112-1 Semester General Chemistry Final Exam (A) - 2024/01/03

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

1) Screening of the nuclear charge by core electrons in atoms is _____.
   A) less efficient than that by valence electrons
   B) essentially identical to that by valence electrons
   C) more efficient than that by valence electrons
   D) responsible for a general decrease in atomic radius going down a group
   E) both essentially identical to that by valence electrons and responsible for a general decrease in atomic radius going down a group

Answer: C

Consider the following electron configurations to answer the questions that follow:

(i) $1s^2\ 2s^2\ 2p^6\ 3s^1$
(ii) $1s^2\ 2s^2\ 2p^6\ 3s^2$
(iii) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
(iv) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$
(v) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

2) The electron configuration belonging to the atom with the highest second ionization energy is _____.
   A) (i) B) (ii) C) (iii) D) (iv) E) (v)

Answer: A

3) The electron configuration of the atom with the most negative electron affinity is _____.
   A) (i) B) (ii) C) (iii) D) (iv) E) (v)

Answer: E

4) Of the following elements, _____ has the most negative electron affinity.
   A) Cl B) Se C) S D) I E) Br

Answer: A

5) The list that correctly indicates the order of metallic character is _____.
   A) O > Se > S
   B) F > Cl > Br
   C) C > Ge > Si
   D) Sr > Ca > Mg
   E) Li > Na > K

Answer: D

6) The acidity of carbonated water is due to the _____.
   A) nonmetal oxides
   B) presence of sulfur
   C) addition of acid
   D) reaction of CO_2 and H_2O
   E) none of the above

Answer: D

7) Transition metals within a period differ mainly in the number of _____ electrons.
A) p
B) d
C) f
D) s
E) all of the above

Answer: B

8) Consider the general valence electron configuration of ns^2np^5 and the following statements:
(i) Elements with this electron configuration are expected to form -1 anions.
(ii) Elements with this electron configuration are expected to have large positive electron affinities.
(iii) Elements with this electron configuration are nonmetals.
(iv) Elements with this electron configuration form acidic oxides.

Which statements are true?
A) (i) and (ii)
B) (i), (ii), and (iii)
C) (i), (iii,) and (iv)
D) (ii) and (iii)
E) All statements are true.

Answer: C

9) The reaction of alkali metals with oxygen produce _____.
A) superoxides
B) peroxides
C) oxides
D) all of the above
E) none of the above

Answer: D

10) Hydrogen is unique among the elements because _____.
1. It has only one valence electron.
2. It is the only element that can emit an atomic spectrum.
3. Its electron is not at all shielded from its nucleus.
4. It is the lightest element.
5. It is the only element to exist at room temperature as a diatomic gas.

A) 1, 3, 4 B) 3, 4 C) 2, 3, 4 D) 1, 2, 3, 4, 5 E) 1, 2, 3, 4

Answer: B

11) Which of the following has eight valence electrons?
A) Na^+
B) Cl^-
C) Kr
D) Ti^{4+}
E) all of the above

Answer: E

12) In ionic bond formation, the lattice energy of ions _____ as the magnitude of the ion charges _____ and the radii _____.

A) increases, decrease, decrease
B) increases, increase, decrease
C) increases, decrease, increase
D) increases, increase, increase
E) decreases, increase, increase

Answer: B

13) Using the Born-Haber cycle, the $\Delta H°_f$ of KBr is equal to _____.

A) $\Delta H°_f$ [K (g)] + $\Delta H°_f$ [Br (g)] - I_1 - E(Br) + $\Delta H_{lattice}$
B) $\Delta H°_f$ [K (g)] - $\Delta H°_f$ [Br (g)] - I_1(K) - E(Br) - $\Delta H_{lattice}$
C) $\Delta H°_f$ [K (g)] + $\Delta H°_f$ [Br (g)] + I_1(K) + E(Br) - $\Delta H_{lattice}$
D) $\Delta H°_f$ [K (g)] - $\Delta H°_f$ [Br (g)] + I_1(K) - E(Br) + $\Delta H_{lattice}$
E) $\Delta H°_f$ [K (g)] + $\Delta H°_f$ [Br (g)] + I_1(K) + E(Br) + $\Delta H_{lattice}$

Answer: E

14) The bond length in an HI molecule is 1.61 Å and the measured dipole moment is 0.44 D. What is the magnitude (in units of *e*) of the negative charge on I in HI?

