4 Questions

**Question 1:** Give the formula of the structural isomers of  $C_4H_8$  which are non cyclic. One of these isomers shows a type of stereoisomerism. Give the structures of the stereoisomer and name them. Suggest how these stereoisomer might be distinguished. One of the isomers of  $C_4H_8$  above reacts with HBr to give two different products; the major product is the one having a chiral molecule. Identify the isomers of  $C_4H_8$ . why is the major product chiral but the minor one is not? Why is the chiral product the major one, and the non chiral product is minor one? The major product of this addition reaction is found to be optically inactive. Explain why this is so.

**Question 2:** This question relates to the following reaction scheme:



Give the reagents, the conditions required and the equation for (a) step 1 and (b) step 2. what type of mechanism is step 1? The conversion of  $C_2H_5Br$  to  $C_2H_5OH$  by this method is ineffective, not least because step 3 gives a very poor yield of only 7%. Outline an alternative synthetic route, stating clearly the reagent and conditions of the steps you suggest.

**Question 3:** Hydrogen and iodine reacts together to give an equilibrium:  $[H_2 + I_2 \rightleftharpoons 2HI_{(g)}]$  write an expression for  $K_p$  for this equilibrium, giving consideration to its units. when 0.5 mol of  $I_2$  and 0.50 mol of  $H_2$  were mixed in a closed container at 723K and 2 atm pressure, 0.11 mol of  $I_2$  were found to be present when equilibrium was established. Calculate the partial pressure of  $I_2$ ,  $H_2$  and HI in the equilibrium mixture. Hence calculate the value of  $K_p$  at 723K. in an experiment to establish the equilibrium concentration given above the reaction was allowed to reach equilibrium at 723K and then quenched by addition to a known, large volume of water, the concentration of iodine in this solution was then determined by titration with standard sodium thiosulphate solution. Explain what is meant by the word 'quench' and why quenching is necessary. Write an expression for the reaction between thiosulphate and iodine. What indicator would you use? Give the colour change at the end point. In this titration and in titration involving potassium manganate (VII), a colour change occurs during reaction. Why is an indicator usually added iodine/thiosulphate titration but not in titrations involving potassium manganate(VII).

**Question 4:** Draw a born Haber cycle for formation of calcium oxide. Use the data as[] identify which change represents the lattice enthalpy of CaO. Use the data above to calculate the ionization of oxygen. Use this value of ionization of oxygen to calculate the first electron affinity of oxygen, given that the second electron affinity of oxygen is  $844 \text{ kJ mol}^{-1}$ . Would the ionization energy for magnesium will be higher or lower than it is for calcium. Explain your answer.

**Question 5:** When ethanoic acid is dissolved in water, the following equilibrium is established:  $[CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+]$  when hydrogen chloride dissolves in ethanoic acid, the equilibrium established is  $[CH_3COOH + HCl \rightleftharpoons CH_3COOH_2^+ + Cl^-]$ . Comment on the role of ethanoic acid in both the equilibrium. What is the relationship between species  $CH_3COOH_2^+$  and  $CH_3COOH$ ? The value of  $K_a$  for ethanoic acid at 298K is  $1.74 \times 10^{-5} \text{ mol dm}^{-3}$  and for methanoic acid, HCOOH, is  $1.60 \times 10^{-4} \text{ mol dm}^{-3}$  at the same temperature. Write an expression for  $K_a$  for  $CH_3COOH$ . Hence calculate the pH of a  $0.100 \text{ mol dm}^{-3}$  solution of  $CH_3COOH$  at 298K. the pH of a  $0.050 \text{ mol dm}^{-3}$  methanoic acid solution is 2.55. using this together with the data above and your answer (a) state which of the two acids is the strongest (b) comment on the relative pH value of the two acids. Sketch with reasonable accuracy, on a pair of axes, how the pH change during the titration of  $20.0 \text{ cm}^3$  of  $0.100 \text{ mol dm}^{-3}$  solution of methanoic acid with  $0.050 \text{ mol dm}^{-3}$  sodium hydroxide solution. Select using the data below a suitable indicator for this titration and also give a brief reason for your choice based on the curve drawn.

indicator	range	indicator	range
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From your knowledge of the characteristic reactions of functional groups, how would you show the presence of (a) CHO group in A and (b) the COOH group in B. give the reagent and conditions required to carry out step 1 and step 3. name the type of reaction occurring in step 1 and step 3. give the essential structural features necessary for geometrical isomerism to occur in simple organic molecules. Hence deduce whether or not this type of isomerism exists in compound D.

