

1. Record your **name and ID number** on the scantron form.
2. Record the **test ID** letter in the top right box of the scantron form.
3. Record all of your answers on the scantron form.
4. Show your ID and scantron form to a TA.
5. Put your scantron form in the correct box by color.

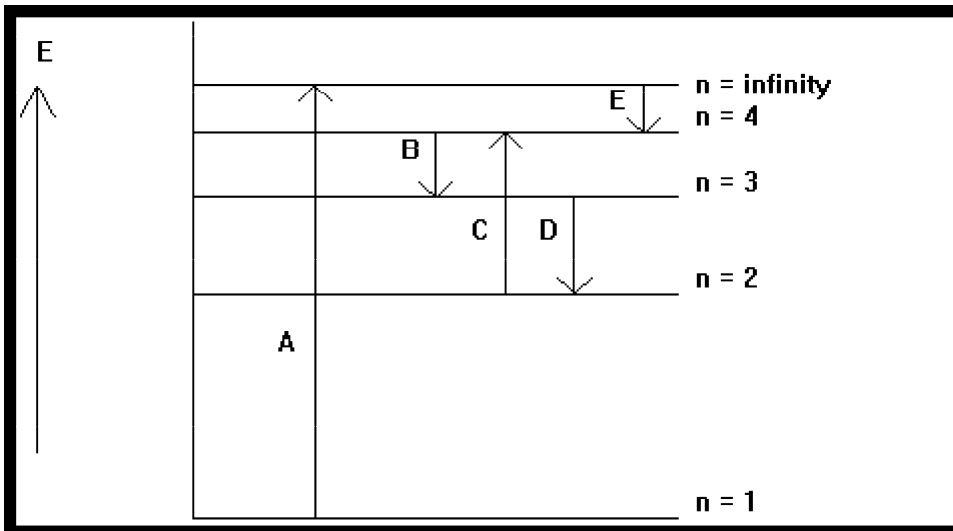
You have 120 minutes. GOOD LUCK !

Final

- _____ 1. Which species in the reaction below undergoes reduction?
- $$2 \text{Na(s)} + 2 \text{H}_2\text{O(aq)} \rightarrow 2 \text{Na}^+\text{(aq)} + 2 \text{OH}^-\text{(aq)} + \text{H}_2\text{(g)}$$
- a. Na
 - b. H_2O
 - c. Na^+
 - d. OH^-
 - e. H_2
- _____ 2. Ammonia gas is synthesized according to the balanced equation below.
- $$\text{N}_2\text{(g)} + 3 \text{H}_2\text{(g)} \rightarrow 2 \text{NH}_3\text{(g)}$$
- If 1.56 L N_2 react with 4.32 L H_2 , what is the theoretical yield (in liters) of NH_3 ? Assume that the volumes of reactants and products are measured at the same temperature and pressure.
- a. 2.88 L
 - b. 3.12 L
 - c. 4.32 L
 - d. 4.68 L
 - e. 5.88 L
- _____ 3. If an aqueous solution of _____ is added to an aqueous solution of BaCl_2 and $\text{Fe}(\text{NO}_3)_3$, the barium ion will precipitate, but the iron ion will remain in solution.
- a. NaOH
 - b. Na_2SO_4
 - c. K_3PO_4
 - d. KCl
 - e. $\text{Pb}(\text{NO}_3)_2$
- _____ 4. Which of the following molecules is/are polar **molecule(s)**?
- BF_3 ClF_3 NH_3 C_2H_4
- a. BF_3 only
 - b. NH_3 only
 - c. C_2H_4 only
 - d. C_2H_4 and BF_3
 - e. NH_3 and ClF_3
- _____ 5. Which of these isoelectronic species has the **smallest radius**?
- (a) K^+ (b) Ca^{2+} (c) Cl^- (d) Ar
- a. K^+
 - b. Ca^{2+}
 - c. Cl^-
 - d. Ar

