



# Chemistry 101

Final Exam

Done by:

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1. Which is a reasonable mass corresponding to 1026 molecules of a substance?

- a. 100 gram
- b. 100 microgram
- c. 100 nanogram
- d. 100 milligram
- e. 100 kilogram

2. Consider the following reaction:  $2A + B \rightarrow 3C + D$ ; 3.0 mol A and 2.0 mol B react to form 4.0 mol C. Which is the percent yield of this reaction?

- a. 75%
- b. 67%
- c. 50%
- d. 89%
- e. 100%

3. What is the net ionic equation for the reaction of  $\text{NH}_3$  with  $\text{HNO}_3$ ?

- a.  $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
- b.  $\text{H}^-(\text{aq}) + \text{H}^+(\text{aq}) \rightarrow \text{H}_2(\text{g})$
- c.  $\text{NH}_3(\text{aq}) + \text{HNO}_3(\text{aq}) \rightarrow \text{NH}_4\text{NO}_3(\text{aq})$
- d.  $\text{NH}_3(\text{aq}) + \text{H}^+(\text{aq}) \rightarrow \text{NH}_4^+(\text{aq})$
- e.  $\text{NH}_3(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{NH}_2^-(\text{aq}) + \text{HNO}_3(\text{aq})$

4. Which of the following atoms is the most electronegative?

- a. B
- b. N
- c. Na
- d. Cs
- e. Al

5. What is the molecular geometry around an atom in a molecule or ion which is surrounded by five single bonds and no lone pairs of electrons?

- a. trigonal planar
- b. tetrahedral
- c. linear
- d. octahedral
- e. trigonal bipyramidal

6. What volume of ammonia gas measures at 547.9 mmHg and 27.6 °C, is required to produce 8.98 g of ammonium sulfate according to the following balanced chemical equation?

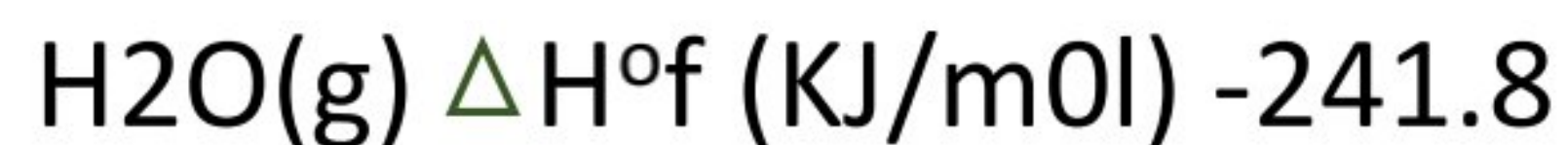
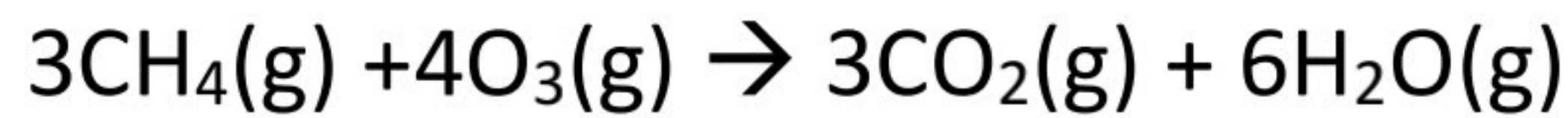


