

INSTRUCTIONS:

1. Fill in your social security number carefully.
2. It will be to your advantage to answer all questions.
3. Only one answer per question is allowed. Select the *best answer* from choices given.
4. Use a #2 soft lead pencil.
5. Erasures must be complete.
6. Marks must blacken the entire space in the circle.
7. Answer sheets must not be torn or have holes.
8. This is a 100 point exam.
9. THIS EXAM HAS 43 QUESTIONS. PLEASE MAKE SURE YOUR EXAM IS COMPLETE.
10. Answer number 1 - 43 on your answer sheet.

Useful information:

$$N_A = 6.022 \times 10^{23}$$

$$PV = nRT$$

$$1 \text{ atm} = 101 \text{ kPa}$$

$$R = 0.0821 \text{ (L} \cdot \text{atm)/(mol} \cdot \text{K)}$$

$$q = ms\Delta t$$

$$c = \lambda\nu$$

$$E_n = -R_H \left(\frac{1}{n^2} \right)$$

$$R_H = 2.18 \times 10^{-18} \text{ J}$$

$$?^\circ\text{C} = (?^\circ\text{F} - 32^\circ\text{F}) \times \frac{5^\circ\text{C}}{9^\circ\text{F}}$$

$$1 \text{ mmHg} = 1 \text{ torr}$$

$$T(\text{K}) = T(^{\circ}\text{C}) + 273$$

$$P_A = X_A P_T$$

$$q = C\Delta t$$

$$c = 3.00 \times 10^8 \text{ m/s}$$

$$\Delta E = R_H \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right)$$

$$h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$$

$$?^\circ\text{F} = \frac{9^\circ\text{F}}{5^\circ\text{C}} \times ^\circ\text{C} + 32^\circ\text{F}$$

$$1 \text{ atm} = 760 \text{ torr}$$

$$\text{STP} = 1 \text{ atm}, 0^\circ\text{C}$$

$$X_A = n_A/n_T$$

$$E = h\nu$$

1. Which of the following substances is an element?

- A. air
- B. fluorine
- C. sand
- D. water
- E. methane

2. What is the result to the proper number of significant figures for the following calculation:

$$\frac{(6.433 + 0.841)}{19.26}$$

- A. 0.377673935
- B. 0.3776
- C. 0.3777
- D. 0.377
- E. 0.378

3. What is the density, in g/cm^3 , of a 4.7 kg object with a volume of 850 cm^3 ?

- A. $5.5 \times 10^{-3} \text{ g/cm}^3$
- B. 0.18 g/cm^3
- C. 3995 g/cm^3
- D. 18 g/cm^3
- E. 5.5 g/cm^3

4. Which of the following symbols represents the isotope of Co with 33 neutrons?

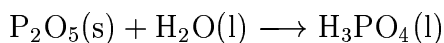
- A. ${}_{27}^{33}\text{Co}$
- B. ${}_{33}^{60}\text{Co}$
- C. ${}_{27}^{60}\text{Co}$
- D. ${}_{33}^{58.93}\text{Co}$

5. Which of the following elements is a halogen?

- A. Fe
- B. P
- C. He
- D. Br
- E. K

6. Which of the following is known as the sulfate ion?
- A. H_2SO_4
 - B. SO_4^{2-}
 - C. HSO_4^-
 - D. HS^-
 - E. SO_2
7. A compound with the empirical formula CH has a molecular weight of 78.11 g/mol. What is its molecular formula?
- A. CH
 - B. C_4H_4
 - C. C_5H_{18}
 - D. C_6H_6
 - E. $\text{C}_4\text{H}_{14}\text{O}$
8. Which pairs of elements are most likely to form a molecular compound?
- A. Na and O
 - B. Fe and Cl
 - C. C and H
 - D. Na and K
 - E. He and B
9. The percentage composition of a vitamin is found to be 40.9% C, 4.58% H, and 54.5% O. What is the empirical formula for this vitamin?
- A. CHO
 - B. CH_2O
 - C. C_2HO_2
 - D. $\text{C}_4\text{H}_3\text{O}_4$
 - E. $\text{C}_3\text{H}_4\text{O}_3$

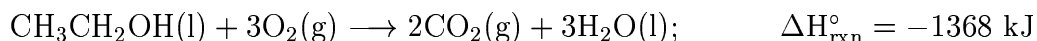
10. The following chemical equation is unbalanced:



What are the correct stoichiometric coefficients in the balanced equation, in order?

