CHEM 1411 – STUDY-GUIDE-for-TEST-2

(CHAPTERS 4, 5 and 6)

1. Which of the following compounds is a *strong electrolyte*?
   A) H_2O B) CH_3OH C) CH_3CH_2OH D) HF E) NaF
   Ans: E

2. Which of the following compounds is a *nonelectrolyte*?
   A) NaOH
   B) HNO_3
   C) C_2H_6O (ethanol)
   D) KF
   E) CH_3COOH (acetic acid)
   Ans: C

3. Based on the solubility rules, which one of the following compounds should be *insoluble* in water?
   A) NaCl B) $MgBr_2$ C) $FeCl_2$ D) AgBr E) $ZnCl_2$
   Ans: D

4. Which of the following will occur when solutions of $CuSO_4(aq)$ and $BaCl_2(aq)$ are mixed?
   A) A precipitate of $CuCl_2$ will form; Ba^{2+} and SO_4^{2-} are spectator ions.
   B) A precipitate of $CuSO_4$ will form; Ba^{2+} and Cl^- are spectator ions.
   C) A precipitate of $BaSO_4$ will form; Cu^{2+} and Cl^- are spectator ions.
   D) A precipitate of $BaCl_2$ will form; Cu^{2+} and SO_4^{2-} are spectator ions.
   E) No precipitate will form.
   Ans: C

5. Identify the precipitate(s) formed when solutions of $Pb(NO_3)_2(aq)$, $Mg(ClO_4)_2(aq)$, and $(NH_4)_2SO_4(aq)$ are mixed.
   A) $PbSO_4$
   B) $MgSO_4$
   C) NH_4ClO_4
   D) NH_4NO_3 and NH_4ClO_4
   E) $PbSO_4$ and $MgSO_4$
   Ans: A

6. Identify the correct *net ionic equation* for the reaction that occurs when solutions of $AgNO_3$ and NH_4Cl are mixed.
   A) $AgNO_3(aq) + NH_4Cl(aq) \rightarrow AgCl(s) + NH_4Cl(aq)$
   B) $NH_4^+(aq) + NO_3^-(aq) \rightarrow NH_4NO_3(s)$
   C) $AgNO_3(aq) + NH_4Cl(aq) \rightarrow AgCl(s) + NH_4Cl(s)$
   D) $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
   E) $AgNO_3(aq) + NH_4^+(aq) \rightarrow NH_4AgNO_3(s)$
   Ans: D Category: Medium

7. Which of the following compounds is a *weak acid*?
A) HF B) HCl C) HBr D) HI E) $HClO_4$
Ans: A

8. Identify the *major* ions present in an aqueous LiOH solution.
A) Li^{2+}, O^-, H^- B) Li^+, OH^- C) LiO^-, H^+ D) Li^+, O^{2-}, H^+ E) Li^-, OH^+
Ans: B

9. Identify the correct *net ionic equation* for the reaction that occurs when solutions of HF and KOH are mixed.
A) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
B) $HF(aq) + OH^-(aq) \rightarrow H_2O(l) + F^-(aq)$
C) $H^+(aq) + KOH(aq) \rightarrow H_2O(l) + K^+(aq)$
D) $HF(aq) + KOH(aq) \rightarrow H_2O(l) + KF(s)$
E) $HF(aq) + KOH(s) \rightarrow H_2O(l) + KF(aq)$
Ans: B

10. The oxidation number of Mn in $KMnO_4$ is
A) +8 B) +7 C) +5 D) –7 E) –8
Ans: B

11. For the chlorate ion, ClO_3^- , what are the oxidation states of the Cl and O, respectively?
A) – 1, – 2 B) +5, – 2 C) +6, – 2 D) +7, – 2 E) +2, – 1
Ans: B

12. Determine the correct oxidation numbers for all three elements in $Ca(ClO)_2$ in the order that the elements are shown in the formula?
A) +2, +1, –2 B) +2, –2, +1 C) +2, –3, +2 D) –2, +2, –1 E) –2, +3, –2
Ans: A

13. How many total electrons are transferred in the following reaction?
$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$
A) 1 B) 2 C) 3 D) 4 E) 5
Ans: B