- a. L 18
- b. 1.16
- c. L 0.00397

d. L 4.65

e. L 0.000992

7. *What is the standard enthalpy change for the following reaction?*



a. +2285.1 KJ

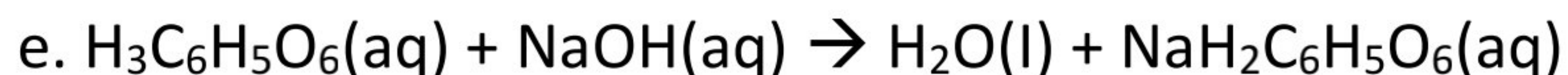
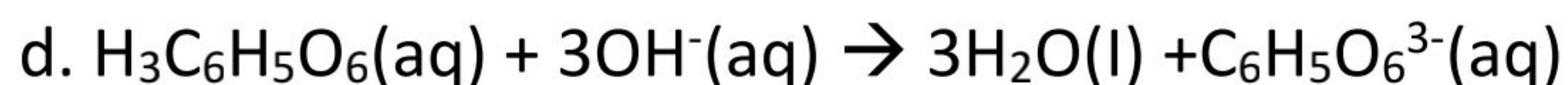
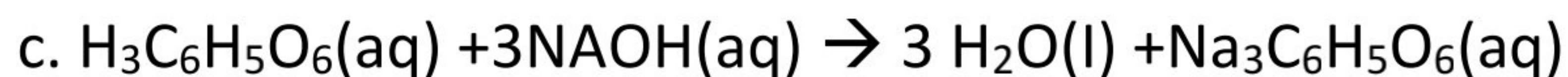
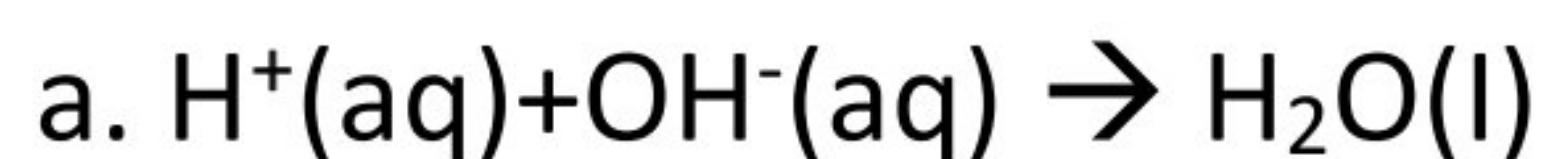
b. +2977.5 KJ

c. -3426.5 KJ

d. -2977.5 KJ

e. -2285.1 KJ

8. *What is the net ionic equation for the complete neutralization of the triprotic acid citric acid,  $\text{H}_3\text{C}_6\text{H}_5\text{O}_6$ , by a strong base?*



9. Which of the following electron configuration represents an excited state of the indicated atom?

- a. He:  $1s^2$
- b. P:  $1s^2 2s^2 2p^6 3s^2 3p^2 4s^1$
- c. Na:  $1s^2 2s^2 2p^6 3s^1$
- d. Ne:  $1s^2 2s^2 2p^6$
- c. N:  $1s^2 2s^2 2p^3$

10. A thin sheet of iridium metal that is 3.12 cm by 5.21 cm has a mass of 87.2 g and a thickness of 2.360 mm. What is the density of iridium?

- a.  $0.441 \text{ g/cm}^3$
- b.  $0.044 \text{ g/cm}^3$
- c.  $2.260 \text{ g/cm}^3$
- d.  $22.600 \text{ g/cm}^3$
- e.  $3.36 \times 10^3 \text{ g/cm}^3$

11. A 1.74 g sample for an element contains  $7.887 \times 10^{21}$  atoms. What is the element symbol?

- a. I
- b. Cs
- c. Cd
- d. Sb
- e. In

12. Which of the following subshells does not exist?

- a. 4d
- b. 2s
- c. 6g
- d. 3f
- e. 3p

13. which of the following compounds would be expected to have the highest melting point?

- a.  $\text{OCl}_2$
- b.  $\text{CCl}_4$
- c.  $\text{LiCl}$
- d.  $\text{MgCl}_2$
- e.  $\text{NCl}_3$

14. The complete combustion of phenylhydrazine,  $\text{C}_6\text{H}_5\text{NHNH}_2$ , with the oxidizer dinitrogen tetroxide is shown in the following equation:

$\_\_ \text{C}_6\text{H}_5\text{NHNH}_2 + \_\_ \text{N}_2\text{O}_4 \rightarrow \_\_ \text{CO}_2 + \_\_ \text{H}_2\text{O} + \_\_ \text{N}_2$ ; When this equation is balanced, the sum of all the coefficients (using smallest whole numbers) is:

- a. 10
- b. 30
- c. 20

d. 25

e. 15

*15. Which molecule or ion has the same molecular geometry as  $\text{SeO}_3^{2-}$ ?*

a.  $\text{CO}_3^{2-}$

b.  $\text{NO}_3^-$

c.  $\text{SO}_3^{2-}$

d.  $\text{SeO}_3$

e.  $\text{SO}_3$

*16. Which pair of species is isoelectronic?*

a. Ne and Ar

b.  $\text{Li}^+$  and Ne

c.  $\text{K}^+$  and  $\text{Cl}^-$

d.  $\text{Na}^+$  and  $\text{Be}^{2+}$

e.  $\text{K}^+$  and  $\text{Na}^+$

*17. Which of the following is true?*

a. The krypton 1s orbital and the helium 1s orbital are the same size because both s orbitals can have only two electrons.

b. The krypton 1s orbital is smaller than the helium 1s orbital because krypton's p and d orbitals crowd the s orbitals.

