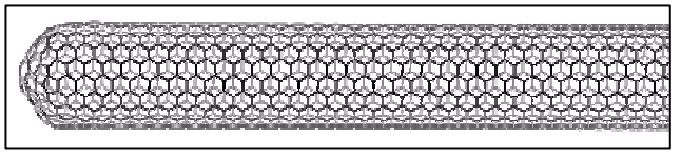
1. The allotrope of carbon shown to the right is:



(A) buckminsterfullerene
(B) graphite
(C) nanotube
(D) diamond

2. The largest and most complicated class of minerals are:

(A) the halides
(B) the sulfates
(C) the silicates
(D) the oxides

3. In flame testing cobalt glass is used to help detect

(A) potassium
(B) lithium
(C) calcium
(D) sodium

4. In balancing the following reaction, the **coefficient for nitrogen** is:

$$\_\_\_\_\_HNO_3 + \_\_\_\_\_N_2H_4 \rightarrow \_\_\_\_\_N_2 + \_\_\_\_\_H_2O$$

(A) 4
(B) 7
(C) 8
(D) 9

5. Which of the following has the ability to be both a conjugate acid and a conjugate base?

(A) OH^-
(B) H_3O^+
(C) $HC_2H_3O_2$
(D) SO_4^{2-}

6. A radioactive element X decays by electron (beta) emission with a half-life of 4 days to a stable nuclide of element Z. Which of the following statements is **CORRECT**?
(A) After 8 days the sample will consist of one-fourth element Z and three-fourths element X.
(B) Element Z will weigh **exactly** the same as element X when decay is complete (weighed to an infinite number of significant figures).
(C) 2.0 g of element X is required to produce 1.5 g of element Z after 8 days (to 2 significant figures).
(D) If element X as an atomic number equal to n, element Z has an atomic number equal to n-1.

7. Which one of the following statements about solid Cu (face-centered cubic unit cell) is **INCORRECT**?

(A) The length of a face diagonal is four times the Cu radius.
(B) The solid has a cubic closest-packed structure.
(C) The number of atoms surrounding each Cu atom is twelve.
(D) There are 2 atoms per unit cell.

8. A spherical molecule crystallizes in a simple (primitive) cubic lattice. The molar mass of the molecules is 800.0 g/mol and density is 1.328 g/cm^3, what is the radius of the molecule in nanometers (nm)? 1 nm = 10^{-9} m

   (A) 0.50 nm
   (B) 0.053 nm
   (C) 1.0 nm
   (D) 0.25 nm

9. How many grams of Zn^{2+} will be plated out by a current of 4.00 A for 3.00 hours through a solution containing the ion? (Zn = 65.4 g/mol, *F* =96500, 1 hour = 3600 s)

   (A) 7.31 g
   (B) 14.6 g
   (C) 29.3 g
   (D) 73.0 g

10. Based on the reaction below, determine the average Xe—F bond enthalpy in XeF_6.
    The value for enthalpy of dissociation for fluorine, $F_2(g) \rightarrow 2F(g)$ ΔH= -160 kJ/mole

    $Xe(g) + 3\ F_2(g) \text{---> } XeF_6(g)$ ΔH= -400 kJ/mole

    (A) 13 kJ
    (B) 67 kJ
    (C) 147 kJ
    (D) 880 kJ

11. When $Ca_3P_2(s)$ is treated with water, the products are $Ca(OH)_2(s)$ and $PH_3(g)$, as given by the balanced equation:

    $$Ca_3P_2(s) + 6H_2O(l) \rightarrow 3Ca(OH)_2(s) + 2PH_3(g)$$

    A student reacts 15.0 g of Ca_3P_2 (molar mass = 182.2) and 9.00 g H_2O (molar mass = 18.0) and obtains 5.00 g of PH_3 (molar mass = 34.0). The student's percent yield is

    (A) 26.4%
    (B) 33.3%
    (C) 79.4%
    (D) 89.2%

12. Choose a name-formula pair that does **not** correctly match.

    (A) hypochlorous acid = HClO
    (B) carbonic acid = H_2CO_3
    (C) periodic acid = HIO_4
    (D) phosphorous acid = H_2PO_3

13. A compound used to make PVC plastic tubing took 7.73 minutes to effuse through a porous plug and 6.18 minutes for the same amount of argon. What is the molar mass of the compound? (Atomic masses: Ar=40.0)

    (A) 25.5
    (B) 32.0
    (C) 50.0
    (D) 62.5

14. Which of the following has the same number of grams of oxygen as 42 g of nitric acid, HNO_3?
(N = 14.0, H=1.0, O = 16.0)

(A) 1.33 moles of NO_2
(B) 1.80 x 10^{24} moles of NO
(C) 46 grams of N_2O_4
(D) 12 grams of H_2O

15. A balanced chemical equation gives all but one of the following:

(A) The number of moles of reactants and products
(B) The number of molecules of reactants and products
(C) The relative mass of each reactant and product
(D) Whether the reaction will proceed as written

16. Excessive exposure to sunlight increases the risk of skin cancer because some of these photons have enough energy to break chemical bonds in biological molecules. The minimum energy required to break a carbon-carbon single bond is 350 kJ/mole. Find the minimum wavelength of electromagnetic radiation in nanometers that will provide this energy.

