P525/1
S.6 Chemistry weekly test 1

Name ……**.Signature**……

KORO SECONDARY SCHOOL

GROUP TWO ELEMENTS AND THERMOCHEMISTRY

TIME: 2:45 minutes

INSTRUCTIONS*:*

- Attempt **all** questions in section A and B

SECTION A (GROUP (II) ELEMENTS)

1. a) Explain what is meant by the term diagonal relationship (01 mark)

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(b) State three reasons why beryllium and aluminum exhibit diagonal relationship. (1½mark)

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(c) Using equations explain four properties to show diagonal relationship exhibited by beryllium and aluminium. (04marks)

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(d) Using equations explain four properties to show diagonal relationship exhibited by lithium and magnesium. (04marks)

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(e) Using equations explain four properties to show diagonal relationship exhibited by boron and silicon. (04marks

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2. . The first ionization energy of some elements are as shown below.

Elements	1st ionization energy	2nd ionization energy	3rd ionization energy	4th ionization energy
A	500	4600	9600	9500
B	740	1500	7700	10500
C	630	1600	3000	4800
D	900	1800	14800	21000
E	580	1800	2700	11600

a) What is meant by the term ionization energy? (01 marks)

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b) (i) State the elements that are most likely to form an ion with a unit positive charge. Give reasons for your answer. (02 marks)

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(ii). Identify two elements that are in the same group of the periodic table. (01 marks)

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3. (a) Compare the following properties of group (II) and group (I) elements. In each case, give a reason for your answer.

(i) First ionization energy

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(ii) Melting point

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(iii) Electro positivity

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(b) The decomposition temperatures of the carbonates of group (II) elements are given below

Carbonate	$MgCO_3$	$CaCO_3$	$SrCO_3$	$BaCO_3$
Decomposition temperature ^oC	404	826	1098	1370

(i) State how the decomposition temperatures vary (01 mark)

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(ii) Explain your answer in (b) (i) (3 ½ marks)

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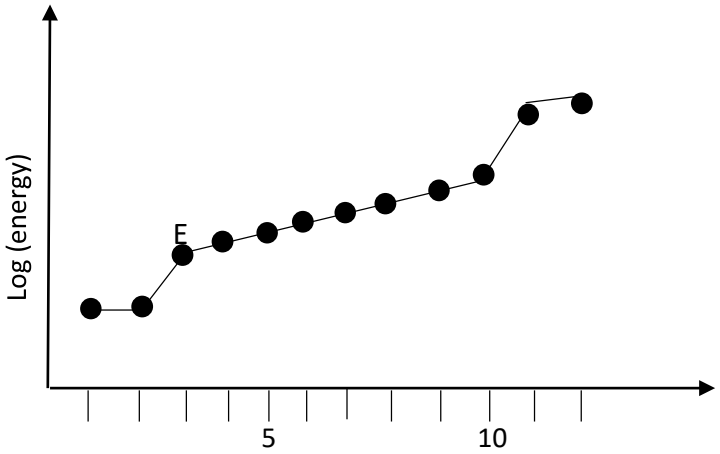
4. The diagram below shows successive ionisation energies for an element X, showing removal of all electrons.



(a) Giving reasons state

(i) The group of element X (1½marks)

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(ii) The period of element X (1½ marks)

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(iii) Identify element X (01mark)

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(b) Explain the sudden increase in the energy required to removed electron E (2marks)

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(c) Explain how the size of X will change as electrons are removed (01mark)

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(d) (i) explain what would be the sign of change if an electron was added to X to give X^- (01 mark)

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(ii) How would you expect it to affect the size if X (01mark)

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(e) Explain giving reasons whether you would expect X to form compound in the +1 oxidation state (01mark)

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5. (a) Explain what is meant by the term ***electronegativity***. (01mark)

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(b) State the factors that affect determine the value of electronegativity of an element. (2marks)

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(c) Explain how the following factors affect the value of electronegativity of the element

(i) Atomic radius (2marks)

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(ii) Nuclear charge (2marks)

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(iii) The screening effect of the inner electrons (02marks)

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(d) Explain the difference between ***electronegativity*** and ***electron affinity*** (02marks)

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6. (a) Explain what is meant by the term first election affinity. (01mark)

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(b) State three factors that can affect electron affinity. (01 ½marks)

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(c) The first electron affinities of some elements of period – 3 are given in the table below

Element	Al	Si	P	S
First electron affinity ($KJmol^{-1}$)	– 44	– 134	– 71.7	– 200

(i) State the trend in variation of electron affinities (0 ½ mark)

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(ii) Explain your answer in c (i) above
(02 marks)

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7. (a)Explain the following observations

i) Group (II) metal carbonates decompose on heating but group (I) metal carbonates are resistant to decomposition by heat.

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ii) Group (II) metal sulphates are more soluble in water than group (I) metal sulphates. (03 marks)

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iii) The decomposition temperature of group (II) metal carbonates increases down the group.
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iv) Lithium compounds are mainly covalent while the compounds of other group (I) elements are mainly ionic. (03 marks)

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v) The solubility of group (II) metal hydroxides increases down the group. (03 marls)

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vi) The solubility of sulphates of group (II) metals decreases down the group. (03 marks)

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SECTION B THERMOCHEMSTRY

8. (a)States the laws of thermochemistry (04 marks)

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(b) Explain the factors that affect enthalpy of reaction (05 marks)

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(c) Define standard enthalpy of formation (02 marks)

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(d) Calculate the enthalpy of formation of methane given that the enthalpy of combustion of carbon is −393 $kJmol^{-1}$, that of hydrogen is −286 $kJmol^{-1}$ and enthalpy of combustion of methane is −890 $kJmol^{-1}$. (04 marks)