14. Which one of the following is a *redox* reaction?

A) $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$
B) $2KBr(aq) + Pb(NO_3)_2(aq) \rightarrow 2KNO_3(aq) + PbBr_2(s)$
C) $CaBr_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + 2HBr(g)$
D) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
E) $CO_3^{2-}(aq) + HSO_4^-(aq) \rightarrow HCO_3^-(aq) + SO_4^{2-}(aq)$

Ans: A

15. Identify the *oxidizing agent* in the following chemical reaction.

$$2MnO_4^- + 5H_2SO_3 \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 4H^+ + 3H_2O$$

A) MnO_4^- B) H_2SO_3 C) Mn^{2+} D) SO_4^{2-} E) H^+

Ans: A

16. Identify the *reducing agent* in the following chemical reaction.

$$Cd + NiO_2 + 2H_2O \rightarrow Cd(OH)_2 + Ni(OH)_2$$

A) Cd B) NiO_2 C) H_2O D) $Cd(OH)_2$ E) $Ni(OH)_2$

Ans: A

17. Predict the products of the following single replacement reaction.

$$Fe(s) + CuSO_4(aq) \rightarrow$$

A) $Cu(s) + FeSO_4(aq)$
B) $Fe(s) + Cu(s) + SO_4(aq)$
C) $CuS(s) + Fe_2SO_4(aq)$
D) $FeCuSO_4(aq)$
E) $FeO(s) + CuSO_3(aq)$

Ans: A

18. Which of the following represents a *hydrogen displacement reaction*?

A) $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$
B) $2KBr(aq) + Cl_2(g) \rightarrow 2KCl(aq) + Br_2(l)$
C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
D) $CaBr_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + 2HBr(g)$
E) $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

Ans: E

18. The reaction below can be classified as which type of reaction ?

$2\ NO_2(g) + H_2O(l) \rightarrow HNO_2(aq) + HNO_3(aq)$

A) Combination reaction
B) Acid-base neutralization reaction
C) Hydrogen displacement reaction
D) Disproportionation reaction
E) Combustion reaction

Ans: D

19. What type of reaction is the following?

$Ca(OH)_2(s) + 2\ HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + 2\ H_2O(l)$

A) Combination reaction
B) Acid-base neutralization reaction
C) Hydrogen displacement reaction
D) Disproportionation reaction
E) Combustion reaction

Ans: B

20. Categorize the following reaction as an *acid-base neutralization*, *precipitation*, *combination*, *decomposition*, *combustion*, *displacement*, or *disproportionation* reaction.

$Ba(C_2H_3O_2)_2(aq) + Na_2CO_3(aq) \rightarrow BaCO_3(s) + 2\ NaC_2H_3O_2(aq)$

Ans: Precipitation

21. Describe the procedure used to make 3.0 liters of a 2.0 M KCl solution, starting with solid KCl and water.

Ans: Determine the molar mass of KCl, which is 74.55 g/mol; weigh out 447.3 grams (6 mol) of KCl; dissolve the KCl in enough water to form exactly 3 liters of solution.

22. The solubility of $Ba(NO_3)_2$ is 130.5 grams per liter at 0°C. How many moles of dissolved salt are present in 4.0 liters of a saturated solution of $Ba(NO_3)_2$ at 0ºC?

Ans: 2.0 moles

23. During a titration the following data were collected. A 10. mL portion of an unknown monoprotic acid solution was titrated with 1.0 M NaOH; 40. mL of the base were required to neutralize the sample. How many moles of acid are present in 2.0 liters of this unknown solution?

Ans: 8.0 moles

24. Identify the Brønsted acid in the following reaction.

$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

Ans: H_2O

25. Write the balanced molecular and net ionic equations for the reaction that would occur between $CuCl_2(aq)$ and Pb(s). Be sure to include the correct states in your final equations. If no reaction is expected, write "no reaction."