c = 3.00 x 10^8 m/s, h = 6.62 x 10^{-34} J/s, 1 mole =6.02 x 10^{23}, 1 nm = 10^{-9} m

(A) 5.67 x 10^{-19} nm
(B) 233 nm
(C) 342 nm
(D) 552 nm

17. The category of biological molecule is used to make starch is

(A) carbohydrates
(B) lipids
(C) proteins
(D) nucleic acids

18. The number of unpaired electrons in the gaseous Fe^{2+} ion is:

(A) 4
(B) 5
(C) 6
(D) 7

19. When the Fe^{2+} is octahedrally coordinated with CN^- to make $Fe(CN)_6^{4-}$ a strong crystal field results. The number of unpaired electrons in Fe is:

(A) 0
(B) 1
(C) 2
(D) 4

20. When liquid O_2 is cooled at 1 atm pressure, it freezes to form **Solid I** at 54.5 K. At a lower temperature, **Solid I** rearranges to **Solid II**, which has a different crystal structure. For the phase transition of **Solid I** to **Solid II**, ΔH= -743.1 J/mol and ΔS = -17.0 J/K·mol. At what temperature are **Solids I** and **II** in equilibrium?

(A) 2.06 K
(B) 31.5 K
(C) 43.7 K
(D) 53.4 K

Questions 21 and 22 deal with the electrochemical cell described below. The Nernst equation is:

$$E_{cell} = E° - \frac{0.0592}{n} \log Q$$

21. The following cell is made: The cathode is a Zn rod dipped in a 1.0 M $Zn(NO_3)_2$ solution. The anode is a Zn rod dipped in a 1.0 M solution of KOH. Immediately $Zn(OH)_2$ forms on its surface. A salt bridge is inserted between the two half cell solutions and a voltmeter connects the two Zn rods. The schematic is given below. The cell potential at 25°C for the cell is

$$Zn(s)|Zn(OH)_2(s)|OH^-(1.0\ M)||Zn^{2+}(1.0\ M)|Zn(s).$$

$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	E^o = -0.762 V
$Zn(OH)_2(s) + 2e^- \rightarrow Zn(s) + 2OH^-(aq)$	E^o = -1.249 V

(A) -2.011 V
(B) -0.487 V
(C) 0.487 V
(D) 2.011 V

22. From the above cell, the K_{sp} for $Zn(OH)_2$ is:

(A) 2.7×10^{-4}
(B) 7.2×10^{-8}
(C) 5.9×10^{-9}
(D) 3.5×10^{-17}

23. For the reaction below K_c is 1.2×10^3.

$$CO(g) + Cl_2(g) \rightleftarrows COCl_2(g)$$

A mixture is prepared at 395°C in which [CO] = 1.5 M, [Cl_2] = 2.0 M and [$COCl_2$] = 0.10. What will happen to this mixture?

(A) Nothing, the mixture is at equilibrium.
(B) The mixture will proceed to the right to reach equilibrium.
(C) The mixture will proceed to the left to reach equilibrium.
(D) The mixture will run out of CO(g) before the system reaches equilibrium.

24. Given the following K values:

½ $N_2(g)$ + ½ $O_2(g) \rightleftarrows$ NO(g)	K= 6.6 x 10^{-13}
2 $NO_2(g) \rightleftarrows$ 2 NO(g) + $O_2(g)$	K= 1.6 x 10^{-10}

Calculate the value of K for the following reaction: 2 $NO_2(g) \rightleftarrows N_2(g)$ + 2 $O_2(g)$

(A) 131
(B) 242
(C) 3.7 x 10^{14}
(D) 2.4 x 10^{29}

25. Nickel oxide, NiO, is reduced to nickel metal in an industrial process according to the following reaction:

$NiO(s) + CO(g) \rightarrow Ni(s) + CO_2(g)$

The equilibrium constant (at 1600 K) for the above reaction is 6.0 x 10^2. Find ΔG^o for the reaction. (R = 8.314 J/mol · K)

(A) 85 kJ
(B) -37 kJ
(C) -85 kJ
(D) -100 kJ

26. Which statement about enzyme catalyzed reactions is **NOT** true?

(A) Enzymes change the K_{eq} for chemical reactions.
(B) Enzymes lower the activation energy for chemical reactions.
(C) Many enzymes change shape slightly when substrate binds.
(D) Reactions occur at the "active site" of enzymes, where a precise 3D orientation of amino acids is important.

27. In the balanced equation below, the particle X is:

$${}^{252}_{98}\mathrm{Cf} + {}^{10}_{5}\mathrm{B} \rightarrow 3{}^{1}_{0}\mathrm{n} + \mathrm{X}$$

(A) ${}^{262}_{102}\mathrm{No}$
(B) ${}^{259}_{100}\mathrm{Fm}$
(C) ${}^{261}_{103}\mathrm{Lr}$
(D) ${}^{259}_{103}\mathrm{Lr}$

28. Ag^+ at a concentration of 10-100 ppb is an effective disinfectant for swimming pools. However, the silver ion concentration should not exceed the above limit for human health. Which salt below would be an effective disinfectant? 1 ppb = 1 x10^{-9} g/mL, Ag = 107.9 g/mole

(A) AgCl only
(B) AgBr only
(C) AgI only
(D) none of the three.