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9. (a) Define standard enthalpy of atomization (02 marks)

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(b) Calculate the C-C bond energy in ethane given that; (04 marks)

C$(s) \rightarrow C(g)$; +713 $kJmol$−1 … …… . … . . . (i)

$H_2(g) \rightarrow 2H(g)$ + 436 $kJmol^{-1}$ … … … …. . . (ii)

$2C(s) + 3H2(g) \rightarrow C2H6(g)$; −84 $kJmol$−1 … …… … … . . (iii)

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10. Given that the standard enthalpy of formation of $CH4$ is $-63\ kJmol-1$ and that of $C_2\ H_6$ is $-84\ kJmol-1$, calculate the standard enthalpy change for the reaction below
$C2H6 + H2\ (g) \rightarrow 2CH4\ (g)$ (04 marks)

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11. Some bond energies, BE are given below;

Bond	$C-H$	$C=O$	$O-H$	$O=O$	$C-O$	$C\equiv C$	$C-C$	$H-H$
BE ($kJmol^{-1}$)	412	803	463	496	326	813	346	436

Use the bond energies given above to calculate;

(i) The standard enthalpy of combustion of methanol. (03 marks)

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(ii) The enthalpy of hydrogenation of ethyne. State whether hydrogenation of ethyne is feasible or not. (02 mars)

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12. (a) define born Haber cycle (02 marks)

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(b) Describe the energy changed that takes place in a born Haber cycle (04 marks)

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(c) Standard enthalpy changes for some reactions are given below;

$Ca_{(s)} \rightarrow Ca_{(g)}$	+ 193 $kJmol^{-1}$
$\frac{1}{2} F2_{(g)} \rightarrow F_{(g)}$	+ 79 $kJmol^{-1}$
$F_{(g)} + e \rightarrow F^-_{(g)}$	− 348 $kJmol^{-1}$
$Ca_{(s)} + F_{2(g)} \rightarrow CaF_{2(S)}$	− 1214 $kJmol^{-1}$
$Ca_{(g)} \rightarrow Ca^+_{(g)} + e$	+ 590 $kJmol^{-1}$
$Ca^+_{(g)} \rightarrow Ca^{2+}_{(g)} + e$	+ 1150 $kJmol^{-1}$

(i) Construct a Born-Haber cycle for the formation of calcium fluoride. (8 marks)

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(ii) Use the cycle you have constructed in (i) to calculate the lattice energy of calcium fluoride.
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13. Given the following thermochemical data,

$Ca_{(s)} \rightarrow Ca_{(g)}$	+ 193 $kJmol^{-1}$
$\frac{1}{2} F2_{(g)} \rightarrow F_{(g)}$	+ 79 $kJmol-1$
$F_{(g)} + e \rightarrow F_{(g)}^{-}$	− 348 $kJmol^{-1}$
$Ca_{(s)} + F_{2(g)} \rightarrow CaF_{2(S)}$	− 1214 $kJmol^{-1}$
$Ca_{(g)} \rightarrow Ca^{+}_{(g)} + e$	+ 590 $kJmol^{-1}$
$Ca_{(g)}^{+} \rightarrow Ca^{2+}_{(g)} + e$	+ 1150 $kJmol^{-1}$

(a) Construct an energy level diagram for the formation of calcium fluoride. (02marks)

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(b) Use the energy level diagram you have constructed in (a) to calculate the lattice energy of calcium fluoride. (02 marks)

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14. (a)Define the terms

(i) Lattice energy (02 marks)

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(ii) Solvation energy (02 marks)

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(iii)Enthalpy of solution (02 marks)

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(b) State two factors that can affect hydration energy. (02 marks)

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(c) The table below shows the enthalpies of hydration of cations of group (II) elements of the periodic table.

Cation	$Mg2+$	$Ca2+$	$Sr2+$	$Ba2+$
Enthalpy of hydration ($kJmol^{-1}$)	-1920	-1640	-1480	-1360

(i) State how hydration energy of the ions vary. (01 marks)

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(ii) Explain your answer in b(i) above. (03 marks)

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(iii) Explain why the values of hydration energy are negative. (02 marks)

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(c) The values for some energy changes are given below.

Lattice energy of $CaCl_2(s)$	-2230 $kJmol^{-1}$
Enthalpy of hydration of $Cl^-(g)$	-343 $kJmol^{-1}$

(i) Calculate the enthalpy of solution of calcium chloride. (02 marks)

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(ii) State how the solubility of calcium chloride, would be affected when the temperature is increased. Give a reason for your answer. (04 marks)

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13. (a)Define enthalpy of neutralisaton. (02 marks)

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(a) Briefly explain why the enthalpy of neutralisation of ethanoic acid by potassium hydroxide is -55.8 $kJmol^{-1}$ while the enthalpy of neutralisation of hydrochloric acid by potassium hydroxide is -57.3 $kJmol^{-1}$ (03 marks)

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(b) Explain why the enthalpy of neutralisation of sodium hydroxide by nitric acid is 57.1 $kJmol^{-1}$ whereas the enthalpy of neutralisation of sodium hydroxide by hydrocyanic acid is 12.0 $kJmol^{-1}$. (02 marks)

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(c) 250cm3 of 0.5M KOH at 12oC were mixed in a plastic beaker of negligible heat capacity with an equal volume of 0.5M HCl at the same temperature. The final temperature was 15.4oC. Calculate the enthalpy of neutralisation assuming that the specific heat capacity of the solution is $4.2Jg{-}1K{-}1$. (06 marks)

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