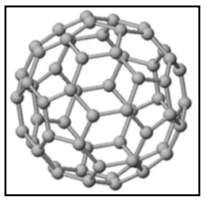
2005 Ashdown

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



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

2. An important classification of minerals is how they react to acids. Which class of minerals effervesces in acid?

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

3. Which of the following ions produces a bright yellow flame in a Bunsen burner?

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

4. In balancing the following aqueous reaction, the sum of the coefficients of the **products** is:

____$CrCl_3(aq)$ + ____$H_2O_2(aq)$ + ____$NaOH(aq)$ → ____$Na_2CrO_4(aq)$ + ____$H_2O(aq)$ +____$NaCl(aq)$

(A) 5
(B) 13
(C) 16
(D) 31

5. What is conjugate base of HCN in the reaction?

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

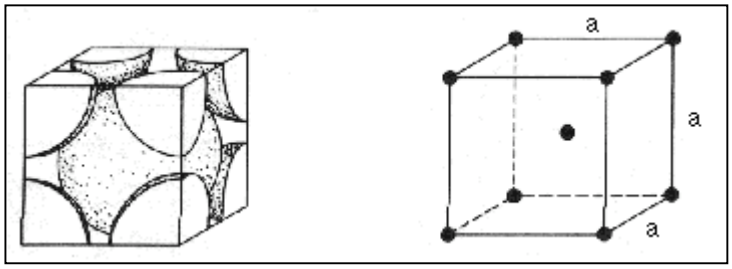
(A) CN^-
(B) NH_3
(C) HCN
(D) NH_4^+

6. The mass of "antifreeze" (ethylene glycol, MW = 62.0 g/mol) necessary to mix with 10. kg (~10 L) of water in order to protect the car's radiator below -10°F (-23.°C) is: (K_f for water is -1.86°C/molal)

(A) 3.3 kg
(B) 7.7 kg
(C) 14 kg
(D) 21 kg

Questions 7 and 8 deals with the CsCl crystal shown below.

7. CsCl crystallizes in a body-centered cubic crystal with a unit cell length a = 4.123 Å as shown below. The ionic radius of Cl^- is 1.81Å. The radius of the Cs^+ ion is:



(A) 1.76 Å
(B) 2.31 Å
(C) 3.57 Å
(D) 5.33 Å

8. The density of CsCl (MW =168.4 g/mol) is:
($1 Å = 10^{-8}$ cm)

(A) 2.41 g/cm^3
(B) 3.99 g/cm^3
(C) 4.81 g/cm^3
(D) 7.98 g/cm^3

9. What is the charge on the tin ion if 7.42 g of tin is plated out by a current of 2.25 A for 3.00 hours through a solution containing the ion? (Sn = 118.7 g/mol, *F* =96500, 1 hour = 3600 s)

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

10. Determine the average P—H bond energy in phosphine, PH_3.

$\Delta H°_f$ for $PH_3(g)$ = 5.4 kJ/mol
$P_4(s) \rightarrow 4\ P(g)$; $\Delta H° = 235.6$ kJ
$H_2(g) \rightarrow 2\ H(g)$; $\Delta H° = 436$ kJ

(A) 685 kJ
(B) 529 kJ
(C) 236 kJ
(D) 69.5 kJ

11. Methane gas can be prepared by reacting water with solid aluminum carbide, according to the following unbalanced reaction:

$$Al_4C_3(s) + 12\ H_2O(l) \rightarrow 4\ Al(OH)_3(s) + 3\ CH_4(g)$$

In the above reaction, 75.0 of Al_4C_3 (MW = 90.03 g/mole) reacted with 100.0 g of H_2O (MW = 18.02 g/mole), and a student obtains 20.0 g of CH_4 (MW = 16.04 g/mole). The student's percent yield is:

(A) 39.8%
(B) 71.4%
(C) 79.7%
(D) 90.0%

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

    (A) sodium hydrochlorite = NaClO
    (B) nickel(II) carbonate = $NiCO_3$
    (C) silver nitrate = $AgNO_3$
    (D) copper(II) sulfate pentahydrate = $CuSO_4 \cdot 5H_2O$

13. Ammonia, NH_3, and gaseous nitric acid, HNO_3, enter from the opposite ends a 1.000 meter evacuated tube and effuse through the tube until they meet and form ammonium nitrate. How many meters does the ammonium nitrate form from the **end which the ammonia entered?** Molar masses: $NH_3 = 17.0$, $HNO_3 = 63.0$)