Ans: Molecular equation: $CuCl_2(aq) + Pb(s) \rightarrow Cu(s) + PbCl_2(s)$

Net ionic equation: $Cu^{2+}(aq) + 2Cl^-(aq) + Pb(s) \rightarrow Cu(s) + PbCl_2(s)$

26. TRUE/FALSE: The following equation is an example of a net ionic equation.

$Na^+(aq) + Br^-(aq) + Ag^+(aq) + NO_3^-(aq) \rightarrow AgBr(s) + Na^+(aq) + NO_3^-(aq)$

Ans: False

27. TRUE/FALSE: Hydrogen is oxidized in the following chemical reaction.

$H_2 + Cl_2 \rightarrow 2HCl$

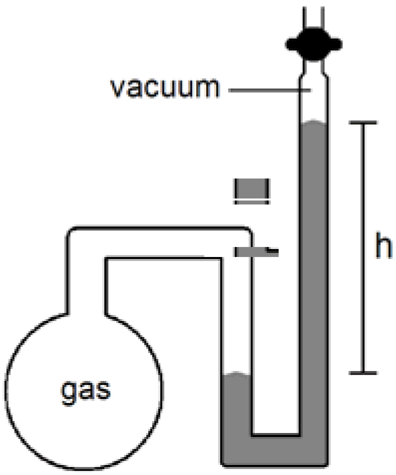
Ans: True

28. TRUE/FALSE: The following reaction is a redox reaction.

$$CaC_2(s) + H_2O(l) \rightarrow HCCH(g) + CaO(s)$$

Ans: False

29. What will happen to the height (h) of the mercury column in the manometer shown below if the stopcock is opened, given that the atmospheric pressure is 755 mmHg?



A) h will decrease
B) h will not change
C) h will increase
D) not enough information given to answer the question

Ans: A

30. The pressure of a gas sample was measured to be 654 mmHg. What is the pressure in kPa? (1 atm = 1.01325×10^5 Pa)

A) 87.2 kPa
B) 118 kPa
C) 6.63×10^4 kPa
D) 8.72×10^4 kPa
E) 8.72×10^7 kPa

Ans: A

31. Which of the following statements is consistent with Boyle's Law concerning an ideal gas?

A) At constant temperature and moles, a plot of volume versus pressure is linear.
B) At constant pressure and volume, a plot of temperature versus moles is linear.
C) At constant pressure and moles, a plot of temperature versus volume is linear.
D) At constant temperature and moles, a plot of pressure versus the inverse of volume is linear.
E) At constant temperature and pressure, a plot of moles versus volume is linear.

Ans: D

32. A 45 mL sample of nitrogen gas is cooled from 135ºC to 15°C in a container that can contract or expand at constant pressure, what is the new volume of the nitrogen gas?

A) 64 mL B) 5.0 mL C) 410 mL D) 32 mL E) 41 mL

Ans: D

33. If the pressure on a gas sample is tripled and the absolute temperature is quadrupled, by what factor will the volume of the sample change?

A) 12 B) 4/3 C) 3/4 D) 1/3 E) 4

Ans: B

34. Calculate the number of moles of gas contained in a 10.0 L tank at 22°C and 105 atm. (R = 0.08206 L·atm/K·mol)

A) 1.71×10^{-3} mol B) 0.0231 mol C) 1.03 mol D) 43.4 mol E) 582 mol

Ans: D

35. How many atoms of He gas are present in a 450 mL container at 35°C and 740 mmHg?

A) 0.017 He atoms
B) 0.068 He atoms
C) 1.2×10^5 He atoms
D) 1.0×10^{22} He atoms
E) 7.9×10^{24} He atoms

Ans: D

36. Calculate the density, in g/L, of SF_6 gas at 27°C and 0.500 atm pressure.

A) 3.38×10^{-3} g/L B) 2.96 g/L C) 22.4 g/L D) 32.9 g/L E) 3.38 kg/L

Ans: B

37. A 0.271 g sample of an unknown vapor occupies 294 mL at 140.°C and 847 mmHg. The empirical formula of the compound is CH_2. What is the molecular formula of the compound?

