

Multiple Choice: *Identify the letter of the choice that best completes the statement or answers the question.* (30)

- Which object(s) would you use to describe the shape of the $2p$ orbital?
 - a dumb-bell
 - a circle
 - a sphere
 - two perpendicular dumb-bells
 - a doughnut
- Which situation must be true for two electrons to occupy the same orbital?
 - The electrons must have the same principal quantum number, but the other quantum numbers must be different.
 - The electrons must have the same spin.
 - The electrons must have identical sets of quantum numbers.
 - The electrons must have low energy.
 - The electrons must have the opposite spin.
- An electron has the following set of quantum numbers:

$$n = 3, l = 1, m_l = 1, m_s = +\frac{1}{2}$$
 In which orbital is this electron found?
 - $3s$
 - $3p$
 - $3d$
 - $3f$
 - $4p$
- Which element contains a full $3s$ orbital?
 - B
 - Na
 - Mg
 - Be
 - Ne
- Which set of quantum numbers is not possible?
 - $n = 3, l = 0, m_l = 0, m_s = \frac{1}{2}$
 - $n = 5, l = 3, m_l = -3, m_s = -\frac{1}{2}$
 - $n = 5, l = 3, m_l = 2, m_s = \frac{1}{2}$
 - $n = 4, l = 4, m_l = 2, m_s = -\frac{1}{2}$
 - $n = 4, l = 3, m_l = -1, m_s = -\frac{1}{2}$
- Which set of quantum numbers is not possible?
 - $n = 5, l = 3, m_l = 0, m_s = -\frac{1}{2}$
 - $n = 1, l = 0, m_l = 0, m_s = \frac{1}{2}$
 - $n = 3, l = 2, m_l = 1, m_s = \frac{1}{2}$
 - $n = 4, l = 4, m_l = -3, m_s = \frac{1}{2}$
 - $n = 5, l = 2, m_l = 0, m_s = -\frac{1}{2}$
- Which scientist postulated that electrons can only move between certain energy levels?
 - Rutherford
 - Dalton
 - Einstein
 - Schrodinger
 - Bohr
- The electron was discovered by
 - Thomson
 - Democritus
 - Rutherford
 - Goldstein
- In Rutherford's experiment, alpha particles were _____ charged
 - negatively
 - positively
 - neutral
 - both a & b
- What did Heisenberg contribute to the quantum mechanical model of the atom?
 - Uncertainty principle
 - Aufbau principle
 - Hund's rule
 - Wave equation
- What did Schrodinger contribute to the quantum mechanical model of the atom?
 - Uncertainty principle
 - Aufbau principle
 - Hund's rule
 - Wave equation
- "A region of space in which there is a high probability of finding an electron" is the definition of a(n)
 - orbital
 - absorption spectrum
 - photon
 - quanta
- Which electron configuration represents a reactive non-metallic element?
 - $1s^2 2s^2 2p^6 3s^2 3p^5$
 - $1s^2 2s^2 2p^6 3s^2 3p^1$
 - $1s^2 2s^2 2p^6 3s^2$
 - $1s^2 2s^2 2p^6 3s^2 3p^6$
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
- How many p orbitals are in each energy level, except $n = 1$?
 - 1
 - 3
 - 5
 - 6
 - 7

