THE ROYAL
SOCIETY OF
CHEMISTRY

25. The Flatlandian Periodic Table

Time

1–1.5 h.

Curriculum links

Principle quantum numbers.

Group size

1–3.

Commentary

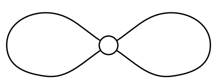
This problem is challenging! It probes the students' understanding of quantum numbers, bonding and the Periodic Table.

The answers are:

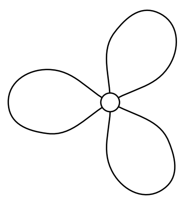
a) The Flatlandian periodic table:

1 $1s^1$									2 $1s^2$
3 $()2s^1$	4 $()2s^2$					5 $()2s^2 2p^1$	6 $()2s^2 2p^2$	7 $()2s^2 2p^3$	8 $()2s^2 2p^4$
9 $()3s^1$	10 $()3s^2$					11 $()3s^2 3p^1$	12 $()3s^2 3p^3$	13 $()3s^2 3p^3$	14 $()3s^2 3p^4$
15 $()4s^1$	16 $()4s^2$	17 $()4s^2 3d^1$	18 $()4s^2 3d^2$	19 $()4s^2 3d^3$	20 $()4s^2 3d^4$	21 $()4s^2 3d^4 4p^1$	22 $()4s^2 3d^4 4p^2$	23 $()4s^2 3d^4 4p^3$	24 $()4s^2 3d^4 4p^4$

b)

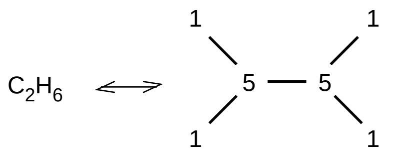


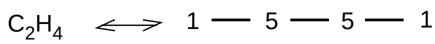
sp^1

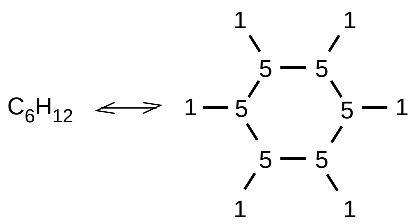


sp^2

The element of life: 5



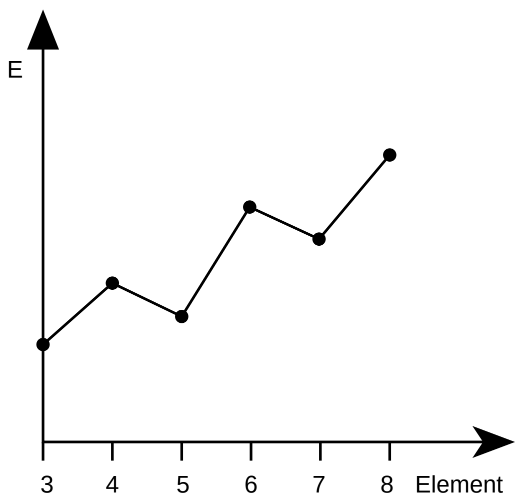


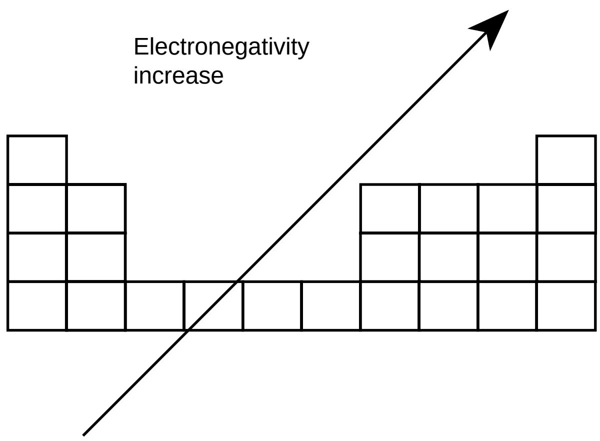


There are no aromatic ring compounds.

c) Sextet rule
14 electron rule

d) The ionisation energies and the trends in electronegativity:

