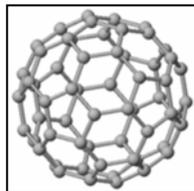1. The allotrope of carbon shown to the right is
    (A) graphite
    (B) diamond
    (C) buckminsterfullerene
    (D) carbofullerene.

2. Which of the following sets of ions is responsible for "hard" water?
    (A) Na^+, Ca^{2+}
    (B) Na^+, K^+
    (C) Ca^{2+}, Mg^{2+}
    (D) Mg^{2+}, SO_4^{2-}

3. The symbol for an isotope of iron is ^{56}Fe. The number of protons and neutrons in this isotope are
    (A) 26, 30
    (B) 30, 26
    (C) 26, 26
    (D) 26, 56

4. How was Earth's gold produced?
    (A) In the core of stars through fusion.
    (B) In nuclear decay of radioactive elements.
    (C) In supernovae explosions.
    (D) In the "big bang"

5. The K_a of the monoprotic acid is 4.0×10^{-5}. What percent of a 0.10 M solution is ionized?
    (A) 0.040
    (B) 2.0
    (C) 2.7
    (D) 6.3

6. A solution containing Zn^{2+} is prepared by dissolving 3.596 g of pure zinc in HCl and diluting to 500. mL. A 10.00 mL aliquot is then diluted to exactly 1.00 L. What is the molarity of the final solution? (Atomic weight: Zn= 65.39).
    (A) 1.10×10^{-3}
    (B) 5.50×10^{-4}
    (C) 1.10×10^{-1}
    (D) 1.10

7. What is the half life of Pa-234 if we started with 120 g of Pa-234, and had 1.88 g after 7 minutes?
    (A) 1.40 minutes
    (B) 0.109 minutes
    (C) 1.00 minutes
    (D) 1.17 minutes

8. The bond angle in degrees between lobes of sp hybrid orbitals is
    (A) 90º
    (B) 109.5º
    (C) 120º
    (D) 180º

9. The K_{sp} for $Fe(OH)_3$ is $Fe(OH)_3(s) \Leftrightarrow Fe^{3+}(aq) + 3OH^-(aq)$
   (A) $K_{sp} = [Fe^{3+}][OH^-]^3/[\,Fe(OH)_3]$
   (B) $K_{sp} = [Fe^{3+}][3OH^-]$
   (C) $K_{sp} = \{\,[Fe^{3+}][OH^-]^3\}^{1/2}$
   (D) $K_{sp} = [Fe^{3+}][OH^-]^3$

10. Consider the reaction:

    $H_2O_2 + 2H^+ + 3I^- \rightarrow 2\,H_2O + I_3^-$

    The rate of reaction of I^- is 0.030 M/sec. The rate of production of I_3^- is
    (A) 0.0050 M/sec
    (B) 0.010 M/sec
    (C) 0.030 M/sec
    (D) 0.090 M/sec

11. Which of the following statements about kinetic molecular theory is **false**?
    (A) When gas molecules collide, there is no loss in kinetic energy.
    (B) Gases have no volume.
    (C) All gases are moving with the same velocity at the same temperature.
    (D) The average kinetic energy of a gas is proportional to its temperature.

12. The solution with the lowest boiling point is
    (A) 0.008 m $Cu(NO_3)_2$
    (B) 0.006 m K_2SO_4
    (C) 0.01 m sucrose
    (D) 0.01 m NaCl

13. Choose a name-formula pair that does **not** correctly match.
    (A) sodium phosphate = Na_3PO_3
    (B) nickel (II) nitrite = $Ni(NO_2)_2$
    (C) silver acetate = $AgC_2H_3O_2$
    (D) aluminum hydroxide = $Al(OH)_3$

14. Acid rain is primarily due to the presence of sulfuric acid, H_2SO_4, in rain water When a 25.0 mL sample of acid rain is titrated, 1.00 mL of 0.0500 M NaOH to reach the end point. The pH of the original acid rain solution is

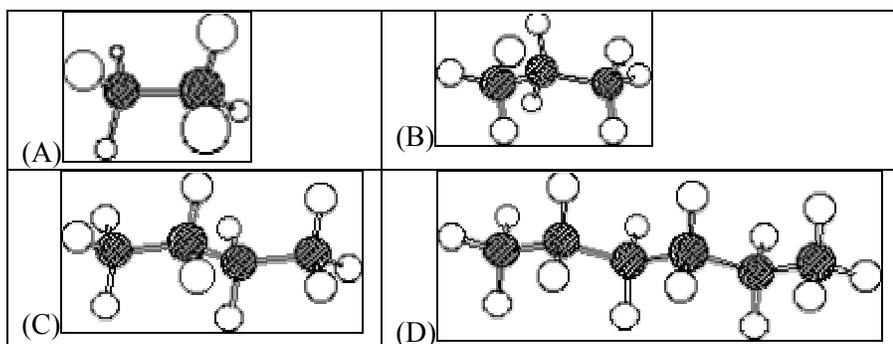 $H_2SO_4(aq) + 2\,NaOH(aq) \rightarrow Na_2SO_4(aq) + 2\,H_2O(l)$
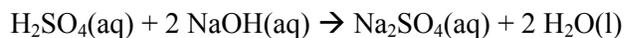
    (A) 2.40
    (B) 2.70
    (C) 3.00
    (D) 4.80

