Periodic table assignment

CHAPTER 5: PERIODIC TABLE Development of the Periodic Table ??? i) Substance exist: naturally in elemental form Example: Gold, Uranium as unstable compound Example: Radioactive compounds as stable compound (majority) How to know whether a substance is a compound OR an element? ii) iii) ??? ??? ??? Grouping system: 1800: 31 elements identified 1865: 63 elements identified Audi Majdan ??? DMC 101 ??? KLIUC 1 ??? Dmitri Mendeleev: i) ii) iii) iv) Develop a system to group the elements Arranged elements by atomic weight Grouped elements by characteristics Able to predict future elements by using group characteristics Henry Moseley: (i) Investigated: frequencies of X-rays produced by every elements (ii) Discovered: a relationship between the frequency and the atomic number (iii) Proposed: atomic number = number of electrons The Periodic Table ??? ??? The periodic table comprises of two main components: Group & Period Group: The elements placed in a column of the periodic table > 2 systems: 18 Groups or 8 Groups Audi Majdan ??? DMC 101 ??? KLIUC 2 Standard System Roman Numeral System 1 IA 2 II A 3 III B 4 IV B 5 VB 6 VI B 7 8 9 10 11 12 13 14 15 16 17 18 ???

VII B VIII IB II B III A IV A VA VI A VII A VIII A Transition Elements Main groups can be designated as ‘ A’ and ‘ B’ with column number in Roman numerals. 3 Audi Majdan ??? DMC 101 ??? KLIUC Group 1A 2A 6A 7A 8A Elements Li, Na, K, Rb, Cs, Alkali metals Fr Be, Mg, Ca, Sr, Ba, Alkaline earth metals Ra Chalcogens O, S, Se, Te, Po Halogens F, Cl, Br, I, At Noble gases (inert or rare He, Ne, Ar, Kr, Xe, gases) Rn Name ??? Period: The elements in a row of the periodic table > 7 Periods Audi Majdan ??? DMC 101 ??? KLIUC 4 Audi Majdan ??? DMC 101 ??? KLIUC 5 ??? Categories of elements: i) Metals (ii) Non-

metals (iii) Metalloids 1 2 3 4 5 6 7 8 9 1 0 1 1 1 2 1 3 1 4 1 5 1 6 1 18 7 Metal Nonmetal Metalloids Example: Metalloids: Boron (B), Silicon(Si), Germanium(Ge), Arsenic(As), Antimony(Sb), Tellurium(Te), Astatine(At) Audi Majdan ??? DMC 101 ??? KLIUC 6 Metals Alkali metals Nonmetals Inner transition Alkaline Transition Other Metalloids Other Noble Unknown elements earth Halogens elements metals nonmetals gases metals Lanthanides Actinides ??? ??? Elements in a Group have similar properties because they have the same type of electronic configuration of their atoms.

Example: Li Na : 1s22s1 : 1s22s22p63s1 Group IA 3 11 Group IA: Lithium (Li), Sodium (Na) and Potassium (K) are all soft, very reactive metals He Ne : 1s2 (Exception) : 1s22s22p6 2 Group VIIIA 10 ??? Group VIIIA: Helium (He), Neon (Ne) and Argon (Ar) are very non-reactive gasses Audi Majdan ??? DMC 101 ??? KLIUC 7 How do we get the name Periodic Table? If the elements are arranged in order of increasing atomic number, their chemical and physical properties show a repeating, or periodic pattern. Physical Properties Of Element ??? 1. 5 main physical properties of element:

Atomic size 2. Ionization energy 3. Electron affinity 4. Electronegativity 5. Oxidation Number 1. Atomic Size ??? ??? Atomic size = radius of atom Down a column of the periodic table: atomic radius ^, size of atom ^ ??? REASON: ??? The addition of new shell, n ^ Audi Majdan ??? DMC 101 ??? KLIUC 8 ??? From left to right within a row of the periodic table: atomic radius v, size of atom v ??? REASON: ??? The effective nuclear charge, Zeff ^ Zeff = Z ??? S Z = proton number S = number of shielding electron ??? Within a row: number of shielding electrons remains constant but the number of protons ^

If (Zeff) on the valence electrons ^ = electron will be attracted towards the nucleus > atomic radius v Example: Audi Majdan ??? DMC 101 ??? KLIUC 9 For elements up to the 3p subshell ??? Number of shielding electrons for each elements: 12 (1s22s22p63s2) Element Z??? S Zeff Al 1312 1+ Si 14 P 15 S 16 Cl 17 Ar 18 Atomic no 13 14- 15- 16- 17- 1812 12 12 12 12 2+ 3+ 4+ 5+ 6+ Size of ion Audi Majdan ??? DMC 101 ??? KLIUC 10 ??? ??? ??? ??? Depends on: nuclear charge number of evalence orbitals formed by removing 1 or more valence edecreases the total electron-electron repulsion in the outer orbital