K_{sp}	AgCl	2. x 10^{-10}
	AgBr	5. x 10^{-13}
	AgI	8. x 10^{-17}

29. The strongest acid in water is

(A) $HClO_4$
(B) $HClO_3$
(C) $HClO_2$
(D) HClO

.

30. In the correct Lewis dot structure for carbonic acid, H_2CO_3, the structure contains ___ single bonds, ___ double bonds and ___ lone pairs of electrons.

(A) 5, 1, 6
(B) 5, 0, 8
(C) 5, 0, 7
(D) 4, 1, 6

31. A fuel cell uses $H_2(g)$ and $O_2(g)$ to form H_2O. The half cell reactions are given below. The standard electrode emf for the cell 1.23 V. The maximum electrical work per mole of H_2O from the cell is: (F = 96,500)

(A) 119 kJ
(B) 237 kJ
(C) 475 kJ
(D) 1.23 J

Cathode:	$4e^- + O_2(g) + 2\ H_2O(l) \rightarrow 4OH^-(aq)$
Anode:	$2\ H_2(g) + 4OH^-(aq) \rightarrow 4H_2O + 4e^-$
Cell:	$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l)$

32. Human blood has a pH of 7.3. On the basis of the information in the table below, a buffer that is compatible with the pH of human blood can best be made by using

(A) pure NaH_2PO_4
(B) $H_3PO_4 + H_2PO_4^-$
(C) $H_2PO_4^- + PO_4^{3-}$
(D) $H_2PO_4^- + HPO_4^{2-}$

Acid	Acid Dissociation Constant, K_a
H_3PO_4	7×10^{-3}
$H_2PO_4^-$	8×10^{-8}
HPO_4^{2-}	5×10^{-13}

33. Which of the following is appropriate for laboratory safety?

(A) No food or drink in the laboratory.
(B) Wash your hands before leaving the lab.
(C) Be well prepared before coming to lab.
(D) All of the above are appropriate for safety.

34. The **best** indicator to use in a standard titration of aqueous 0.1 M $HClO_2$, with 0.1 M NaOH is:
(K_a of $HClO_2 = 1.0 \times 10^{-2}$)

	Indicator	pH Range
(A)	Methyl orange	3.1 - 4.4
(B)	Bromothymol blue	6.0 - 7.6
(C)	Phenolphthalein	8.3 - 9.9
(D)	Alizarin yellow	10.1-12.0

35. The reaction below has an equilibrium constant, $K_c = 36$.

$$SO_2(g) + NO_2(g) \rightleftarrows SO_3(g) + NO(g)$$

The initial concentrations of $[SO_2] = 0.10$ M and $[NO_2] = 0.10$M are placed in a reaction flask. What is the concentration of SO_2 at equilibrium?

(A) 0.0027 M
(B) 0.014 M
(C) 0.086 M
(D) 0.097 M

36. The rate equation for the reaction given below is: rate = $k[Cl_2][H_2S]$.

$$Cl_2(aq) + H_2S(aq) \rightarrow S(s) + 2\ H^+(aq) + 2\ Cl^-(aq)$$

Which of these mechanisms is (are) consistent with this rate equation?

I. $Cl_2 + H_2S \rightarrow H^+ + Cl^- + Cl^+ + HS^-$ (slow)
$Cl^+ + HS^- \rightarrow H^+ + Cl^- + S$ (fast)

II. $H_2S \rightleftarrows H^+ + HS^-$ (fast equilibrium)
$Cl_2 + HS^- \rightarrow 2Cl^- + H^+ + S$ (slow)

(A) I only
(B) II only
(C) both I and II
(D) neither I or II

37. Antimony (Atomic mass 121.75) has two naturally-occurring isotopes with isotopic weights 120.9038 and 122.9041. What is the percentage abundance of the heavier isotope?

(A) 42.7%
(B) 57.3%
(C) 42.3%
(D) 43.3%

38. A soft drink, bottled under 2.0 atm pressure of CO_2 has a concentration of 2.90 g of CO_2 per 1.00 L. What will be the CO_2 concentration in the drink after it has been opened and left to come to equilibrium with the atmosphere which has a CO_2 partial pressure of 3.0×10^{-4} atm?

(A) 4.4×10^{-4} g CO_2/L
(B) 2.2×10^{-3} g CO_2/L
(C) 1.0×10^{-4} g CO_2/L
(D) 4.6×10^{-4} g CO_2/L

39. The compound which is soluble in a concentrated OH^- solution is

(A) $Fe(NO_3)_3$
(B) $Al(NO_3)_3$
(C) $Cu(NO_3)_2$
(D) $Bi(NO_3)_3$

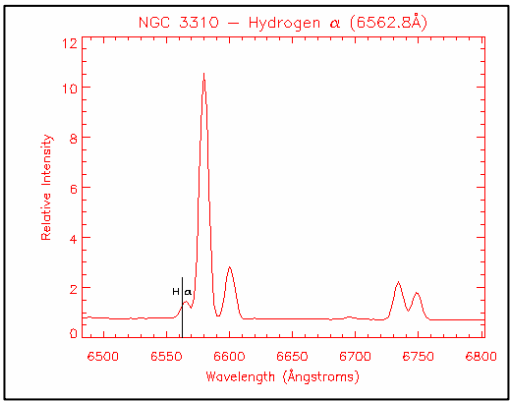
40. Which statement is **INCORRECT**?