15. What is the maximum number of electrons in $n = 3$?
a. 2
b. 3
c. 6
d. 9
e. 18
16. What is the total number of electrons in the $2p$ orbitals of a sulfur atom at ground state?
a. 8
b. 6
c. 4
d. 3
e. 2
17. Which sublevel, when full, corresponds to the first row of transition elements?
a. $3d$
b. $3f$
c. $4d$
d. $4f$
e. $4p$
18. Which sublevel, when full, corresponds to the lanthanide series of elements?
a. $3d$
b. $3f$
c. $4d$
d. $4f$
e. $5f$
19. Which pair of atoms and/or ions is isoelectric?
a. O^{2-} and Cl^-
b. Ca^{2+} and Cl^-
c. F^- and N^{2-}
d. Li^+ and Na^+
e. K^+ and Kr
20. How does atomic radius change from left to right across a period in the periodic table?
a. It increases.
b. It decreases.
c. It stays the same.
d. It increases and then decreases.
e. It decreases and then increases.
21. Which element has the highest electron affinity?
a. Li
b. N
c. O
d. F
e. Ni
22. Which element has the largest atomic radius?
a. Mg
b. Be
c. F
d. Cl
e. Si
23. Which element has the lowest first ionization energy?
a. Ca
b. Cs
c. Br
d. O
e. Ba
24. Which forces exist between hydrogen chloride, HCl , particles?
I. Van der Waals (Dispersion Forces)
II. metallic bonding
III. hydrogen bonding
IV. dipole
a. I only
b. I and IV only
c. I and II only
d. I, III and IV only
e. I, II and III only
25. In general, the valence electrons of metals are:
a. few in number and strongly held
b. few in number and weakly held
c. many in number and strongly held
d. many in number and weakly held
26. Which statement is the best description of chlorine, Cl_2 ?
a. polar molecule
b. polar bonds, non polar molecule
c. non polar molecule
d. ionic compound
e. none of the above
27. Which statement is the best description of potassium chloride, KCl ?
a. polar molecule
b. polar bonds, non polar molecule
c. non polar molecule
d. ionic compound
e. none of the above
28. What is the specific shape of a molecule of antimony(III) fluoride, SbF_3 ?
a. linear
b. trigonal planar
c. trigonal pyramidal
d. tetrahedral
e. angular
29. Why are diamonds so hard?
a. because they are made of carbon
b. because they are made of a three dimensional array of particles
c. because it is able to conduct electricity
d. because there are covalent bonds between particles
e. none of the above
30. A solid compound consists of ions bound in a crystal lattice. Which property would you not expect this solid to have?
a. high melting point
b. good conductivity in the solid state
c. brittle
d. soluble in a polar solvent
e. brittle

31. Molecule Structure Chart. Complete the following chart.(24)

MOLECULE	e ⁻ CALCULATIONS (NGe, Ve, Bonds, Le) [/2]	LEWIS STRUCTURES (indicate co-ordinate covalent bonds, δ^-/δ^+ , dipole moments &/or resonance structures where appropriate) [/2]	3-D DRAWING (indicate correct bond angles) [/2]	NAME (general & Specific) [/2]
XeI₄				
NH₄⁺				
BBr₃				

Short Answer: Choose a selection of questions that total out of 21 marks and write the answers on the fullscap provided. (21)

32. Which of the following would be larger? Explain (4)

a) Mg or Mg^{+2}

b) O or O^{-2}

33. Explain emission spectra and absorption spectra by referring how the terms apply to Bohr's Quantum model of the atom. (4)

34. The first and second stage ionization energies of lithium and beryllium are given below:

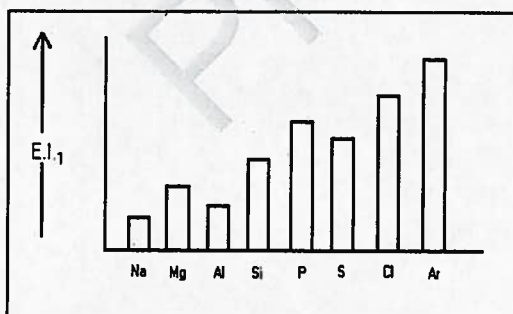
Ionization Energy (kJ/mol)	Lithium	Beryllium
First	520	899
Second	7297	1757

Explain why beryllium has the higher first ionization energy than lithium, but a lower value for the second. (4)

35. What are resonance structures? Using a SO_3 molecule draw all possible resonance structures to represent its bonding (4)

36. Write the electron configuration for an iron atom with a +2 charge. Also, write the short form of the orbital diagram. Explain how the ~~Pauli-Exclusion Principle~~ ^{Hund's Rule} applies to this element's electron configuration and also explain the inconsistency in the electron configuration that occurred to achieve a more stable energy arrangement. (5)

37. State the trend for ionization energy across a period. There are two exceptions to that rule in the graph below. Explain the two exceptions using Quantum Theory. (5)



38. Consider the following electron configurations of neutral atoms: (5)

(i) $1s^2 2s^2 2p^6 3s^2$ (ii) $1s^2 2s^2 2p^6 3s^1$ (iii) $1s^2 2s^2 2p^5$ (iv) $1s^2 2s^2 2p^3$ (v) $1s^2 2s^2 2p^6$

a. Which of these atoms would you expect to have the lowest ionization energy?

b. Which atom would you expect to be an inert gas?

c. List the five atoms in a predicted order of increasing first ionization energies.

d. Predict the atom that should have the highest second ionization energy.

e. Predict the atom that should have the lowest second ionization energy.

39. With use of a diagram, draw and name ALL intra and intermolecular forces present when hydrofluoric acid is dissolved in water. (6)