15. The butane molecule is

16. For which of these processes is the value of ΔS negative?
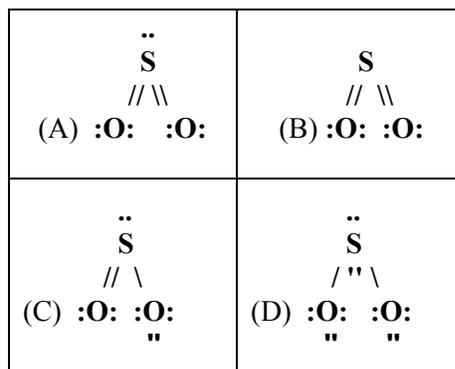
I. Sugar is dissolved in water.
II. Steam condenses on a surface.
III. $CaCO_3$ is decomposed into CaO and CO_2.

(A) I only
(B) II only
(C) I and III only
(D) II and III only

17. Aluminum dissolves in an aqueous solution of NaOH according to the following reaction::

$$2\ NaOH\ +\ 2\ Al\ +\ 2\ H_2O \rightarrow\ 2\ NaAlO_2\ +\ 3\ H_2$$

When 84.1 grams of NaOH is reacted with 51.0 grams of Al, the liters of H_2 at STP produced is
(atomic and molar masses: Al = 26.98, NaOH = 40.00, H_2=2.016)
(A) 42.3
(B) 47.1
(C) 63.5
(D) 70.6

18. The correct Lewis structure for SO_2 is

(A) $\overset{\displaystyle \cdot\cdot}{\underset{// \backslash\backslash}{S}}$:O: :O:	(B) $\overset{\displaystyle }{\underset{// \backslash\backslash}{S}}$:O: :O:
(C) $\overset{\displaystyle \cdot\cdot}{\underset{// \backslash}{S}}$:O: :O: "	(D) $\overset{\displaystyle \cdot\cdot}{\underset{/\ "\ \backslash}{S}}$:O: :O: " "

19. What is conjugate acid of NH_4^+ in the reaction

$$NH_4^+ + OH^- \rightarrow H_2O + NH_3$$
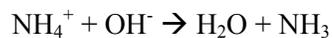
(A) NH_2^-
(B) NH_3
(C) OH^-
(D) H_2O

20. How many of the following would shift this reaction to the right?

$PbO_2(s) + 4\ H^+(aq) + Cu(s) \Leftrightarrow Pb^{2+}(aq) + 2\ H_2O + Cu^{2+}(aq)$

Acid is added.
PbO_2 is added.
The $[Pb^{2+}]$ is increased.
The pH is increased.
Sulfide ion is added.

(A) 1
(B) 2
(C) 3
(D) 4

21. Concentrated phosphoric acid, H_3PO_4, is 85.0% H_3PO_4 by mass and has a density of 1.70 g/mL. How many milliliters of this solution are required to prepare 500. mL of a 1.00 M H_3PO_4 solution?
(Molar mass: $H_3PO_4 = 98.0$)
(A) 25.5
(B) 33.9
(C) 98.0
(D) 339

22. Vanadium (V), atomic mass = 50.94, can exist in solution as different ionic species. When a 2.00 Amp current is applied for 500.0 seconds, 0.176 grams of V is produced. What is the oxidation state of V?
(Atomic mass of V=50.94, F=96500)

(A) +2
(B) +3
(C) +4
(D) +5

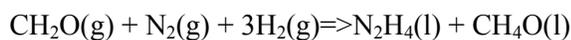23. Balance the following reaction and determine the sum of the coefficients of the reaction.

____$NaNO_2(aq) +$ ____$H_2SO_4(aq) \rightarrow$ ____$NO(g) +$ ____$HNO_3(aq) +$ ____$H_2O(l) +$ ____$Na_2SO_4(aq)$
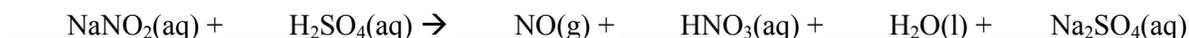
(A) 7
(B) 13
(C) 20
(D) 32

24. The element with the least metallic character is
(A) C
(B) N
(C) P
(D) Si

25. Use Hess's Law to find the enthalpy for the reaction:

$CH_2O(g) + N_2(g) + 3H_2(g) => N_2H_4(l) + CH_4O(l)$

$2NH_3(g) \rightarrow N_2H_4(l) + H_2(g)$	$\Delta H = 110.kJ$
$2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$	$\Delta H = 280.kJ$
$CH_4O(l) \rightarrow CH_2O(g) + H_2(g)$	$\Delta H = -395.kJ$