(A) The most stable ion of potassium is K^+.
(B) The radius of a sodium atom is larger than that of a sodium cation.
(C) Oxygen is less electronegative than fluorine
(D) A phosphorus atom is larger than an antimony (Sb) atom.

41. How was most of the carbon in the Universe 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."

42. The hydrogen emission spectrum for galaxy NGC 3310 is shown below. Marked on the spectrum with a vertical line is the red hydrogen emission line, Hα, at 6562.8 Å (656.2 nm) that originates from the Balmer series (3→2) at the spot where it would be found in a hydrogen spectrum produced in a laboratory on Earth. The reason the Hα line is now found around 6580 Å is due to the



(A) scattering off of dust particles between the Earth and NGC 3310.
(B) strong gravitational attraction of the galaxy.
(C) different abundances of hydrogen isotopes.
(D) expansion of the Universe.

43. The ^{14}C activity of some ancient Peruvian corn was found to be 10 disintegrations per minute (dpm) per gram of C. If present-day plant life shows 15 dpm/g, how old is the Peruvian corn? The half-life of ^{14}C is 5730 years.

(A) 1455 years
(B) 1910 years
(C) 3350 years
(D) 3820 years

44. The operation of the electron microscope depends on the

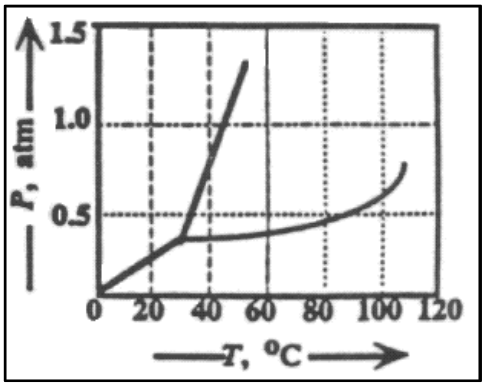
(A) very short wavelengths of X-rays.
(B) electromagnetic theory of waves.
(C) wave nature of electrons.
(D) photoelectric effect.

45. Calculate the pH that results when the following three solutions are mixed. The pK_a for formic acid is 3.75.

35 mL	0.20 M	formic acid (HCOOH)
55 mL	0.10 M	sodium formate (NaHCOO)
110 mL		water (H_2O

(A) 3.39
(B) 3.64
(C) 3.85
(D) 4.20

46. What phase change will occur in the substance represented in the phase diagram when the temperature and pressure are changed from 60°C and 0.2 atm to 40°C and 1.0 atm



(A) liquid to solid
(B) gas to solid
(C) solid to liquid.
(D) solid to gas

47. The commercial fertilizer urea, $CO(NH_2)_2$, is prepared by the following reaction:

$$CO_2 + 2\ NH_3 \rightarrow CO(NH_2)_2 + H_2O$$

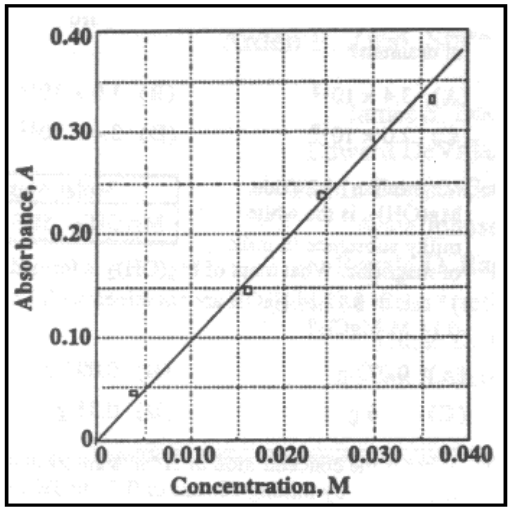
When 100. g of CO_2 is reacted with 100. g of NH_3, 100. g of $CO(NH_2)_2$ is recovered. The percent yield is (The molar masses in g/mole are: CO_2 = 44.0, NH_3 = 17.0, $CO(NH_2)_2$ = 60.0 and H_2O = 18.0)

(A) 28 %
(B) 32 %
(C) 57 %
(D) 73 %

48. The formulas of four compounds of element Z are listed below. Which one of them is **INCORRECT**?

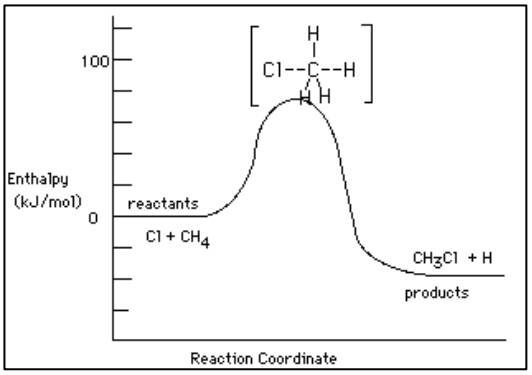
(A) Z_2O_3
(B) $Z_2(SO_4)_3$
(C) ZPO_4
(D) Z_2Cl_3

49. The concentration of Cu^{2+} in an unknown solution was found by comparing the absorbance of a diluted sample of the unknown with the Beer's Law plot of four standard solutions. When a 2.0 mL sample of the unknown Cu^{2+} solution is diluted to 5.0 mL, its absorbance is 0.29. What is the concentration of Cu^{2+} in the unknown?