- c. The krypton 1s orbital is larger than the helium 1s orbital because krypton's ionization energy is lower so it's easier to remove electrons.
- d. The krypton 1s orbital is smaller than the helium 1s orbital because krypton's nuclear charge draws the electrons closer.
- e. The krypton 1s orbital is larger than the helium 1s orbital because krypton contains more electrons.

*18. The reaction of iron with hydrochloric acid is represented by the following thermochemical equation:*

*$Fe(s) + 2HCl(aq) \rightarrow FeCl_2(aq) + H_2(g); \Delta H^\circ: -87.9 \text{ KJ}$ ; If, in a particular experiment, 1.56KJ of heat was released at constant pressure what volume of  $H_2(g)$ , measured at STP, was produced?*

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

- a. 0.397 L
- b. 22.4 L
- c.  $1.26 \cdot 10^3 \text{ L}$
- d.  $1.38 \cdot 10^3 \text{ L}$
- e. 0.434 L

*19. Which of the following is the best explanation for a covalent bond?*

- a. positive ion attracting negative ions.
- b. an interaction between outer electrons.
- c. electrons simultaneously attracted by more than one nucleus.



d. the overlapping of two electron-filled orbitals having different energies.

e. the overlapping of unoccupied orbitals of two or more atoms.

20. A 70.4-L sample of a gaseous hydrocarbon measured at 1.00 atm pressure and 25.0 °C is burned in excess oxygen, liberating  $4.06 \times 10^3$  KJ of heat at constant pressure. What is the identity of the hydrocarbon?

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

| Substance | $\Delta H^{\circ}_f(\text{KJ/mol})$ |
|-----------|-------------------------------------|
|-----------|-------------------------------------|

|                         |        |
|-------------------------|--------|
| $\text{CO}_2(\text{g})$ | -393.5 |
|-------------------------|--------|

|                                |        |
|--------------------------------|--------|
| $\text{H}_2\text{O}(\text{l})$ | -285.8 |
|--------------------------------|--------|

a. ethane ( $\text{C}_2\text{H}_6, \Delta H^{\circ}_f = -84.68 \text{ KJ/mol}$ )

b. acetylene ( $\text{C}_2\text{H}_2, \Delta H^{\circ}_f = 226.73 \text{ KJ/mol}$ )

c. propane ( $\text{C}_3\text{H}_8, \Delta H^{\circ}_f = -104.7 \text{ KJ/mol}$ )

d. ethylene ( $\text{C}_2\text{H}_4, \Delta H^{\circ}_f = 52.47 \text{ KJ/mol}$ )

e. propylene ( $\text{C}_3\text{H}_6, \Delta H^{\circ}_f = 20.41 \text{ KJ/mol}$ )

21. ammonia can be made by reaction of water with magnesium nitride:  $\_\_ \text{Mg}_3\text{N}_2(\text{s}) + \_\_ \text{H}_2\text{O}(\text{l}) \rightarrow \_\_ \text{Mg}(\text{OH})_2(\text{s}) + \_\_ \text{NH}_3(\text{g})$ ; When the equation is properly balanced, the sum of the coefficients is:

a. 6

b. 9

c. 8

d. 12

e. 14

22. Which of the following solutes dissolved in 1000g of water, would provide the greatest number of particles?

a. 0.030 mol of acetic acid,  $\text{CH}_3\text{COOH}$

b. 0.030 mol of calcium sulfate,  $\text{Ca}(\text{NH}_2)_2$

c. 0.030 mol of urea,  $\text{CO}(\text{NH}_2)_2$

d. 0.030 mol of barium chloride,  $\text{BaCl}_2$

e. 0.030 mol of ammonium nitrate,  $\text{NH}_4\text{NO}_3$

23. How much heat is liberated at constant pressure when 97.7 g of calcium oxide reacts with 29.0 L of carbon dioxide gas, measured at 1.00 atm pressure and 25.0 °C? ( $R = 0.0821 \text{ L}\cdot\text{atm}/(\text{K}\cdot\text{mol})$ )