  (A) -5 kJ
  (B) 335 kJ
  (C) -565 kJ
  (D) 225 kJ

26. Point B indicates the
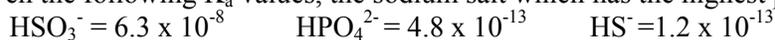 (A) boiling point as a function of pressure
  (B) conditions where gas and solid are in equilibrium.
  (C) melting point as a function of pressure
  (D) pressure and temperature at which the gas is the stable state
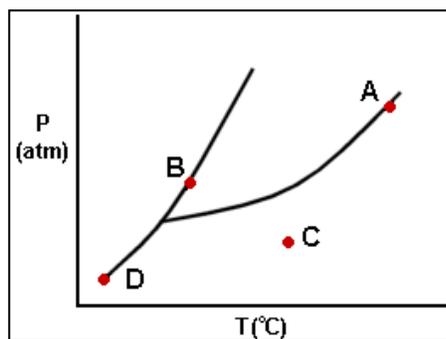
27. The freezing point of p-dichlorobenzene is 53.1°C; its K_f value is -7.10°C/m. A solution of 1.25 g. of a sulfa drug in 10.0 g of p-dichlorobenzene freezes at 47.1°C. What is the molecular weight of the sulfa drug?
  (A) 57
  (B) 83
  (C) 106
  (D) 148

28. Given the following K_a values, the sodium salt which has the highest pH when dissolved in water is
    $HSO_3^- = 6.3 \times 10^{-8}$ $HPO_4^{2-} = 4.8 \times 10^{-13}$ $HS^- = 1.2 \times 10^{-13}$
  (A) Na_2S
  (B) Na_2HPO_4
  (C) Na_3PO_4
  (D) Na_2SO_3

29. The molar mass of the gas was determined in the vapor density method. The molar mass of a gas whose density at 714 torr and 125°C is 4.43 g/L was found to be

  (A) 43
  (B) 48
  (C) 136
  (D) 154

30. For the reaction of the decomposition of formic acid: $HCOOH(l) \rightarrow CO(g) + H_2O(l)$, $\Delta H = 15.79$ kJ and $\Delta S = 215.27$ J/K. At what temperature will this reaction first became spontaneous?

  (A) It will never be spontaneous.
  (B) It will always be spontaneous.
  (C) 73.4 K
  (D) 346.4 K

31. The true statement about resonance structure of carbonate ion is
    (A) One C O bond energy is larger than the other two as shown by stretching frequencies the IR spectrum.
    (B) All three C O bonds are the same lengths, which is somewhat shorter than a single C O bond.
    (C) A sample contains many molecules, each of which has one C O bond shorter than the other two. Averaging all of these molecules produces an average distance that is somewhat shorter that a single C O bond.
   (D) One C O bond is more reactive than the other two because the double bond is less stable.

32. The graph to the right shows the change in temperature of water in an open container as heat is added at a constant rate. Which segment represents heating the sample in its liquid phase only?
    (A) BC
    (B) CD
    (C) DE
    (D) EF
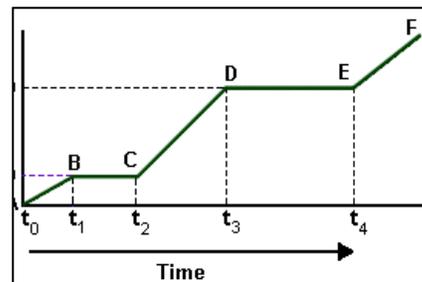
33. How many unpaired electrons are present in the ground state of gaseous Fe^{2+}?
    (A) 4
    (B) 5
    (C) 6
    (D) 7

34. The following rate data were obtained at 25°C for the given reaction. What is its rate-law expression?

$$2\ ClO_3^- + 9\ I^- + 6\ H^+ \rightarrow 3\ I_3^- + 2\ Cl^- + 3\ H_2O$$
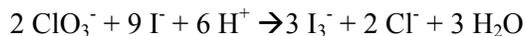
The rate law consistent with this data is

(A) Rate = $k[ClO_3^-][I^-][H^+]$
(B) Rate = $k[ClO_3^-][I^-]$
(C) Rate = $k[ClO_3^-][I^-][H^+]^2$
(D) Rate = $k[ClO_3^-]^2[I^-]^9[H^+]^3$

Exp.	$[ClO_3^-]$	$[I^-]$	$[H^+]$	initial rate (M/sec)
1	0.10	0.10	0.10	x
2	0.10	0.20	0.10	2x
3	0.20	0.40	0.10	8x
4	0.20	0.10	0.20	8x

35. What are the formal charges of carbon and oxygen in carbon monoxide, $:C\equiv O:$

|	C	O
(A)	0	0
(B)	-1	+1
(C)	+1	-1
(D)	0	-1

36. The enthalpy of fusion of iodine is 15.5 kJ/mol, and the enthalpy of sublimation of iodine is 57.3 kJ/mol. What is the enthalpy of vaporization of iodine?