(A) 0.0062 M
(B) 0.012 M.
(C) 0.031 M.
(D) 0.078 M.

50. The reaction profile to the right is for the chlorination of methane, which of the following statements is **true**:



I. The activation energy for the forward reaction is about 80 kJ/mol.
II. The overall reaction is exothermic.
III. The species at the top of the barrier is the activated complex.

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

51. The freezing point of a 1.00 m aqueous solution of nitrous acid is found to be -1.96 °C. The freezing point constant is water, k_f, is 1.86°C /m. What is the percent of dissociation of nitrous acid at this concentration?

(A) 5.3
(B) 0.94
(C) 1.05
(D) 2.7

52. Hydrolysis (saponification) of a fat gives
(A) water and an alkene
(B) glycerol and soap
(C) ethanol and a soap
(D) a triester of glycerol with fatty acids

53. Which of the following signs should be prominently displayed in a chemistry laboratory?

(A) I only
(B) II only
(C) III only
(D) All should be displayed.

54. Which of the following pairs of aqueous solutions gives a precipitate when are mixed? Assume that the concentrations of all compounds are 1.0 M immediately after mixing.

(A) HNO_3 and NH_4I
(B) $CuBr_2$ and K_2CO_3
(C) $CuCl_2$ and K_2SO_4
(D) Na_2CO_3 and H_2SO_4

55. How many p electrons are there in an atom of rubidium?

(A) 9
(B) 12
(C) 18
(D) 24

56. For the reaction: $2\ H_2O_2(aq) \rightarrow 2\ H_2O(aq) + O_2(g)$

How does the value of $\frac{\Delta[H_2O_2]}{\Delta t}$ compare with $\frac{\Delta[O_2]}{\Delta t}$?

(A) $\frac{\Delta[H_2O_2]}{\Delta t} = \frac{\Delta[O_2]}{\Delta t}$

(B) $-\frac{\Delta[H_2O_2]}{\Delta t} = \frac{\Delta[O_2]}{\Delta t}$

(C) $\frac{\Delta[H_2O_2]}{\Delta t} = 2\frac{\Delta[O_2]}{\Delta t}$

(D) $-\frac{\Delta[H_2O_2]}{\Delta t} = 2\frac{\Delta[O_2]}{\Delta t}$

Questions 57, 58, 59, and 60 deal with aqueous solutions of hydrofluoric acid, HF.
HF =20.0 g/mole, H_2O = 18.0 g/mole

57. Commercial hydrofluoric acid has a concentration (%w/w) of 50.0% HF in water and a density of 1.13 g/mL. What is the molarity of 50% HF?

(A) 22.1 M
(B) 25.0 M
(C) 28.3 M
(D) 35.4 M

58. How many mL of 50% HF are required to make 500 mL of 1.00 M HF?

(A) 17.7 mL
(B) 22.6 mL
(C) 35.5 mL.
(D) 45.2 mL.

59. What is the molality of the 1.0 M HF solution? The density of the 1.0 M HF is the same as water, 1.00 g/mL.

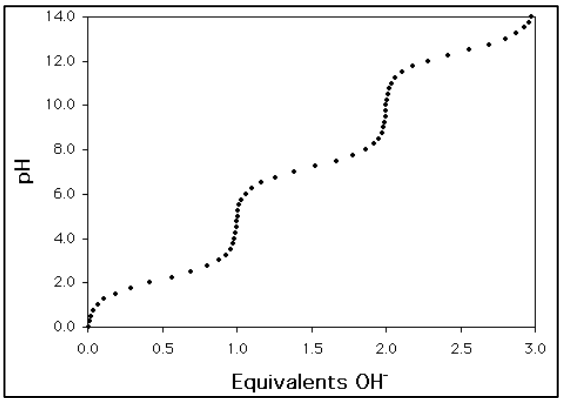
(A) 0.98 m
(B) 1.00 m
(C) 1.02 m
(D) 2.63 m

60. What is the % ionization of the 1.0 M HF solution? HF has an acid dissociation constant of $K_a = 6.8 \times 10^{-4}$

(A) 0.068
(B) 1.58
(C) 2.61
(D) 2.68

61. The graph shows the titration curve of one of the weak polyprotic acid listed below with a strong base. The acid is

	Acid	pK_1	pK_2
(A)	Phosphoric	2.14	7.20
(B)	Oxalic	1.23	4.19
(C)	Succinic	4.21	5.63
(D)	Carbonic	6.37	10.20



62. Cesium-137 decays spontaneously by emitting beta particles and form Barium-137. Cs-37 has a half-life is 30 years. Approximately what length of time will have elapsed before 97% of the Cs-137 in a particular sample will have decomposed?

