

Technische Universität München Analytical Research Group PD Dr. Thomas Letzel; PD Dr. Johanna Graßmann	Exam Questions Atomic structure, chemical bond and periodic table of the elements
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Questions from the “PAL Prüfungsbuch”
Atomic structure, chemical bond and periodic table of the elements

001: Which nuclide ranks in the same position in the periodic table of elements as the nuclide ${}_{26}^{54}\text{X}$?

- 1) ${}_{27}^{53}\text{X}$
- 2) ${}_{24}^{56}\text{X}$
- 3) ${}_{28}^{54}\text{X}$
- 4) ${}_{28}^{53}\text{X}$
- 5) ${}_{26}^{56}\text{X}$

002: An atom of the element of the fifth main group and the third period has 15 protons in its nucleus and the relative atomic mass of 31. How many neutrons are in the nucleus of this atom?

- 1) 31
- 2) 5
- 3) 15
- 4) 16
- 5) 3

003: For the element chlorine the two following symbols are specified: ${}_{17}^{35}\text{Cl}$ and ${}_{17}^{37}\text{Cl}$. Which statement is wrong?

- 1) All chlorine atoms have 17 electrons
- 2) Chlorine atoms have either 35 or 37 nucleons
- 3) Chlorine atoms have 17 protons
- 4) Chlorine atoms have either 18 or 20 neutrons
- 5) Chlorine atoms have either 35 or 37 neutrons

004: Which statement about phosphor is due to its notation ${}_{15}^{31}\text{P}$ correct?

- 1) The molar mass of phosphor is 15g/mol
- 2) A phosphor atom has 16 electrons
- 3) A phosphor atom has 31 nucleons
- 4) A phosphor atom has 31 electrons
- 5) The molar mass of phosphor is 16g/mol

006: Which statement about atomic structure is *wrong*?

- 1) Atoms are arranged into the periodic table of elements (PTE) depending on their increasing number of protons
- 2) The nucleus always contains an identical number of protons and neutrons
- 3) The atomic mass is practically concentrated in the nucleus
- 4) Nuclei which have an identical number of protons but a different number of neutrons belong to the same element
- 5) The number of protons in the nucleus is identical to the number of electrons in the extranuclear region



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007: In which element valence electrons have the strongest bond to the atomic core?

- 1) Fluorine
- 2) Carbon
- 3) Boron
- 4) Lithium
- 5) Nitrogen

008: Which group of the periodic table contains the most inert elements?

- 1) First main group
- 2) Fourth main group
- 3) Second main group
- 4) Sixth main group
- 5) Seventh main group

012: What does the number of the period, that the element is in, indicate?

- 1) The atomic mass of the element
- 2) The number of electrons of an atom of the element
- 3) The number of electron shells in the Bohr atomic model
- 4) The number of valence electrons in the Bohr atomic model
- 5) The maximum oxidation number of an element

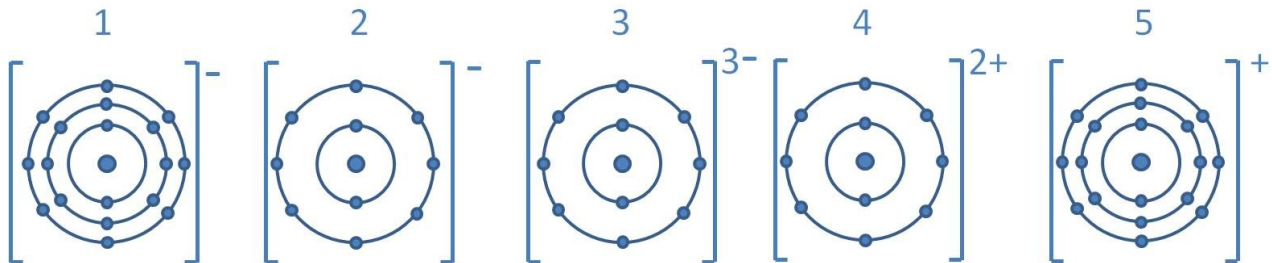
013: What does the number of the main group, that an element in the periodic table belongs to, indicate?

