

Name _____

Useful constants: $h = 6.626 \times 10^{-34} \text{ J s}$, $c = 3 \times 10^8 \text{ m / s}$

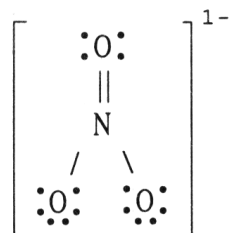
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) According to VSEPR theory, if there are five electron domains in the valence shell of an atom, they will be arranged in a(n) _____ geometry. 1) _____
A) trigonal bipyramidal
B) linear
C) trigonal planar
D) octahedral
E) tetrahedral
- 2) A _____ covalent bond between the same two atoms is the longest. 2) _____
A) triple
B) double
C) single
D) They are all the same length.
E) strong
- 3) Based on the octet rule, sulfur most likely forms a _____ ion. 3) _____
A) S^{2-}
B) S^{5+}
C) S^{3-}
D) S^{3+}
E) S^{-}
- 4) _____ is credited with organizing the first periodic table. 4) _____
A) Ernest Rutherford
B) Dmitri Mendeleev
C) Michael Faraday
D) Lothar Meyer
E) Henry Moseley
- 5) A nonpolar bond will form between two _____ atoms of _____ electronegativity. 5) _____
A) different, opposite
B) identical, equal
C) similar, different
D) identical, different
E) different, different
- 6) In a hydrogen atom, an electron in a _____ orbital can absorb a photon, but cannot emit a photon. 6) _____
A) 3p
B) 1s
C) 2s
D) 3s
E) 3f

7) If the visible spectrum is ranked: violet, blue, green, yellow, and red, from highest frequency to lowest frequency. What color of visible light has the shortest wavelength _____? 7) _____

A) violet
 B) red
 C) blue
 D) yellow
 E) green

8) The formal charge on nitrogen in NO_3^- is _____. 8) _____



- A) -1
 B) -2
 C) +2
 D) 0
 E) +1

9) All of the _____ have a valence shell electron configuration ns^2 . 9) _____

- A) halogens
 B) alkaline earth metals
 C) alkali metals
 D) chalcogens
 E) noble gases

10) The halogens, alkali metals, and alkaline earth metals have _____ valence electrons, respectively. 10) _____

- A) 2, 7, and 4
 B) 8, 2, and 3
 C) 1, 5, and 7
 D) 7, 1, and 2
 E) 7, 4, and 6

11) The _____ have the largest (most negative) electron affinities. 11) _____

- A) alkaline earth metals
 B) chalcogens
 C) transition metals
 D) alkali metals
 E) halogens

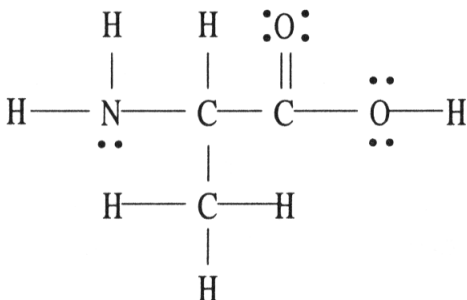
- 12) The energy of a photon of light is _____ proportional to its frequency and _____ proportional to its wavelength. 12) _____
A) directly, inversely
B) directly, directly
C) inversely, inversely
D) inversely, directly
E) indirectly, not
- 13) The molecular geometry of the CHCl_3 molecule is _____. 13) _____
A) tetrahedral
B) bent
C) T-shaped
D) trigonal planar
E) trigonal pyramidal
- 14) _____ energy is responsible for the stability of ionic crystals. 14) _____
A) Blackbody
B) Hydrogen
C) Hybrid
D) Lattice
E) Metallic
- 15) There are _____ paired and _____ unpaired electrons in the Lewis symbol for a phosphorus atom. 15) _____
A) 4, 3
B) 4, 2
C) 0, 3
D) 2, 4
E) 2, 3
- 16) According to valence bond theory, which orbitals on bromine atoms overlap in the formation of the bond in Br_2 ? 16) _____
A) 3s
B) 3p
C) 4s
D) 4p
E) 3d
- 17) The first ionization energies of the elements _____ as you go from left to right across a period of the periodic table, and _____ as you go from the bottom to the top of a group in the table. 17) _____
A) increase, increase
B) increase, decrease
C) decrease, increase
D) decrease, decrease
E) are completely unpredictable

18) Which of the following would have to gain two electrons in order to achieve a noble gas electron configuration _____? 18) _____

O Sr Na Se Br

- A) O, Se
- B) Sr, O, Se
- C) Br
- D) Na
- E) Sr

19) There is/are _____ σ bond(s) in the molecule below. 19) _____



- A) 1
- B) 2
- C) 12
- D) 13
- E) 18

20) Of the following transitions in the Bohr hydrogen atom, the _____ transition results in the emission of the highest-energy photon. 20) _____

