2008 Ashdown Examination

DIRECTIONS

- Put your name, school, and test number on the bubble sheet, as follows;

  NAME__Your_Name____

  SUBJECT__School_____

  PERIOD_____DATE_____Test Number____

- There are 90 questions, and the exam will last 100 minutes.
- When you have selected your answer to each question, blacken the corresponding space on the answer sheet using a soft, #2 pencil. Make a heavy, full mark, but no stray marks. If you decide to change an answer, erase the unwanted mark very carefully.
- There is only one correct answer to each question. Any questions for which more than one response has been blackened **will not be counted**.
- Your score is based solely on the number of questions you answer correctly. **It is to your advantage to answer every question.**
- When you are told to start the exam, you may tear off this sheet and the periodic table sheet below this one.
- After the test is over and the proctors have collected the bubble sheets, you may take this exam home with you.
- Answers will be posted in the registration area after the examination.
- Prize winners and qualifiers will be notified within 3 days or sooner.
- Good luck!

ABBREVIATIONS AND SYMBOLS					
ampere	A	Faraday constant	F	molal	m
atmosphere	atm	formula molar mass	M	molar	M
atomic mass unit	u	free energy	G	molar mass	M
atomic molar mass	A	frequency	ν	mole	mol
Avogadro constant	N_A	gas constant	R	Planck's constant	h
Celsius temperature	°C	gram	g	pressure	P
centi– prefix	c	heat capacity	C_p	rate constant	k
coulomb	C	hour	h	retention factor	R_f
electromotive force	E	joule	J	second	s
energy of activation	E_a	kelvin	K	temperature, K	T
enthalpy	H	kilo– prefix	k	time	t
entropy	S	liter	L	volt	V
equilibrium constant	K	milli– prefix	m		

CONSTANTS

$R = 8.314\ \text{J·mol}^{-1}\text{·K}^{-1}$

$R = 0.0821\ \text{L·atm·mol}^{-1}\text{·K}^{-1}$

$1\ F = 96{,}500\ \text{C·mol}^{-1}$

$1\ F = 96{,}500\ \text{J·V}^{-1}\text{·mol}^{-1}$

$N_A = 6.022 \times 10^{23}\ \text{mol}^{-1}$

$h = 6.626 \times 10^{-34}\ \text{J·s}$

$c = 2.998 \times 10^{8}\ \text{m·s}^{-1}$

$0\ °\text{C} = 273.15\ \text{K}$

$1\ \text{atm} = 760\ \text{mmHg}$

EQUATIONS

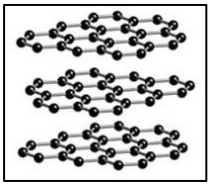
$$E = E° - \frac{RT}{nF}\ln Q \qquad \ln K = \left(\frac{-\Delta H}{R}\right)\left(\frac{1}{T}\right) + \text{constant} \qquad \ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

PERIODIC TABLE OF THE ELEMENTS

1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H 1.008	2 2A																2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (269)	111 Rg (272)	112 Uub (277)		114 Uuq (???)		116 Uuh (???)		118 Uuo (???)

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

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



A. graphite B. diamond C. bucky ball D. nanotube

2. The element whose symbol comes from the Latin word for "shining dawn" is:
A. tin B. copper C. silver D. gold

3. The following reaction takes place in aqueous solution. Balance this equation with the smallest whole number coefficients and select the answer that is the **sum of the coefficients**.

_____$CuSO_4$ + _____NH_3 + _____H_2O → _____$(NH_4)_2SO_4$ + _____$Cu(NH_3)_4(OH)_2$

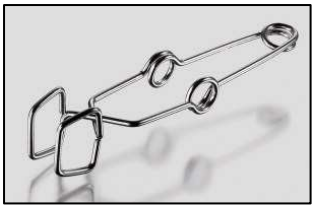
A. 8 B. 11 C. 12 D. 14

4. Which of the following matched pairs of name and formula has an error?
A. KBrO—potassium hypobromite
B. K_2SO_4—potassium sulfate
C. K_2BrO_4—potassium perbromate
D. KNO_2—potassium nitrite

5. Which of the following is a chemical change?
A. dissolving sodium hydroxide in water
B. sublimation of dry ice into carbon dioxide gas
C. combustion of hydrogen gas with oxygen gas to make water
D. fractional distillation of crude oil