- 1) The atomic mass
- 2) The atomic number
- 3) The number of valence electrons of an atom
- 4) The number of atomic shells of an atom
- 5) The number of protons in an atomic nucleus

014: What is electronegativity?

- 1) The capability of a substance to dissociate into ions
- 2) The release of energy when an electron is accepted by an atom, ion or molecule
- 3) The expense of energy to split an electron from an atom
- 4) A measure for the aspiration of atoms in a covalent bonding to attract electrons
- 5) A measure for the mutual repulsion of like charged particles

025: Atoms of an element with the atomic number 11 react with atoms of an element with the atomic number 17. Which depiction describes the ion that forms with the given reaction?



026: What is described with the help of the secondary quantum number l in the orbital model?

- 1) The size of the orbital
- 2) The three dimensional shape
- 3) The orientation in space
- 4) The manner of self-rotation
- 5) The number of shells

027: Which statement regarding the valence of ions is *wrong*?

- 1) The valence 3- means: Three electrons per atom have been taken up
- 2) A positive valence comes about by the oxidation of an atom
- 3) The valence 2+ means: Two electrons per atom have been released
- 4) The maximum valence always corresponds to the group number of the element in the periodic table of elements
- 5) The valence is an evidence for the amount of electricity that is necessary for the deposition of one mol of the ion

030: Which of the named compounds is *not a salt*?

- 1) Sodium carbonate
- 2) Phosphor trichloride
- 3) Iron sulfate
- 4) Sodium chloride
- 5) Potassium chloride

034: Which statement about atomic bonds is *correct*?

- 1) Atomic bonds are the typical type of bonds in salts
- 2) Atomic bonds arise from the formation of mutual pairs of electrons
- 3) Atomic bonds are primarily found in metals
- 4) The formation of a crystal lattice is typical for compounds with atomic bonding
- 5) In contrast to ionic bonds atomic bonds are not directional

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035: In which of the mentioned compounds non-polar atomic bonds exist?

- 1) Water, H₂O
- 2) Nitrogen, N₂
- 3) Potassium iodide, KI
- 4) Hydrogen chloride, HCl
- 5) Magnesium chloride, MgCl₂

036: Which of the mentioned compounds contain strongly polarized atomic bonds?

- 1) H₂
- 2) NaCl
- 3) H₂O
- 4) O₂
- 5) N₂

037: The following pairs of elements form bonds with each other. In which case is the bond the least polar?

- 1) Mg and Cl
- 2) K and F
- 3) K and Cl
- 4) Na and S
- 5) C and O

038: Compounds that are described as dipoles possess a particular property. What is it?

- 1) They consist of molecules that have an elongated build
- 2) They consist of molecules that are assembled from equal kinds of atoms
- 3) They contain only ionic bonds
- 4) They consist of molecules with an asymmetric charge distribution
- 5) They can be used as electrodes in electrolysis

039: Which of the mentioned substances contains molecules with strongly polarized atomic bonds?

- 1) Oxygen
- 2) Hydrogen
- 3) Carbon dioxide
- 4) Sodium chloride
- 5) Methane

040: Which particles are the lattice points in a metallic lattice?

- 1) Free electrons
- 2) Metal atoms
- 3) Metal molecules
- 4) Negative ions
- 5) Atomic cores



041: Which statement regarding the model of the metallic bond is *wrong*?

- 1) Metals form metallic lattices
- 2) Atomic cores form the lattice points in metallic lattices
- 3) Free electrons cause the electric conductivity in metals
- 4) The metallic bond comes about by mutual pairs of electrons
- 5) Valence electrons are able to move freely

042: Metals are good conductors for electric current. Why?

- 1) Because their valence electrons are able to move freely in the metallic lattice
- 2) Because their ions are able to move easily in the metal
- 3) Because their protons are able to move easily in the metal
- 4) Because their atoms are placed very close without distance to each other
- 5) Because their structure changes completely during electric current flow

046: Which chemical compound is assigned to the correct type of bond?

<u>Compound</u>	<u>Type of bond</u>
1) Propane C ₃ H ₈	Ionic bond
2) Potassium nitrate KNO ₃	Metallic bond
3) Nitrogen N ₂	Atomic bond
4) Carbon dioxide CO ₂	Ionic bond
5) Sodium fluoride NaF	Polar atomic bond

049: Which compound has to be filled in the blank?

