Chemistry assignment

Answer all questions in section A – section D. Make sure that the section heading is included and your answers are correctly numbered. The assignment must have a completed cover sheet. It must be placed in the drop- box on or before the deadline. st section an electronic structure&Ionization energy. 2. Write the electronic structure in s, p, d notation of the following: O, Na, Na+, A1, Cl- and co (Total 6 Marks) Write the electronic configuration in box notation of the following: N, Si and Ni (Total 3 Marks) 3.

Write the electronic configuration in box notation of chromium and copper. Suggest reasons for the apparently anomalous arrangement of electrons in their atoms. (Total 4 Marks) 4. The following table shows the first three ionization energies (in kJ mol-l) of elements Element c OHM 383 425 502 527 OHi2 2437 2667 3065 4568 7314 OHi3 3376 3881 4438 6929 11820 In which group of the Periodic Table should the elements be placed? Give a reason for your answer. Which of the elements has the largest atomic number? Give a reason for your answer. Turn to page 2 for SECTION A – Question 5. Marks) (Total 4 Marks) 5. kJ mol-l. 740 418 577 2400 1 500 1757 3069 1816 3700 7700 14850 4439 2745 OHi4 25000 10500 21000 5876 11575 In which group of the Periodic Table should each element be placed? (5 Marks) How much energy is needed to convert one mole of gaseous atoms of element (2 Marks) C into 1 mole of dipositive ions? (Total 7 Marks) 6. Calculate number of moles of: (a) HCI in 25 cm3 of 0. 10 mol dm-3 solution (b) H2S04 in 32 cm3 of 0. 50 mol dm-3 solution (Total 2 Marks) 7. Calculate the volume of (a) 0. 02 mol dm-3 HCI solution containing 1 X 10-3 moles of HCI (b) 0. mol dm-3 H2S04 solution containing 2 X 10-3 moles of H2S04 (Total 2 Marks) 8.

Calculate the molar concentrations (in mol dm-3) of the following solutions that contain: (a) 2. 2 x 10-3 moles AgN03 in 37 cm3 (b) 7 x 10-3 moles sac12 20 crn3 9. 23 cm3 of 1. 5 mol dm-3 H2S04 reacts completely with 40. 5 cm3 of a given KOH solution. 2KOH + H2S04 0 K2S04 + 2H20 What is the molar concentration of the KOH solution? Turn to page 3 for SECTION A – Question 10. 2 10. 27. 823g of Na2C03. xH20 crystals were dissolved in water and made up to 1000 cm3 of solution. cm3 of this solution required 48. 8 cm3 of 0. 1 mol dm-3 HCI for complete neutralisation. Find the value of x in Na2C03. xH20 using the following steps: 2HCl + Na2C03 0 2NaCl + C02 + H20 (f) 11. calculate the number of moles of Na2C03 in 25 cm3 calculate the number of moles of Na2C03 in 1000 cm3 calculate the mass of Na2C03 in 1000 cm3 calculate the mass of water of crystallization associated with this mass of Na2C03 calculate the moles of water of crystallization associated with this mass of Na2C03 calculate the value of x in Na2C03. xH20 (Total 8 Marks) . 0g of lawn sand (a mixture of sand and ammonium sulphate) was weighed into a conical flask, and 25 cm3 of 2. 0 mol dm-3 sodium hydroxide solution was pipetted into the same flask. The conical flask was boiled for 20 minutes, after which time all the ammonia had been driven off, because: (NH4) 2S04 (s) + 2NaOH (aq) 2NH3 (g) + Na2S04 (aq) + 2H20 (1) The residue in the flask was cooled and filtered to remove the sand. The filtrate containing unreacted NaOH was made up to 250 cm3 in a volumetric flask. 25 cm3 samples of this solution were titrated against 0. ol dm-3 hydrochloric acid using bromothymol blue as an indicator. HCI + NaOH O Naci + H20 3 The mean titre was 20. 0 cm . Calculate the percentage of ammonium sulphate by mass in the lawn sand. (Total 8 BONDING & ENERGY 12. (a) Using the Valence shell electron pair repulsion theory state and explain the shape of

GaC13. Sketch a diagram to show the arrangement of atoms in space, labelling the bond angles. Draw a dot & cross diagram to show the bonding in hydrogen sulphide, H2S. State and explain the shape of H2S using the ‘ valence shell electron pair repulsion theory’, stimating the bond angle. i) Draw a dot & cross diagram to show the bonding in methanal, HCHO. State and explain the shape of HCHO using the ‘ electron pair repulsion theory’, estimating the (H-C-H) bond angle. (it) Methanal (HCHO) is a gas at room temperature whereas methanol (CH30H) is a liquid. Suggest an explanation for this. (4 Marks) (3 Marks) (Total 14 Marks) 13. Predict the shapes of phosphine, PH3 sulphur trioxide, S03 (iii) the sulphite ion, S032(iv) the amide ion, NH2(v) the tetrahydroborate ion, BH4(Total 5 Marks) 14.