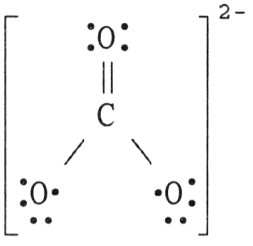
(1 debye = 3.34×10^{-30} coulomb-meters; e = 1.6×10^{-19} coulombs)

A) 0.057 B) 0.22 C) 9.1 D) 1 E) 1.6×10^{-19}

Answer: A

15) The Lewis structure of the CO_3^{2-} ion is _____.

A)



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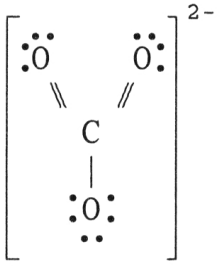

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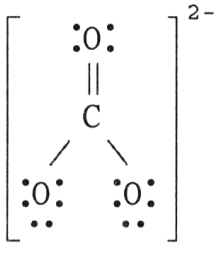

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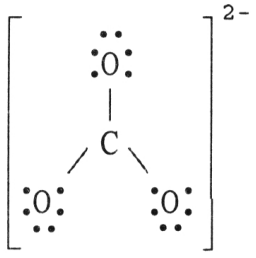
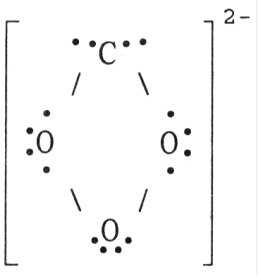


E)



Answer: C

For the questions that follow, consider the BEST Lewis structures of the following oxyanions:

(i) NO_2^- (ii) NO_3^- (iii) SO_3^{2-} (iv) SO_4^{2-} (v) BrO_3^-

16) There can be four equivalent best resonance structures of _____.
A) (i) B) (ii) C) (iii) D) (iv) E) (v)
Answer: D

17) The Lewis structure of HCN (H bonded to C) shows that _____ has _____ nonbonding electron pair(s).
A) N, 1 B) N, 2 C) C, 1 D) C, 2 E) H, 1
Answer: A

18) The electron configuration $[Kr]4d^{10}$ represents _____.
A) Cd^+ B) Ag^{2+} C) Cd D) Ag^+ E) Sr^{2+}
Answer: D

19) There are _____ valence electrons in the Lewis structure of CH_3OCH_3.
A) 24 B) 20 C) 22 D) 16 E) 18
Answer: B

20) The oxidation number of phosphorus in PF_5 is _____.
A) +3 B) 0 C) -5 D) +1 E) +5
Answer: E

21) The electron-domain geometry of _____ is tetrahedral.
A) PH_3
B) CCl_2Br_2
C) CBr_4
D) XeF_4
E) all of the above except XeF_4

Answer: E

22) PCl_5 has _____ electron domains and a _____ molecular arrangement.
A) 6, tetrahedral
B) 6, seesaw
C) 5, trigonal bipyramidal
D) 6, trigonal bipyramidal
E) 5, square pyramidal

Answer: C

Consider the following species when answering the following questions:

(i) PCl_3 (ii) CCl_4 (iii) $TeCl_4$ (iv) XeF_4 (v) SF_6

23) For which of the molecules is the molecular geometry (shape) the same as the VSEPR electron domain arrangement (electron domain geometry)?
A) (i) and (ii) B) (i) and (iii) C) (ii) and (v) D) (iv) and (v) E) (v) only

Answer: C

24) Three monosulfur fluorides are observed: SF_2, SF_4, and SF_6. Of these, _____ is/are polar.
A) SF_6 only
B) SF_2, SF_4, and SF_6
C) SF_2 and SF_4 only
D) SF_4 only
E) SF_2 only

Answer: C

Consider the following species when answering the following questions:

(i) PCl_3 (ii) CCl_4 (iii) $TeCl_4$ (iv) XeF_4 (v) SF_6

25) Which of the molecules has a see-saw shape?
A) (i) B) (ii) C) (iii) D) (iv) E) (v)

Answer: C

26) There are _____ σ bonds and _____ π bonds in $H_3C\text{-}CH_2\text{-}CH{=}CH\text{-}CH_2\text{-}C{\equiv}CH$.
A) 16, 3 B) 12, 2 C) 13, 2 D) 10, 3 E) 14, 2

Answer: A

27) The hybridization of the terminal carbons in the $H_2C{=}C{=}CH_2$ molecule is _____.
A) sp^3 B) sp^3d^2 C) sp^2 D) sp E) sp^3d

Answer: C

28) The bond order of any molecule containing equal numbers of bonding and antibonding electrons is _____.
A) 0 B) 1 C) 2 D) 3 E) 1/2

Answer: A

29) Based on molecular orbital theory, the bond orders of the H—H bonds in H_2, H_2^+, and H_2^- are _____, respectively
A) 1, 1/2, and 1/2
B) 1, 2, and 0
C) 1, 0, and 0
D) 1, 1/2, and 0
E) 1, 0, and 1/2

Answer: A

30) Molecular Orbital theory correctly predicts paramagnetism of oxygen gas, O_2. This is because _____.
A) the bond order in O_2 can be shown to be equal to 2.
B) there are two unpaired electrons in the MO electron configuration of O_2
C) the energy of the π_{2p} MOs is higher than that of the σ_{2p} MO
D) the O—O bond distance is relatively short
E) there are more electrons in the bonding orbitals than in the antibonding orbitals.

Answer: B

31) Of the following, only _____ appears to gain mass in a magnetic field.
A) N_2 B) F_2 C) Li_2 D) O_2 E) C_2

Answer: D

32) The order of MO energies in B_2, C_2, and N_2 ($\sigma_{2p} > \pi_{2p}$), is different from the order in O_2, F_2, and Ne_2 ($\sigma_{2p} < \pi_{2p}$). This is due to _____.
A) greater 2s-2p interaction in O_2, F_2, and Ne_2
B) greater 2s-2p interaction in B_2, C_2, and N_2
C) the more metallic character of boron, carbon and nitrogen as compared to oxygen, fluorine, and neon
D) less effective overlap of p orbitals in O_2, F_2, and Ne_2
E) less effective overlap of p orbitals in B_2, C_2, and N_2

Answer: B

33) The pressure exerted by a column of liquid is equal to the product of the height of the column times the gravitational constant times the density of the liquid, P = *ghd*. How high a column of water (d = 1.0 g/mL) would be supported by a pressure that supports a 713 mm column of mercury (d = 13.6 g/mL)?
A) 52 mm
B) 9.7×10^3 mm
C) 14 mm
D) 713 mm
E) 1.2×10^4 mm

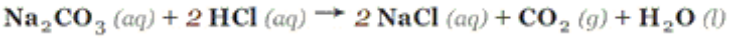
Answer: B

34) The pressure exerted by a column of liquid is equal to the product of the height of the column times the gravitational constant times the density of the liquid, P = *ghd*. How high a column of methanol (d = 0.79 g/mL) would be supported by a pressure that supports a 713 mm column of mercury (d = 13.6 g/mL)?

A) 41 mm
B) 1.2×10^4 mm
C) 17 mm
D) 9.7×10^3 mm
E) 713 mm

Answer: B

35) Sodium bicarbonate is reacted with concentrated hydrochloric acid at 25.0 °C and 1.50 atm. The reaction of 7.75 kg of sodium bicarbonate with excess hydrochloric acid under these conditions will produce _____ L of CO_2.



A) 1.82×10^3 B) 1.50×10^3 C) 1.82×10^4 D) 2.85×10^4 E) 8.70×10^2

Answer: B 送分

36) The density of NO_2 in a 4.50 L tank at 760.0 torr and 25.0 °C is _____ g/L.