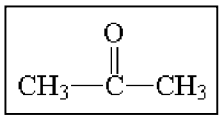
    $NH_3(g) + HNO_3(g) \rightarrow NH_4NO_3(s)$

    (A) 0.212 m
    (B) 0.657 m
    (C) 0.730 m
    (D) 0.788 m

14. Which of the following does have the same number of grams of carbon as 42 g of ethene, C_2H_4?
    (C = 12.0, H=1.0, O = 16.0)

    (A) 1.5 moles of CO
    (B) 1.80×10^{24} moles of CH_4
    (C) 66 grams of CO_2
    (D) 39 grams of benzene, C_6H_6

15. The compound to the right is commonly known as



    (A) acetone
    (B) acetic acid
    (C) dimethyl ether
    (D) formaldehyde

16. The first ionization potential of Cs is 3.894 electron volts. The minimum wavelength of electromagnetic radiation in nanometers required to ionize gaseous Cs is:

    1 eV = 1.6×10^{-19} J, c = 3.00×10^{8} m/s, h = 6.62×10^{-34} J/s

    (A) 1.06×10^{-6} nm
    (B) 233 nm
    (C) 319 nm
    (D) 552 nm

17. Many of the flavors isolated from foods are:

    (A) carboxylic acids
    (B) esters
    (C) alcohols
    (D) ketenes

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

(A) 7
(B) 6
(C) 4
(D) 3

19. When the Co^{2+} ion is placed in a strong octahedral crystal field such as $Co(CN)_6^{4-}$ the number of unpaired electrons is:

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

20. Vegetable oils are generally differ from animal fats because their fatty acids

(A) are smaller
(B) are saturated with hydrogen
(C) have more C=C double bonds
(D) are polyesters

Questions 21and 22 deal with the electrochemical cell below. (Nernst equation is $E = E^o - (0.05916/n)\log Q$

21. The cell potential at 25°C for the following cell is

$$Ag(s)|AgI(s)|I^-(1.0\ M)||Ag^+(1.0\ M)|Ag(s).$$

$Ag^+(aq) + e^- \rightarrow Ag(s)$	$E^o = 0.800$ V
$AgI(s) + e^- \rightarrow Ag(s) + I^-(aq)$	$E^o = -0.152$ V

(A) -0.952 V
(B) -0.648 V
(C) 0.648 V
(D) 0.952 V

22. From the above cell, the K_{sp} for AgI is:

(A) 1.2×10^{16}
(B) 8.8×10^{10}
(C) 1.1×10^{-11}
(D) 8.3×10^{-17}

23. In gas phase reactions, the equilibrium constant is normally expressed as partial pressures of the reactants and products. If [M] represents the molar concentration, and other symbols of the ideal gas equation are used, which of the following is correct?

(A) [M] = RT/P
(B) [M] = RT/V
(C) [M] = P/(RT)
(D) [M] = PV/(RT)

24. Using the set of reactions and their equilibrium constants in the table, the K for the reaction below is :

$$CO_2(g) <=> C(s) + O_2(g)$$

$H_2(g) + 1/2O_2(g) <=> H_2O(l)$	K= 4.44
$CH_4(g) + 2O_2(g) <=> CO_2(g) + 2H_2O(l)$	K= 4.04
$C(s) + 2H_2(g) <=> CH_4(g)$	K= 2.12

(A) 0.433
(B) 1.04
(C) 2.30
(D) 10.3

25. Urea may be prepared by reacting ammonia with carbon dioxide according to the following reaction:

$$2NH_3(g) + CO_2(g) \rightarrow NH_2CONH_2(s) + H_2O(l)$$

The thermodynamic data for the reaction is: ΔH° = -119.3 kJ/mol, ΔS° = -354.7 J/mol, R = 8.314 J/mol · K
The equilibrium constant (at 25°C) for the above reaction is:

(A) 4.13×10^{-3}
(B) 1.01
(C) 242
(D) 2.60×10^{28}

26. Raw milk sours in 4 hours at 27°C and 72 hours at 7°C. The activation energy for this reaction is:
(R = 8.314 J/mol · K)

(A) 43.8 kJ
(B) 101 kJ
(C) 108 kJ
(D) 149 kJ

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

$$^{27}Al + {}^{4}He \rightarrow {}^{30}P + X$$

(A) ^{1}H
(B) ^{1}n
(C) β^-
(D) β^+

28. An alkaline swimming pool absorbed CO_2 from the air and was 2×10^{-4} M in CO_3^{2-}. If the pool water was originally 4×10^{-3} M in Mg^{2+}, 6×10^{-4} M in Ca^{2+} and 8×10^{-7} M in Fe^{2+}, which ions precipitate?