a.  $-1.74 \times 10^4 \text{ KJ}$

b.  $-2.11 \times 10^2 \text{ KJ}$

c.  $-5.22 \times 10^2 \text{ KJ}$

d.  $-5.17 \times 10^3 \text{ KJ}$

e.  $-3.11 \times 10^2 \text{ KJ}$

24. What is the molecular geometry of the bromate ion,  $\text{BrO}_3^-$ ?

a. square planar

b. square pyramidal

- c. trigonal planar
- d. tetrahedral
- e. trigonal pyramidal

25. A barn is an atomic unit of area equal to  $10^{-28}$  m<sup>2</sup>. What is the surface area of the Earth expressed in unit of barn? Assume Earth is a sphere with a radius of km. (The surface area of a sphere is  $4\pi r^2$ ).

- a.  $5.12 \times 10^{42}$  barn
- b.  $5.12 \times 10^{-14}$  barn
- c.  $5.12 \times 10^{30}$  barn
- d.  $5.12 \times 10^{36}$  barn
- e.  $5.12 \times 10^{-20}$  barn

26. Which of the following statements concerning lattice energy is false?

- a. MgO has a larger lattice energy than NaF
- b. MgO has a larger lattice energy than LiF
- c. Lattice energy is often defined as the change in energy that occurs when an ionic solid is separated into isolate ions in the gas phase.
- d. The lattice energy for a solid with 2+ and 2- ions should be two times that for a solid with 1+ and 1- ions
- e. all of these are true

27. Which of the following statements is true about the ionization energy of  $Mg^{2+}$ ?

- a. it will be equal to the ionization energy of Li
- b. it will be equal to and opposite in sign to the electron affinity of  $Mg^{2+}$
- c. it will be equal to and opposite in sign to the electron affinity of  $Mg^+$
- d. none of the above
- e. it will be equal to and opposite in sign to the electron affinity of Mg

28. What is the total number of valence electrons in the sulfite ion?

- a. 32
- b. 8
- c. 30
- d. 26
- e. 24

29. In 0.266 mol of trimellitic acid,  $C_6H_3(COOH)$ , there are:

- a.  $2.67 \times 10^{23}$  hydrogen atoms
- b.  $1.60 \times 10^{22}$  molecules
- c.  $4.80 \times 10^{23}$  oxygen atoms
- d.  $6.41 \times 10^{24}$  molecules
- e.  $1.44 \times 10^{24}$  carbon atoms

30. The total number of oxygen atoms in 1.93 g of  $\text{CaCO}_3$  is:

- a.  $2.24 \times 10^{23}$
- b.  $1.92 \times 10^{23}$
- c.  $5.81 \times 10^{22}$
- d.  $3.49 \times 10^{22}$
- e.  $4.65 \times 10^{22}$

31. What is the total number of valence electrons in  $\text{N}_2\text{O}$ ?

- a. 17
- b. 11
- c. 22
- d. 34
- e. 16

32. In which of the following reaction will the pressure increase upon completion of the reaction at constant temperature?

- a.  $\text{C}_2\text{H}_6\text{O}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$
- b.  $\text{Cl}_2(\text{g}) + 3\text{F}_2(\text{g}) \rightarrow 2\text{ClF}_3(\text{g})$
- c.  $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$
- d.  $\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$
- e.  $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g})$

33. What is the volume occupied by a mixture of 0.774 mol of  $N_2$  and 0.774 mol of  $O_2$  gases at 1.04 atm and  $25.6^\circ C$ ?

- a. 3.12 L
- b. 36.5 L
- c. 1.56 L
- d. 18.2 L
- e.  $1.1 \times 10^3$  L

34. When 50.0 mL of 1.27 M of  $HCl(aq)$  is combined with 50.0 mL of 1.32 M of  $NaOH(aq)$  in a coffee cup calorimeter, the temperature of the solution increase by  $8^\circ C$ . What is the change in enthalpy for this balanced reaction?

