SECTION 1: MATCHING. Use the choices below to answer the following questions. Answer choices may be used once, more than once, or not at all. (1 point each)

1. Has the smallest atomic radius.
   - (A) Aluminum (Al)
   - (B) Beryllium (Be)
   - (C) Carbon (C)
   - (D) Silicon (Si)

2. Has an electron configuration [Ne] 3s² 3p².

3. Has the largest ionization energy.

4. Has two valence electrons.

SECTION 2: MULTIPLE CHOICE. Select the best answer choice for each question. (2 points each)

5. How many atomic orbitals are on the fifth energy level (n = 5)?
   - (A) 2
   - (B) 8
   - (C) 18
   - (D) 25

6. What is the maximum number of electrons that can fill the 4f orbitals?
   - (A) 7
   - (B) 8
   - (C) 10
   - (D) 14

7. Which of the following is the correct electron configuration for the electrons in 34S²⁻?
   - (A) [Ne] 3s² 3p²
   - (B) [Ne] 3s² 3p⁴
   - (C) [Ne] 3s² 3p⁶
   - (D) [Ne] 3s⁶

8. Which of the following electron configurations is correct for a ground state neutral atom?
   - (A) 1s² 2s² 2p⁶ 3s² 3p⁶ 3d²
   - (B) 1s² 2s² 2p⁶ 3s² 3p⁶ 4s²
   - (C) 1s² 2s² 2p⁶ 3s² 3p⁶ 4s⁴
   - (D) 1s² 2s² 3s² 3p⁶ 4s²

9. Which electrons are being placed into orbitals correctly?
   - (A)
   - (B)
   - (C)
   - (D)
Questions 10-13: Consider the element iron, Fe.

10. The electrons in Fe that are farthest from the nucleus occupy the ____ orbital.
   (A) 3p
   (B) 3d
   (C) 4s
   (D) 4p

11. The electrons in Fe that have the highest energy occupy the ____ orbital.
   (A) 3p
   (B) 3d
   (C) 4s
   (D) 4p

12. How many orbitals in Fe are half-filled, that is, have only one electron?
   (A) 1
   (B) 2
   (C) 3
   (D) 4

13. How many valence electrons does Fe have?
   (A) 2
   (B) 6
   (C) 8
   (D) 4

14. Which group of elements forms 1— ions?
   (A) Alkali metals
   (B) Alkaline earth metals
   (C) Halogens
   (D) Noble gases

15. Which of the following elements has the same number of valence electrons as carbon (C)?
   (A) Calcium (Ca)
   (B) Lead (Pb)
   (C) Oxygen (O)
   (D) Titanium (Ti)

16. When a neutral Cl atom becomes a Cl— ion how and why does the size change?
   (A) bigger / more electron-electron repulsion
   (B) bigger / more electron-proton repulsion
   (C) smaller / more electron-electron attraction
   (D) smaller / more electron-proton attraction

17. Which sets of atoms represent the alkali metals?
   (A) W
   (B) X
   (C) Y
   (D) Z

Questions 17-18: Consider the following elements on the Periodic Table:

18. Which element has the largest atomic radius?
   (A) Br
   (B) I
   (C) Se
   (D) Te

19. Which element has the largest ionization energy?
   (A) Br
   (B) I
   (C) Se
   (D) Te

20. Where are the largest atoms located on the periodic table?
   (A) lower left
   (B) lower right
   (C) upper left
   (D) upper right
SECTION 3: FREE RESPONSE. Show all your work to receive full credit.

21. Consider the element cadmium, Cd.
   (a) Write the **long form** electron configuration for the neutral atom, Cd. (2 points)

   

   (b) How many valence electrons does Cd have? (1 point) ________

   (c) Write the **short form** electron configuration for the cadmium ion, Cd^{2+}. (2 points)

   

   (d) Which is expected to have a larger radius, Cd or Cd^{2+}? Explain briefly. (3 points)

       _______ is expected to have a larger radius because …

22. Consider the following elements: K, Ca, Rb
   (a) Arrange the elements in order of increasing atomic radius: (3 points)

   

   (b) Explanation why B has a larger atomic radius than A. Use a complete sentence. (2 points)

   

   (c) Arrange the elements in order of increasing ionization energy: (3 points)

   

   (d) Explanation why Y is higher ionization energy than X. Use a complete sentence. (2 points)

   


### Answers:

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21. (a) \[1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10}\]
    (b) 2
    (c) [Kr] \[4d^{10}\]
    (d) Cd … it has more electrons than Cd\(^{2+}\), so there are more electron-electron repulsions.

22. (a) Ca < K < Rb
    (b) K has a larger radius than Ca because there are fewer protons, so it has weaker attractions to the nucleus, resulting in a larger radius.
    (c) Rb < K < Ca
    (d) K has higher ionization energy than Rb because it has fewer layers of electrons, so its outer electrons are closer and more attracted to nucleus, and requires more energy to remove from the atom.