(A) only $CaCO_3$
(B) only $FeCO_3$
(C) only $CaCO_3$ and $FeCO_3$
(D) $MgCO_3$, $CaCO_3$ and $FeCO_3$

K_{sp}	$MgCO_3$	$4. \times 10^{-5}$
	$CaCO_3$	$4. \times 10^{-9}$
	$FeCO_3$	$2. \times 10^{-11}$

29. Which oxyacid listed below has the greatest acidic strength in water?

(A) $HClO_4$
(B) H_3PO_4
(C) H_3BO_3
(D) HClO

.

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

(A) 3, 1, 7
(B) 3, 0, 7
(C) 4, 0, 9
(D) 2, 1, 5

31. A 100. gram sample of $CaCO_3$ was heated until 3.33 L of CO_2 was collected at 50.0°C and 742 torr. What percentage of the $CaCO_3$ had **decomposed?** R =0.08206 L atm/mol K, 760 torr = 1 atm

(A) 6.84%
(B) 9.10%
(C) 12.3%
(D) 15.8%

32. The body maintains the pH of blood at around 7.4. If the pH level changes just a few tenths of a pH unit, serious health consequences can result. The carbonic acid (H_2CO_3): bicarbonate (HCO_3^-) system acts as a buffer in blood. H_2CO_3 has a $pK_a = 6.4$. The $[HCO_3^-]/[H_2CO_3]$ ratio in normal blood is

(A) 1.0
(B) 10.
(C) 0.10
(D) 2.7

33. Which one of the following is an unnecessary laboratory safety practice?

(A) No food or drink in the laboratory.
(B) Keep your hands away from your face.
(C) Be well prepared before coming to lab.
(D) All of the above are appropriate safety practices.

34. The **best** indicator to use in a standard titration of aqueous NH_3 with an HCl is:
(K_a of $NH_4^+ = 5.7 \times 10^{-10}$)

	Indicator	**pH Range**
(A)	Cresol purple	1.2 - 2.8
(B)	Methyl orange	3.1 - 4.4
(C)	Bromothymol blue	6.0 - 7.6
(D)	Phenolphthalein	8.3 - 9.9

35. In the following equilibrium the initial concentrations were 0.060 M SO_2 and 0.050 M O_2. After equilibrium was reached, the concentration of SO_3 was 0.040 M. What is K_c for this reaction?

$$2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$$

(A) 0.11
(B) 8.9
(C) 67
(D) 133

36. A possible mechanism for the reaction, $2A + B \rightarrow C + D$, is:

(1)	$A + A \Leftrightarrow A_2$	fast, equilibrium
(2)	$A_2 + A \rightarrow A_3$	slow
(3)	$A_3 + B \rightarrow A + C + D$	fast

According to the mechanism, the rate law will be:

(A) Rate = $k[A]^2$
(B) Rate = $k[A][B]$
(C) Rate = $k[A]^2[B]$
(D) Rate = $k[A]^3$

37. Naturally occurring rubidium, atomic mass 85.468, consists of just two isotopes. One of the isotopes consists of atoms having a mass of 84.912 amu; the other of 86.901 amu. What is the percent natural abundance of the **heavier** isotope?

(A) 28%
(B) 37%
(C) 72%
(D) 85%

38. A 500 mL toluene solution containing 25 g of a polymer had an osmotic pressure of 0.050 atm at 27°C. What is the apparent formula weight of the polymer? R = 0.08206 L atm/ mol K

(A) 2200 g/mol
(B) 9800 g/mol
(C) 25,000 g/mol
(D) 38,000 g/mol

39. Before glass pH electrodes were in common use, the pH of unknown solutions could be determined by measuring the potential of a solution by using a saturated quinhydrone electrode. Quinhydrone is an equimolar mixture of quinone (Q) and hydroquinone (H_2Q). The half-cell reaction between the two species is:

$Q + 2H^+ + 2e^- <==> H_2Q \qquad E^o = 0.699V$

A saturated quinhydrone electrode was placed in a solution vs. a reference saturated calomel electrode, SCE (E_{SCE} = 0.242V.) The cell potential is 0.161V. The Nernst equation is $E = E° - 0.0592/n \log Q$.
The pH of a solution is

