IV. Structure of the Atom

1. Which of the following represents a pair of isotopes?

<table>
<thead>
<tr>
<th>Atomic Number</th>
<th>Mass Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>I 6</td>
<td>14</td>
</tr>
<tr>
<td>II 7</td>
<td>14</td>
</tr>
<tr>
<td>(A)</td>
<td></td>
</tr>
<tr>
<td>I 6</td>
<td>7</td>
</tr>
<tr>
<td>II 14</td>
<td>14</td>
</tr>
<tr>
<td>(B)</td>
<td></td>
</tr>
<tr>
<td>I 6</td>
<td>14</td>
</tr>
<tr>
<td>II 14</td>
<td>28</td>
</tr>
<tr>
<td>(C)</td>
<td></td>
</tr>
<tr>
<td>I 7</td>
<td>13</td>
</tr>
<tr>
<td>II 7</td>
<td>14</td>
</tr>
<tr>
<td>(D)</td>
<td></td>
</tr>
<tr>
<td>I 8</td>
<td>20</td>
</tr>
<tr>
<td>II 16</td>
<td>20</td>
</tr>
<tr>
<td>(E)</td>
<td></td>
</tr>
</tbody>
</table>

2. Which of the following represents the ground state electron configuration of Mn$^{3+}$ ion?
(A) 1s$^2$2s$^2$2p$^6$3s$^2$3p$^6$3d$^4$
(B) 1s$^2$2s$^2$2p$^6$3s$^2$3p$^6$3d$^5$4s$^2$
(C) 1s$^2$2s$^2$2p$^6$3s$^2$3p$^6$3d$^5$4s$^2$
(D) 1s$^2$2s$^2$2p$^6$3s$^2$3p$^6$3d$^3$4s$^2$

3. Gaseous atoms of which of these (Ca, V, Co, Zn, As) are paramagnetic?
(A) Ca, As (B) Zn, As (C) Ca, V, and Co (D) V, Co, As (E) V, Co, Zn

4. One of the outermost electrons in a strontium atom in the ground state can be described by which of the following sets of four quantum numbers?
(A) 5,2,0,1/2 (B) 5,1,1/2 (C) 5,1,0,1/2 (D) 5,0,1,1/2 (E) 5,0,0,1/2

5. Which element exhibits the greatest number of different oxidation states?
(A) O (B) La (C) Rb (D) Mg (E) N

Use the following to answer questions 6-9
(A) 1s$^2$2s$^2$2p$^6$3s$^2$3p$^5$
(B) 1s$^2$2s$^2$2p$^6$3s$^2$3p$^6$
(C) 1s$^2$2s$^2$2p$^6$2d$^{10}$3s$^2$3p$^6$
(D) 1s$^2$2s$^2$2p$^6$3s$^2$3p$^6$3d$^5$
(E) 1s$^2$2s$^2$2p$^6$3s$^2$3p$^6$3d$^3$4s$^2$

6. An impossible electron configuration

7. The ground-state configuration for the atoms of a transition element

8. The ground-state configuration of a negative ion of a halogen
9. The ground-state configuration of a common ion of an alkaline earth element

10. Which of the following conclusions can be drawn from J. J. Thomson’s cathode ray experiment? (A) atoms contain electrons (B) practically all of the mass of an atom is contained in the nucleus (C) atoms contain protons, neutrons, and electrons (D) no two electrons in one atom can have the same four quantum numbers

Use the following choices to answer questions 11-14
(A) Heisenberg uncertainty principle
(B) Pauli exclusion principle
(C) Hund’s Rule (principle of maximum multiplicity)
(D) Shielding effect
(E) Wave nature of matter

11. Can be used to predict that a gaseous carbon atom in its ground state is paramagnetic

12. Explains the experimental phenomenon of electron diffraction

13. Indicates that an atomic orbital can hold no more than two electrons

14. Predicts that it is impossible to determine simultaneously the exact position and the exact velocity of an electron

15. Which of the following sets of quantum numbers \((n, l, m_l, m_s)\) best describes the valence electron of highest energy in the ground-state gallium atom?
(A) 4,0,0,1/2  (B) 4,0,1,1/2  (C) 4,1,1,1/2  (D) 4,1,2,1/2  (E) 4,2,0,1/2

16. Which of the following is a correct interpretation of the results of Rutherford’s experiments in which gold atoms were bombarded with alpha particles? (A) Atoms have equal numbers of positive and negative charges.  (B) Electrons in atoms are arranged in shells.  (C) Neutrons are at the center of an atom  (D) Neutrons and protons in atoms have nearly equal mass  (E) The positive charge of an atom is concentrated in a small region
17. Atoms of an element, X, have the electronic configuration shown below. The compound most likely formed with magnesium, Mg, is:

\[ 1s^22s^22p^63s^23p^3 \]

(A) MgX  (B) Mg\(_2\)X  (C) MgX\(_2\)  (D) Mg\(_2\)X\(_3\)  (E) Mg\(_3\)X\(_2\)

For #18, 19, use the following choices for answers.
Consider atoms of the following elements. Assume that the atoms are in the ground state.

(A) S  (B) Ca  (C) Ga  (D) Sb  (E) Br

18.) The atom that contains exactly two unpaired electrons

19.) The atom that contains only one electron in the highest occupied energy sublevel.

20.) In which of the following groups are the three species isoelectronic; i.e. have the same number of electrons?

(A) S\(^2\)\(^-\), K\(^+\), Ca\(^2+\)  (B) Sc, Ti, V\(^{2+}\)  (C) O\(^2\)\(^-\), S\(^2\)\(^-\), Cl\(^-\)

(D) Mg\(^2+\), Ca\(^2+\), Sr\(^{2+}\)  (E) Cs, Ba\(^{2+}\), La\(^{3+}\)

21.) The atomic mass of copper is 63.55. Given that there are only two naturally occurring isotopes of copper, \(^{63}\)Cu and \(^{65}\)Cu, the natural abundance of the \(^{65}\)Cu isotope must be approximately. (a) 90%  (b) 70%  (c) 50%  (d) 25%  (e) 10%

Answers