6. MSDS's should be consulted:
A. In case of fire or explosion
B. Before working with a chemical
C. In the event of a spill
D. All of the above

7. Teachers just love it when students request the proper equipment when doing a laboratory. To impress your teacher, you ask for the item to the right as:



A. a buret clamp
B. a test tube holder
C. a universal extension clamp
D. crucible tongs

8. Rank the following acids from the strongest to the weakest:
Strongest→Weakest
A. HF > HCl > HBr > HI
B. HI > HBr > HCl > HF
C. HCl > HBr > HI > HF
D. HF > HI > HBr > HCl

9. A compound is 23.8% C, 6.00% H and 70.2% Cl by mass. What is the empirical formula for this compound? (C=12.0, H=1.01, Cl=35.5)
A. CH_3Cl_2 B. CH_3Cl C. CH_2Cl_2 D. $C_2H_7Cl_2$

10. A 25.0-L cylinder holds a mixture of 16.0 g of O_2, 21.0 g of N_2, and 16.0 g of He at 20°C. The partial pressures of O_2, N_2, and He respectively in this mixture are: (R = 0.0821 atm·L/mole·K)
A. 0.481 atm O_2, 1.44 atm N_2, 3.85 atm He
B. 0.481 atm O_2, 0.721 atm N_2, 3.85 atm He
C. 0.962 atm O_2, 1.44 atm N_2, 3.85 atm He
D. 0.962 atm O_2, 0.721 atm N_2, 0.240 atm He

11. A 0.720-gram sample, containing only $CaCO_3$ and $BaCO_3$, was heated until the carbonates were decomposed to oxides as indicated below. After heating, the solid residue was 0.516 grams. What mass of $BaCO_3$ was present in the sample? ($CaCO_3$ = 100.1, $BaCO_3$ = 197.3, CO_2 = 44.0, CaO = 56.1, BaO = 153.3)

    $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ and $BaCO_3(s) \rightarrow BaO(s) + CO_2(g)$

    A. 0.384 g B. 0.516 g C. 0.463 g D. 0.520 g

12. How many moles of $Fe(OH)_3$ can be produced by reacting 1.0 mole Fe_2S_3, 2.0 mole H_2O and 3.0 mole O_2 in the reaction given below?

    $2Fe_2S_3 + 6H_2O + 3O_2 \rightarrow 4Fe(OH)_3 + 6S$

    A. 1.3 B. 1.4 C. 1.7 D. 2.0

13. The electronic configuration of Cr is [Ar] $4s^1 3d^5$ and not [Ar] $4s^2 3d^4$ as predicted by the standard electron configurations. The reason for this is because:
    A. the 4s orbital can hold only one electron
    B. the 3d orbital is full with 5 electrons
    C. the 4s and 3d orbitals are half-full
    D. it violates the Pauli exclusion principle

For questions 14 and 15, use the following information:

Calcium forms a face centered cubic (FCC) crystal structure with a unit cell edge of 557 pm. Assuming the calcium atoms are spheres, (Calcium atomic mass = 40.08, Avogadro's number = 6.02×10^{23}, 1pm = 1×10^{-12} m)

14. The atomic radius of calcium in pm is:
    A. 139 B. 197 C. 279 D. 437

15. The crystallographic density of calcium in grams/cm^3 is:
    A. 0.385 B. 1.15 C. 1.54 D. 11.5

16. Using the bond energies below, calculate ΔH^o for the following reaction:

    $4NH_3(g) + 3O_2(g) \rightarrow 6H_2O(g) + 2N_2(g)$

    A. –1288 kJ
    B. –1622 kJ
    C. –4400 kJ
    D. 1490 kJ

Bond	Bond Enthalpy
H-N	389 kJ
O=O	494 kJ
H—O	463 kJ
N≡N	941 kJ

17. When 0.10 M aqueous solutions of $CuSO_4$ and $(NH_4)_2CO_3$ are mixed, what happens?
    A. $CuCO_3$ will precipitate, and NH_4^+ and SO_4^{2-} are spectator ions.
    B. $CuSO_4$ will precipitate, and NH_4^+ and CO_3^{2-} are spectator ions.
    C. $(NH_4)_2SO_4$ will precipitate, and Cu^{2+} and CO_3^{2-} are spectator ions.
    D. No precipitate will form.

