

Topic: Periodic Table

Periodic Table Outline

1. The placement of an element on the Periodic Table gives an indication of the chemical and physical properties of that element.

- ✓ Elements to the left of the stair step line are metals, and therefore are easily oxidized (lose electrons) in bonding situations, are good electrical conductors, are shiny, malleable, ductile, and have low ionization energies and electronegativities.
- ✓ Elements to the right of the stair step line, but not in Group 18 are nonmetals, and therefore react to gain electrons (get reduced), are not conductors, are dull appearing, brittle, have high ionization energies and electronegativities.
- ✓ Some of the elements along the stair step line have properties of both metals and non-metals and are known as "metalloids" or "semi-metals".
- ✓ Elements in Group 18 are the noble gases and they are chemically inert (unreactive) and have extremely high ionization energies.

2. Elements are arranged in order of increasing atomic number (NOT MASS!)

3. The number of protons in an atom (atomic number) identifies the element.

- ✓ The number of protons in an atom only changes through nuclear reactions.

4. The atomic mass is the sum of protons and neutrons in the nucleus.

- ✓ The mass number given on the periodic table is a weighted average of the different isotopes of that element.
- ✓ Electrons do not significantly add to the atomic mass.

5. Isotopes of an element are identified by the sum of protons and neutrons.

- ✓ Isotopes of the same element have the same number of protons and a different number of neutrons.
- ✓ Examples of isotopic notation are: $^{14}_6\text{C}$, ^{14}C , carbon-14, C-14

6. Elements can be classified by their properties and their location on the Periodic Table as metals, non-metals, metalloids, and noble gases.

7. Elements may be differentiated by their physical properties.

- ✓ Ex: Density, conductivity, malleability, hardness, ductility, solubility

8. Elements may be differentiated by their chemical properties.

- ✓ Chemical properties describe how an element behaves in a chemical reaction.

9. Elements are arranged into periods and groups.

10. Elements of the same period have the same number of occupied energy levels.

11. Elements of the same group have the same valence configuration and similar chemical properties.

- ✓ Group 1 elements other than H are alkali metals.
- ✓ Group 2 elements are alkali earth metals.
- ✓ Group 17 elements are halogens.
- ✓ Alkali metals, alkali earth metals, and halogens all are highly reactive and do not exist as free elements in nature (they are all found in compounds).
- ✓ Group 18 elements are noble or inert gases. These elements have filled valence levels and are do not normally react with other substances.

12. The succession of elements within a group demonstrates characteristic trends in properties. As you progress *down* a group:

- ✓ atomic radius increases.
- ✓ electronegativity decreases.
- ✓ first ionization energy decreases.
- ✓ metallic character increases.

13. The succession of elements within a period demonstrates characteristic trends in properties. As you progress *across* a group from *left to right*:

- ✓ atomic radius decreases.
- ✓ electronegativity increases.
- ✓ first ionization energy increases.
- ✓ metallic character decreases.

14. Some elements may exist in two or more forms in the same phase. These forms differ in their molecular or crystal structure, hence their different properties. These different forms are called "allotropes,"

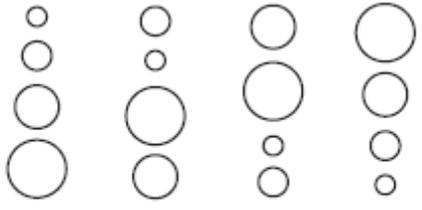
- ✓ Ex: Solid carbon exists in three different forms: graphite, diamond (a network solid) and coal.
- ✓ Ex: the element oxygen can exist in two different forms: O₂ gas and ozone (O₃ gas)

Periodic Table – Practice Questions

- Elements in the Periodic Table are arranged according to their
 - atomic number
 - atomic mass
 - relative activity
 - relative size
- Elements in a given period of the Periodic Table contain the same number of
 - protons in the nucleus
 - neutrons in the nucleus
 - electrons in the outermost level
 - occupied principal energy levels
- Atoms of metals tend to
 - lose electrons and form negative ions
 - lose electrons and form positive ions
 - gain electrons and form negative ions
 - gain electrons and form positive ions
- Which properties are most common in nonmetals?
 - low ionization energy and low electronegativity
 - low ionization energy and high electronegativity
 - high ionization energy and low electronegativity
 - high ionization energy and high electronegativity
- Which two elements have chemical properties that are most similar?
 - Cl and Ar
 - Li and Na
 - K and Ca
 - C and N
- Which of the following Period 4 elements has the most metallic characteristics?
 - Ca
 - Ge
 - As
 - Br
- If M represents an alkali metal, what is the formula for the compound formed by M and oxygen?
 - MO₂
 - M₂O
 - M₂O₃
 - M₃O₂
- As the elements in Group 15 are considered in order of increasing atomic number, which sequence in properties occurs?
 - nonmetal, metalloid, metal
 - metalloid, metal, nonmetal
 - metal, metalloid, nonmetal
 - metal, nonmetal, metalloid
- Which group contains a metalloid?
 - 1
 - 11
 - 15
 - 18
- As elements of Group 15 of the Periodic Table are considered in order from top to bottom, the metallic character of the atoms of each successive element generally
 - increases
 - decreases
 - remains the same