Cations (‘+’ ions) ??? ??? Cations are therefore smaller than the parent atom Anions (‘-‘ ions) ??? ??? formed by addition of 1 or more valence eincreases electron-electron repulsion in outer orbital Anions are therefore larger than the parent atom ??? ??? For ions of the same charge (same group) the size ^ as moving down a group in the periodic table n ^ = size of both the parent atom and ion ^ 11 Audi Majdan ??? DMC 101 ??? KLIUC Audi Majdan ??? DMC 101 ??? KLIUC 12 ??? Effect of the nuclear charge Example: Ion O2FNa+ Mg2+ Al3+ ??? Electrons 10 10 10 10 10 Protons 8 9 11 12 13 Isoelectronic = ions that posses the same number of electron (example: 10; with configuration 1s22s22p6) But each has different Zeff The radius of each ion vwhen Zeff ^: Audi Majdan ??? DMC 101 ??? KLIUC 13 Ionization Energy ??? ??? The ionization energy of an atom measures how strongly an atom holds its electrons The ionization energy = the minimum energy required to remove an electron from the ground state of the isolated gaseous atom The first ionization energy, I1 = energy needed to remove the first electron from the atom: 14 ??? Audi Majdan ??? DMC 101 ??? KLIUC

Na (g) > Na+ (g) + 1e??? ??? Metal atoms have LOW ionization energy BECAUSE they easily release electrons Nonmetal atoms have HIGH ionization energy BECAUSE they tend to accept electrons Periodic trends in ionization energies Across a row from left to right Ionization energy ^ Ionization increases 1 2 3 4 5 6 7 8 Ionization increases H 131 2 He 2372 Audi Majdan ??? DMC 101 ??? KLIUC 15 Li Be 520 899 B C 801 108 6 N O S F 168 1 Ne 2081 1402 131 4 Na Mg 496 738 Al Si P 578 786 Cl Ar 125 1 1521 1012 100 0 Element Na Mg Al I1 (kJ/mol) 496 738 577 Reason: ??? ??? ??? tomic size v; Zeff ^ from left to right When Zeff ^ or the distance of the electron from the nucleus v; the greater the attraction between the nucleus and the electron difficult to remove remaining electrons (the ionization energy is higher for each subsequent electron) 16 Audi Majdan ??? DMC 101 ??? KLIUC Down a group Ionization energy v Reason: ??? ??? ??? atomic size ^; the distance of electron from nucleus ^ the attraction between electrons and the nucleus v easier to remove electron (the ionization energy is lower for every next electron) Audi Majdan ??? DMC 101 ??? KLIUC 17

Example: Which of the following elements has the lowest ionization energy? B, Al, C and Si Al Exercise 1 Arrange the following atoms in order of increasing first ionization energy: Ne, Na, P, Ar, K. Electron Affinities ??? ??? ??? ??? ??? Atoms received electrons to form negatively charged ions (anions) Electron affinity = the energy change associated with an atom or ion in the gas state gaining an electron Exothermic process = energy is released by the system Endothermic process = energy is absorbed by the system Energy is released when an electron is added: 18 Audi Majdan ??? DMC 101 ??? KLIUC Cl (g) + e- > Cl- (g) E = -328 kJ/mol Chlorine has an

electron affinity of -328 kJ/mol The greater the attraction for the electron, the more exothermic the process The halogens (Group VII): largest electron affinity (greatest attraction for an electron): Reason: Group VII elements are one electron short of a completely filled p subshell ??? ??? Audi Majdan ??? DMC 101 ??? KLIUC 19 General trend From left to right in a period toward the halogens > Electron affinity ^ (increasingly negative) (stronger binding of an electron) Reason: ??? Atomic size v; the added electron closer to the nucleus ??? > Stronger attraction Audi Majdan ??? DMC 101 ??? KLIUC 20

Moving down a group > electron affinities do not change much Reason: ??? Atomic size ^; distance from the nucleus ^ (less attraction) Element F Cl Br I Ion FClBrI- E (kJ/mol) -328 -349 -325 -295 Audi Majdan ??? DMC 101 ??? KLIUC 21 Electronegativity ??? Electronegativity = the ability of an atom in a molecule to attract e- to itself Electronegativity ^; the greater the attractiveness for e??? ??? Fluorine = the most electronegative element (electronegativity = 4. 0) Cesium = the least electronegative Audi Majdan ??? DMC 101 ??? KLIUC 22 ??? General trends: Left to right: Electronegativity ^ Reason: ??? Nonmetal has higher tendency to accept electron Metal has higher tendency to released electron Audi Majdan ??? DMC 101 ??? KLIUC 23 Moving down group: Electronegativity v Reason: ??? Atomic size ^; distance between outer electron and nucleus ^ ??? Weak attraction towards electron Oxidation Number ??? ??? ??? ??? ??? Definition: The charge that results when the e- in a covalent bond are assigned to the more electronegative atom Oxidation number (O. N.) depends on the release or the addition of electron of the outer shell to form noble gases configuration (8 valence electron). The value of O. N. epends on the number

of electron involved. The release of electron produce O. N. of negative value The gain of electron produce O. N. of positive value Audi Majdan ??? DMC 101 ??? KLIUC 24 ??? Atom in elemental form: O. N. = 0. > O. N. = 0 > O. N. = 0 Example: Each H atom in H2 Each P atom in P4 ??? Metals: O. N. = charge of the ion. Example: K+ > O. N. = +1 Ca2+ > O. N. = +2 Group I Group II Group III ??? = +1 = +2 = +3 Nonmetals: O. N. = charge of the ion. (a) Oxygen (O2-) > O. N. = -2 (b) Fluoride (F-) > O. N. = -1 Group V Group VI Group VII = -3 = -2 = -1 Audi Majdan ??? DMC 101 ??? KLIUC 25