18. What is the molarity of an aqueous concentrated nitric acid solution, which is 70.0% nitric acid by mass and has a density of 1.41 grams/mL? (HNO_3 = 63.0 grams/mole)
    A. 11.1 M B. 15.7 M C. 8.5 M D. 16.7 M

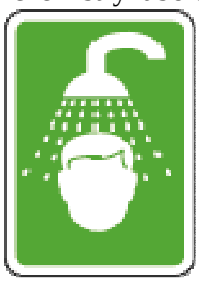
19. In comparing the atoms of oxygen and sodium, which of the following is correct?
    A. Oxygen has the highest electronegativity and sodium has the highest ionization energy.
    B. Sodium has the lowest ionization energy and oxygen has the lowest electronegativity.
    C. Oxygen has the highest ionization energy and sodium has the largest radius.
    D. Sodium has the lowest electronegativity and oxygen has the largest radius.

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

I.

II.

III.


IV.

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

21. A block of lead, weighing 1587.0 grams, has dimensions of 4.50 cm by 5.20 cm by 6.00 cm. Its density is:
    A. 11. grams/cm^3 B. 11.3 grams/cm^3 C. 11.30 grams/cm^3 D. 11.303 grams/cm^3

22. The reason for the failure of Bohr's atomic theory was:
    A. It failed to account for the line emission spectrum of hydrogen.
    B. It failed to predict the energy levels of the hydrogen atom.
    C. It assumed that the energy of the atom is quantized.
    D. It assumed that the electron follows a well-defined orbital pathway.

23. The preferred Lewis structure for the thiocyanate ion, NCS^- is:

    A. $[:\ddot{N}-C\equiv S:]^-$ B. $[:N\equiv C-\ddot{S}:]^-$ C. $[\ddot{N}=C=\ddot{S}]^-$ D. Structures A, B, and C are equally preferred

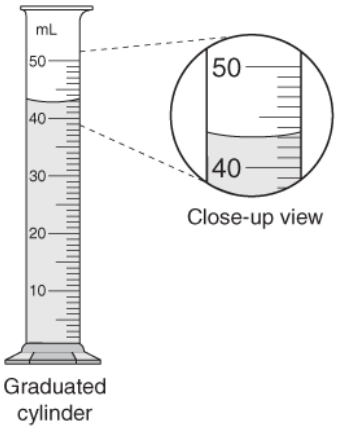
24. Which of the following does **NOT** have the same number of grams of carbon as 45 g of methane, CH_4?
    A. 39.4 g C_2H_4
    B. 1.69 x 10^{24} atoms of graphite, C(s)
    C. 1.41 mole $H_2C_2O_4$
    D. 1.50 x 10^{24} molecules of CO_2

25. A hypothetical element has of the following naturally occurring isotopes. What is its atomic mass?
    A. 46.89 amu
    B. 47.02 amu
    C. 47.10 amu
    D. 47.24 amu

Isotope	Mass	Abundance
1	46.041 amu	26.00%
2	47.038 amu	58.00%
3	49.034 amu	16.00%

26. The current Federal standards for carbon monoxide exhaust emissions for cars is 3.4 grams of CO per mile. In 2007 the Boston metropolitan area had 2.482 million vehicles, each driven an average of 40.0 miles per 24-hour period. How many tons/day of CO could legally be discharged into the metropolitan Boston area's atmosphere? (1 pound =453.6 grams, 2000 pounds = 1 ton)
    A. 9.30 tons/day B. 109 tons/day C. 372 tons/day D. 7.44 x 10^5 tons/day

27. The proper reading of the graduated cylinder to the right is:
    A. 43. mL
    B. 43.0 mL
    C. 44.5 mL
    D. 43.25 mL



28. In the following reaction, which ion or molecule is the Bronsted-Lowry base?

$$H^- + H_2O \rightarrow H_2 + OH^-$$

A. H^- B. H_2O C. H_2 D. OH^-

29. When U-238 is bombarded with C-12 nuclei a new transuranium element is produced along with 4 neutrons. The nuclear reaction is shown below.

$$^{238}_{92}U + {}^{12}_{6}C \rightarrow {}^{N}_{X}\text{Element} + 4\ {}^{N}_{X}n$$

The new transuranium element is:

A. $^{246}_{98}Cf$ B. $^{250}_{94}Pu$ C. $^{246}_{94}Pu$ D. $^{250}_{102}No$

30. In the following equilibrium reaction:

$FeO(s) + CO(g) \rightleftharpoons Fe(s) + CO_2(g)$ $(K_c = 0.516)$

excess FeO(s) is reacted with 0.065 moles of CO(g) in a one-liter flask until equilibrium is reached. How many moles of CO(g), Fe(s), and CO_2(g) are there at equilibrium?