- A. 1, 2, 3
- B. 1, 3, 2
- C. 2, 1, 3
- D. 2, 3, 1
- E. 3, 2, 1
- F. 3, 1, 2

The next four questions refer to the following thermochemical equation



11. If 1.39 mol of ethanol, $\text{CH}_3\text{CH}_2\text{OH}$, are reacted with 3.06 mol of O_2 , how many moles of carbon dioxide, CO_2 , are produced?
- A. 1.39 mol
B. 2.78 mol
C. 3.06 mol
D. 2.04 mol
E. 1.02 mol
12. How many grams of water are produced from the complete reaction of 2.54 g of ethanol, $\text{CH}_3\text{CH}_2\text{OH}$?
- A. 2.98 g
B. 1.98 g
C. 0.99 g
D. 2.54 g
E. 7.62 g
13. How many moles of ethanol must be burned to produce 2.50×10^5 kJ of heat?
- A. 60.9 mol
B. 91.4 mol
C. 183 mol
D. 244 mol
E. 250 mol
14. What is the enthalpy of reaction for the reaction
- $$4\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l}) \longrightarrow 2\text{CH}_3\text{CH}_2\text{OH}(\text{l}) + 6\text{O}_2(\text{g})$$
- A. -1368 kJ
B. +1368 kJ
C. -2736 kJ
D. +2736 kJ
15. Which one of the following compounds is insoluble in water?
- A. AgNO_3
B. NaNO_3
C. NH_4NO_3
D. AgCl
E. NaCl
F. NH_4Cl

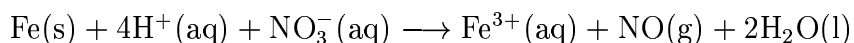
16. When barium hydroxide $[\text{Ba}(\text{OH})_2]$ and sodium sulfite $[\text{Na}_2\text{SO}_3]$ solutions are mixed, a precipitate of barium sulfite forms. The net ionic equation for this reaction is written correctly as:

- A. $\text{Ba}^{+2}(\text{aq}) + \text{SO}_3^{-2}(\text{aq}) \longrightarrow \text{BaSO}_3(\text{s})$
- B. $2\text{Ba}^+(\text{aq}) + \text{SO}_3^{-2}(\text{aq}) \longrightarrow \text{Ba}_2\text{SO}_3(\text{s})$
- C. $\text{Ba}(\text{OH})_2(\text{aq}) + \text{Na}_2\text{SO}_3(\text{aq}) \longrightarrow \text{BaSO}_3(\text{s}) + 2\text{NaOH}(\text{aq})$
- D. $2\text{Ba}(\text{OH})_2(\text{aq}) + \text{Na}_2\text{SO}_3(\text{aq}) \longrightarrow \text{Ba}_2\text{SO}_3(\text{s}) + 2\text{Na}(\text{OH})_2(\text{aq})$

17. The oxidation number of Mn in MnO_4^- is:

- A. 0
- B. +2
- C. +4
- D. +6
- E. +7
- F. +8

18. What species is the oxidizing agent in the following reaction?



- A. $\text{Fe}(\text{s})$
- B. $\text{H}^+(\text{aq})$
- C. $\text{NO}_3^-(\text{aq})$
- D. $\text{Fe}^{3+}(\text{aq})$
- E. $\text{NO}(\text{g})$
- F. $\text{H}_2\text{O}(\text{l})$

19. What is the molarity of a solution containing 32.5 g of $\text{LiCl}(\text{s})$ in 1.50 L of solution?

- A. 0.458 M
- B. 0.511 M
- C. 0.766 M
- D. 0.879 M
- E. 0.931 M

20. A sample of gas occupies 3.9 L when the pressure is 1.0 atm. What pressure must be applied to reduce the gas volume to 0.53 L at a constant temperature?

- A. 7.4 atm
- B. 3.9 atm
- C. 2.2 atm
- D. 0.26 atm
- E. 0.14 atm

21. A quantity of ideal gas weighing 88.5 g at a pressure of 3.15 atm and a temperature of 38 °C occupies a volume of 13.2 L. What is the molar mass of the gas?
- A. 31.5 g/mol
 - B. 42.8 g/mol
 - C. 48.1 g/mol
 - D. 54.4 g/mol
 - E. 62.0 g/mol

22. Based on the table of standard enthalpies of formation (see exam cover page), what is the standard enthalpy of reaction for the reaction