- A) $n = 3 \rightarrow n = 6$
- B) $n = 1 \rightarrow n = 4$
- C) $n = 1 \rightarrow n = 6$
- D) $n = 6 \rightarrow n = 1$
- E) $n = 6 \rightarrow n = 3$

21) In order to produce sp^2 hybrid orbitals, _____ s atomic orbital(s) and _____ p atomic orbital(s) must be mixed. 21) _____

- A) one, two
- B) one, three
- C) two, two
- D) two, three
- E) one, one

22) The ground state electron configuration for Ga is _____. 22) _____

- A) $[\text{Ar}]4s^23d^{10}$
- B) $[\text{Ar}]4s^13d^{10}$
- C) $[\text{Kr}]3s^23d^{10}$
- D) $[\text{Ar}]3s^23d^{10}$
- E) $[\text{Kr}]3d^{10}4s^24p^1$

- 23) The hybridization of orbitals on the central atom in a molecule is sp . The electron-domain geometry around this central atom is _____.
- 23) _____
- A) trigonal bipyramidal
 - B) linear
 - C) tetrahedral
 - D) octahedral
 - E) trigonal planar

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 24) (3 pts) Briefly describe the characteristics of an ionic bond
- 24) _____

- 25) (5 pts) How many electron domains are there in CO_2 ? what will the shape be? Is it polar or nonpolar?
- 25) _____

- 26) (3 pts) Why is water bent? Why is the bond angle for water 104.5° when the expected tetrahedral angle is 109° ?
- 26) _____

- 27) (3 pts) Explain WHY atomic radius decreases from left to right on the periodic table.
- 27) _____

- 28) (1 pts) (True / False) For two atoms bonded together, as their electronegativity difference increases, bond polarity will decrease. 28) _____
- 29) (6 pts) Draw a picture of the resulting orbitals when an 's' orbital hybridizes with three 'p' orbitals. How many hybrid orbitals are produced? What is the name of this hybridization? 29) _____
- 30) (3 pts) The energy of a infrared photon is 1.87×10^{-19} J. What is the wavelength of this photon? 30) _____
- 31) (3 pts) Describe two of the three observations of the photoelectric effect. When Einstein explained how this phenomenon works what new idea was at the heart of his theory? 31) _____

32) (1 pts) (Circle the right choice) Alkali metals are very reactive because they have very LOW / HIGH ionization energy. 32) _____

33) (9 pts) Draw the Lewis structure for H_2CO (both H atoms are bonded to C), HBr , and SO_3^{2-} (draw all resonance structures, if any). For each compound indicate the total number of electrons and the formal charge of each atom. 33) _____

34) (5 pts) How many electron domains are there in PF_3 ? what is the name of its shape? Is it polar or nonpolar? 34) _____

35) (2 pts) Describe the location of the electrons in a sigma bond with respect to the nuclei. 35) _____

36) (2 pts) What is the condensed electronic configuration calcium (Ca) and indicate how many core electrons it has and how many valence electrons it has. 36) _____

37) (3 pts) The Lewis structure of ozone, O_3 , can be drawn with one double bond and one single bond. When O_3 is experimentally measured the bond length seems to be half way between the length of a single bond and a double bond. Briefly explain this observation. 37) _____

Answer Key

Testname: EXAM 3 A

- 1) A
 - 2) C
 - 3) A
 - 4) B
 - 5) B
 - 6) B
 - 7) A
 - 8) E
 - 9) B
 - 10) D
 - 11) E
 - 12) A
 - 13) A
 - 14) D
 - 15) E
 - 16) D
 - 17) A
 - 18) A
 - 19) C
 - 20) D
 - 21) A
 - 22) E
 - 23) B
 - 24) An ionic bond is an electrostatic attraction between positive and negative ions. Electrons are not shared as in covalent bonds.
 - 25) 2 domains, linear, nonpolar
 - 26) There are 4 electron domains with two pairs of nonbonding electrons, this makes water bent. The two nonbonding pairs compress the normal tetrahedral angle from 109 to 104.5 degrees.
 - 27) The effective nuclear charge increases from left to right which pulls valence electrons in towards the nucleus, decreasing the size of the atom.
 - 28) False
 - 29) 4 orbitals are produced. The hybridization is an 'sp³' hybrid.
 - 30) 1064 nm
 - 31) 1) A threshold frequency (or energy) of light was required to emit an electron.
2) The higher the frequency the more energy the ejected electron had.
3) The more photons of light hit the metal, the more electrons were ejected
- The theory relied on the idea that light came in quantized particles of energy called photons, whose $E = h\nu$
- 32) Low
 - 33)
 - 34) 4 domains, trigonal pyramidal, polar
 - 35) The bonding electrons are directly in between the nuclei.
 - 36) Ca : [Ar] 4s² 18 core electrons and 2 valence
 - 37) The double bond can alternate from one pair of oxygens to the other. The two structures are in resonance. The electrons are delocalized when in resonance so neither bond is completely single or double, but instead half way between.