    (A) -41.8 kJ/mol
    (B) 41.8 kJ/mol
    (C) -72.8 kJ/mol
    (D) 72.8 kJ/mol

37. Aqueous solutions of the compounds listed are mixed. The mixture which NOT result in a precipitate is
    (A) $Na_2CO_3 + AgNO_3$
    (B) $CoCl_2 + H_2SO_4$
    (C) $Cd(C_2H_3O_2)_2 + Na_2S$
    (D) $Pb(NO_3)_2 + KI$

38. Which is not part of Dalton's atomic theory?
    (A) In a chemical reaction, mass is conserved
    (B) For a compound, the ratio of the weights of any two elements is always a fixed
    (C) Atoms of the same element are identical.
    (D) Atoms are composed of protons, neutrons, and electrons

39. Using bond energies, given in kJ/mole, estimate the enthalpy of formation, in kJ/mol, of N_2F_4 (g), which has the following structure

    (A) -30 kJ
    (B) 30 kJ
    (C) 188 kJ
    (D) -816 kJ
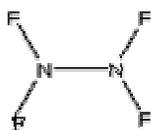
$N\equiv N$	945 kJ
$N - N$	159 kJ
$F - F$	158 kJ
$F - N$	283 kJ

40. One of the additives in unleaded gasoline that replaced tetraethyl lead in leaded gasoline is called MTBE. MTBE contains only C, H and O. When 1.508 g MTBE is burned completely, 3.764 g CO_2 and 1.848 g H_2O formed. In a separate experiment the molecular mass of MTBE is found to be in the range of 85-95. What is the empirical formula for MTBE? (Atomic masses: C = 12.0, O = 16.0, H = 1.01).
    (A) $C_3H_6O_3$
    (B) $C_3H_3O_3$
    (C) $C_4H_{10}O_2$
    (D) $C_5H_{12}O$

41. The correct formula for a compound of aluminum and nitrogen is
    (A) AlN
    (B) Al_3N_2
    (C) Al_2N_3
    (D) AlN_2

42. From the resonance structure for ozone, O_3, the bond order of the O – O bond is
    (A) 1
    (B) 1⅓
    (C) 1½
    (D) 2

43. A sample consisting of 25.00 mL of 0.200 M HBr is titrated with a solution of NaOH, which is 0.15 M. What is the pH of the solution after the addition of 10.00 mL base?
    (A) 0.10
    (B) 0.12
    (C) 1.00
    (D) 1.30

44. The energy in kJ/mole of blue light with wavelength 400 nm is (h=6.626 x 10^{-34} J-s, c=2.997 x 10^8 m/s)
   (A) 250
    (B) 299
    (C) 478
    (D) 496

45. A 25.00 g cadmium electrode in a solution of $CdSO_4$, functioning as the cathode, is used in a galvanic cell with Zn in a solution of $ZnSO_4$ as the anode. A current of 1.50 A flows for 3.05 hours. What is the mass of the Cd electrode at that time? (Atomic Mass Cd =112.4)
    (A) 9.59
    (B) 19.18
    (C) 34.59
    (D) 15.41

46. The hybrid orbitals that are used in the bonding of XeF_4 are
    (A) sp^3
    (B) d^2sp^3
    (C) dsp^3
    (D) dsp^2

47. The a graphical representation of Temperature vs. Volume of an ideal gas is
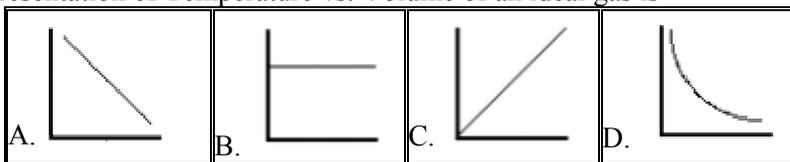
48. It takes 10.3 s for 1.0 mL of hydrogen to effuse from a porous container. It takes 61.8 s for 1.0 mL of an unknown gas to effuse under the same conditions from the porous container. The molecular mass of the gas is (Atomic mass: of H = 1.01).
    (A) 6.0
    (B) 12.
    (C) 36.
    (D) 72.

49. The pH of a solution made from 50.0 mL of 0.10 M of a weak acid and 100 mL of 0.20 M of its conjugate base when the pK_a is 7.10
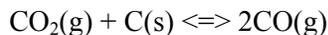   (A) 3.70
    (B) 6.50
    (C) 7.70
    (D) 10.30

50. The equilibrium constant is K_1 for the reaction $N_2(g) + O_2(g) \Longleftrightarrow 2NO(g)$
    The equilibrium constant is K_2 for the reaction $2NO(g) + O_2(g) \Longleftrightarrow 2NO_2(g)$

    What is K for this reaction? $NO_2(g) \Longleftrightarrow \frac{1}{2} N_2(g) + O_2(g)$

    (A) $1/(K_1K_2)$
    (B) $1/(2K_1K_2)$
    (C) $1/4K_1K_2$
    (D) $1/[K_1K_2]^{1/2}$

51. The condition that would make more product for the endothermic reaction shown is

    $CO_2(g) + C(s) \Longleftrightarrow 2CO(g)$

    (A) decrease the volume of the reaction vessel
    (B) increase the temperature
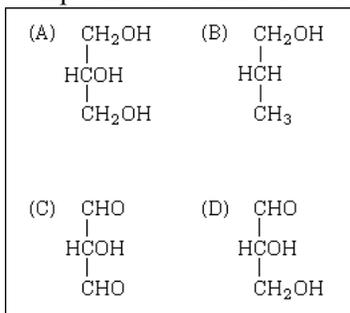   (C) add C(s) to the reaction
    (D) add a catalyst