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$ ; Assume that the solution density is 1.00 g/mL and the specific heat capacity of the solution is  $4.18 J/g \cdot ^\circ C$

- a. 55.8 KJ
- b. -51.5 KJ
- c. -26.8 KJ
- d. 51.5 KJ
- e. -55.8 KJ

35. What is the standard enthalpy change for the combustion of gaseous propylene,  $C_3H_6$ ?



- a. -658.9 KJ
- b. +2017.5 KJ
- c. -2058.3 KJ
- d. +2058.3 KJ
- e. -2017.5 KJ

36. What is the total number of valence electrons in the monohydrogen phosphate ion,  $HPO_4^{2-}$ ?

- a. 30
- b. 34
- c. 28
- d. 32
- e. 36

37. What is the O-N-O bond angle in the nitrite ion?

- a.  $109^\circ$
- b.  $180^\circ$  and  $90^\circ$

c.  $90^\circ$

d.  $180^\circ$

e.  $120^\circ$

*38. Which ground-state electron configuration is incorrect?*

a. K:  $[\text{Ar}]4s^1$

b. Na:  $1s^22s^22p^63s^1$

c. Zn:  $[\text{Ar}]3d^{10}4s^2$

d. Fe:  $[\text{Ar}]3d^5$

e. Br:  $[\text{Ar}]3d^{10}4s^24p^5$

*39. Which molecule or ion has a trigonal pyramidal molecular geometry?*

a.  $\text{H}_2\text{CCO}$

b.  $\text{H}_2\text{CO}$

c.  $\text{C}_2\text{H}_4$

d.  $\text{CH}_3^+$

e.  $\text{CH}_3^-$

*40. Which of the following subshells does not exist?*

a. 2s

b. 6g



- c. 4d
- d. 3p
- e. 3f

41. Which of the following compounds has the most ionic bonding has the highest percentage of ionic character?

- a.  $\text{CaF}_2$
- b.  $\text{CsF}$
- c.  $\text{OF}_2$
- d.  $\text{LiF}$
- e.  $\text{LiI}$

42. The approximate CCO angle in acetone, is:

- a.  $180^\circ$
- b.  $60^\circ$
- c.  $109^\circ$
- d.  $90^\circ$
- e.  $120^\circ$

43. What is the standard enthalpy of formation of liquid methylamine ( $\text{CH}_3\text{NH}_2$ )?





- a. +3899.2 KJ/mol
- b. -3899.2 KJ/mol
- c. -47.3 KJ/mol
- d. +3178.4 KJ/mol
- e. +47.3 KJ/mol

44. A barleycorn is an English unit of length equal to  $\frac{1}{3}$  of an inch. What is the height of the Empire state Building (449 m) expressed in barleycorn?

- a.  $4 \times 10^4$  barleycorn
- b.  $5 \times 10^4$  barleycorn
- c.  $3 \times 10^5$  barleycorn
- d.  $6 \times 10^{-1}$  barleycorn
- e.  $6 \times 10^3$  barleycorn

45. The amount of calcium in a 15.0 g sample was determined by converting the calcium to calcium oxalate,  $CaC_2O_4$ . The  $CaC_2O_4$  weighed 10.3 g. What is the percent of calcium in the original sample?

- a. 12.1%
- b. 68.7%

- c. 21.5%
- d. 8.8%
- e. 27.5%

46. Which molecule or ion has the same molecular geometry for its central atom(s) as  $\text{BF}_3$ ?

- a.  $\text{C}_2\text{F}_4$
- b.  $\text{BF}_4^-$
- c.  $\text{CF}_4$
- d.  $\text{C}_2\text{F}_6$
- e.  $\text{CH}_3^-$

47. What is the total volume of gases produced at 1092 K and 1.00 atm pressure when 320 g of ammonium nitrite undergoes the following decomposition reaction?



- a.  $5 \times 22.4 \text{ L}$
- b.  $22.4 \text{ L}$
- c.  $20 \times 22.4 \text{ L}$
- d.  $60 \times 22.4 \text{ L}$
- e.  $4 \times 22.4 \text{ L}$

*48. In which of the series of elements listed below would the elements have most nearly the same atomic radius?*

- a. B, Si, As, Te
- b. Na, Mg, Al, Si
- c. F, Cl, Br, I
- d. Na, K, Rb, Cs
- c. Sc, Ti, V, Cr