(A) 4.9
(B) 5.0
(C) 9.1
(D) 10.0

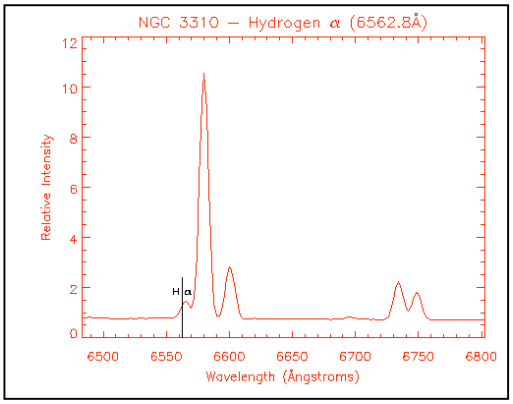
40. Arrange these substances in order of **increasing** boiling point: Xe, H_2, H_2O, LiCl, H_2S

(A) $Xe < H_2 < H_2O < LiCl < H_2S$
(B) $Xe < H_2 < H_2S < H_2O < LiCl$
(C) $H_2 < Xe < H_2S < H_2O < LiCl$
(D) $H_2 < Xe < H_2O < H_2S < LiCl$

41. How was most of the helium 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. Which of the following is **incorrect**?

(A) Reduction increases in oxidation number.
(B) The oxidation number of oxygen atoms in ozone, O_3, is zero.
(C) The oxidizing agent in a redox reaction is reduced.
(D) Electrons are being transferred in a redox reaction.

44. From the following equations, the heat of formation of sulfuric acid, $H_2SO_4(l)$ is

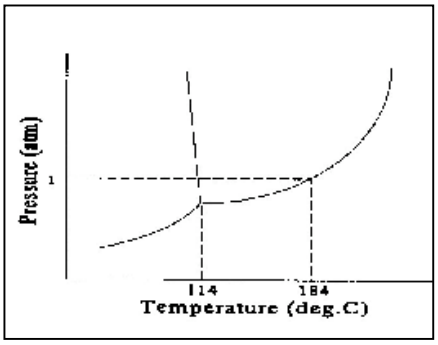
$S_8(s) + 8\ O_2(g) \rightarrow 8\ SO_2(g)$	$\Delta H = -2375$ kJ
$S_8(s) + 12\ O_2(g) \rightarrow 8\ SO_3(g)$	$\Delta H = -3166$ kJ
$H_2O(l) + SO_3(g) \rightarrow H_2SO_4(l)$	$\Delta H = -132$ kJ
$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l)$	$\Delta H = -572$ kJ

(A) -242 kJ
(B) -715 kJ
(C) -814 kJ
(D) -1934 kJ

45. Assuming no change in volume, the grams of solid sodium acetate that should be added to 2.00 L of a 0.250 M acetic acid solution to prepare a buffer with a pH of 4.100 is
(pK_a(acetic acid) = 4.757, molar mass ($NaC_2H_3O_2$) = 82.05 g/mol, molar mass ($HC_2H_3O_2$) = 60.05 g/mol)

(A) 2.26 g
(B) 4.52 g
(C) 9.04 g
(D) 27.0 g

46. According to the phase diagram for a substance X, which of the following statements is **false**?



(A) The normal boiling point of X is 184°C.
(B) The normal freezing point of X is 114°C.
(C) X is liquid at 120°C and 1 atm.
(D) The melting point of X varies slightly with pressure.

47. Nitrogen may be prepared using the following **<u>unbalanced</u>** reaction:

$$KN_3 + KNO_3 \rightarrow K_2O + N_2$$

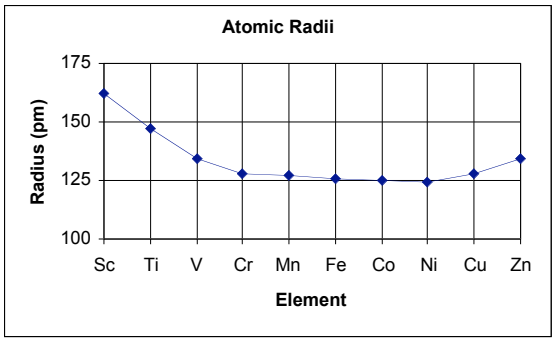
When 5.0 g of KN_3 is reacted with excess KNO_3, 1.0 g of N_2(g) is recovered. The percent yield is
(The molar masses are: KN_3 = 81.1 g, KNO_3 = 101.1 g, N_2 = 28.0 and K_2O = 94.2)