52. The molecule with the highest heat of vaporization is
   (A) HF
    (B) HCl
    (C) HBr
    (D) HI

53. The pH of a saturated solution of calcium hydroxide is 12.40. What is K_{sp} for this salt?

    (A) 6.3×10^{-38}
    (B) 1.58×10^{-25}
    (C) 7.9×10^{-6}
    (D) 1.58×10^{-5}

54. The compound that forms diastereomers (optical isomers) is

    (A) CH_2OH
         |
         $HCOH$
         |
         CH_2OH

    (B) CH_2OH
         |
         HCH
         |
         CH_3

    (C) CHO
         |
         $HCOH$
         |
         CHO

    (D) CHO
         |
         $HCOH$
         |
         CH_2OH

55. Given K_a values of 1.8×10^{-5} and 6.8×10^{-4} for $HC_2H_3O_2$ and HF respectively, the equilibrium constant for the following reaction is

    $C_2H_3O_2^- + HF \rightarrow HC_2H_3O_2 + F^-$
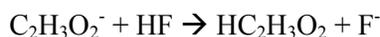
    (A) 7.0×10^{-4}
    (B) 1.2×10^{-8}
    (C) 2.7×10^{-2}
    (D) 37.8

56. NaCl is a face-centered cubic crystal. The coordination number of Na^+ ion in this crystal is:

    (A) 2
    (B) 4
    (C) 6
    (D) 8

57. This is a schematic of a typical dry cell battery. What is the half-reaction of the reduction in this cell?

    (A) $Zn(s) + 2\ OH^- \rightarrow Zn(OH)_2(s) + 2\ e^-$
    (B) $Zn(s) + 2\ MnO_2(s) + 2\ e^- \rightarrow Mn_2O_3(s) + 2\ OH^-(aq)$
    (C) $Zn(s) + H_2O(l) + 2\ MnO_2(s) \rightarrow Mn_2O_3(s) + Zn(OH)_2(s)$
    (D) $2\ MnO_2(s) + H_2O\ (l) + 2\ e^- \rightarrow Mn_2O_3(s) + 2\ OH^-(aq)$

Carbon Rod
Paste of KOH, MnO$_2$
Zinc Can
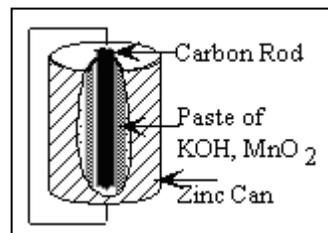
58. The solution with the lowest vapor pressure is
    (A) water at 20°C.
    (B) 1 M NaCl(aq) at 40°C
    (C) 1 M NaCl(aq) at 20°C.
    (D) water at 40°C.

59. Sodium benzoate, $NaC_7H_4O_2$, is used as a food preservative. Calculate the pH of a 0.50 M solution of sodium benzoate given $K_a = 6.3 \times 10^{-5}$ for benzoic acid.
    (A) 2.25
    (B) 5.05
    (C) 8.95
    (D) 11.75

60. The units of a second-order rate constant are:
    (A) sec^{-1}
    (B) $mol\ L^{-1}\ sec^{-1}$
    (C) $mol^2\ L^{-2}\ sec^{-1}$
    (D) $L\ mol^{-1}\ sec^{-1}$

61. The correct ordering of the following ionic substances in order of increasing lattice energy is

| NaCl | $MgCl_2$ | $AlCl_3$ |

    (A) $NaCl < MgCl_2 < AlCl_3$
    (B) $AlCl_3 < MgCl_2 < NaCl$
    (C) $MgCl_2 < NaCl < AlCl_3$
    (D) $NaCl < AlCl_3 < MgCl_2$

62. Carbohydrates are the building blocks of polymers called
    (A) proteins
    (B) cellulose
    (C) fats
    (D) polypeptides

63. What is the $[H^+]$ concentration of a solution that is prepared by mixing 50.0 mL of 0.50 M HCl with 200.0 mL of 0.25 M HCl?
    (A) 0.30 M
    (B) 0.35 M
    (C) 0.40 M
    (D) 0.45 M

64. A 0.500 g sample of an unknown acid is dissolved in 50.0 mL of water and titrated with 0.100 M NaOH to the equivalence point. The volume of the base used is 45.5 mL. The molecular weight of the unknown acid assuming one dissociable proton per molecule is
    (A) 9.10
    (B) 52.3
    (C) 105
    (D) 110

65. K_a for hydrofluoric acid is 6.9×10^{-4}. What is the K for the reaction?

    $F^-(aq) + H_2O(l) \rightarrow HF(aq) + OH^-(aq)$
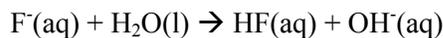
    (A) 6.9×10^{-11}
    (B) 1.4×10^{-11}
    (C) 2.6×10^{-9}
    (D) 8.3×10^{-6}

66. Oxalic acid, $H_2C_2O_4$, has two pK_a values, 1.25 and 4.27. A 0.100 M solution of oxalic acid was titrated with a 0.100 M solution of NaOH. What is the pH at the second equivalence point is
    (A) 1.23
    (B) 5.60
    (C) 8.40
    (D) 12.52

67. Which of the following compounds contains only 1 double bond?
    (A) CO_2
    (B) KNO_3
    (C) $CHClF_2$
    (D) C_2H_2

