Science Olympiad Regional
February 2012

Chem Lab Station 2
Perodicity

Directions: Answer each of the following problems. Record all the required information on the attached **Team Answer Sheet.** Each problem, or part thereof, is worth 2 points unless otherwise specified.

Problems 1-7 are based upon the following experiment.

The oxides of several elements were added to separate water samples to produce a saturated solution. The pH of each resulting solution was measured and summarized in the following table:

Oxide added to water	pH of resulting saturated solution
CaO	12.4
MgO	10.5
CO_2	3.8
SO_2	1.5

1. Write the balanced equation for the reaction between CaO and water.
2. Write the balanced equation for the reaction between MgO and water.
3. Write the balanced equation for the reaction between CO_2 and water.
4. Write the balanced equation for the reaction between SO_2 and water.
5. How are Ca & Mg classified differently than C & S on the periodic table?
6. What conclusion can we draw about the differences between the reaction of metal and nonmetal oxides with water?
7. Predict the pH of the saturated solution produced by the reaction between strontium oxide (SrO) and water.

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8. Who is generally regarded as the father of the Periodic Table?
9. Who was responsible for organizing the elements on the Periodic Table in their current order, which predicts the properties of the elements better than the original version?
10. Element 118, like many transuranium elements, has been given the temporary symbol “Uuo” until a permanent name can be agreed upon. What is the temporary name of this element.
11. According to the International Union of Pure and Applied Chemistry (IUPAC) what group numbers on the Periodic Table make up the *transition metals*?

Station 2 Continued

For problems 12-15, use the terms ***increases, decreases***, and ***remains constant*** to describe the trend in the following properties as one goes from left to right across Period 3 on the Periodic Table:

12. Acidic properties

13. Atomic radii

14. Metallic properties

15. First ionization energy

For problems 16-19, use the terms ***increases, decreases***, and ***remains constant*** to describe the trend in the following properties as one goes from top to bottom down Group 2 on the Periodic Table:

16. Electronegativity

17. Ionic radii

18. Metallic properties

19. Melting point

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20. Identify the last element on the Periodic Table that has stable isotopes.

21. Identify the last naturally occurring element on the Periodic Table.

22. Identify the first element on the Periodic Table for which all isotopes are radioactive.

23. The two densest elements on the Periodic Table are osmium (D = 22.59 g/cm^3) and iridium (D = 22.56 g/cm^3). Referred to as heavy metals, part of the reason for their high densities is the close packing of their atoms which is typical for most dense metals like lead and gold. (This makes them the favorite metals of rock bands like Judas Priest and Metallica.) Name the two closely related forms of close packing. (3 pts. for each correct answer)

24. Name the intermolecular force of attraction that exists between diatomic halogen molecules.

25. *In a single sentence*, use the principles of chemical bonding to explain why Cl_2 has a lower boiling point than Br_2.

26. Titanium ($_{22}$Ti) is best known for its low density, high strength, and high resistance to corrosion. Write the complete electron configuration, with sublevel notation ($1s^2$, $2s^2$, etc.) for titanium.

27. Write the complete electron configuration, with sublevel notation ($1s^2$, $2s^2$, etc.) for the Ti^{2+} ion.

28. Explain why Ti^{3+} forms colored aqueous solutions while Sc^{3+} does not. (3 pts. for each correctly explained ion).

29. Chromium (chrome, $_{24}Cr$) is best known for its high luster and resistance to corrosion. This makes it a favorite element to people attracted to pretty, shiny objects. Write the complete electron configuration, with sublevel notation ($1s^2$, $2s^2$, etc.) for chromium.

30. Elements 57 through 71 are called the lanthanide (or lanthanoid) series and are often represented as one of two separate rows under the main Periodic Table. What three-word term is often used to refer to these elements?

31. Alkali metals are too reactive to be found as uncombined atoms in nature. Pure sodium metal is produced by the electrolysis of molten sodium chloride. Write the balanced half reaction that occurs at the anode when sodium chloride undergoes electrolysis.

32. Write the balanced half reaction that occurs at the cathode for the process described in problem #28 above.

For problems 33-40, write the letter of the best answer on your answer sheet.

33. The atoms and ions in order of *increasing* radius are
(A) Ar; Ca^{2+}; Cl^-; Cl.
(B) Ca^{2+}; Ar; Cl; Cl^-
(C) Cl^-; Ar; Ca^{2+}; Cl.
(D) Cl; Cl^-; Ar; Ca^{2+}.
(E) Ca^{2+}; Ar; Cl^-; Cl.

34. Which element has the highest *second* ionization energy?
(A) $_8O$
(B) $_{10}Ne$
(C) $_{11}Na$
(D) $_{12}Mg$
(E) $_{13}Al$

35. The decreased effect of the force of attraction of a nucleus for valence electrons due to the presence of intervening electrons is the
(A) periodic effect
(B) shielding effect
(C) electronegativity effect
(D) first ionization energy effect
(E) noble gas configuration effect

36. As one moves down a column in the periodic table, electron affinity tends to
(A) increase due to the shielding effect
(B) increase due to the increasing nuclear charge
(C) decrease due to the increasing electron repulsion
(D) increase due to the increasing atomic radius
(E) remain the same

37. When atoms of the of noble gas element Group 0 in the Periodic Table are compared in order from top to bottom, the attractions between the atoms of each successive element
(A) increase and the boiling point decreases.
(B) increase and the boiling point increases.
(C) decrease and the boiling point increases.
(D) decrease and the boiling point decreases.
(E) remains the same and boiling point remains approximately the same.

38. Which compound has the *greatest* ionic character in its bonds?
(A) KCl
(B) $CaCl_2$
(C) $GaCl_3$
(D) $AsCl_3$
(E) O_2

39. The bond in HCl is polar covalent because the
(A) shared electrons are closer to the chlorine atom.
(B) chlorine has a higher atomic number than hydrogen.
(C) hydrogen chloride molecules are weakly held together.
(D) chemical bonds consist of electrical forces between atoms.
(E) shared electrons are closer to the hydrogen atom.

40. The bond which holds atoms of copper together is the
(A) ionic bond
(B) metallic bond
(C) polar covalent bond
(D) nonpolar covalent bond
(E) coordinate covalent bond