(A) 60 years
(B) 150 years
(C) 180 years
(D) 2900 years

63. Which list is arranged in order of <u>increasing</u> atomic size?

(A) H, K, Li, As, Cs
(B) H, Li. K, As, Cs
(C) H, Li, As, K, Cs
(D) H, As, Li, K, Cs

64. What is the conjugate acid of HCN in the following reaction?

$HCN + NH_3 \rightarrow CN^- + NH_4^+$

(A) NH_4^+
(B) NH_3
(C) CN^-
(D) None of the above

65. The K_{sp} for calcium oxalate and strontium oxalate are given in the table. A 1.0 M solution of $K_2C_2O_4$ is added slowly to a solution that is 1.0×10^{-4} M in Ca^{2+}, and 1.0×10^{-4} M in Sr^{2+}. What percentage of one cation has precipitated at the point which the second cation just begins to precipitate?

(A) Under 10%
(B) About 25%
(C) About 75%
(D) Over 90 %

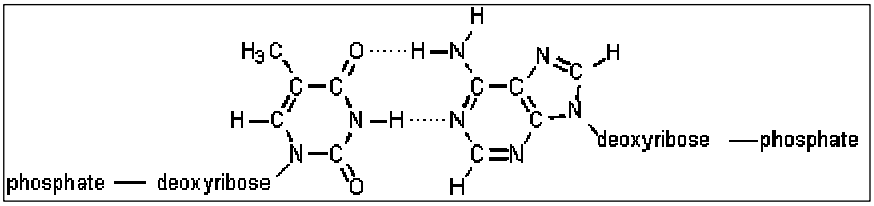
K_{sp} for CaC_2O_4	1.3×10^{-8}
K_{sp} for SrC_2O_4	2.6×10^{-7}

66. ^{35}Ar, lies below the "band of stability." (Its neutron to proton ratio is too low). To correct this ^{35}Ar decays by

(A) positron emission
(B) beta emission
(C) alpha emission
(D) nuclear fission

67. The diagram shows part of the DNA double helix in which the bases thymine on the left and adenine on the right are linked. What type of linking bonds are represented by the dotted lines?

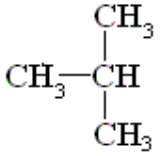
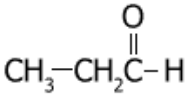
(A) covalent bonds
(B) hydrogen bonds
(C) ionic bonds
(D) molecular bonds



68. When 25.00 mL of 0.100 M HCl is titrated with 0.100 M NaOH, what is the pH of the solution when 24.90 mL of the base is added?

(A) 3.4
(B) 3.7
(C) 5.7
(D) 6.7

69. Consider the compounds P to T:

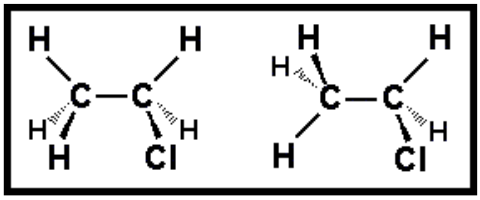
 **P**	$CH_3—CH_2—CH_2OH$ **Q**	 **R**
$CH_3CH_3CH_3CH_2OH$ **S**	$CH_3CH_2CH_2CH_3$ **T**	

Which of the following gives the **descending** order (highest to lowest) of boiling point?

(A) S > Q > R > P > T
(B) S > Q > T > P > R
(C) S > Q > R > T > P
(D) R > T > P > Q > S

70. The molecules in the diagram are

(A) structural isomers
(B) geometric isomers
(C) conformational structures
(D) optical isomers

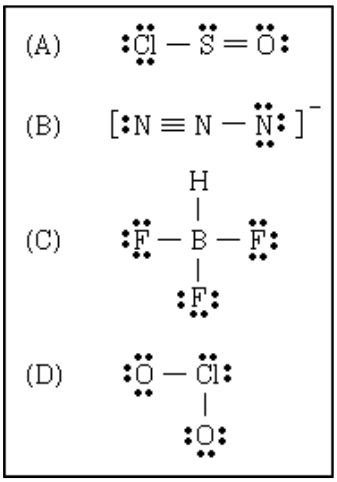


71. The density of a metal block was found by weighing it, and then finding its volume by submerging it in water. Based on the data in the table, what is the density of the metal?

Data	
Mass of block	65.4728g
Volume of H_2O	10.5 mL
Volume of H_2O with block	20.0 mL

(A) 6.9 g/cm^3
(B) 6.89 g/cm^3
(C) 6.892 g/cm^3
(D) 6.23 g/cm^3

72. Which Lewis structure is correct?



73. The following **endothermic** reaction is at equilibrium.

$$2\ Cl_2(g) + 2\ H_2O(g) \rightleftarrows 4\ HCl(g) + O_2(g)$$

Which of the following will result in a shift of the equilibrium so that more HCl is produced?
I. Adding Cl_2
II. Raising the temperature at constant pressure
III. Decreasing the volume at constant temperature

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

74. The solubility of $Cr(OH)_3$ in 0.50 M NaOH when the complex ion $Cr(OH)_4^-$ is formed is:

$Cr(OH)_{3\ (s)} \rightleftarrows Cr^{3+}_{(aq)} + 3\ OH^-_{(aq)}$	$K_{sp} = 6.7 \times 10^{-31}$
$Cr^{3+}_{(aq)} + 4\ OH^-_{(aq)} \rightleftarrows Cr(OH)_4^-{}_{(aq)}$	$K_f = 8 \times 10^{29}$

(A) 0.32 M
(B) 0.59 M
(C) 0.27 M
(D) 0.18 M

75. Cathode rays are

(A) gamma (γ) rays.
(B) helium nuclei (α particles).
(C) positrons.
(D) electrons.