	CO	**CO_2**	**Fe**
A.	0.087	0.022	0.022
B.	0.043	0.022	0.022
C.	0.043	0.011	0.011
D.	0.022	0.043	0.043

31. The combination of hydrazine and hydrogen peroxide was used as a rocket fuel. Using the enthalpies listed in the table, what is the enthalpy of this reaction?

$N_2H_4(l) + 2H_2O_2(g) \rightarrow N_2(g) + 4H_2O(l)$

Reaction	ΔH^o (kJ)
$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2\ H_2O(l)$	-622 kJ
$H_2(g) + ½\ O_2(g) \rightarrow H_2O$**(l)**	-286 kJ
$H_2(g) + O_2(g) \rightarrow H_2O_2(l)$	-188 kJ

A. –720 kJ B. -818 kJ C. -1390 kJ D. –2142 kJ

32. The chemistry laboratory is a place of discovery and learning. However, by the very nature of laboratory work, it can be dangerous if proper common sense precautions aren't taken. Which of the following laboratory safety rules should be strictly followed?
    A. Don't eat or drink in the lab.
    B. Notify the instructor immediately in case of an accident.
    C. No unauthorized experiments are to be performed.
    D. All of the above should be strictly followed.

33. The pH of a 0.10 M solution of chlorous acid, $HClO_2$, which has a K_a of 1.12×10^{-2} is:
A. 1.00 B. 1.48 C. 1.55 D. 1.95

For questions 34 and 35 use the following information:

The kinetics of the reaction between bromate ions and bromide ions in acid solution, whose stoichiometry is given by the equation below, was examined.

$$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

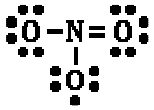
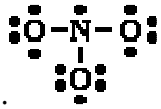
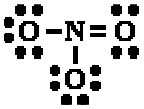
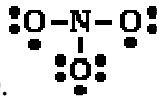
Consider the following experimental data:

Experiment	$[BrO_3^-]$, M	$[Br^-]$, M	$[H^+]$, M	$-\Delta[Br^-]/\Delta t$, M s^{-1}
1	0.200	0.200	0.200	0.0104
2	0.400	0.200	0.200	0.0208
3	0.400	0.400	0.200	0.0416
4	0.200	0.200	0.400	0.0416

34. The initial rate of the appearance of Br_2, $\Delta[Br_2]/\Delta t$, in experiment 1 is:
A. 0.00125 Ms^{-1} B. 0.00624 Ms^{-1} C. 0.0104 Ms^{-1} D. 0.0173 Ms^{-1}

35. The rate law expression for the reaction is:
A. Rate = k $[BrO_3^-][Br^-][H^+]$
B. Rate = k $[BrO_3^-][Br^-][H^+]^2$
C. Rate = k $[BrO_3^-][Br^-]^6[H^+]^6$
D. Rate = k $[BrO_3^-][Br^-]^2[H^+]$

36. The correct Lewis structure for NO_3^- ion is:

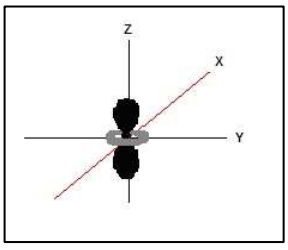
A. 
B. 
C. 
D. 