A) CH_2 B) C_2H_4 C) C_3H_6 D) C_4H_8 E) C_6H_{12}

Ans: B

38. What volume of sulfur dioxide gas at 45 °C and 723 mmHg will react completely with 0.870 L of oxygen gas at constant temperature and pressure?

$$2\,SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

A) 0.0317 L B) 0.0634 L C) 0.870 L D) 1.74 L E) 3.48 L

Ans: D

39. How many liters of chlorine gas at 25°C and 0.950 atm can be produced by the reaction of 12.0 g of MnO_2 with excess HCl(aq) according to the following chemical equation?

$$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + 2H_2O(l) + Cl_2(g)$$

A) 5.36×10^{-3} L B) 0.138 L C) 0.282 L D) 3.09 L E) 3.55 L

Ans: E

40. If equal masses of $O_2(g)$ and HBr(g) are in separate containers of equal volume and temperature, which one of these statements is *true*?

A) The pressure in the O_2 container is greater than that in the HBr container.
B) There are more HBr molecules than O_2 molecules.
C) The average velocity of the O_2 molecules is less than that of the HBr molecules.
D) The average kinetic energy of HBr molecules is greater than that of O_2 molecules.
E) The pressures of both gases are the same.

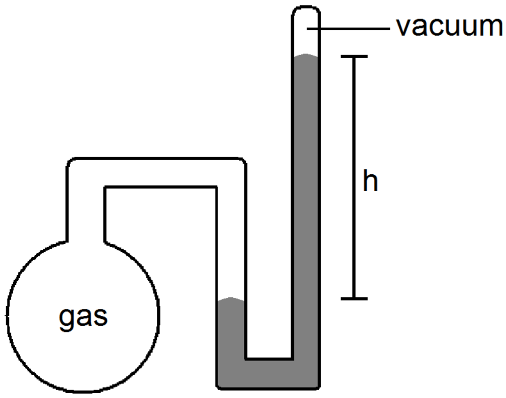
Ans: A

41. A sample of mercury(II) oxide is placed in a 5.00 L evacuated container and heated until it decomposes entirely to mercury metal and oxygen gas. The container is then cooled to 25°C. One now finds that the gas pressure inside the container is 1.73 atm. What mass of mercury(II) oxide was originally placed into the container?

A) 1.51 g B) 45.6g C) 76.6 g D) 913 g E) 153 g

Ans: E

42. What is the pressure (mmHg) of the sample of gas trapped in the closed-tube mercury manometer shown below if atmospheric pressure is 751 mmHg and h = 17.3 cm?



Ans: 173 mmHg

43. Define *Avogadro's Law*

Ans: At constant pressure and temperature, the volume of a gas is directly proportional to the number of moles of the gas present.

44. The following data describes an initial and final state for an ideal gas. Given that the amount of gas does not change in the process, what is the final volume (mL) of the gas?

	P	V	T
initial:	720 mmHg	235 mL	25°C
final:	860 mmHg	?	15°C

Ans: 190. mL

45. *Heat* is

A) a measure of temperature.
B) a measure of the change in temperature.
C) a measure of thermal energy.
D) a measure of thermal energy transferred between two bodies at different temperature.

Ans: D

46. An endothermic reaction causes the surroundings to

A) warm up.
B) become acidic.
C) condense.
D) decrease in temperature.
E) release CO_2.

Ans: D

47. An endothermic reaction causes the surroundings to

A) warm up.
B) become acidic.
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D) decrease in temperature.
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Ans: D

48. Aluminum metal has a specific heat of 0.900 J/g·°C. Calculate the amount of heat required to raise the temperature of 10.5 moles of Al from 30.5 °C to 225°C.

A) 1.84 kJ B) 2.41 kJ C) 65.1 kJ D) 49.6 kJ E) 57.3 kJ

Ans: D

49. Three separate 3.5g blocks of Al, Cu, and Fe at 25 °C each absorb 0.505 kJ of heat. Which block reaches the highest temperature? The specific heats of Al, Cu, and Fe are 0.900 J/g·°C, 0.385J/g·°C, and 0.444 J/g·°C, respectively.

A) Al B) Cu C) Fe D) Al and Cu E) Fe and Cu

Ans: B

50. If 10.6 moles of water at 35°C absorbs 12.30 kJ, what is the final temperature of the water? The specific heat of water is 4.184 J/g·°C.

