Atomic and Molecular Structure

Select the alternative that correctly answers the following questions.

1. Which of the following statements regarding atomic particles is false?

a) Protons are found in the nucleus and are positively charged particles
b) Electrons move around the nucleus and contribute little to the mass of the atom
c) Neutrons are found in the nucleus and they have no charge
d) The numbers of neutrons, protons and electrons are always equal in a neutral atom

2. Mass number refers to

a) the number of protons in the nucleus of an atom
b) the number of electrons in an atom
c) the number of neutrons in an atom
d) the total number of protons and neutrons in the nucleus of an atom
e) the total number of protons and electrons in the nucleus of an atom

3. A neutral atom of silver has atomic number (Z) = 47 and mass number (A) =107. Examine the table below and decide which alternative correctly shows the numbers of protons, electrons and neutrons for the silver atom.

	Number of protons	Number of electrons	Number of neutrons
a)	47	47	107
b)	47	47	60
c)	107	107	47
d)	47	60	47

4. The species $^{24}_{12}Mg^{2+}$ contains

a) 12 protons, 12 neutrons and 12 electrons
b) 12 protons, 12 neutrons and 14 electrons
c) 12 protons, 10 neutrons and 10 electrons
d) 12 protons, 12 neutrons and 10 electrons

5. Atoms of the same element which have the same number of protons but a different number of neutrons are known as

a) ions.
b) isotopes.
c) neutral atoms.
d) a chemical family.

6. Which of the following statements concerning the two isotopes of helium, ${}^{3}_{2}He$ and ${}^{4}_{2}He$, is false?

a) Both of these atoms would behave in exactly the same manner in a chemical reaction.
b) The atoms differ only in their mass, ${}^{4}_{2}He$ atoms being heavier than ${}^{3}_{2}He$ atoms.
c) ${}^{4}_{2}He$ atoms have an extra proton compared to ${}^{3}_{2}He$ atoms.
d) In nature, ${}^{4}_{2}He$ atoms are more abundant than ${}^{3}_{2}He$ atoms.

7. Which of the following determines the *size* of an atom?

a) The number of protons in the atom.
b) The number of neutrons in the atom.
c) The size of the nucleus of the atom.
d) The number of electrons in the atom.

8. The electron configuration: 2, 8, 4 is that of

a) Carbon
b) Nitrogen
c) Neon
d) Silicon

9. The electron configuration for Al^{3+} is

a) 2, 8, 3
b) 2, 8
c) 2, 8, 6
d) 2, 8, 2

10. Which of the following is the most important factor in determining the chemical properties of an element?

a) The total number of electrons in its atoms.
b) The number of protons in the nucleus of its atoms.
c) The number of neutrons in the nucleus of its atoms.
d) The number of valence electrons in its atoms.

11. The number of valence electrons in an atom is equal to

a) the number of electrons in the atom.
b) the charge on a positive or negative ion formed by that atom.
c) the number of electrons in the outer energy level of the atom.
d) the number of electrons needed to fill all the energy levels of the atom.

The next two questions refer to the information below.

An element, X, has the following electron configuration: 2, 5

12. The atomic number of element X would be

a) 2
b) 5
c) 7
d) 3
e) impossible to predict based on this information alone.

13. The number of valence electrons in element X is

a) 2
b) 5
c) 7
d) 3

14. The number of valence electrons in the Group 2 elements of the Periodic Table is

a) 2
b) 4
c) 6
d) 8

15. Which of the following species does NOT have a stable electron configuration (i.e. like those of an inert gas)?

a) Cl^- b) K^+
c) Al^{3+} d) Mg^+
e) S^{2-}

16. If an element has the electron configuration: 2, 8, 2 then it would most likely form an ion of charge

a) +2 b) -2
c) +6 d) -6

17. Which one of the following statements about atomic structure is TRUE?

a) The numbers of protons, neutrons and electrons is always equal in a neutral atom.
b) The numbers of protons and neutrons are always equal in a neutral atom.
c) The numbers of neutrons and electrons are always equal in a neutral atom.
d) The numbers of protons and electrons are always equal in a neutral atom.

18. Electrons are thought to be located in distinct energy levels or shells in an atom. The maximum number of electrons which can be found in the third (n=3) shell of an atom is

a) 2 b) 8
c) 18 d) 36

19. The region of space in a particular energy level where an electron is most likely to be found is called

a) an electron configuration.
b) an orbital
c) an orbit.
d) a principal energy level.

20. The types of orbitals found in the second shell (principal energy level) are

a) s orbitals only.
b) s and p orbitals.
c) s, p and d orbitals.
d) s, p and f orbitals.

21. How many 'p' orbitals are to be found in any given shell?

a) 1 b) 2
c) 3 d) 4

22. An element has the following ground state electron configuration:

$1s^2$ $2s^2$ $2p^5$

How many 'valence' electrons does this atom have?

a) 1 b) 2
c) 5 d) 7

23. The ground state electron configuration for nitrogen is

a) $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^2$
b) $1s^2$ $2s^2$ $2p^3$
c) $1s^2$ $2s^2$ $2p^2$ $4s^1$
d) $1s^2$ $2s^2$ $2p$

24. An element has the following ground state electron configuration:

$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^2$

Based on this information, the element would most likely belong to which group in the periodic table?

a) Group I.
b) Group II.
c) Group III.
d) Group IV.