A coffee-cup calorimeter contains 55. cm3 of a dilute solution of copper(ll) sulfate at a temperature of 22. 8 oc. A small amount of zinc powder also at 22. 8 oc is added to the solution. Copper metal is formed, and the temperature of the solution rises to 32. 3 oc. The copper is collected, dried and weighted, when it is found to have a mass of 0. 324 g. Calculate the total amount of energy released in this reaction, ignoring the heat capacity of the zinc and the calorimeter (Take the specific heat capacity of the solution as 4. J g-1 K-1). Calculate the enthalpy change for this reaction per mole of the copper formed. 15. Use the values for average bond enthalpies (E) from the table below to calculate the enthalpy changes in each of the reactions: (a) and (b) Bond c-c E/kJ mol-1 346 c= c 611 412 c= o 743 339 H-Cl 431 497 CH4 (g) + 202(g) O C02(g) + 2H20(g) CH2 = CH2(g) + HCl(g) O CH3CH2Cl(g) How would your answer to (a) compare to the data book value for the (2 Marks) standard enthalpy of combustion of methane? Explain your

answer. Total 8 Marks) 16. (a) Draw a diagram of the energy distribution of gas particles in a system at one temperature Tl . On the same diagram, show the shape the distribution at (3 Marks) ome higher temperature T2. Relate the two curves in (a) to the change in the rate of a gas phase reaction (2 with increased temperature. Draw a labelled energy profile showing the energy changes during an endothermic reaction. Use this and the diagram drawn in (a) to explain how (4 Marks) catalysts increase the rate of reactions. Total 9 Marks) Turn to page 5 for SECTION A – Question 17. 4 17. enthalpy of formation of ethane, OHf [C2H6]. 2c(s) + 3H2(g) -+ C2H6 (g) OHc carbon OHc hydrogen OHc ethane -394 kJ mol-l -286 kJ mol-l -1560 kJ mol-l Use the values for average bond enthalpies (E) from the table below along with the standard enthalpy of atomisation of carbon to calculate the standard enthalpy of formation of ethane, OHf [C2H6] using the equation given in (a). Structural formula of ethane: -1 346 E/kJ mol = 717 kJ mol-l 18.

Comment briefly on the discrepancy between the two calculated values for the standard enthalpy of formation of ethane in (a) and (b). Stating, with a reason, (3 which of the two values is likely to be more accurate. (Total 10 Marks) Given the following data, construct a Hess’s Law cycle and calculate the standard nthalpy of hydration of ethene C2H4(g) + H20(l) -+ C2H50H (l) ethene ethanol OHf ethene = +52 kJ mol-l OHf water OHf ethanol -278 kJ mol-l 19.

The standard molar enthalpy of combustion of propanoic acid is -1527. 2 kJ mol-l . Given that the standard molar enthalpy change of formation of water is -285. 5 kJ mol-l and that of caron dioxide is -393. 5 kJ mol-l, construct a Hess’s Law cycle and calculate the standard molar enthalpy change of

formation of propanoic acid. TOTAL FOR SECTION A 5 108 Marks Part A RATES OF REACTION Two gases react according to the equation: X (g) + 2Y(g) XY2(g) Experiments were done at 7000C to determine the rate equation.

The following results were obtained: Experiment Initial [X] Initial [Y] Initial rate of formation ofXY2 number [mol dm-3 [mol dm-3 [mol dm-3 s-l 0. 1 1 x 10-4 0. 2 4 x 10-4 State with reasons the order with respect to X State with reasons the order with respect to Y Write the rate equation for the reaction (1 Mark) Using the results from experiment 1 , calculate the value of the rate constant for (2 the reaction and state its units. Hydrogen and nitrogen oxide react according to the equation: 2H2 (g)