A) 15°C B) 20°C C) 35°C D) 50.°C E) 312°C

Ans: D

51. Which of the following processes is *endothermic*?

A) $O_2(g) + 2H_2(g) \rightarrow 2H_2O(g)$

B) $H_2O(g) \rightarrow H_2O(l)$

C) $3O_2(g) + 2CH_3OH(g) \rightarrow 2CO_2(g) + 2H_2O(g)$

D) $H_2O(s) \rightarrow H_2O(l)$

Ans: D

52. The reaction that represents the standard enthalpy of formation for acetone (CH_3COCH_3), a common ingredient in nail polish remover is:

A) $3\ C(graphite) + 3\ H_2(g) + \frac{1}{2}\ O_2(g) \rightarrow CH_3COCH_3(l)$

B) $6\ C(diamond) + 6\ H_2(g) + O_2(g) \rightarrow 2\ CH_3COCH_3(l)$

C) $3\ C(diamond) + 3\ H_2(g) + \frac{1}{2}\ O_2(g) \rightarrow CH_3COCH_3(l)$

D) $CH_3COCH_3(l) \rightarrow 3\ C(graphite) + 3\ H_2(g) + \frac{1}{2}\ O_2(g)$

E) $CH_3COCH_3(l) + 4\ O_2(g) \rightarrow 3\ CO_2(g) + 3\ H_2O(g)$

Ans: A

53. When 0.560 g of Na(s) reacts with excess $F_2(g)$ to form NaF(s), 13.8 kJ of heat is evolved at standard-state conditions. What is the standard enthalpy of formation ($\Delta H°_f$) of NaF(s)?

A) -570 kJ/mol

B) –24.8 kJ/mol

C) –7.8 kJ/mol

D) 24.8 kJ/mol

E) 570 kJ/mol

Ans: A

54. Octane (C_8H_{18}) undergoes combustion according to the following thermochemical equation:

$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(l)$ $\Delta H°_{rxn} = –11,020$ kJ/mol.

Given that $\Delta H°_f[CO_2(g)] = –393.5$ kJ/mol and $\Delta H°_f[H_2O(l)] = –285.8$ kJ/mol, calculate the standard enthalpy of formation of octane.

A) –210 kJ/mol
B) –11,230 kJ/mol
C) 22,040 kJ/mol
D) –420 kJ/mol
E) 420 kJ/mol

Ans: A

55. Glycine, $C_2H_5O_2N$, is important for biological energy. The combustion reaction of glycine is given by the equation

$4C_2H_5O_2N(s) + 9O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l) + 2N_2(g)$ $\Delta H°_{rxn} = –3857$ kJ/mol

Given that $\Delta H°_f[CO_2(g)] = –393.5$ kJ/mol and $\Delta H°_f[H_2O(l)] = –285.8$ kJ/mol, calculate the enthalpy of formation of glycine.

A) –3,178 kJ/mol
B) –964 kJ/mol
C) –537.2 kJ/mol
D) –268.2 kJ/mol
E) 2,149 kJ/mol

Ans: C

56. During volcanic eruptions, hydrogen sulfide gas is given off and oxidized by air according to the following chemical equation:

$2H_2S(g) + 3O_2(g) \rightarrow 2SO_2(g) + 2H_2O(g)$

Calculate the standard enthalpy change for the above reaction given:

$3S(s) + 2H_2O(g) \rightarrow 2H_2S(g) + SO_2(g)$ $\Delta H° = 146.9$ kJ/mol

$S(s) + O_2(g) \rightarrow SO_2(g)$ $\Delta H° = –296.4$ kJ/mol

A) –1036.1 kJ/mol
B) –742.3 kJ/mol
C) –149.5 kJ/mol
D) 443.3 kJ/mol
E) 742.3 kJ/mol

Ans: A

57. Calculate the standard enthalpy change for the reaction

$2A + 2A_2 + 4AB + B \rightarrow 5A_2B$

Given:

$2A + B \rightarrow A_2B$ $\Delta H° = -25.0$ kJ/mol

$2A_2B \rightarrow 2AB + A_2$ $\Delta H° = 35.0$ kJ/mol

A) – 95.0 kJ/mol
B) – 60.0 kJ/mol
C) – 15.0 kJ/mol
D) 10.0 kJ/mol
E) 45.0 kJ/mol

Ans: A

58. An average home in Colorado requires 20. GJ of heat per month. How many grams of natural gas (methane) must be burned to supply this energy?