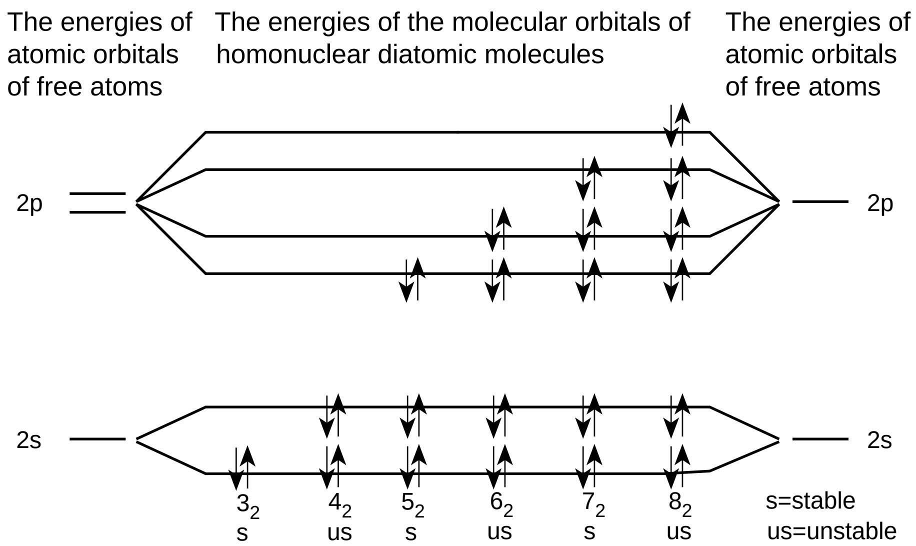




THE ROYAL SOCIETY OF CHEMISTRY

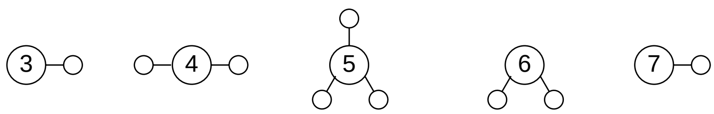
Esso

e) The molecular orbital diagram of the homonuclear X_2 molecules:



f) The Lewis structures and geometries:

Lewis structures	3 : 1	1 : 4 : 1	1 (above) : 5 : 1, 1	1 : 6 : 1	: 7 : 1
Geometry					
3D-analogue	LiH	BeH_2	BH_3 or CH_4	H_2O or NH_3	FH



g) The three dimensional analogues and the states of Flatlandian elements:

H					He	G					G
Li	Be	B/C	N/O	F	Ne	S	S	S	G	G	G
Na	Mg	Al/Si	P/S	Cl	Ar	S	S	S	S	G	G

Acknowledgement

The activity is based on a question set at the final of the International Chemistry Olympiad held in Finland during July 1988.

THE ROYAL SOCIETY OF CHEMISTRY

Esso

25. The Flatlandian Periodic Table

The periodic system of the elements in our three dimensional world is based on the four electron quantum numbers n = 1,2,3…, l = 0, 1…, n-1; m_l = 0, ±1, ±2 …, ±l; and m_s = ±½. Let us move to Flatlandia. It is a two dimensional world where the periodic system of the elements is based on three electron quantum numbers: n = 1,2,3…; m = 0, ±1, ±2…, ±(n-1); and m_s = ±½. m plays the combined role of l and m_l of the three dimensional worlds (*ie* s,p,d,… levels are related to m). The following tasks and the basic principles relate to this two dimensional Flatlandia where the chemical and physical experience obtained from our common three dimensional world are applicable.

a) Draw the first four periods of the Flatlandian Periodic Table of the elements. Use the atomic number (Z) as the symbol of the element. Number the elements according to their nuclear charge. Give the electron configuration of each element.

b) Draw the hybrid orbitals of the elements with n=2. Which element is the basis for organic chemistry in Flatlandia? Give the Flatlandian analogues for ethane, ethene and cyclohexane. What kind of aromatic ring compounds are possible in Flatlandia?

c) Which rules in Flatlandia correspond to the octet and 18-electron rules in the three dimensional world?

d) Predict graphically the trends in the first ionisation energies of the Flatlandian elements with n=2. Show graphically how the electronegativities of the elements increase in the Flatlandian Period Table.

e) Draw the molecular orbital energy diagrams of the neutral homonuclear diatomic molecules of the elements with n=2. Which of these molecules are stable in Flatlandia?

f) Consider simple binary compounds of the elements (n=2) with the lightest element (Z=1). Draw their Lewis structures, predict geometries and propose analogues for them in the three dimensional world.

g) Consider elements with n<3. Propose an analogue and write the chemical symbol from our three dimensional world for each Flatlandian element. On the basis of this chemical and physical analogy predict which two dimensional elements are solid, liquid or gas at the normal pressure and temperature.