- _____ 6. Which may be a correct **Lewis structure** for carbon disulfide, CS₂?
- a. $\ddot{\text{S}}=\text{C}=\ddot{\text{S}}:$ c. $\ddot{\text{S}}=\text{C}-\ddot{\text{S}}:$
 b. $\ddot{\text{S}}=\text{C}=\ddot{\text{S}}$ d. $\ddot{\text{S}}=\text{C}=\ddot{\text{S}}:$
- _____ 7. Estimate ΔH in kJ for the following gas phase reaction:
 $\text{CFCl}_3 + \text{HF} \rightleftharpoons \text{CF}_2\text{Cl}_2 + \text{HCl}$
 given the following bond energies in kJ/mol:
 C-F 485, H-F 565, C-Cl 331, H-Cl 431
- a. +20 d. -180
 b. -20 e. +288
 c. +180
- _____ 8. Write a balanced net ionic equation for the reaction of aqueous solutions of baking soda (NaHCO₃) and acetic acid.
- a. $\text{HCO}_3^-(\text{aq}) + \text{CH}_3\text{CO}_2\text{H}(\text{aq}) \rightarrow \text{CH}_3\text{CO}_2^-(\text{aq}) + \text{H}_2\text{O}(\ell) + \text{CO}_2(\text{g})$
 b. $2 \text{NaHCO}_3(\text{aq}) + \text{CH}_3\text{CO}_2\text{H}(\text{aq}) \rightarrow 2 \text{Na}_2\text{CO}_3(\text{aq}) + \text{CH}_4(\text{aq}) + 2\text{H}_2\text{O}(\ell) + \text{CO}_2(\text{g})$
 c. $\text{NaHCO}_3(\text{aq}) + \text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{CO}_3(\text{s}) + \text{Na}^+(\text{aq})$
 d. $\text{HCO}_3^-(\text{aq}) + \text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{O}(\ell) + \text{CO}_2(\text{g})$
 e. $\text{HCO}_3^-(\text{aq}) + \text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{CO}_3(\text{aq})$
- _____ 9. Sodium azide decomposes rapidly to produce nitrogen gas, according to the **balanced** chemical equation below:
- $$2 \text{NaN}_3(\text{s}) \rightarrow 2 \text{Na}(\text{s}) + 3 \text{N}_2(\text{g})$$
- What mass of sodium azide will inflate a 56.6 L airbag for a car to a pressure of 811 mm Hg at 25 °C? ($R = 0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$; 760 mmHg = 1 atm)
- a. 17.6 g
 b. 39.5 g
 c. 107 g
 d. 161 g
 e. 241 g
- _____ 10. Which of the following sets of quantum numbers refers to an atomic *d*-orbital?
- a. $n = 4, l = 0, m_l = 0$ c. $n = 3, l = 1, m_l = 1$
 b. $n = 4, l = 3, m_l = 1$ d. $n = 3, l = 2, m_l = 1$
- _____ 11. A certain radiation has a wavelength (λ) of 3.40×10^{-7} meters. Calculate the energy in kJ of **one mole** of photons of this radiation.
- a. 5.85×10^{-19} d. 1.20×10^{-4}
 b. 1.03×10^{39} e. 352
 c. 252

12. Photons **absorbed** by the H-atom which have the **shortest** wavelength are represented by which lettered transition?



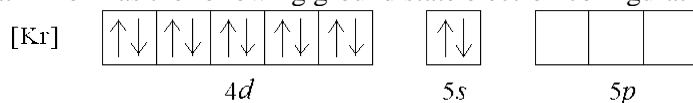
- a. A
b. B
c. C
d. D
e. E
13. Chloroform, CHCl_3 , is a common organic solvent. Which of the following statements concerning chloroform is/are CORRECT?
- CHCl_3 has three isomers. For one isomer of CHCl_3 , the chlorine atoms are all adjacent to each other and the molecule is polar.
 - CHCl_3 has three isomers. For one isomer of CHCl_3 , the chlorine atoms are in a trigonal arrangement, the molecule is nonpolar.
 - The hybridization of the central carbon atom is sp^3 .
- a. 1 only
b. 2 only
c. 3 only
d. 1 and 2
e. 1, 2, and 3
14. A molecule is found to contain 64.27% by mass C, 7.191% by mass H, and 28.54% by mass O. What is the empirical formula for this molecule?
- a. $\text{C}_2\text{H}_6\text{O}$
b. $\text{C}_3\text{H}_4\text{O}$
c. $\text{C}_3\text{H}_8\text{O}_2$
d. $\text{C}_4\text{H}_6\text{O}_2$
e. $\text{C}_4\text{H}_8\text{O}_3$

15. What are the spectator ions in the reaction between aqueous hydrobromic acid and aqueous sodium hydroxide?
- Na^+ only
 - H^+ and OH^-
 - Na^+ and Br^-
 - Br^- only
 - H^+ , Br^- , Na^+ , and OH^-