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ $\Delta H°_{rxn} = -890.4$ kJ/mol

A) 7.1×10^{-4} g
B) 1.4×10^{3} g
C) 1.4×10^{4} g
D) 2.2×10^{4} g
E) 3.6×10^{5} g

Ans: E

59. A gas is compressed in a cylinder from a volume of 20.0 L to 2.0 L by a constant pressure of 10.0 atm. Calculate the amount of work done on the system.

A) -1.81×10^{4} J B) –180 J C) 180 J D) 1.01×10^{4} J E) 1.81×10^{4} J

Ans: E

60. The *bond enthalpy* of the Br–Cl bond is equal to ΔH° for the reaction

$BrCl(g) \rightarrow Br(g) + Cl(g)$.

Use the following data to find the bond enthalpy of the Br–Cl bond.

$Br_2(l) \rightarrow Br_2(g)$ $\Delta H° = 30.91$ kJ/mol

$Br_2(g) \rightarrow 2Br(g)$ $\Delta H° = 192.9$ kJ/mol

$Cl_2(g) \rightarrow 2Cl(g)$ $\Delta H° = 243.4$ kJ/mol

$Br_2(l) + Cl_2(g) \rightarrow 2BrCl(g)$ $\Delta H° = 29.2$ kJ/mol

A) 14.6 kJ/mol
B) 203.5 kJ/mol
C) 219.0 kJ/mol
D) 438.0 kJ/mol
E) 407.0 kJ/mol

Ans: C

61. Given the following ΔH° values,

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l)$ $\Delta H^\circ_f = -285.8$ kJ/mol

$H_2O_2(l) \rightarrow H_2(g) + O_2(g)$ $\Delta H^\circ_{rxn} = 187.6$ kJ/mol

calculate ΔH°_{rxn} for the reaction $H_2O_2(l) \rightarrow H_2O(l) + \frac{1}{2} O_2(g)$,

Ans: –98.2 kJ/mol

62. A 0.3423 g sample of pentane, C_5H_{12}, was burned in a bomb calorimeter. The temperature of the calorimeter and the 1.000 kg of water contained therein rose from 20.22°C to 22.82°C. The heat capacity of the calorimeter is 2.21 kJ/°C. The heat capacity of water = 4.184 J/g·°C. What is the heat of combustion, in kilojoules, per gram of pentane?

Ans: 48.6 kJ/g

63. TRUE/FALSE: If $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$, $\Delta H^\circ = -1203.6$ kJ/mol.
For $Mg(s) + (1/2)O_2(g) \rightarrow MgO(s)$, the enthalpy change is $\Delta H = -601.8$ kJ/mol.

Ans: True

CHEM 1411 Formulas and Constants

mass of proton = 1.00728 amu	**mass of neutron = 1.00866 amu**
c = 3.00 X 10^8 m/s	**F = 96500 C/(mol of e^-) = 96500 J/(V mol of e^-)**
K = ^oC + 273.15	**R = 0.08206 (L atm)/(mol K) = 8.314 J/(mol K)**
1 g = 6.022 X 10^{23} amu	**1 atm = 760 mm Hg**

1 mL = 1 cm^3

Temperature scales/Conversion:

- $T_K = T_C + 273$ (Celsius to Kelvin)
- $T_C = T_K - 273$ (Kelvin to Celsius)
- $T_F = (1.8 \times T_C) + 32$ (Celsius to Fahrenheit)
- $T_C = (T_F - 32) / 1.8$ (Fahrenheit to Celsius)

$$\textbf{Percent by mass} = \frac{\text{mass of solute}}{[\text{mass of solute + mass of solvent}]} \times 100\%$$

Two-component solution:
Mole fraction of solute A: $$\mathbf{X_A} = \frac{\text{moles of solute A}}{\text{moles of solute A + moles of solvent B}}$$

Molarity = number of moles of solute in **1 L** of solution:

$$\textbf{Molarity} = \frac{\text{moles of solute}}{\text{Liters of solution}}$$

Molality = number of moles of solute dissolved in 1 kg (1000 g) of solvent:
$$\textbf{Molality} = \frac{\text{moles of solute}}{\text{Mass of solvent (1 kg)}}$$

Density = Mass / Volume.