37. A crystal does not conduct electricity, yet its melt and aqueous solutions do. It is hard and brittle and melts at a high temperature. It is
A. a molecular crystal
B. a covalent network crystal
C. a metallic crystal
D. an ionic crystal

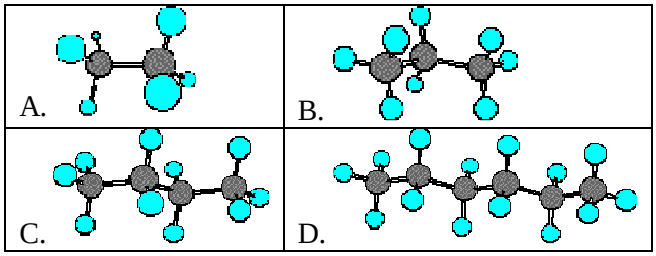
38. How was most of the helium in the Universe produced?
A. In the core of stars through fusion
B. In nuclear decay of radioactive elements
C. In supernovae explosions
D. In the "big bang"

39. Carbohydrates are the building blocks of polymers called
A. proteins B. cellulose C. fats D. DNA

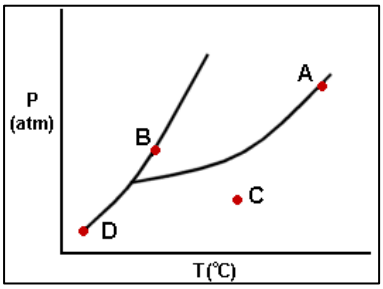
40. The type of orbital illustrated to the right is an:
A. s orbital B. p orbital C. d orbital D. f orbital



41. The propane molecule is:



42. Point A on the diagram to the right shows the:
    A. triple point
    B. sublimation point
    C. melting point
    D. critical pressure and temperature

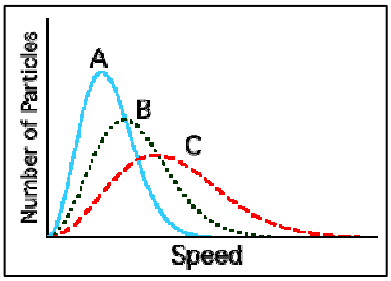


43. One of the additives in unleaded gasoline that replaced tetraethyl lead is called MTBE. MTBE contains only C, H and O. When 1.508 g MTBE is burned completely, 3.764 g CO_2 and 1.848 g H_2O form. In a separate experiment the molecular mass of MTBE is found to be 88.150. What is the empirical formula for MTBE? (Atomic masses: C = 12.0, O = 16.0, H = 1.01, CO_2 = 44.0, H_2O = 18.0).
    A. CH_2O B. CH_3O C. C_3H_6O D. $C_5H_{12}O$

44. What is the total vapor pressure of a solution containing 0.75 moles of acetone (58.0 grams/mole) and 1.25 moles of methanol (32.0 grams/mole)? At the measured temperature the vapor pressure of pure acetone is 260 torr and pure methanol is 140 torr
    A. 185 torr B. 200 torr C. 215 torr D. 370 torr

45. A 0.400 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 40.5 mL. The molecular weight of the unknown acid assuming one dissociable proton per molecule is:
    A. 10.1 grams/mole B. 24.8 grams/mole C. 98.8 grams/mole D. 101 grams/mole

46. The graph to the right shows three O_2 gas samples at different temperatures. Which gas is at the highest temperature?
    A. A B. B C. C D. Not enough information given.



47. How many grams of copper will dissolve if 0.300 moles of copper pellets is mixed with 100.0 mL of 2.00 M HCl at 75°C? (Cu = 63.55 grams/mole, HCl = 36.45 grams/mole)
    A. none B. 6.36 grams C. 12.7 grams D. 19.1 grams

48. In the Arrhenius equation, the rate constant, $k = A\, e^{-Ea/RT}$, the "A" term in the equation corresponds to:
    A. a minimum kinetic energy required for molecules to react.
    B. the ideal gas law constant.
    C. the initial kinetic energy of the system.
    D. a collision factor relating to molecular orientation.

49. Stars produce energy by fusing of 4 H atoms into He and 2 positrons according to the reaction:

$$4\,{}^{1}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + 2\,{}^{0}_{+1}\beta + \text{energy}$$

The amount of energy in kJ resulting in fusing of hydrogen into a mole of helium is: ($c = 3.00 \times 10^8$ m/s)

A. 9624 B. 2.89×10^9 C. 2.89×10^{12} D. 2.98×10^{12}

Particle	Rest Mass
${}^{1}\mathrm{H}$	1.00867
${}^{4}\mathrm{He}$	4.00150
${}^{0}_{+1}\beta$	0.00055