16. What is the mass percent of iodine in calcium iodide?
- 13.64%
 - 24.00%
 - 66.67%
 - 76.00%
 - 86.36%

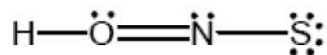
17. Which of the following atomic orbitals has exactly one spherical node?
- 3p
 - 3s
 - 3d
 - 4s

18. What $2+$ ion has the following ground state electron configuration?



- Cd^{2+}
 - Sr^{2+}
 - Zn^{2+}
 - Sn^{2+}
 - None
19. Which of the following relationships is/are CORRECT for gases?
- The moles of a gas is inversely proportional to its volume (at constant pressure).
 - The volume of a gas is inversely proportional to its temperature in kelvin (at constant pressure).
 - The pressure of a gas is directly proportional to its temperature in kelvin (at constant volume).
- 1 only
 - 2 only
 - 3 only
 - 1 and 2
 - 2 and 3

20. What is the **formal charge** on each non-hydrogen atom in the Lewis structure for the neutral molecule HONS, shown below?



- $\text{O} = +5$; $\text{N} = +5$; $\text{S} = +7$
- $\text{O} = -1$; $\text{N} = -1$; $\text{S} = +2$
- $\text{O} = +1$; $\text{N} = 0$; $\text{S} = -1$
- $\text{O} = 0$; $\text{N} = +1$; $\text{S} = -1$

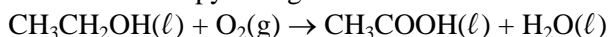
_____ 21. What is the net ionic equation for the reaction of aqueous calcium acetate and aqueous sodium sulfide ?

- $\text{Ca}^{2+}(\text{aq}) + 2 \text{CH}_3\text{CO}_2^-(\text{aq}) \rightarrow \text{Ca}(\text{CH}_3\text{CO}_2)_2(\text{s})$
- $\text{Na}^+(\text{aq}) + \text{CH}_3\text{CO}_2^-(\text{aq}) \rightarrow \text{NaCH}_3\text{CO}_2(\text{aq})$
- $\text{Na}^+(\text{aq}) + \text{CH}_3\text{CO}_2^-(\text{aq}) \rightarrow \text{NaCH}_3\text{CO}_2(\text{s})$
- $\text{Ca}^{2+}(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{CaS}(\text{s})$
- $\text{Ca}^{2+}(\text{aq}) + 2 \text{Na}^+(\text{aq}) \rightarrow \text{CaNa}_2(\text{s})$

_____ 22. How many protons, neutrons, and electrons are in a yttrium-89 atom?

- 39 protons, 50 neutrons, 39 electrons
- 39 protons, 89 neutrons, 39 electrons
- 39 protons, 50 neutrons, 50 electrons
- 50 protons, 39 neutrons, 50 electrons
- 39 protons, 11 neutrons, 39 electrons

_____ 23. Determine the enthalpy change for the oxidation of ethanol to acetic acid,



given the thermochemical equations below.



- 985.2 kJ
- 492.6 kJ
- 183.6 kJ
- +183.6 kJ
- +492.6 kJ

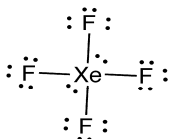
_____ 24. Rank S, Se, & Cl in order of increasing (smaller<larger) **first ionization energy**.

- | | |
|---------------------------------------|---------------------------------------|
| a. $\text{S} < \text{Se} < \text{Cl}$ | c. $\text{Cl} < \text{S} < \text{Se}$ |
| b. $\text{Se} < \text{Cl} < \text{S}$ | d. $\text{Se} < \text{S} < \text{Cl}$ |

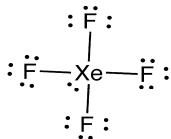
_____ 25. Elements in periodic groups IA and VIIA react with each other to form compounds that are usually

- | | |
|-------------|----------------------|
| a. covalent | c. metallic |
| b. ionic | d. nsoluble in water |

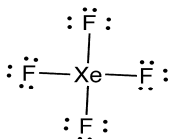
_____ 26. Which of the structures below is a valid Lewis dot structure for XeF_4 ?