(A) 36 %
(B) 40 %
(C) 58 %
(D) 72 %

48. A reaction has a ΔG^o = -50 kJ/mol. At 25°C, its equilibrium constant K is (R = 8.314 J/ mol K)

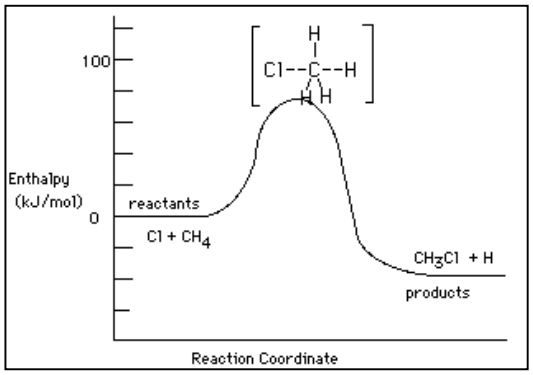
(A) equal to 0.
(B) greater than10^6.
(C) less than 10^6 but greater than 0.
(D) less than 0.

49. The graph to the right shows the atomic radii of the first row transition elements. The **best** explanation for explaining the trend in atomic radii is increasing



(A) nuclear charge.
(B) electronegativity.
(C) shielding effect.
(D) number of valence electrons.

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

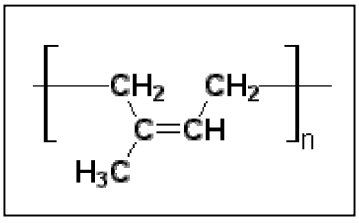
51. The chemistry of vision involves

(A) structural isomerism.
(B) geometric isomerism.
(C) stereoisomerism.
(D) linkage isomerism.

52. How many isomers of $[Co(NH_3)_6Cl_3]$ are there?

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

53. The polymer whose structure is shown the right is



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

54. Which of the following statements about resonance structures are always true? Resonance can occur when

I. A central atom of a molecule has a multiple bond on it.
II. A central atom of a molecule has a lone pairs of electrons on it.
III. The molecule's electronic geometry and molecular geometry are the same.

(A) I only
(B) I and II
(C) I and III
(D) none are true

55. Element X has the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^3$. The compound is most likely formed with magnesium, Mg, is

(A) MgX
(B) MgX_2
(C) Mg_2X_3
(D) Mg_3X_2

56. From the bond energies in the table, the molar enthalpy of combustion of acetylene, C_2H_2 is

$C_2H_2 + 5/2\ O_2 \rightarrow 2CO_2 + H_2O$

C—H	410 kJ
C==O	800 kJ
O==O	494 kJ
C__C	835 kJ
H—O	460 kJ

(A) -370 kJ
(B) -1230 kJ
(C) -5 kJ
(D) -6330 kJ

Questions 57and 58 deal with the following titrations:

You have two separate 0.2 M solutions of HX and HY. The K_a for HX is 1.0×10^{-4} and for HY is 1.0×10^{-6}. A 35.0 mL portion of each is titrated with 0.1 M NaOH

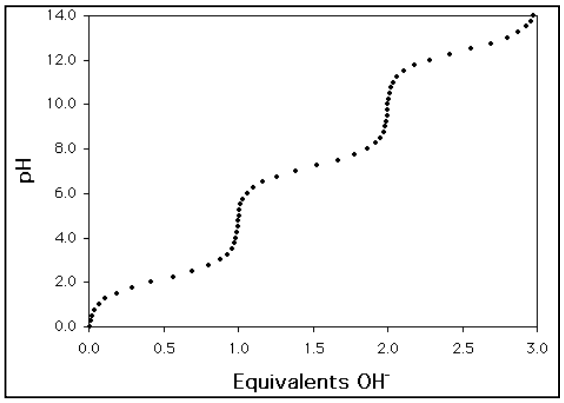
57. The volume of NaOH required to reach the equivalence point of each is

(A) greater for HX than for HY.
(B) greater for HY than for HX.
(C) identical.
(D) depends upon the indicators used.

58. At the equivalence point of each titration,

(A) the pH of both solutions will be the same but <u>not</u> equal to 7.
(B) the pH of the HX solution will be greater than the pH of the HY solution.
(C) the pH of the HX solution will be less than the pH of the HY solution.
(D) the pH of each solution will be equal to 7.

59. 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

60. Which of the following statements about sulfuric acid is **false**?

(A) It is a strong acid.
(B) One mole of sulfuric acid reacts completely with two moles of potassium hydroxide.
(C) The sulfur atom is sp^2 hybridized.
(D) During the dilution of sulfuric acid, the correct method is to add sulfuric acid to water.