68. The concentration of oxygen saturated solution due to atmospheric oxygen dissolving in distilled water at room temperature is about 8.3 ppm. What would the concentration be if the concentration of oxygen in the atmosphere were 45% instead of 21%? Assume the temperature and pressure is constant.
   (A) 3.9 ppm
    (B) 18 ppm
    (C) 110 ppm
    (D) 7800 ppm

69. Which indicator would you chose for a titration between a weak acid (K_a=1.8 x 10^{-5}) and a strong base?
    (A) bromthymol blue pKa = 7.0
    (B) indigo carmine pKa = 13.8
    (C) cresol red pKa = 8.0
    (D) methyl red pKa = 5.1

70. Concentration of reactant [A] versus time that produces a straight line for a first order reaction when plotted is:
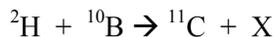
    (A) 1/[A]
    (B) [A]
    (C) ln[A]
    (D) $[A]^2$

71. The ΔG^o of $NH_3(g)$ is –33.3 kJ/mole. Calculate ΔG for the reaction mixture containing 1.0 atm N_2, 2.0 atm H_2, and 1.0 atm NH_3 at 1000K.

    $$3 H_2(g) + N_2(g) \Leftrightarrow 2 NH_3(g)$$
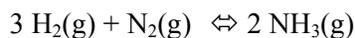
    (A) –16.0 kJ
    (B) –39.1 kJ
    (C) –50.6 kJ
    (D) 6.8 kJ

72. In balancing the following nuclear reaction, the particle X is:

$$^{2}H + {}^{10}B \rightarrow {}^{11}C + X$$

    (A) a proton
    (B) a neutron
    (C) an electron
    (D) an alpha particle

73. Which identical gas samples in the graph has the lowest temperature?

    (A) A
    (B) B
    (C) C
    (D) All are at the same temperature
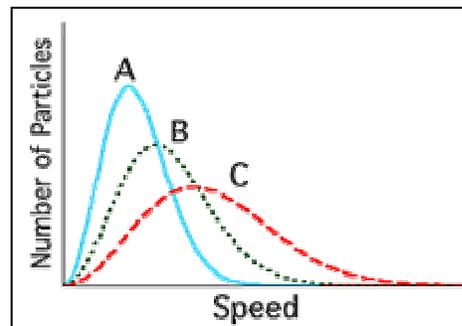
74. Stars produce by fusion of 4 protons (^{1}H atoms) into ^{4}He and 2 positrons, β^{+}, positive electrons and heat, Q, according to the following reaction:

$$4\,^{1}H \rightarrow {}^{4}He + 2\,\beta^{+} + Q$$

The heat, Q, produced in J/mole Helium, is:
(A) 9624
(B) 2.89×10^{12}
(C) 2.89×10^{15}
(D) 2.98×10^{12}

Particle	Rest Mass
^{1}H	1.00867
^{4}He	4.00150
β^{+}	0.00055

75. A 1.000 g sample of iron ore sample is converted into a solution of Fe^{2+} and is titrated with $KMnO_4$. If one requires 25.0 mL of 0.0250 M $KMnO_4$, what is the percent of iron in the iron ore? The major products are Fe^{3+} and Mn^{2+}. (Atomic mass: Fe=55.84)
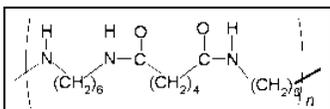   (A) 3.49
    (B) 10.5
    (C) 17.4
    (D) 34.9

76. The electron configuration which has the lowest ionization energy is (n is a nonspecific energy level)
    (A) $ns^2\,np5$
    (B) $ns^2\,(n-1)d^{10}\,np^6$
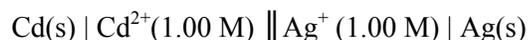   (C) $ns^2\,(n-1)d^1$
    (D) ns^1

77. The common polymer shown below is

    (A) nylon
    (B) polyethylene
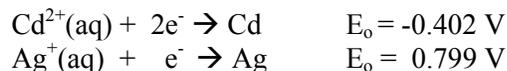   (C) teflon
    (D) polystyrene

Questions 78 and 79 relate to the following

A galvanic cell is made from a Cd strip, a Ag rod coated with AgCl and 1.0 M solutions of $CdCl_2$, $AgNO_3$, This cell may be described as:

Cd(s) | Cd^{2+}(1.00 M) ‖ Ag^+ (1.00 M) | Ag(s)

The standard electrode potentials are

Cd^{2+}(aq) + 2e⁻ → Cd E_o = -0.402 V
Ag^+(aq) +   e⁻ → Ag E_o = 0.799 V

78. The standard cell potential E^o for this cell is:
    (A) 0.598 V
    (B) 0.399 V
    (C) 0.397 V
    (D) 1.201 V

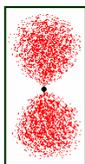79. What is the cell voltage if $[Cd^{2+}]$ = 0.010 M and $[Ag^+]$ = 0.50 M?
    (A) 1.160 V
    (B) 1.242 V
    (C) 1.222 V
    (D) 1.283 V

80. The number of isomers that can be drawn for $C_4H_{10}O$ is
    (A) 4
    (B) 5
    (C) 6
    (D) 7

81. The type of orbital illustrated is
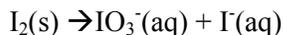   (A) p orbital
    (B) f orbital
    (C) s orbital
    (D) d orbital