H ₂ SO ₃	SO ₂
H ₂ SO ₄	SO ₃
H ₃ PO ₄	P ₄ O ₁₀
HNO ₃	_____

- 1) N₂O
- 2) NH₃
- 3) NO
- 4) N₂O₅
- 5) N₂O₃

050: Which of the following particles is a „Lewis acid“ (acceptor of electron pairs)?

- 1) NH₃
- 2) OH⁻
- 3) AlCl₃
- 4) Cl⁻
- 5) H₂O

051: Which of the following substances is a „Lewis base“

- 1) BF_3
- 2) SO_3
- 3) NH_3
- 4) CO_2
- 5) H^+

052: Which statement about the neutralization reaction is *wrong*?

- 1) The basic reaction is: $\text{H}_3\text{O}^+ + \text{OH}^- \rightarrow 2 \text{H}_2\text{O}$
- 2) The end point is always at pH 7
- 3) The reaction is exothermic
- 4) A saline solution is formed
- 5) It is an acid-base-reaction

053: Which of the following answers contains only acids, that are able to form primary as well as secondary salts?

- 1) Carbonic acid, phosphoric acid, sulfuric acid
- 2) Hydrochloric acid, sulfuric acid, nitric acid
- 3) Acetic acid, hydrochloric acid, nitric acid
- 4) Nitric acid, carbonic acid, phosphoric acid
- 5) Phosphoric acid, formic acid, acetic acid

054: Which statement about acids is *wrong*?

- 1) Acids are chemical compounds
- 2) Acids corrode base metals
- 3) Acid molecules contain bonded hydrogen atoms
- 4) Acids turn phenolphthalein purple
- 5) Highly diluted acids have an acidic taste

055: Which row contains a *wrong* statement?

<u>Acid</u>	<u>Acid anhydride</u>	<u>Acid residue ion</u>
1) HNO_3	NO	NO^{3-}
2) H_2SO_3	SO	SO_3^{2-}
3) H_2SO_4	SO_3	SO_4^{2-}
4) H_3PO_4	P_2O_5	PO_4^{3-}
5) H_2CO_3	CO_2	CO_3^{2-}

056: Which statement about the degree of dissociation α in a weak acid is *wrong*?

- 1) α increases with increasing temperature
- 2) α decreases with decreasing temperature
- 3) α increases with decreasing amount-of-substance concentration
- 4) α is unaffected by temperature and amount-of-substance concentration
- 5) α increases with increasing temperature and decreasing amount-of-substance concentration

057: There is a correlation between the normality and the degree of dissociation of a weak acid. How can this be stated qualitatively?

- | <u>Equivalent concentration</u> | <u>Degree of dissoziation</u> |
|---------------------------------|-------------------------------|
| 1) decreases | increases |
| 2) decreases | decreases |
| 3) increases | increases |
| 4) decreases | remains constant |
| 5) increases | remains constant |

065: Which of the following answers does *not* show a conjugated pair of acid and base?

- | <u>Acid</u> | <u>Base</u> |
|---|---|
| 1) ClO_4^- | ClO_3^- |
| 2) H_3O^+ | H_2O |
| 3) H_2O | OH^- |
| 4) $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ | $[\text{Al}(\text{H}_2\text{O})_5\text{OH}]^{2+}$ |
| 5) H_2PO_4^- | HPO_4^{2-} |

066: Which statement regarding the fifth main group of the periodic table of elements (N, P, As, Sb, Bi) is *wrong*?

- 1) HNO_3 is a stronger acid than H_3PO_4
- 2) SbH_3 is thermically more stable than NH_3
- 3) All atoms of the elements possess five valence electrons
- 4) The metallic characteristics of Bi are more pronounced than those of As
- 5) The basicity of the hydroxides increases with increasing atomic number

067: Which statement is correct?

- 1) If a salt is dissolved in water, the solution will always cool
- 2) Hydration is always an endothermic process
- 3) Hydration is based on a ionic dipolar bond
- 4) The destruction of the lattice is always an exothermic process
- 5) If NaCl is dissolved in water, the lattice energy is always bigger than the hydration energy