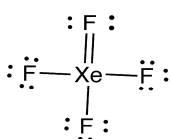
A



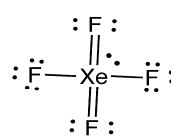
B



C



D

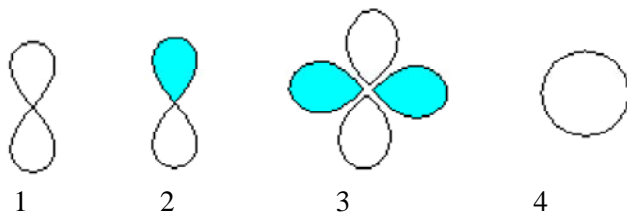


E

- | | |
|------|------|
| a. A | d. D |
| b. B | e. E |
| c. C | |

- _____ 27. Which of the following chemical equations does not correspond to a standard molar enthalpy of formation?
- $\text{Ca(s)} + \text{C(s)} + 3/2 \text{O}_2\text{(g)} \rightarrow \text{CaCO}_3\text{(s)}$
 - $\text{C(s)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$
 - $\text{NO(g)} + 1/2 \text{O}_2\text{(g)} \rightarrow \text{NO}_2\text{(g)}$
 - $\text{N}_2\text{(g)} + 2 \text{O}_2\text{(g)} \rightarrow \text{N}_2\text{O}_4\text{(g)}$
 - $\text{H}_2\text{(g)} + 1/2 \text{O}_2\text{(g)} \rightarrow \text{H}_2\text{O(l)}$
- _____ 28. One product of the combustion of ethane, C_2H_6 , is carbon dioxide. What change in hybridization of the carbon occurs in this reaction?
- sp^3 to sp^2
 - sp^3 to sp
 - sp^2 to sp^3
 - sp^2 to sp^3d^2
 - sp^2 to sp
- _____ 29. You have 0.575 mole of each of the following elements: C, Cl, Ca, Cr, and Cd. Which sample has the greatest mass?
- C
 - Cl
 - Ca
 - Cr
 - Cd
- _____ 30. An element consists of two isotopes. The abundance of one isotope is 60.1% and its atomic mass is 68.9256 u. The atomic mass of the second isotope is 70.9247 u. What is the average atomic mass of the element?
- 69.7 u
 - 69.9 u
 - 70.1 u
 - 84.1 u
 - 139.9 u
- _____ 31. Which of the following statements about molecular orbital theory (MO theory) is/are true?
- electron occupation of a **bonding** MO **favors** chemical bonding
 - electron occupation of an **anti-bonding** MO **favors** chemical bonding
 - electron occupation of a **bonding** MO **disfavors** chemical bonding
 - electron occupation of an **anti-bonding** MO **disfavors** chemical bonding
- i only
 - i and ii
 - iv only
 - i and iv
- _____ 32. In formaldehyde, $\text{H}_2\text{C=O}$, the type of hybrid orbitals of carbon consistent with the molecular geometry is:
- sp
 - sp^2
 - sp^3
 - sp^3d
 - sp^3d^2

_____ 33. Which of the following is the boundary surface for an atomic *d*-orbital?



- | | |
|------------|------------|
| a. 2 only | d. 4 only |
| b. 1 and 2 | e. 2 and 3 |
| c. 3 only | |

_____ 34. Which of the following molecules would have the greatest polarity?

- | | |
|--------|-------------------|
| a. HF | d. HI |
| b. HCl | e. F ₂ |
| c. HBr | |

_____ 35. Which combination of atoms is most likely to produce a compound with ionic bonds?

- a. B and Cl
b. S and H
c. C and N
d. Si and I
e. Al and Br

_____ 36. Write a balanced chemical equation for the reaction of copper with oxygen to yield copper(I) oxide.

- a. $4 \text{ Cu(s)} + \text{O}_2\text{(g)} \rightarrow 2 \text{ Cu}_2\text{O(s)}$
b. $\text{Cu} + \text{O}_2\text{(g)} \rightarrow \text{CuO}_2\text{(s)}$
c. $2 \text{ Cu(s)} + \text{O}_2\text{(g)} \rightarrow 2 \text{ CuO(s)}$
d. $\text{Cu(s)} + \text{O(g)} \rightarrow \text{CuO(s)}$
e. $2 \text{ Cu(s)} + \text{O(g)} \rightarrow 2 \text{ Cu}_2\text{O(s)}$

_____ 37. Identify the ions present in KClO₄.

- a. K⁺, Cl⁻, and O²⁻
b. KCl⁺, and O₄⁻
c. K⁺ and ClO₄⁻
d. KCl²⁺ and O₄²⁻
e. K²⁺ and ClO₄²⁻