82. The $[H_3O^+]$ concentration in blood needs to be maintained around 4 x 10^{-8} M. Which buffer system would be most effective in maintaining this concentration?
    (A) pyridine (pK_b = 8.75)
    (B) $H_2PO_4^-$ (pK_a = 7.20)
    (C) phenol (pK_a = 9.77)
    (D) H_2CO_3 (pK_a = 6.37)

83. Iodine undergoes autoxidation in basic solution. The unbalanced reaction is:

    I_2(s) → IO_3^-(aq) + I^-(aq)

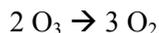   When the equation is correctly balanced, the coefficient in front of I^- is:
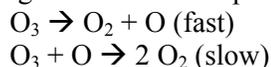   (A) 1
    (B) 3
    (C) 5
    (D) 10

13

84. Based on VSEPR, the molecular shape of XeO_3 is
    (A) trigonal planar
    (B) trigonal pyramidal
    (C) T-shaped
    (D) Square planar

85. Ozone decomposes according to the following balanced equation:

    $$2 O_3 \rightarrow 3 O_2$$

    The following mechanism was proposed
    $O_3 \rightarrow O_2 + O$ (fast)
    $O_3 + O \rightarrow 2 O_2$ (slow)

    Select the rate law rate expression for this mechanism.

    (A) rate $= k [O_3]^2 / [O_2]$
    (B) rate $= k [O_3]^2 [O]$
    (C) rate $= k [O_3]^2$
    (D) rate $= k [O_2]^3$

86. A solution is 0.10 M $La(NO_3)_3$ and 0.10 M $Ca(NO_3)_2$. If solid NaF is added to the solution, what is $[La^{3+}]$ when CaF_2 first begins to precipitate? (K_{sp} $CaF_2 = 4.0 \times 10^{-11}$; $LaF_3 = 2.0 \times 10^{-19}$)
    (A) 2.5×10^{-5}
    (B) 2.7×10^{-8}
    (C) 5.0×10^{-9}
    (D) 8.0×10^{-15}

87. A solutions is prepared by mixing 100.0g of acetone (molar mass = 58.1 g/mol) and 50.0 g of methanol (molar mass = 32.0g/mol) at 25°C. At this temperature, the vapor pressures of the pure substances are 271 and 143 torr, respectively. The total vapor pressure of the solution is
    (A) 140 torr
    (B) 171 torr
    (C) 210 torr
    (D) 414 torr

88. Which of the following has bond angles of approximately 109.5°?

1) ClF_3	2) NH_3	3) SO_3^{2-}	4) BF_3

    (A) 1 and 2
    (B) 2 and 4
    (C) 2 and 3
    (D) 3 and 4

89. Which one of the following relationships when graphed does **not** give a straight line for an ideal gas?
    I. V versus n at constant pressure and temperature
    II. P versus 1/V at constant temperature for a constant mass
    III. V versus 1/T at constant volume for a constant mass
    (A) I
    (B) II
    (C) III
    (D) I & III

90. Based on the following information arrange four metals, A, B, C, and D in order of increasing ability to act as reducing agents.
      I. A, B, and D do not react with 1 M HCl to give H_2 (g).
      II. When A is added to solutions of the other metal ions, no metallic products are obtained.
      III. Metal D does not react with B^{n+}

    (A) C > B > D > A
    (B) C > B > A > D
    (C) B > C > D > A
    (D) B > C > A > D

91. In the reaction $3A(g) + 2B(g) <=> C(g)$, the initial concentrations were A = C = 0.20 M, B = 0. At equilibrium, the concentration of B is 0.10 M. The equilibrium constant, K_c, is:
    (A) 6
    (B) 43
    (C) 60
    (D) 350

92. A piece of gold weighing 50.0 g is heated to 200°C and then dropped into a Styrofoam cup of water at 20°C. There is 100.0 g of water in the cup. What is the final temperature in °C of the water-Au-cup system?
    (Specific heats: Au = 0.129 J/ g · °C and H_2O = 4.18 J/ g · °C)
    (A) 16.7
    (B) 22.7
    (C) 23.4
    (D) 43.4

Questions 93 and 94 deal with the titration curve (shown below) of a weak acid with a strong base.

93. In the titration curve on the right, 100 mL of a 0.100 M acid solution was titrated with a standardized solution NaOH. What is the molarity of the base?
    (A) 0.025 M
    (B) 0.050 M
    (C) 0.100 M
    (D) 0.200M

94. Select the acid titrated.

$HClO_2$	$K_a = 1.1 \times 10^{-2}$
HClO	$K_a = 3.0 \times 10^{-8}$
$HC_4H_7O_2$	$K_a = 1.5 \times 10^{-5}$