76. A student pipetted five 25.00-mL samples of hydrochloric acid into five separate Erlenmeyer flasks, diluted each with distilled water, and added a few drops of phenolphthalein into each. Each sample was then titrated with a sodium hydroxide solution to the appearance of the first permanent faint pink color. The following results given in the table were obtained.

Volumes of NaOH Solution
First Sample.....35.22 mL
Second Sample.....36.14 mL
Third Sample.....36.13 mL
Fourth Sample.....36.15 mL
Fifth Sample.....36.12 mL

Which of the following is the most probable explanation for the variation in the student's results?

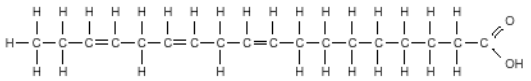
(A) A different amount of water was added to the first sample.
(B) The pipette was not rinsed with the HCl solution.
(C) The burette was not rinsed with NaOH solution.
(D) The student added too little indicator to the first sample.

77. What is a MSDS?

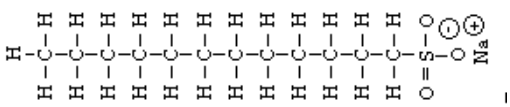
(A) An indicator used in acid-base titrations.
(B) A scientific instrument for analyzing sugars.
(C) Information on hazardous materials, substances, and wastes.
(D) A hazardous waste dangerous to the environment.

Questions 78-80 involve the molecules given below

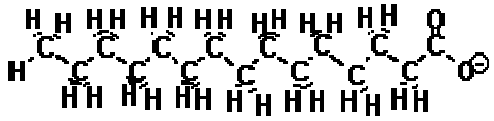
A



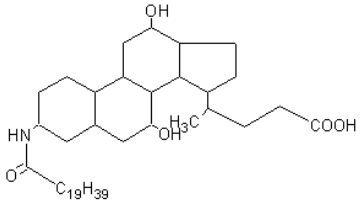
B.



C



D



78. The molecule that is a soap.

79. The molecule that is a bile acid.

80. The molecule that is a detergent.

81. Select all the correct characteristics of phosphorus trichloride, PCl_3.
I. trigonal planar
II. one unshared pair of electrons on P
III. sp^2 hybridized at P
IV. polar molecule
V. polar bonds

(A) I, IV, V
(B) II, III, IV
(C) I, II, IV
(D) II, IV, V

82. Select all of the following relationships when graphed give a straight line for an ideal gas.

I. V versus n at constant pressure and temperature
II. P versus V at constant temperature for a constant mass
III. P versus 1/T at constant volume for a constant mass

(A) I
(B) III
(C) I and II
(D) I, II, and III.

83. How many isomers are there of the alkane with the molecular formula: C_5H_{12}?

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

84. Which of the following compounds displays optical isomerism?

(A) CH_3-CHCl-COOH
(B) CH_2(OH)-CH_2(OH)
(C) CH_3-O-C_2H_5
(D) CHCl=CHCl

85. Solid NaOH is **NOT** a primary standard for preparing standard bases. Consequently aqueous solutions of NaOH must be standardized. The reasons for this are

.

I Solid NaOH forms carbonates
II Solid NaOH absorbs water.
III Aqueous NaOH reacts with glass.
IV Aqueous NaOH absorbs CO_2 from the air.

(A) I, III
(B) II, IV
(C) I, IV
(D) I, II, III, IV

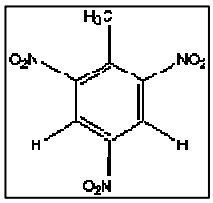
86. Which of the following solids give basic solutions when dissolved in water?

(A) II, V
(B) III, IV
(C) II, IV, V
(D) I, III

I. KNO_3	II. $KC_2H_3O_2$	III. NH_4NO_3	IV. $Fe(NO_3)$	V. NaCN

Problems 87 and 88 deal with trinitrotoluene (TNT). TNT is a solid that is used as an explosive since it produces a large amount of several gases when ignited. The reaction for this explosion, the decomposition of TNT, is

$$2\ C_7H_5N_3O_6(s) \rightarrow 3\ N_2(g) + 7\ CO_2(g) + 5\ H_2O(g) + 7\ C(s)$$



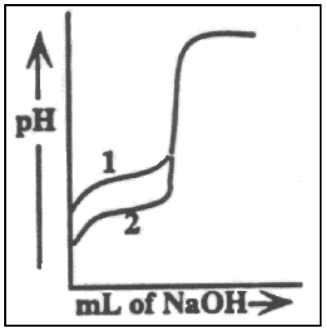
87. Find the difference in kJ between ΔH^o and ΔE^o for the above reaction at 25°C.
    (A) 30.8
    (B) 37.2
    (C) 49.6
    (D) 367

88. Determine the enthalpy change, ΔH, when 1 mole of TNT decomposes.

    (A) -1925 kJ
    (B) -1975 kJ
    (C) -3852 kJ
    (D) -3960 kJ

ΔH^o_f of $CO_2(g)$	-393. kJ/mole
ΔH^o_f of $H_20(g)$	-242. kJ/mole
ΔH^o_f of TNT	-54. kJ/mole

89. The curves 1 and 2 are titration curves of equal volumes of two different acid samples with portions of the same sodium hydroxide solution. What conclusions can be drawn about the relative concentrations and strengths of acids 1 and 2 from these curves?



