

(1) Which atom is most likely to be radioactive?

- (a) Cl-35 (b) P-31 (c) Kr-88 (d) Br-81

(2) A student wishes to find a source of positive beta particles, β^+ . She also wants to have this source decay to silver (Ag, $Z=47$) as it releases the positive beta particles. The best parent nuclide for this is:

- (a) $^{113}_{49}\text{In}$ (b) $^{115}_{48}\text{Cd}$ (c) $^{110}_{46}\text{Pd}$ (d) $^{108}_{48}\text{Cd}$

(3) Calculate the binding energy per nucleon in kJ for the P-31 atom given that the atomic mass of this atom is observed to be 30.9737615 u.

- (a) 0.2822535 (b) 21.3×10^{-5} (c) 8.19×10^8 (d) 2.54×10^{10}

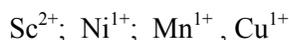
(4) Which single species has the same number of neutrons and electrons?

- (a) $^{52}_{24}\text{Cr}^{2+}$ (b) $^{40}_{20}\text{Ca}$ (c) $^{48}_{22}\text{Ti}^{2+}$ (d) $^{16}_8\text{O}^{2-}$

(5) According to the Bohr theory, when an electron moves from $n = 2$ to $n = 4$ a photon of what **wavelength** in nm is emitted?

- (a) 410 (b) 4.09×10^{-19} (c) 486 (d) 846

(6) Arrange these 4 ions in order of increasing number of unpaired electrons. (less < more).



- (a) $\text{Cu}^{1+} < \text{Sc}^{2+} < \text{Ni}^{1+} < \text{Mn}^{1+}$ (b) $\text{Cu}^{1+} < \text{Mn}^{1+} < \text{Ni}^{1+} < \text{Sc}^{2+}$
(c) $\text{Mn}^{1+} < \text{Sc}^{2+} < \text{Ni}^{1+} < \text{Cu}^{1+}$ (d) $\text{Sc}^{2+} < \text{Cu}^{1+} < \text{Ni}^{1+} < \text{Mn}^{1+}$

(7) Which statement about the atomic orbital wave function, ψ , is **false**?

- (a) is an allowed solution to the Schrodinger equation for electron waves
(b) allowed solutions require three (3) quantum restrictions
(c) represents the square root of the electron density at a point
(d) represents a single orbit in the Bohr atom

(8) The 3p orbital has how many total, radial, and planar nodes?

- (a) 3 total; 2 radial and 1 planar (b) 2 total; 2 radial and 0 planar
(c) 2 total; 1 radial and 1 planar (d) 1 total; 1 radial and 0 planar

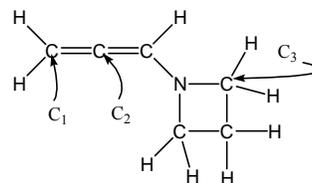
(9) Which species is (are) **diamagnetic**?



- (a) I only (b) II & III (c) I, III & IV (d) all are diamagnetic

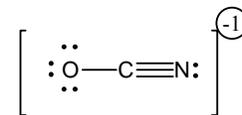
(10) Which hybrid orbital set is used by atoms C₁, C₂, and C₃ respectively in the molecule shown to the right

- (a) sp², sp, sp² (b) sp², sp², sp³ (c) sp², sp, sp³ (d) sp³, sp², sp²



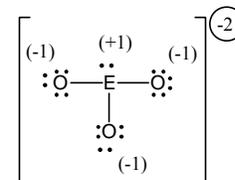
(11) What are the **formal charges** on atoms O, C, and N respectively in the Lewis structure shown to the right?

- (a) O = 0; C = 0; N = -1 (b) O = -1; C = 0; N = 0
 (c) O = -2; C = +1; N = 0 (d) O = 0; C = +1; N = -1



(12) Which atom could be E in the structure to the right →?

- (a) Br (b) C (c) S (d) P



(13) What is (are) the possible ideal bond angle(s) in degrees in SF₄ (all atoms bonded to S)?

- (a) 90 only (b) 109 & 180 (c) 90 and 120 (d) 90, 120 & 180

(14) According to MO theory, which species has the strongest bond?