    (A) HCl
    (B) HClO
    (C) $HClO_2$
    (D) $HC_4H_7O_2$
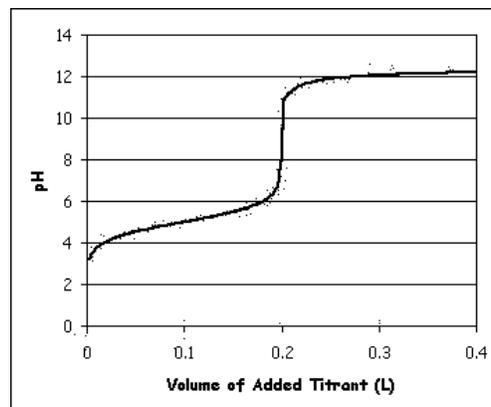
95. The sample which contains the most oxygen atoms is
    (Atomic masses: C = 12.0, O = 16.0, N=14.0, S = 32.1)
    (A) 12 grams of CO_2
    (B) 0.24 moles of NO_2
    (C) 1.8×10^{23} molecules of SO_2
    (D) 5.6 liters of SO_2 at STP

96. A student determines the concentration of a NaOH solution. She pipets the NaOH solution into a flask and adds two drops of indicator. Standardized acid is added from a buret until the indicator changes color. Which device may contain residual water without affecting the results of the titration?

   1. buret
   2. flask
   3. pipet

   (A) 1 only
   (B) 2 only
   (C) 1 and 3 only
   (D) 2 and 3 only

97. When atoms or molecules are excited to high energy levels, they decay to lower levels by releasing radiation. This is called
   (A) absorption
   (B) scattering
   (C) resonance
   (D) emission .

98. The line segment in the diagram represents the activation energy and heat of reaction for this reaction, $A + B \rightarrow C + D$, is

	Activation Energy	Heat of Reaction
(A)	1	2
(B)	2	3
(C)	2	4
(D)	4	2
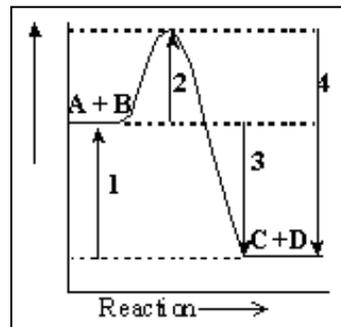
99. The solubility of solid silver chromate, Ag_2CrO_4, $Ksp = 9 \times 10^{-12}$, is determined in three solvents.

   I. pure water
   II. 0.1 M $AgNO_3$
   III. 0.1 M Na_2CrO_4

   Predict the relative solubility of Ag_2CrO_4 in the three solvents.

   (A) I = II = III
   (B) I < II < III
   (C) II = III < I
   (D) II < III < I

100. The drug, ibuprofen, is shown on the right. Which region of ibuprofen is most responsible for the fact that this drug dissolves well in nonpolar cell membranes and fatty tissues?

   (A) 1
   (B) 2
   (C) 3
   (D) 4
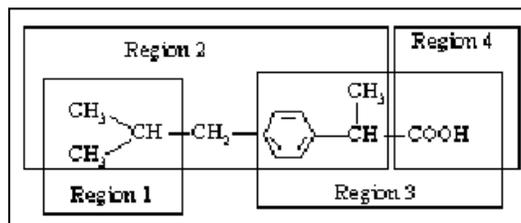
Common Physical and Chemical Constants

Avogadro's Number	**6.022×10^{23} things/mole**
Planck's Constant	**6.626×10^{-34} Js**
1 atmosphere (atm)	**101,325 Pascals (Pa) = 101.325 kPa** **= 760 mm of Hg = 760 Torr = 1.01325 bar**
1 mole of any gas at STP	**22.4 L (0°C, 1 atm)**
1 mole of any gas at SATP	**24.8 L (25°C, 1 atm)**
Ideal Gas Law Constant (R)	**0.0821 L atm mol^{-1} K^{-1} = 8.314 L kPa mol^{-1} K^{-1}** **= 8.314 J mol^{-1} K^{-1}**
1 calorie (cal)	**4.184 J**
1 Cal	**1 kcal = 1000 calories**
1 atomic mass unit (amu)	**1.661×10^{-24} g**
1 tonne(t)	**1000 kg = 1 Mg**
Speed of light in a vacuum	**3.00×10^{8} m s^{-1}**
Rest mass of an electron (m_e)	**9.109×10^{-28} g**
Rest mass of a proton (m_p)	**1. 1.673×10^{-24} g**
Rest mass of a neutron (m_n)	**1.675×10^{-24} g**
1 kiloWattHour(kWh)	**3.6 MJ**
1 Joule (J)	**1 kg m^2 s^{-2} = 1.0×10^{7} erg**
1 Coulomb(C)	**6.24×10^{18} e^-**
Electronic charge on an electron	**1.60×10^{-19} C**
1 Ampere(A)	**1 Coulomb/s**
1 Volt(V)	**1 J/C = 96.5 kJ/mole**
1 electron volt (eV)	**1.60219×10^{-19} J**
Faraday's Constant	**96,500 C/mole e^-**

http://www.ucdsb.on.ca/tiss/stretton/chem2/data03.htm

Common Equations

Light	Gases	Thermochemistry	Equilibrium	Redox
$E = h\nu = hc/\lambda$	$PV = nRT$	$\Delta G^0 = \Delta H^o - T\Delta S^o$	$K_p = K_c^{\Delta n}$	$E_{cell} = E^o_{cell} - (0.0592/n) \log Q$
		$\Delta G = \Delta G^o + RT\ln Q$	$K_w = 1 \times 10^{-14}$	
		$q = mc\Delta T$		
Energy-Mass				
$E = mc^2$				