61. A molten solution of $AlCl_3$ is electrolyzed for 10.0 hours with a current of 0.50 amperes to produce Al at one electrode and Cl_2, at the other. The electrode efficiency is 60%. The liters of Cl_2 at STP produced is (F =96500. 1 hour = 3600 sec)

(A) 1.25 L
(B) 2.09 L
(C) 2.50 L
(D) 4.18 L

62. A Geiger counter registered 1000 counts/second from a sample that contained a radioactive isotope of polonium. After 10.0 minutes, the counter registered 320 counts/second. The half-life of this isotope is

(A) 159 s
(B) 182 s
(C) 364 s
(D) 389 s

63. From the thermodynamic values given below, the lattice energy for $BaCl_2$ is

(A) 1010 kJ/mole
(B) 2050 kJ/mole
(C) 1530 kJ/mole
(D) 1360 kJ/mole

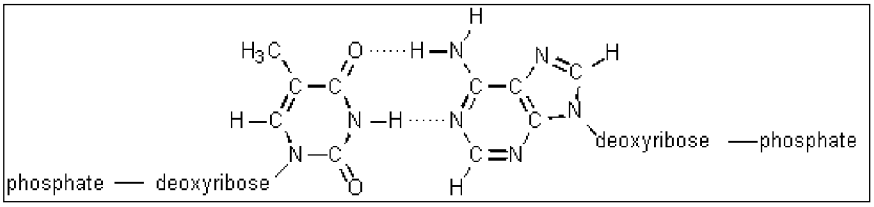
$Ba(s) + Cl_2(g) \rightarrow BaCl_2(s)$ Enthalpy of formation, ΔH_f	-520 kJ/mol
Heat of sublimation of Ba	525 kJ/mole
First ionization energy of Ba	500 kJ/mol
Second ionization energy of Ba	965 kJ./mol
Bond energy of Cl_2	240 kJ/mol
Electron affinity of Cl	-350 kJ/mol

64. Sulfuric acid is the top industrial chemical produced in the United States: 8.735×10^{10} pounds were produced in 2000. What volume would be by this quantity occupy? The density of sulfuric acid is 15.33 pounds/gallon. (1 gallon = 3.7854 liters, 1 pound = 2.2046 kg)

(A) 1.0505×10^9 L
(B) 2.157×10^{10} L
(C) 3.537×10^{11} L
(D) 5.069×10^{12} L

65. 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 is the name given to the linking bonds, represented by the dotted lines?

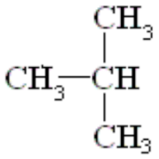
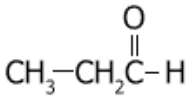
(A) covalent bonds
(B) hydrogen bonds
(C) ionic bonds
(D) molecular bonds



66. How many moles of oxygen atoms are contained in 0.030 mole of Na_2SO_4_10 H_2O

(A) 0.030
(B) 0.30
(C) 0.12
(D) 0.42

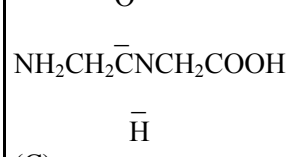
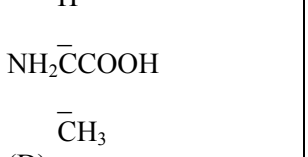
67. Consider the compounds P to T:

 **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

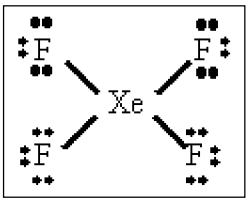
68. Which one of the following compounds can exist as optical isomers?

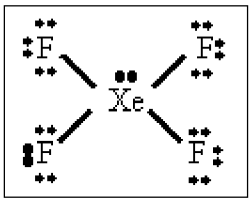
(A) NH_2CH_2COOH	(B) $NH_2CH_2CH_2COOH$
 (C)	 (D)

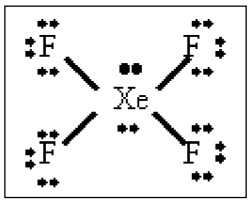
69. A marine scientist made a synthetic seawater solution by weighing out and mixing the following components: 3.02 g of NaCl, 0.0512 g of $MgSO_4$, 0.023 g $CaCl_2$ and 50.3 g of H_2O. The final mass of the solution in grams, stated to the correct number of significant figures is.

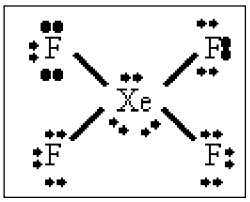
(A) 53.3
(B) 53.39
(C) 53.4
(D) 53.3942

70. Which one of the following is a valid Lewis structure for XeF_4?

(A) 

(B) 

(C) 

(D) 

Questions 71 and 72 deal with the solubility of $Cr(OH)_3$ and the table below.