A) 9.30 B) 3.27 C) 1.88 D) 1.68 E) 1.64

Answer: C

37) The density of air at STP is 1.285 g/L. Which of the following cannot be used to fill a balloon that will float in air at STP?

A) CH_4 B) Ne C) HF D) NO E) NH_3

Answer: D

38) According to kinetic-molecular theory, in which of the following gases will the root-mean-square speed of the molecules be the highest at 200 °C?

A) SF_6
B) HCl
C) Cl_2
D) H_2O
E) None. The molecules of all gases have the same root-mean-square speed at any given temperature.

Answer: D

39) Arrange the following gases in order of increasing average molecular speed at 25 °C.

He, O_2, CO_2, N_2

A) $CO_2 < N_2 < O_2 < He$
B) $CO_2 < He < N_2 < O_2$
C) $He < O_2 < N_2 < CO_2$
D) $He < N_2 < O_2 < CO_2$
E) $CO_2 < O_2 < N_2 < He$

Answer: E

40) A mixture of carbon dioxide (CO_2) and an unknown gas was allowed to effuse from a container. The carbon dioxide took 1.25 times as long to escape as the unknown gas. Which one could be the unknown gas?

A) Cl_2 B) SO_2 C) H_2 D) CO E) HCl

Answer: D

41) In which of the following molecules is hydrogen bonding likely to be the most significant component of the total intermolecular forces?

A) $C_5H_{11}OH$ B) CO_2 C) CH_3OH D) $C_6H_{13}NH_2$ E) CH_4

Answer: C

42) What type(s) of intermolecular forces exist between Br_2 and CCl_4?

A) dispersion forces, ion-dipole, and dipole-dipole
B) dispersion forces
C) dispersion forces and ion-dipole
D) dispersion forces and dipole-dipole
E) None. Since both are gases at room temperature, they do not interact with each other.

Answer: B

43) Viscosity is _____.

A) the resistance to flow
B) inversely proportional to molar mass
C) the "skin" on a liquid surface caused by intermolecular attraction
D) unaffected by temperature
E) the same as density

Answer: A

44) The slope of a plot of the natural log of the vapor pressure of a substance versus 1/T is _____.

A) ΔH_{vap} B) $\frac{-1}{\Delta H_{vap}}$ C) $\frac{1}{\Delta H_{vap}}$ D) $-\frac{\Delta H_{vap}}{R}$ E) $-\Delta H_{vap}$

Answer: D

45) In the _____ liquid crystalline phase, the component molecules exhibit only one dimensional ordering.

A) smectic A B) smectic B C) smectic C D) nematic E) cholesteric

Answer: D

46) Based on molecular mass and dipole moment of the five compounds in the table below, which should have the highest boiling point?

Substance	Molecular Mass (amu)	Dipole Moment (D)
Propane, $CH_3CH_2CH_3$	44	0.1
Dimethylether, CH_3OCH_3	46	1.3
Methylchloride, CH_3Cl	50	1.9
Acetaldehyde, CH_3CHO	44	2.7
Acetonitrile, CH_3CN	41	3.9

A) $CH_3CH_2CH_3$
B) CH_3OCH_3
C) CH_3Cl
D) CH_3CHO
E) CH_3CN

Answer: E

47) Which one of the following exhibits dipole-dipole attraction between molecules?
A) BH_3 B) SiO_2 C) CBr_4 D) Cl_2 E) AsH_3

Answer: E

48) Of the following substances, _____ has the highest boiling point.
A) SiH_4 B) H_2O C) Ar D) BF_3 E) Cl_2

Answer: B

49) Of the following substances, _____ has the highest boiling point.
A) Cl_2 B) H_2 C) N_2 D) Br_2 E) O_2

Answer: D

50) The enthalpy change for converting 1.00 mol of ice at -25.0 °C to water at 50.0 °C is _____ kJ. The specific heats of ice, water, and steam are 2.09 J/g-K, 4.18 J/g-K, and 1.84 J/g-K, respectively. For H_2O, ΔH_{fus} = 6.01 kJ/mol, and ΔH_{vap} = 40.67 kJ/mol.
A) 4709 B) 8.83 C) 12.28 D) 10.71 E) 6.27

Answer: D