**Question 9:** Aluminium chloride,  $\text{Al}_2\text{Cl}_6$  is formed when dry chlorine is passed over heated aluminium. Write the equation for the reaction between aluminium and chlorine. What types of bonding exists in aluminium chloride,  $\text{Al}_2\text{Cl}_6$ ? Silicon tetrachloride,  $\text{SiCl}_4$  is vigorously hydrolysed by water. Write an equation for this hydrolysis reaction. Suggest, with reason, a specific safety precaution when this reaction is carried out. Carbon also forms a tetrachloride,  $\text{CCl}_4$  state the shape of the  $\text{CCl}_4$  molecule. Explain why carbon tetrachloride is not hydrolyzed by water. When lead (IV) oxide is added to concentrated hydrochloric acid at room temperature, the following reaction occurs,  $[\text{PbO}_2 + \text{HCl} \longrightarrow \text{PbCl}_2 + \text{Cl}_2 + \text{H}_2\text{O}]$ . What property of  $\text{PbO}_2$ , lead oxide is shown by this reaction? A student suggested two possibilities for the reaction between tin (IV) oxide and concentrated hydrochloric acid,  $[\text{SnO}_2 + \text{HCl} \longrightarrow \text{SnCl}_2 + \text{Cl}_2 + \text{H}_2\text{O}]$  and  $[\text{SnO}_2 + \text{HCl} \longrightarrow \text{SnCl}_4 + 2\text{H}_2\text{O}]$ . Use your knowledge of chemistry of group 4 to predict which of the above reactions is more likely. Explain your reasoning.

**Question 10:** An organic product A, with molecular formula  $\text{C}_5\text{H}_{10}\text{O}$  contains a carbonyl group. Compound A is reacted with iodine in the presence of alkali, a pale yellow precipitate forms. What is the formula of this precipitate? What does this reaction indicate about the structure of A? Compound A has a branched carbon chain, draw the structural formula and give the name of A. Pentanal is a structural isomer of A. when heated with Fehling's solution, it reacts to produce sodium pentanoate and a red precipitate. Identify the homologous series to which pentanal belongs. Suggest the identity of the red precipitate formed in this reaction. State a reagent which could be used to convert the sodium pentanoate made in the reaction above into pentanoic acid. Solid sodium hydrogen carbonate,  $\text{NaHCO}_3$  is reacted with excess concentrated pentanoic acid solution state what you would see as this reaction proceeds. Write a balanced chemical equation for this reaction.

**Question 11:** Calculate the pH of  $0.050 \text{ mol dm}^{-3}$  hydrochloric acid. Calculate the concentration of hydroxide ions in  $\text{mol dm}^{-3}$  in this solution. At this temperature  $K_w$  is  $1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ . phosphoric acid,  $\text{H}_3\text{PO}_4$ , is a weak acid, forming the following equilibrium in water  $[\text{H}_3\text{PO}_4 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{PO}_4^- + \text{H}_3\text{O}^+]$ . Write an expression for the acid dissociation constant,  $K_a$ , for phosphoric(V) acid. Given that a  $0.500 \text{ mol dm}^{-3}$  solution of  $\text{H}_3\text{PO}_4$  has a pH of 1.20, calculate the value of  $K_a$ , stating its units. Assume that there is no further dissociation of the  $\text{H}_2\text{PO}_4^-$  ions. The  $\text{H}_2\text{PO}_4^-$  ion formed when  $\text{H}_3\text{PO}_4$  is added to water can dissociate further into  $\text{H}_2\text{PO}_4^-$   $[\text{H}_2\text{PO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{HPO}_4^{2-} + \text{H}_3\text{O}^+]$  Identify the conjugate acid base pair in the above equation. Explain why very little dissociation of the  $\text{H}_2\text{PO}_4^-$  ion occurs in solution of  $\text{H}_3\text{PO}_4$ . the change in pH when  $24.0 \text{ cm}^3$  of  $0.100 \text{ mol dm}^{-3}$  phosphoric(V) acid is titrated with sodium hydroxide solution of same concentration can be seen on the graph below. From the list below select a suitable indicator for this titration. Justify your choice.