*49. Which pair of elements would form a covalent bond that is the least polar?*

- a. S and Li
- b. O and F
- c. SS and Cs
- d. Al and N
- e. O and H

*50. What is the final concentration of HCl in a solution prepared by addition of 922.0 mL of 4.73 M HCl to 549.0 mL of 2.03 M HCl? Assume volume are additive.*

- a. 3.03 M
- b. 3.72 M
- c. 3.38 M
- d. 0.00459 M

e. 6.76 M

51. The following equation represents the partial combustion of, CH<sub>4</sub>.  
 $2\text{CH}_4(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}(\text{g}) + 4\text{H}_2\text{O}(\text{g})$ ; At constant temperature and pressure, what is the maximum volume of carbon monoxide that can be obtained from  $6.62 \times 10^2$  L of methane and  $3.31 \times 10^2$  L of oxygen?

- a.  $2.21 \times 10^2$  L
- b.  $2.32 \times 10^3$  L
- c.  $1.32 \times 10^3$  L
- d.  $9.93 \times 10^2$  L
- e.  $6.62 \times 10^2$  L

52. Two metals of equal mass with different heat capacities are subjected to the same amount of heat. Which undergoes the smaller change in temperature?

- a. The metal with the higher capacity undergoes the smaller change in temperature
- b. Both undergoes the same change in temperature
- c. You need to know which metals you have
- d. The metal with the lower heat capacity undergoes the smaller change in temperature
- e. You need to know the initial temperature of the metals

*53. Which of the following true?*

- a. The triple bond in N<sub>2</sub> has a smaller bond order and a smaller bond length than the single bond in F<sub>2</sub>
- b. The triple bond in N<sub>2</sub> has a larger bond order and a larger bond length than the single bond in a F<sub>2</sub>
- c. The triple bond in N<sub>2</sub> has larger bond order and a smaller bond length than the single bond in F<sub>2</sub>
- d. The triple bond in N<sub>2</sub> and the single bond in F<sub>2</sub> have the same bond order and same bond length
- e. The triple bond in N<sub>2</sub> has a smaller bond order and a larger length than single bond in F<sub>2</sub>.

*54. Which of the following has the shortest bond distance?*

- a. H<sub>2</sub>
- b. Br<sub>2</sub>
- c. I<sub>2</sub>
- d. F<sub>2</sub>
- e. Cl<sub>2</sub>

*55. Which of the following processes will result in the lowest final temperature of the metal-water mixture at equal specific heat of cobalt is  $0.421 \text{ J}/(\text{g}\cdot^\circ\text{C})$ ?*

- a. the addition of 100 g of cobalt at  $95^\circ\text{C}$  to 20 mL of water at  $25^\circ\text{C}$  in an insulated container
- b. the addition of 100 g of cobalt at  $95^\circ\text{C}$  to 60 mL of water at  $25^\circ\text{C}$  in an insulated container
- c. the addition of 100 g of cobalt at  $95^\circ\text{C}$  to 80 mL of water at  $25^\circ\text{C}$  in an insulated container
- d. the addition of 100 g of cobalt at  $95^\circ\text{C}$  to 40 mL of water at  $25^\circ\text{C}$  in an insulated container
- e. the addition of 100 g of cobalt at  $95^\circ\text{C}$  to 100 mL of water at  $25^\circ\text{C}$  in an insulated container

# ANSWERS

|   |   |    |   |    |   |    |   |    |   |
|---|---|----|---|----|---|----|---|----|---|
| 1 | C | 9  | B | 17 | D | 25 | E | 33 | B |
| 2 | D | 10 | D | 18 | A | 26 | D | 34 | B |
| 3 | D | 11 | B | 19 | C | 27 | B | 35 | C |
| 4 | B | 12 | D | 20 |   | 28 | D | 36 | D |
| 5 | E | 13 | D | 21 | D | 29 | E | 37 | E |
| 6 | D | 14 | C | 22 | D | 30 | D | 38 | D |
| 7 | D | 15 | C | 23 | B | 31 | E | 39 | E |
| 8 | D | 16 | D | 24 | E | 32 | E | 40 | E |

|    |   |    |   |
|----|---|----|---|
| 41 | B | 49 | B |
| 42 | E | 50 | B |
| 43 | C | 51 | A |
| 44 | B | 52 | A |
| 45 | C | 53 | C |
| 46 | A | 54 | A |
| 47 | D | 55 | E |
| 48 | E |    |   |

GOOD LUCK 