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

71. The solubility of $Cr(OH)_3$ in pure water is

(A) 2.9×10^{-8}M
(B) 8.2×10^{-16}M
(C) 5.4×10^{-11}M
(D) 1.3×10^{-8}M

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

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

73. Which of the following fertilizers contains the greatest weight percent nitrogen per mole of fertilizer?
(A) CON_2H_4
(B) $(NH_4)_2SO_4$
(C) NH_4NO_3
(D) $(NH_4)_3PO_4$

74. When $_{84}Po^{214}$ decays, the emission consists consecutively of an alpha particle, then two beta particles, and finally another alpha particle. The resulting stable nucleus is

(A) $_{83}Bi^{206}$
(B) $_{83}Bi^{210}$
(C) $_{82}Pb^{206}$
(D) $_{82}Pb^{208}$

75. A student pipetted five 25.00-milliliter samples of hydrochloric acid and transferred each sample to an Erlenmeyer flask, diluted each with distilled water, and added a few drops of phenolphthalein to 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) The pipette was not rinsed with the HCl solution.
(B) A different amount of water was added to the first sample.
(C) The burette was not rinsed with NaOH solution.
(D) The student added too little indicator to the first sample.

76. What is a MSDS?

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

77. No two electrons can have the same set of four quantum numbers in any atom is a statement of:

(A) The Aufbau Principle.
(B) Heisenberg Uncertainty Principle.
(C) The Pauli Exclusion Principle.
(D) Hund's Rule.

78. Rank the following five atoms in order of **increasing** atomic radius (smallest to largest): Si, Na, K, F, O
(A) K, Na, Si, O, F
(B) F, O, Si, Na, K
(C) O, F, Si, Na, K
(D) O, F, Na, Si, K

79. The category of organic compounds that are the usual starting materials for polymers:
(A) cycloalkanes
(B) aromatics
(C) aldehydes
(D) alkenes

80. Valence Bond theory is based on _____ of atomic orbitals to produce orbitals for bonding in molecules. VSEPR theory is based on _____ of regions of high electron density around the central atom in a molecule.

(A) repulsion; hybridization
(B) resonance; expansion
(C) hybridization; repulsion
(D) resonance; delocalization

81. The van der Waals equation for a real gas is: $(P + n^2a/V^2)(V \_ nb) = nRT$. Select only the true statements concerning this equation:

I. The constant **b** is related to the intermolecular attractions between the molecules.
II. The constant **a** is related to the physical dimensions of the molecules.
III. Deviations of gases become significant for gases at high pressures and/or low temperatures.

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

82. How many alcohols are structural isomers with the formula: $C_5H_{11}OH$?

(A) 6
(B) 7
(C) 8
(D) 9

83. For which of the compounds below are cis-trans isomers possible?

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

$CH_3CH=CH_2$	$CH_3CH=CHCH_2CH_3$	$CH_3CH=CHCH_3$
I	II	III

84. An indicator that ionized as shown below for which its $K_a = 1.0 \times 10^{-4}$

$$\underset{\text{yellow}}{HIn} + H_2O \rightleftarrows H_3O^+ + \underset{\text{red}}{In^-}$$

Select the answer that has all of the **true** statements.

I The predominant color in its acid range is yellow.
II In the middle of the pH range of its color change a solution containing the indicator will probably be orange.
III At pH = 7.00, a solution containing this indicator will be red.
IV At pH = 7.00, most of the indicator is unionized.
V The pH at which the indicator changes color is pH = 4.

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

85. Which of the following salts give acidic aqueous solutions?

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

I. KNO_3	II. KCH_3COO	III. NH_4NO_3
IV. RbI	V. $BaCl_2$	VI. NaCN

86. If the equilibrium constant for the reaction A + 2B ⇄ C + 5/2 D has a value of 4.0, what is the value of the equilibrium constant for the reaction 2C + 5D ⇄ 2A + 4B at the same temperature?

(A) 0.063
(B) 2.0
(C) 8.0
(D) 16

87. Which of the following statements is **FALSE** given the following net ionic equation?

$$2H^+(aq) + Cu(OH)_2(s) \rightarrow Cu^{2+}(aq) + 2H_2O(l)$$

(A) If all the water evaporated away, the salt remaining could possibly be $Cu(C_2H_3O_2)_2$.
(B) The acid is a strong electrolyte.
(C) $Cu(OH)_2$ is insoluble.
(D) This is classified as a neutralization reaction.