_____ 38. What is the correct formula for an ionic compound that contains barium ions and phosphate ions?

- a. BaPO₄
b. Ba₃P₂
c. Ba₂(PO₄)₃
d. Ba(PO₄)₂
e. Ba₃(PO₄)₂

_____ 39. Which molecule has an **expanded octet**?

- | | |
|---------------------|-------------------------------------|
| a. OCl ₂ | c. SiH ₄ |
| b. IBr | d. (ClF ₄) ⁻ |

- _____ 40. If 245 J is required to increase the temperature of 14.4 g of chromium by 38.0 K, what is the specific heat capacity of chromium?
- a. 0.448 J/g·K
 - b. 2.23 J/g·K
 - c. 4.18 J/g·K
 - d. 4.68 J/g·K
 - e. 92.8 J/g·K
- _____ 41. The molecular geometry of BrF_3 is:
- a. trigonal plane
 - b. tetrahedral
 - c. seesaw
 - d. trigonal bipyramidal
 - e. T-shaped

Final
Answer Section

MULTIPLE CHOICE

- | | | |
|------------|--------|-----------------------------------------------------------|
| 1. ANS: B | PTS: 4 | TOP: 3.9 Oxidation-Reduction Reactions |
| 2. ANS: A | PTS: 4 | TOP: 11.4 Gas Laws and Chemical Reactions |
| 3. ANS: B | PTS: 4 | TOP: 3.6 Precipitation Reactions |
| 4. ANS: E | PTS: 4 | |
| 5. ANS: B | PTS: 4 | |
| 6. ANS: B | PTS: 4 | |
| 7. ANS: B | PTS: 4 | |
| 8. ANS: A | PTS: 4 | TOP: 3.8 Gas-Forming Reactions |
| 9. ANS: C | PTS: 4 | TOP: 11.4 Gas Laws and Chemical Reactions |
| 10. ANS: D | PTS: 4 | |
| 11. ANS: E | PTS: 4 | |
| 12. ANS: A | PTS: 4 | |
| 13. ANS: C | PTS: 4 | TOP: 9.2 Valence Bond Theory |
| 14. ANS: B | PTS: 4 | TOP: 2.10 Describing Compound Formulas |
| 15. ANS: C | PTS: 4 | TOP: 3.7 Acids and Bases |
| 16. ANS: E | PTS: 4 | TOP: 2.10 Describing Compound Formulas |
| 17. ANS: A | PTS: 4 | |
| 18. ANS: D | PTS: 4 | TOP: 7.4 Electron Configurations of Ions |
| 19. ANS: C | PTS: 4 | TOP: 11.2 Gas Laws: The Experimental Basis |
| 20. ANS: C | PTS: 4 | |
| 21. ANS: D | PTS: 4 | TOP: 3.6 Precipitation Reactions |
| 22. ANS: A | PTS: 4 | TOP: 2.2 Atomic Number and Atomic Mass |
| 23. ANS: B | PTS: 4 | TOP: 5.7 Enthalpy Calculations |
| 24. ANS: D | PTS: 4 | |
| 25. ANS: B | PTS: 4 | |
| 26. ANS: A | PTS: 4 | |
| 27. ANS: C | PTS: 4 | TOP: 5.7 Enthalpy Calculations |
| 28. ANS: B | PTS: 4 | TOP: 9.2 Valence Bond Theory |
| 29. ANS: E | PTS: 4 | TOP: 2.9 Atoms, Molecules, and the Mole |
| 30. ANS: A | PTS: 4 | TOP: 2.4 Atom Mass |
| 31. ANS: D | PTS: 4 | |
| 32. ANS: B | PTS: 4 | |
| 33. ANS: C | PTS: 4 | |
| 34. ANS: A | PTS: 4 | |
| 35. ANS: E | PTS: 4 | TOP: 8.1 Chemical Bond Formation |
| 36. ANS: A | PTS: 4 | TOP: 3.2 Balancing Chemical Equations |
| 37. ANS: C | PTS: 4 | TOP: 2.7 Ionic Compounds: Formulas, Names, and Properties |
| 38. ANS: E | PTS: 4 | TOP: 2.7 Ionic Compounds: Formulas, Names, and Properties |
| 39. ANS: D | PTS: 4 | |
| 40. ANS: A | PTS: 4 | TOP: 5.2 Specific Heat Capacity: Heating and Cooling |
| 41. ANS: E | PTS: 4 | |