- A. +2108 kJ
 - B. -2108 kJ
 - C. +117.6 kJ
 - D. -117.6 kJ
 - E. +995.3 kJ
 - F. -995.3 kJ
23. Which of the following sets of quantum numbers (n, l, m_l, m_s) is **not** allowed?
- A. 5, 5, 4, $\frac{1}{2}$
 - B. 5, 4, -4, $\frac{1}{2}$
 - C. 5, 2, 0, $-\frac{1}{2}$
 - D. 5, 1, 1, $\frac{1}{2}$
24. How many electrons can be placed in the 3d subshell?
- A. 1
 - B. 2
 - C. 3
 - D. 5
 - E. 6
 - F. 10

25. The ground state electron configuration for I^- is:

- A. $[\text{Kr}]5s^24d^{10}5p^6$
- B. $[\text{Kr}]5s^24d^{10}5p^5$
- C. $[\text{Kr}]5s^24d^{10}5p^4$
- D. $[\text{Kr}]5s^14d^{10}5p^5$
- E. $[\text{Kr}]5s^04d^{10}5p^6$

26. Which of the following elements has the **smallest** ionization energy?

- A. Cs
- B. Be
- C. Al
- D. Se
- E. Ne

27. The correct Lewis dot symbol for the nitrogen atom is:

- A. $\begin{array}{c} \cdot\cdot \\ : \text{N} : \\ \cdot\cdot \end{array}$
- B. $\begin{array}{c} \cdot\cdot \\ : \text{N} \cdot \\ \cdot\cdot \end{array}$
- C. $\begin{array}{c} \cdot\cdot \\ \cdot \text{N} \cdot \\ \cdot\cdot \end{array}$
- D. $\begin{array}{c} \cdot\cdot \\ \cdot \text{N} \cdot \\ \cdot \end{array}$
- E. $\begin{array}{c} \cdot \\ \cdot \text{N} \cdot \\ \cdot \end{array}$

28. In which of the following compounds is the bonding most covalent?

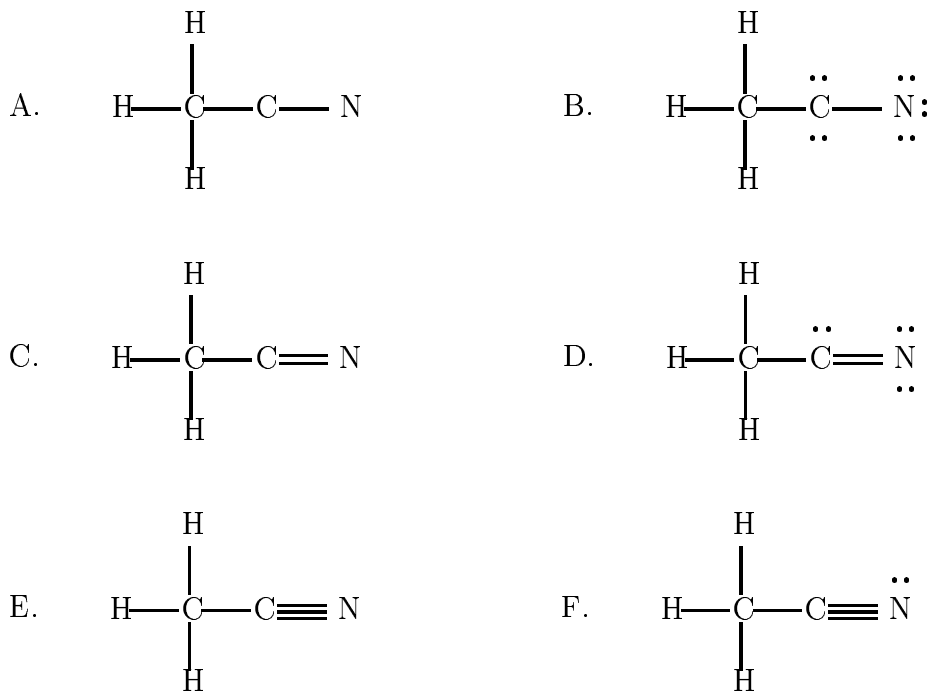
- A. NO_2
- B. AlF_3
- C. CaCl_2
- D. NaCl
- E. Cs_2O

29. The correct Lewis structure for CS_2 is:

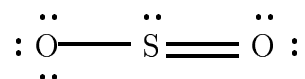
- A. $\text{S} - \text{C} - \text{S}$
- B. $\text{S} = \text{C} = \text{S}$
- C. $\begin{array}{c} \cdot\cdot \quad \cdot\cdot \quad \cdot\cdot \\ : \text{S} - \text{C} - \text{S} : \\ \cdot\cdot \quad \cdot\cdot \quad \cdot\cdot \end{array}$
- D. $:\text{S} = \text{C} = \text{S}:$
- E. $\begin{array}{c} \cdot\cdot \quad \cdot\cdot \\ : \text{S} = \text{C} = \text{S} : \end{array}$