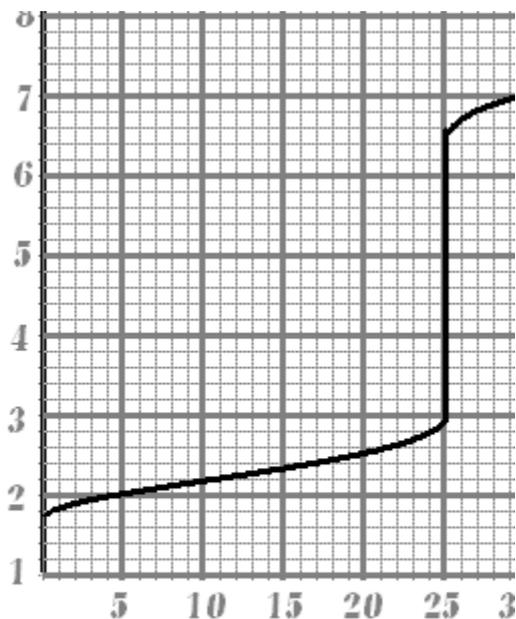
indicator	bromo cresol green	bromo thymol blue	phenolphthalein
$\text{pK}_a$	4.7	7.0	9.3

**Question 12:** The following data relate to the thermodynamic change which occurs when group 2 hydroxides dissolve in water.

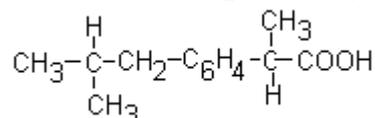
Enthalpy of hydration of $\text{Mg}^{2+}$	$-1890 \text{ kJ mol}^{-1}$
Enthalpy of hydration of $\text{Ba}^{2+}$	$-1275 \text{ kJ mol}^{-1}$
Enthalpy of hydration of $\text{OH}^-$	$-550 \text{ kJ mol}^{-1}$
Lattice enthalpy of $\text{Mg}(\text{OH})_2$	$-2995 \text{ kJ mol}^{-1}$
Lattice enthalpy of $\text{Ba}(\text{OH})_2$	$-2320 \text{ kJ mol}^{-1}$

Define the term enthalpy of hydration, explain why this enthalpy change is always exothermic. Why is the lattice enthalpy of magnesium hydroxide more exothermic than that of barium hydroxide? Draw a labeled Hess's law cycle to show how the lattice energy and the enthalpies of hydration are related to

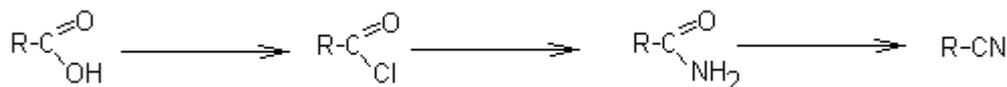
the enthalpy of solution of magnesium hydroxide,  $\text{Mg}(\text{OH})_2$ . Use your cycle and the data to calculate the enthalpy of solution of magnesium hydroxide. Include a sign and units with your answer. Use the data to explain how the solubility of barium hydroxide compares with that of magnesium hydroxide.



**Question 13:** The pain killing drug ibuprofen has the formula,



identify the chiral center in ibuprofen. Explain what is meant by the term chiral. Ibuprofen exists as a pair of optical isomers. How can these two isomers be distinguished? The formula of ibuprofen can be represented as  $\text{RCOOH}$ . Consider the following reaction scheme involving ibuprofen.



Suggest reagents for the conversion of (a) ibuprofen to A (b) B to C (c) classify the type of reaction converting A into B. the amide, B, can be converted into a primary amine. Give the reagents for this reaction. Ibuprofen and compound A both react with ethanol to form the same organic product. Draw the structural formula for this product. You may use 'R-' to represent the same portion of the carbon chain as in previous part. Suggest two reasons why it is preferable to use A, rather than ibuprofen, to carry out the reaction. Compound C can be converted back to ibuprofen. Name the reagent and state the conditions for this reaction.

**Question 14:** Hydrogen sulphide,  $\text{H}_2\text{S}$ , is partially decomposed when heated as  $[ 2\text{H}_2\text{S} \rightleftharpoons 2\text{H}_2 + \text{S}_2 ]$  the enthalpy change for this reaction is  $+170 \text{ kJ mol}^{-1}$ . 0.500 mol of gaseous  $\text{H}_2\text{S}$  were placed in a flask of volume  $20.0 \text{ dm}^3$  and heated until equilibrium was reached. Write an expression for this equilibrium constant,  $K_c$  for this reaction. When equilibrium was established, there were 0.350 moles of hydrogen sulphide,  $\text{H}_2\text{S}$  in the flask. Calculate the value of  $K_c$  at this temperature to two significant figures. State its units. The pressure in the reaction vessel was increased. By considering any change in  $K_c$  explain the effect on the equilibrium position. State the effect, if any, on the value of  $K_c$  of (a) adding a catalyst. (b) increasing the temperature.