25. The electron configuration: $1s^2$ $2s^2$ $2p^6$ could be that of all of the following, with the exception of

a) Na^+
b) Ne
c) O^{2-}
d) Cl^-

26. Which one of the following is the most important factor that determines the chemical properties of an element?

a) The number of protons in the nucleus of the atom.
b) The total number of electrons in the atom.
c) The number of valence electrons in the atom.
d) The number of neutrons in the nucleus of the atom.

27. 'd – block' elements are found in

a) the left hand side of the periodic table.
b) the upper right hand side of the periodic table.
c) the middle of the periodic table.
d) the Lanthanide and Actinide series of the periodic table.

28. An element has the following ground state electron configuration:
$1s^2$ $2s^2$ $2p^6$ $3s^2$

In a chemical reaction, this element is most likely to

a) form two covalent bonds.
b) form six covalent bonds.
c) form ions of charge +1.
d) form ions of charge +2.

29. Which one of the following has the electron configuration, $1s^2$ $2s^2$ $2p^6$?

a) Mg^+
b) Al^{3+}
c) Na
d) Ne^+

The next four questions refer to the information below.

Consider three elements A ,B and C which have atomic numbers less than 20.
The atomic number of A and B are x and (x-3) respectively.
Element A forms cations with formula A^+ and forms a solid substance AC when it reacts with element C.

30. What would be the formula of a compound formed by combining elements A and B?

a) AB
b) A_2B
c) AB_2
d) A_3B

31. Which one of the following elements could be A?

a) Li
b) Na
c) Cl
d) O

32. Which one of the following elements could be B?

a) Li
b) Na
c) Cl
d) O

33. The most likely type of bond formed between A and B would be

a) metallic bonds.
b) covalent bonds.
c) ionic bonds.
d) hydrogen bonds.

34. Study the table below showing some data for the halogens .

HALOGEN	**ATOMIC NUMBER**	**MOLECULAR MASS**	**MELTING POINT (^oC)**
F_2	9	38	-220
Cl_2	17	71	-101
Br_2	35	160	-7
I_2	53	254	114

Which one of the following statements best explains why the boiling points of the halogens increase with increasing atomic number?

a) The number of electrons increases, resulting in the formation of more covalent bonds.
b) The number of electrons increases, resulting in stronger dispersion forces between molecules.
c) The increased number of electrons causes the molecules to be more polar.
d) As the molecular masses increase, so too do the sizes of the molecules, resulting in stronger ionic bonds between the ions.

35. Which one of the following does NOT have the same electron configuration as a sodium, Na^+ ion?

a) Cl^-
b) Mg^{2+}
c) Al^{3+}
d) O^{2-}

36. Which one of the following does NOT occur as we move from left to right across the third row of elements in the periodic table?

a) Electronegativity of the elements across the row increases.
b) The size of the atomic radius increases.
c) Melting and boiling points increase up to the Group IV elements, then decrease.
d) The number of outer energy level electrons increases.

37. Which of the following third row elements is the best reducing agent?

a) Magnesium.
b) Silicon.
c) Phosphorus.
d) Chlorine.

38. Which of the halogens below has the highest boiling point?

a) Fluorine.
b) Chlorine.
c) Bromine.
d) Iodine.

39. Which halogen is the most powerful oxidising agent?

a) Fluorine.
b) Chlorine.
c) Bromine.
d) Iodine.

40. Which one of the following statements about transition metals is FALSE?

a) Transition metals occupy the middle block of the periodic table.
b) Transition metals form colored ions.
c) Transition metals are more reactive than the Group I and II metals.
d) Transition metals may form ions of variable charge.

41. Which metal is red in color and dissolves readily in nitric acid to form a blue solution?

a) Iron.
b) Zinc.
c) Copper.
d) Nickel.

42. Which transition metal forms a white, amphoteric oxide?

a) Lead.
b) Zinc.
c) Chromium.
d) Aluminium.

43. Which one of the following is NOT a trace element?

a) Potassium.
b) Zinc.
c) Copper.
d) Iron.

44. A student is asked to identify a metal, based of the following properties:

The metal does not react with cold water.
The metal reacts with dilute hydrochloric acid.
A solution of the metal will form a white precipitate when ammonia solution is added.
Continued addition of ammonia solution causes the precipitate to dissolve.

The metal could be

a) zinc.
b) magnesium.
c) copper.
d) silver.
e) lead.

45. Which one of the following is a property of zinc?

a) Reacts readily with air.
b) Reacts readily with water, releasing hydrogen gas.
c) Forms the basic oxide, ZnO.
d) Reacts with concentrated hydroxide solution to form the complex ion, $Zn(OH)_4^{2-}$.