30. Which of the following elements has the largest electronegativity?
- A. O
 - B. C
 - C. B
 - D. Li
 - E. Na
31. Based on the Lewis structure for carbon monoxide $:\text{C}\equiv\text{O}:$ what is the formal charge on the oxygen atom?
- A. +2
 - B. +1
 - C. 0
 - D. -1
 - E. -2
32. The correct Lewis structure for methane (CH_4) is
- A. $\text{C}-\text{H}-\text{H}-\text{H}-\text{H}$
 - B. $\text{H}-\text{C}-\text{H}-\text{H}-\text{H}$
 - C. $\begin{array}{c} \text{H} \\ | \\ \text{H}-\text{C}-\text{H}-\text{H} \end{array}$
 - D. $\begin{array}{c} \text{H} \\ | \\ \text{H}-\text{C}-\text{H} \\ | \\ \text{H} \end{array}$
33. For which of the following compounds do the bonds have the greatest bond polarity?
- A. CH_4
 - B. NH_3
 - C. H_2O
 - D. HF
 - E. HCl
 - F. HBr

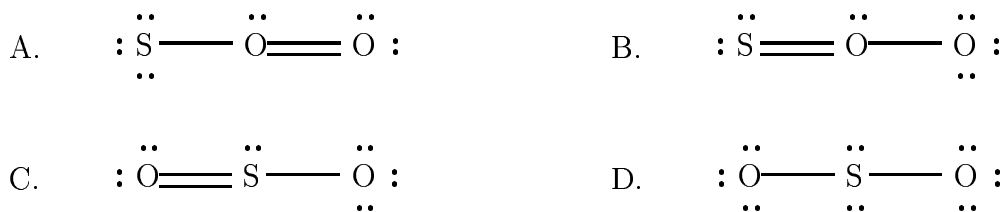
34. The correct Lewis structure for CH_3CN is



35. One possible Lewis structure for the SO_2 molecule is



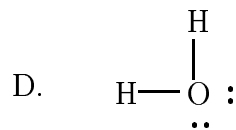
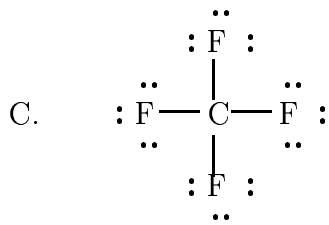
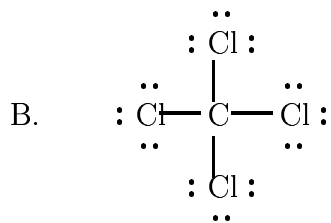
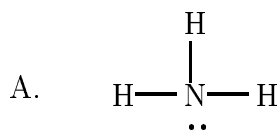
Which of the following is the correct resonance structure to the above?



36. What is the molecular geometry of H_2S ?

- A. linear
- B. bent
- C. tetrahedral
- D. trigonal pyramidal
- E. octahedral

37. Which of the following species has a tetrahedral molecular geometry?



E. A and B

F. B and C

38. What is the bond angle in a perfectly trigonal planar molecule like BF_3 ?

- A. 60°
- B. 90°
- C. 109.5°
- D. 120°
- E. 180°

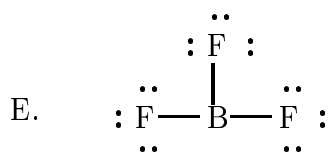
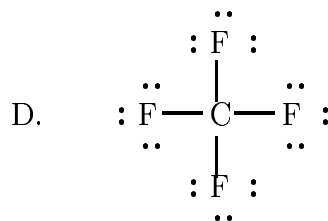
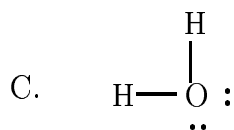
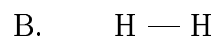
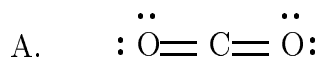
39. Which of the following molecules contains **NO** polar bonds?

- A. CO_2
- B. HF
- C. H_2O
- D. N_2
- E. SO_2

40. The orbitals used for bonding by C in CH_4 are:

- A. sp hybrids
- B. sp^2 hybrids
- C. sp^3 hybrids
- D. sp^4 hybrids
- E. unhybridized p orbitals

41. Which of the following molecules contains a permanent dipole moment, μ ?



42. A set of sp hybrids contains how many orbitals?

- A. one
- B. two
- C. three
- D. four

43. Which of the following molecules contains sp^2 hybrid orbitals?