11. Which statement best describes Group 2 elements as they are considered in order from top to bottom of the Periodic Table?
- (1) The number of principal energy levels increases, and the number of valence electrons increases.
 - (2) The number of principal energy levels increases, and the number of valence electrons remains the same.
 - (3) The number of principal energy levels remains the same, and the number of valence electrons increases.
 - (4) The number of principal energy levels remains the same, and the number of valence electrons decreases.
12. Which Group 15 element exists as a diatomic molecule at STP?
- (1) phosphorous
 - (2) nitrogen
 - (3) bismuth
 - (4) arsenic
13. Which Group 16 element when combined with hydrogen forms a compound that would exhibit the strongest hydrogen bonding?
- (1) selenium
 - (2) tellurium
 - (3) oxygen
 - (4) sulfur
14. Which ion has the largest radius?
- (1) Na^+
 - (2) Mg^{2+}
 - (3) K^+
 - (4) Ca^{2+}
15. What occurs as the atomic number of the elements in Period 2 increases?
- (1) The nuclear charge of each successive atom decreases, and the covalent radius decreases.
 - (2) The nuclear charge of each successive atom decreases, and the covalent radius increases.
 - (3) The nuclear charge of each successive atom increases, and the covalent radius decreases.
 - (4) The nuclear charge of each successive atom increases, and the covalent radius increases.

Periodic Table – questions from previous Regents exams

1. Which element is a solid at STP and a good conductor of electricity?
- (1) iodine (3) nickel
(2) mercury (4) sulfur
2. Which element has both metallic and nonmetallic properties?
- (1) Rb (3) Si
(2) Rn (4) Sr
3. The carbon atoms in graphite and the carbon atoms in diamond have different
- (1) atomic numbers
(2) atomic masses
(3) electronegativities
(4) structural arrangements
4. Atoms of which element have the greatest tendency to gain electrons?
- (1) bromine (3) fluorine
(2) chlorine (4) iodine
5. Which statement describes a chemical property of the element magnesium?
- (1) Magnesium is malleable.
(2) Magnesium conducts electricity.
(3) Magnesium reacts with an acid.
(4) Magnesium has a high boiling point.
6. Which statement explains why sulfur is classified as a Group 16 element?
- (1) A sulfur atom has 6 valence electrons.
(2) A sulfur atom has 16 neutrons.
(3) Sulfur is a yellow solid at STP.
(4) Sulfur reacts with most metals.
7. How do the atomic radius and metallic properties of sodium compare to the atomic radius and metallic properties of phosphorus?
- (1) Sodium has a larger atomic radius and is more metallic.
(2) Sodium has a larger atomic radius and is less metallic.
(3) Sodium has a smaller atomic radius and is more metallic.
(4) Sodium has a smaller atomic radius and is less metallic.
8. Which list of elements consists of metalloids, only?
- (1) B, Al, Ga (3) O, S, Se
(2) C, N, P (4) Si, Ge, As
9. Which general trend is found in Period 2 on the Periodic Table as the elements are considered in order of increasing atomic number?
- (1) decreasing atomic mass
(2) decreasing electronegativity
(3) increasing atomic radius
(4) increasing first ionization energy
10. Which two characteristics are associated with metals?
- (1) low first ionization energy and low electronegativity
(2) low first ionization energy and high electronegativity
(3) high first ionization energy and low electronegativity
(4) high first ionization energy and high electronegativity
11. Which element is most chemically similar to chlorine?
- (1) Ar (3) Fr
(2) F (4) S
12. Which grouping of circles, when considered in order from the top to the bottom, best represents the relative size of the atoms of Li, Na, K, and Rb, respectively?
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- (1) (2) (3) (4)
13. At STP, which element is brittle and *not* a conductor of electricity?
- (1) S (3) Na
(2) K (4) Ar