    (A) The concentrations are the same but acid 1 is weaker than acid 2.
    (B) The concentrations are the same but acid 1 is stronger than acid 2.
    (C) Acid 1 is the same strength as acid 2, but it is less concentrated.
    (D) Acid 1 is the same strength as acid 2, but it is more concentrated.

90. A sample of an unknown hydrate of $NiSO_4$, weighing 1.314 g was gently heated until all the water was driven off. The anhydrous salt weighed 0.774 g. What is the formula for the hydrate? ($NiSO_4$ = 154.8 g/mole)

    (A) $NiSO_4 \cdot 4\ H_2O$
    (B) $NiSO_4 \cdot 5\ H_2O$
    (C) $NiSO_4 \cdot 6\ H_2O$
    (D) $NiSO_4 \cdot 7\ H_2O$

91. A bleaching powder reacts with iodide ion according to the following unbalanced equation:

$$OCl^- + I^- + H^+ \rightarrow I_2 + Cl^- + H_2O$$

A 0.6000 g sample of bleaching powder requires 35.24 mL of 0.1084 N $Na_2S_2O_3$ to titrate the liberated iodine. Note that: $I_2 + 2\ S_2O_3^{2-} \rightarrow 2\ I^- + S_4O_6^{2-}$. The percentage of chlorine in the sample is

    (A) 22.58%
    (B) 5.15%
    (C) 11.29%
    (D) 45.16%

92. The ion-product constant for water, K_w, has a value of 9.6×10^{-14} at 60°C and 1.0×10^{-14} at 25°C. These data indicate the autoionization reaction of water has:

	ΔH°	ΔG°
(A)	+	+
(B)	+	-
(C)	-	+
(D)	-	-

93. What is the ratio of the rates of effusion of $H_2O(g)$ to $D_2O(g)$? (D = is heavy hydrogen, ${}^{2}_{1}H$)

(A) 0.90
(B) 0.95
(C) 1.05
(D) 1.11

94. Which of the following is an acceptable laboratory practice?

(A) Adding a weighed quantity of a solid acid to an Erlenmeyer flask that is wet with distilled H_2O.
(B) Using 15 drops of phenolphthalein indicator for a titration of 25 mL of acid solution.
(C) Using distilled water to rinse your buret just before filling it with n standardized solution.
(D) Cleaning a pH electrode with a paper towel.

95. A coffee cup calorimeter with a heat capacity of 45 J/°C was used to measure the heat evolved when 50 mL of 1.0 M HCl and 50 mL of NaOH are mixed. Assume
- The specific heat of the final solution is 4.18 J/g·°C, and
- The density of each solution is 1.00 g/mL.

The temperature of the solution rises from 21.0°C to 27.0°C. The <u>molar</u> enthalpy of neutralization for the reaction is

(A) -50.2 kJ/mol
(B) -55.5 kJ/mol
(C) -2.78 kJ/mole
(D) -231 kJ/mol

96. When the following reaction was studied.

$$CH_3Cl(g) + H_2O(g) \rightarrow CH_3OH(g) + HCl(g)$$

The following data were obtained. Based on these data, the rate equation is:

	Initial Concentration, M		Initial Rate, M/s
	CH_3Cl	H_2O	
Exp. 1	0.100	0.100	0.182
Exp.2	0.200	0.200	1.45
Exp.3	0.200	0.400	5.81

(A) Rate = $k[CH_3Cl][H_2O]$
(B) Rate = $k[CH_3Cl]^2[H_2O]$
(C) Rate = $k[CH_3Cl][H_2O]^2$
(D) Rate= $k[CH_3Cl]^2[H_2O]^2$

97. The hybridization around the central iodine atom in the I_3^- ion is

(A) sp^3d
(B) sp^3
(C) sp^2
(D) sp

98. At what pH will $Cu(OH)_2$ start to precipitate from a solution with $[Cu^{2+}] = 0.0015$ M? $K_{sp} = 1.6 \times 10^{-19}$

(A) 4.6
(B) 6.0
(C) 8.0
(D) 9.0

99. The amount of copper in a 2.00 gram sample of the mineral cuprite was determined by dissolving the sample in nitric acid (HNO_3) to produce a copper nitrate [$Cu(NO_3)_2$] solution, and then adding an excess of iodide (I^-) solution The iodine (I_2) liberated required 15.7 mL of a 0.200 molar sodium thiosulfate ($Na_2S_2O_3$) solution to be reach to an end point. What is the percentage of Cu in the mineral? The essential reactions are:

$2Cu^{2+} + 4I^- \rightarrow 2CuI + I_2$
$I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$

(A) 5.0%
(B) 10%
(C) 20%
(D) 40%

100. If 68.0 J of energy is added to a sample of gallium initially at 25.0°C, the temperature rises to 38.0°C. What is the volume of the sample?

(A) 2.38 cm^3
(B) 4.28 cm^3
(C) 14.1 cm^3
(D) 31.0 cm^3

Data for Gallium, Ga	
specific heat	0.372 J/g °C
density	5.904 g/cm^3