88. Which of the following was the reason for the failure of the Bohr theory?

(A) It assumed that the energy of the atom is quantized.
(B) It assumed that the electron follows a well-defined orbit.
(C) It failed to account for the line emission spectrum of hydrogen.
(D) It failed to predict the energy levels of the hydrogen atom.

89. Gasoline costs $1.35 per gallon. A car travels 330 miles on a tank of gas at a constant cruising speed of 60 miles per hour. If the car's tank is 13.3 gallons in capacity, how many hours can the car travel at that speed on 10 gallons of gas before the tank runs dry?

(A) 4.1 hr
(B) 5.5 hr
(C) 3.9 hr
(D) 7.4 hr

90. For the transformation of grey tin into white tin, ΔH is 2.09 kJ/mol and _S is 7.31 J/ mol K.
At what temperature (K) are the two forms of tin in equilibrium at 1 atm pressure?

(A) 130
(B) 286
(C) 304
(D) 695

91. Some metals are found in the free uncombined state while other metals are found in combined with other elements. The major reason is:

(A) The more active metals can be found uncombined while the less active metals occur combined.
(B) Metals with negative reduction potentials can be found uncombined while metals with positive reduction potentials are found combined.
(C) Metals with positive reduction potentials can be found uncombined while metals with negative reduction potentials are be found uncombined combined.
(D) There is no way we can predict which metals will be uncombined or combined.

92. Metallic copper is heated strongly with concentrated sulfuric acid. The products of this reaction are

(A) $CuSO_4(s)$ and $H_2(g)$ only
(B) Cu^{2+}, $SO_2(g)$, and H_2O
(C) Cu^{2+}, $H_2(g)$, and H_2O
(D) Cu^{2+}, $SO_3(g)$, and H_2O

93. A salt bridge maintains electrical neutrality in the half cells of an electrochemical cell by

(A) preventing the migration of electrons.
(B) allowing the migration of ions.
(C) allowing the two solutions to mix completely.
(D) preventing the reaction from occurring spontaneously.

94. A coffee cup calorimeter having a heat capacity of 451 J/^oC was used to measure the heat evolved when 0.0300 mol of NaOH(s) was added to 1000 mL of 0.0300 M HNO_3 initially at 23.000^oC. The temperature of the water rose to 23.639^oC. Calculate ΔH (in kJ/mol $NaNO_3$) for this reaction. Assume the specific heat of the final solution is 4.18 J/g^oC; the density of each solution is 1.00 g/mL; and the addition of solid does not changet the volume of the solution.

$$HNO_3(aq) + NaOH(s) \rightarrow NaNO_3(aq) + H_2O(l)$$

(A) -63.7 kJ/mol
(B) -151 kJ/mol
(C) -89.0 kJ/mol
(D) -98.6 kJ/mol

95. Calculate ΔH^o for the reaction: $Na_2O(s) + SO_3(g) \rightarrow Na_2SO_4(g)$
Given:

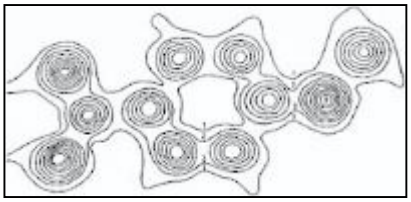
(A) +255 kJ
(B) -435 kJ
(C) -581 kJ
(D) -452 kJ

(1) $Na(s) + H_2O(l) \rightarrow NaOH(s) + 1/2\ H_2(g)$	$\Delta H^o = -146$ kJ
(2) $Na_2SO_4(s) + H_2O(l) \rightarrow 2NaOH(s) + SO_3(g)$	$\Delta H^o = +418$ kJ
(3) $2Na_2O(s) + 2H_2(g) \rightarrow 4Na(s) + 2H_2O(l)$	$\Delta H^o = +259$ kJ

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

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

97. The electron density map of a molecule that contains carbon, hydrogen and oxygen only is shown below. Which statement about molecules of this compound is **incorrect?**



(A) each molecule contains only 11 atoms.
(B) each molecule contains a six-membered ring.
(C) covalent bonds are involved.
(D) the electron density is greatest round the oxygen atoms

98. 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%

99. 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? **Due to a typo, now fixed, this question was not scored.**

(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

100. During a laboratory session, the four solutions shown below were mixed.

I. sodium chloride and potassium nitrate
II. potassium chloride and silver nitrate
III. copper(II) sulfate and magnesium chloride
IV. barium chloride and sodium sulfate

The solutions that produced a precipitate are

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