14. An atom of argon rarely bonds to an atom of another element because an argon atom has

- (1) 8 valence electrons
- (2) 2 electrons in the first shell
- (3) 3 electron shells
- (4) 22 neutrons

15. The elements on the Periodic Table are arranged in order of increasing

- (1) boiling point
- (2) electronegativity
- (3) atomic number
- (4) atomic mass

16. Which element is classified as a nonmetal?

- (1) Be
- (2) Al
- (3) Si
- (4) Cl

17. Solid samples of the element phosphorus can be white, black, or red in color. The variations in color are due to different

- (1) atomic masses
- (2) molecular structures
- (3) ionization energies
- (4) nuclear charges

18. Lithium and potassium have similar chemical properties because the atoms of both elements have the same

- (1) mass number
- (2) atomic number
- (3) number of electron shells
- (4) number of valence electrons

19. At STP, which list of elements contains a solid, a liquid, and a gas?

- (1) Hf, Hg, He
- (2) Cr, Cl₂, C
- (3) Ba, Br₂, B
- (4) Se, Sn, Sr

Base your answers to questions 20 through 22 on the information below.

Elements with atomic numbers 112 and 114 have been produced and their IUPAC names are pending approval. However, an element that would be put between these two elements on the Periodic Table has not yet been produced. If produced, this element will be identified by the symbol Uut until an IUPAC name is approved.

20. Draw a Lewis electron-dot diagram for an atom of Uut. [1]

21. Determine the charge of an Uut nucleus. Your response must include *both* the numerical value and the sign of the charge. [1]

22. Identify *one* element that would be chemically similar to Uut. [1]

Base your answers to questions 23 through 26 on the information below, which describes the proposed discovery of element 118.

In 1999, a nuclear chemist and his team announced they had discovered a new element by crashing krypton atoms into lead. The new element, number 118, was assigned the name ununoctium and the symbol Uuo. One possible isotope of ununoctium could have been Uuo-291.

However, the discovery of Uuo was not confirmed because other scientists could not reproduce the experimental results published by the nuclear chemist and his team. In 2006, another team of scientists claimed that they produced Uuo. This claim has yet to be confirmed.

Adapted from Discover January 2002

23. Based on atomic number, in which group on the Periodic Table would element 118 be placed? [1]
24. What would be the total number of neutrons present in a theoretical atom of Uuo-291?[1]
25. What would be the total number of electrons present in a theoretical atom of Uuo-291? [1]
26. Explain why being able to reproduce scientific results is an important component of scientific research. [1]

Base your answers to questions 27 through 30 on the information below.

The table below lists physical and chemical properties of six elements at standard pressure that correspond to known elements on the Periodic Table. The elements are identified by the code letters, *D*, *E*, *G*, *J*, *L*, and *Q*.

Properties of Six Elements at Standard Pressure

<u>Element D</u> Density 0.00018 g/cm ³ Melting point -272°C Boiling point -269°C Oxide formula (none)	<u>Element E</u> Density 1.82 g/cm ³ Melting point 44°C Boiling point 280°C Oxide formula E ₂ O ₅	<u>Element G</u> Density 0.53 g/cm ³ Melting point 181°C Boiling point 1347°C Oxide formula G ₂ O
<u>Element J</u> Density 0.0013 g/cm ³ Melting point -210°C Boiling point -196°C Oxide formula J ₂ O ₅	<u>Element L</u> Density 0.86 g/cm ³ Melting point 64°C Boiling point 774°C Oxide formula L ₂ O	<u>Element Q</u> Density 0.97 g/cm ³ Melting point 98°C Boiling point 883°C Oxide formula Q ₂ O

27. What is the total number of elements in the “Properties of Six Elements at Standard Pressure” table that are solids at STP? [1]
28. An atom of element *G* is in the ground state. What is the total number of valence electrons in this atom? [1]
29. Letter *Z* corresponds to an element on the Periodic Table other than the six listed elements. Elements *G*, *Q*, *L*, and *Z* are in the same group on the Periodic Table, as shown in the diagram below.

G
Q
L
Z

Based on the trend in the melting points for elements *G*, *Q*, and *L* listed in the “Properties of Six Elements at Standard Pressure” table, estimate the melting point of element *Z*, in degrees Celsius. [1]

30. Identify, by code letter, the element that is a noble gas in the “Properties of Six Elements at Standard Pressure” table. [1]