Metals, Nonmetals and Metalloids Differences between metallic and non-metallic elements: Metallic Elements Distinguishing luster (shine) Malleable and ductile (flexible) as solids Conduct heat and electricity Metallic oxides are basic, ionic Cations in aqueous solution Nonmetallic elements Non-lustrous, various colors Brittle, hard or soft Poor conductors Nonmetallic oxides are acidic, compounds Anions, oxyanions in aqueous solution Metals ??? ??? ??? ??? Malleable = can be pounded into thin sheets Ductile = can be drawn out into a thin wire Solids at room temperature (except liquid Mercury) Low ionization energies 26

Audi Majdan ??? DMC 101 ??? KLIUC Nonmetals ??? ??? ??? ??? ??? Appearance varies Non-lustrous Poor conductors of heat and electricity The melting points: generally non-metals < metals 7 non-metals exist under standard conditions as diatomic molecules: 1. 2. 3. 4. 5. 6. 7. H2(g) N2(g) O2(g) F2(g) Cl2(g) Br2(l) I2(l) Metalloids Audi Majdan ??? DMC 101 ??? KLIUC 27 Intermediate properties between metals and nonmetals. ??? Example: Silicon ??? > lustrous but brittle > poor conductor of heat and electricity >

useful in the semiconductor industry Trends in Metallic and Nonmetallic Character ???

Across the row from left to right (Ionization ^; nonmetallic character ^) > metallic character v Down a group (Ionization v; metallic character ^). ??? > metallic character ^ Audi Majdan ??? DMC 101 ??? KLIUC 28 Audi Majdan ??? DMC 101 ??? KLIUC 29 Group Trends: The Active Metals Group IA: The Alkali Metals IA 3 Li 11 Na 19 K 37 Rb 55 Cs 87 Fr Name Lithium Sodium Potassium Rubidium Cesium Francium Electron Configuration 1s22s1 1s22s22p63s1 1s22s22p63s23p64s1 [Kr]5s1 [Xe]6s1 [Rn]7s1 Audi Majdan ??? DMC 101 ??? KLIUC 30 Moving down group IA: ??? ??? ??? ??? ???

Melting point v Density ^ Atomic radius ^ Good electric and heat conductor Ionization energy v (first ionization energy) The alkali metals are very reactive, readily losing 1 electron to form an ion with a 1+ charge: M > M+ + eReactivity increases moving down the group ??? Group Trends: Selected Nonmetals Hydrogen ??? ??? ??? ??? Electron configuration = 1s1 Located above the alkali metal group Non-metal Exists as a gas (H2) under normal conditions. Ionization energy: Hydrogen > metals. 31 ??? Audi Majdan ??? DMC 101 ??? KLIUC Group VIIA: The Halogens VIIA 9 F 17 Cl 35 Br 53 I 85 At ??? ??? Name Fluorine Chlorine Bromine Iodine Astatine

Electron Configuration 1s22s22p5 1s22s22p63s23p5 [Ar]4s23d104p5 [Kr]5s24d105p5 [Xe]6s24f145d106p5 ??? Halogens = nonmetals Exists as diatomic molecules under standard conditions Colors of diatomic halogens: Fluorine: pale yellow Chlorine: yellow green Bromine: reddish brown Audi Majdan ??? DMC 101 ??? KLIUC 32 Iodine: violet vapor ??? Low boiling and

melting point ??? Low density ??? High electronegativity ??? Negative electron affinities The chemistry of the halogens is dominated by their tendency to gain electrons from other elements (forming a halide ion) X2 + 2e- -> 2X??? Fluorine and chlorine = most reactive halogens (highest electron affinities).

Group 8A: The Noble Gases 33 8A 2 He 10 Ne 18 Ar 36 Kr 54 Xe 86 Rn ??? ??? ??? ??? ??? ??? ??? ??? Name Helium Neon Argon Electron Configuration 1s2 1s22s22p6 1s22s22p63s23p6 Krypton [Ar]4s23d104p6 Xenon Radon [Kr]5s24d105p6 [Kr]6s24f145d106p6 Nonmetals Gases at room temperature Monoatomic Completely filled ‘ s’ and ‘ p’ subshells Large first ionization energy Does not conduct electricity Low boiling and melting point Low density ??? Stable configuration Reaction needs combination with an element which had a high tendency to remove electrons from other atoms. Eg: fluorine. ??? Compounds of noble gases: XeF2 XeF4 XeF6 KrF2 ??? No compounds observed with He, Ne, or Ar