- (a) Be₂¹⁻ (b) N₂⁺ (c) C₂ (d) F₂²⁻

(15) For the carbonate anion, CO₃²⁻, the number of electron pairs in the sigma framework and π-system are, respectively:

- (a) 7,2 (b) 9,3 (c) 8,1 (d) 10,2

(16) Which molecule is polar?

- (a) XeF₂ (b) XeF₄ (c) SF₄ (d) SF₆

(17) The average speed of hydrogen gas, H₂ (g), molecules at 1000. K is?

- (a) 486 (b) 792 (c) 1927 (d) 3532

(18) Which of the following molecules exhibits ONLY London dispersion forces?

- (a) CHCl₃ (b) CCl₄ (c) HCl (d) KCl

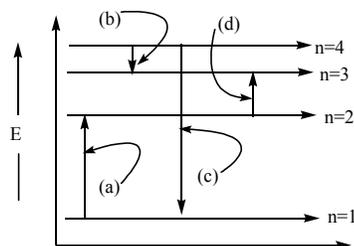
(19) Which set of successive ionization energies (E_i) corresponds to an element in Group IIIA (3A) of the periodic chart?

- (a) 0.8; 1.8; 19.6; 24.3; 28.7; 31.0 (b) 0.6; 1.8; 3.2; 5.1; 24.6; 31.8
 (c) 1.2; 2.1; 3.1; 37.6; 42.0; 51.8 (d) 1.7; 45.2; 63.8; 75.2; 86.7

(20) A photon of wavelength 410 nm is ejected from a H atom when an electron falls from the sixth principal energy level. To which level does this electron fall?

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

- (21) Given the diagram to the right of some of the Bohr principal energy levels, which arrow that represents the absorption of a photon of longest wavelength?



- (22) How many electrons may be described by the quantum numbers: $n = 6, l = 1$
- (a) 3 (b) 6 (c) 12 (d) 18
- (23) A possible set of quantum number that could describe the last electron entering a silver (Ag) atom is:
- (a) $(5, 3, -2, +\frac{1}{2})$ (b) $(4, 2, -1, -\frac{1}{2})$ (c) $(5, 2, -2, +\frac{1}{2})$ (d) $(3, 1, -1, +\frac{1}{2})$
- (24) Which statement about orbital nodes is false?
- (a) A 4d orbital contains three nodes; 2 planar and 1 spherical
 (b) The lowest energy MO in a pi-system has none
 (c) "s" type orbitals have no nodes
 (d) Bonding MOs have fewer nodes than antibonding MOs.
- (25) Which statement is true?
- (a) It is possible to simultaneously determine the precise location and velocity of an electron in an orbital
 (b) The π bond order is 2 for a conjugated system containing 5 atoms and 4 π electrons
 (c) The concentration of solute in a solution is inversely proportional to its boiling point elevation
 (d) An AB_4X_2 molecule has a square pyramidal molecular shape.
- (26) Which is the best **Lewis structure** for NO_2^{1+} ?
- (a) $\overset{(+1)}{\text{O}}-\overset{\cdot\cdot}{\text{N}}=\overset{\cdot\cdot}{\text{O}}$ (b) $\overset{\cdot\cdot}{\text{O}}=\overset{(+1)}{\text{N}}\equiv\overset{\cdot\cdot}{\text{O}}$ (c) $\overset{(-1)}{\text{O}}-\overset{(+2)}{\text{N}}=\overset{\cdot\cdot}{\text{O}}$ (d) $\overset{\cdot\cdot}{\text{O}}=\overset{(+1)}{\text{N}}=\overset{\cdot\cdot}{\text{O}}$
- (27) The number of electrons in the π system of the SO_3 molecule is:
- (a) 2 (b) 4 (c) 6 (d) none
- (28) The molecular shape of $SnCl_3^{1-}$ is:
- (a) octahedral (b) square planar (c) T-shaped (d) trigonal pyramidal
- (29) If the temperature is held constant at 300K, at what pressure in atm. will nitrogen gas, $N_2(g)$, have a density of 2.00 g/L?
- (a) 2.0×10^{-3} (b) 0.95 (c) 1.76 (d) 3.42

