# General Chemistry: Part Inorganic Chemistry

## Exercises chapter 4: „Atomic structure and periodic table"

1) What do elements that are arranged one below the other in the periodic table have in common? Give an example!

2) What do elements arranged next to each other in the periodic table have in common? Give an example!

3) Which properties of the elements can be explained with the help of the octet rule (why is this rule so important for chemistry)?

4) The average distance from the earth to the sun is 149.6 million km. Imagine that a piece of graph paper is stretched from the earth to the sun and 1 atom is placed in each $mm^2$ box. How wide must the graph paper be in order to distribute n = 1 mol ($6.022\ 10^{23}$ atoms) on it in the specified way?

5) The iridium atom (Ir) has a diameter of 0.27 nm. How many iridium atoms lined up in a row would result in a length of 1 mm?

6) How many molecules are contained in
a) 50 g silver
b) 50 g platinum
c) 50 g hydrogen

7) Calculate the mass of a sphere of neutrons with the radius
a) 1 m
b) 5 km
(Neutrons densely packed without cavities, $m_{neutron} = 1{,}6725 \cdot 10^{-24}$ g, $r_{neutron} = 1{,}3 \cdot 10^{-15}$ m)!
c) What do you call such a structure?

8) Explain the terms ionization energy and electron affinity using a simple reaction equation!

9) What are pure and mixed elements? Give an example of each!

10) What energy does a quantum of light with a wavelength of
a) 700 nm (rot)
b) 400 nm (blau)
have?

11) What is the de Broglie wavelength (matter wave) of a
a) Tennis ball of 50 g mass flying at 30 m/s (100 km/h)?
b) electron flying on the 1st shell of the H atom at $2.19 * 10^6$ m/s according to Bohr theory ($m_e = 0.911.10^{-27}$ g)?

12) The flash of light from a laser consists of $10^{15}$ photons with a wavelength of 694 nm. What energy does the flash of light have?

13) The Earth's irradiance from the sun is approx. 170 W/m$^2$ globally and seasonally averaged at sea level.
a) With how many photons of the average wavelength 550 nm is each square meter of the earth irradiated on average?
b) What is the total radiant power received by the Earth ($r_{Earth}$ = 6378 km)?
c) The average global energy consumption is around 14 TW. What surface area would have to be paved with Si solar cells (10% efficiency) in order to cover this energy demand using photovoltaics?
d) So what percentage of the earth's surface is needed for this?

14. Calculate the average atomic mass of iron assuming that the atomic mass of its four stable isotopes (5,82% $^{54}$Fe, 91,66% $^{56}$Fe, 2,19% $^{57}$Fe, 0,33% $^{58}$Fe) corresponds to the atomic number! Where does the difference to the tabulated value in the periodic table come from?

15) According to the equation 4 $^1$H $\rightarrow$ $^4$He + 26,72 MeV 600 million tons of hydrogen are converted into helium every second in the sun.
a) Calculate the mass defect for the above equation from the atomic weights of $^1$H and $^4$He
b) How much He is formed?
c) How much energy is released every second?

16) Sketch the orbital diagram for the electron configuration of $_{28}$Ni!

17) Determine the Avogadro constant from the following physical properties of Cu! Density = 8,93 g/cm$^3$, elementary cell: cubiy, edge length
a = 3,62·10$^{-10}$ m, 4 Cu atoms per unit cell

18) Which electron configurations do the following elements have in their ground state?
a) $_{25}$Mn
b) $_{32}$Ge
c) $_{39}$Y
d) $_{54}$Xe

19) What is the maximum number of electrons that can be incorporated in the 4p, 4d or 4f orbitals? Give reasons!

20) Carbon from the center of the trunk of a living Sequoia tree has an activity of 11 $^{14}$C-decays per per gram of carbon, while carbon from the bark has 15 $^{14}$C-decas per minute per gram.
($t_{1/2}$($^{14}$C) = 5730 a
How old is the tree?

21) Sketch the occupation of the 3d and 4f orbitals for the following electron configurations!
a) 3d$^3$
b) 3d$^8$
c) 4f$^9$
d) 4f$^{12}$