50. Calculate the value of K_c for the reaction using the following information.:

$$2N_2O(g) + 3O_2(g) \rightleftharpoons 2N_2O_4(g)$$

Equation	Equilibrium Constant
$2N_2(g) + O_2(g) \rightleftharpoons 2N_2O(g)$	$K_c = 1.2 \times 10^{-35}$
$2\,N_2O_4(g) \rightleftharpoons 4NO_2(g)$	$K_c = 2.1 \times 10^{-5}$
$N_2(g) + 2O_2(g) \rightleftharpoons 2NO_2(g)$	$K_c = 1.7 \times 10^{-17}$

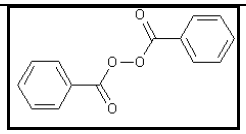
A. 4.3×10^{-57}
B. 8.7×10^{-7}
C. 1.1×10^{6}
D. 6.7×10^{22}

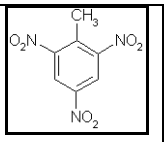
Use the following figures to answer questions 51-53.

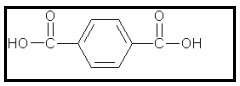
51. It has an "explosive" personality.

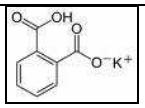
52. It's a "standard."

53. It's a "starter" of polymerization reactions.

A. 

C. 

B. 

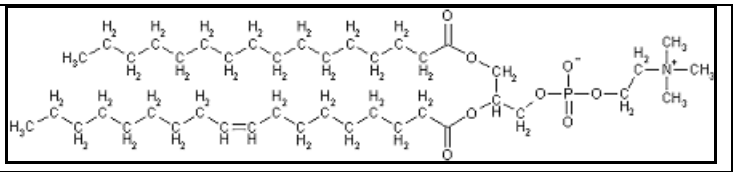
D. 

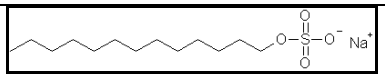
Use the following figures to answer questions 54-56.

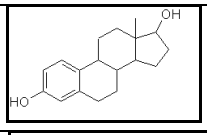
54. A plastics' emulsifier

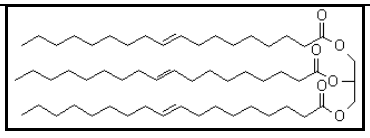
55. A grease and grime remover

56. A "good" fat

A. 

B. 

C. 

D. 

57. How many of the following molecules have at least one bond angle of 180°?

I_3^-	NH_3	XeF_4	BF_3	H_2O	CH_4	SO_2

A. 2 B. 3 C. 4 D. 5

Use the following information to answer questions 58 and 59.

In the rechargeable nickel-cadmium (NiCad) battery, the overall reaction is:

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

58. Which of the following half-reactions is taking place at the anode?
A. $Ni^{2+} + 2e^- \rightarrow Ni$
B. $Cd \rightarrow Cd^{2+} + 2e^-$
C. $Ni + 2OH^-(aq) \rightarrow Ni(OH)_2 + 2e^-$
D. $2NiO(OH) + 2H_2O + 2e^- \rightarrow 2Ni(OH)_2 + 2OH^-$

59. A NiCd battery is recharged with a 0.500 A for 2.00 hours. If the current efficiency is 95.0%, how many grams of $Cd(OH)_2$ are reduced to Cd? (Cd = 112.4 grams/mole, $Cd(OH)_2$ = 146.41 grams/mole, F = 96,500)
2.00 grams B. 2.59 grams C. 3.98 grams D. 5.19 grams

Use the following information to answer questions 60, 61, and 62. The Nernst equation is: $E = E^o - \frac{0.0592}{n} \log Q_c$.

A popular demonstration uses glucose, $C_6H_{12}O_6$, to reduce Ag^+ ions to form a silver mirror on the inner surface of the container. The standard half-cell reduction potentials for the reaction are:

1. $C_6H_{12}O_7(aq) + 2\ H^+ + 2\ e^- \rightarrow C_6H_{12}O_6(aq) + H_2O$ $\quad E^o = 0.050$ V
2. $Ag^+(aq) + e^- \rightarrow Ag$ $\quad E^o = 0.800$ V

60. The standard cell potential, E^o, for this cell is:
A. 0.750 V B. 0.775 V C. 0.850 V D. 1.550 V

61. In reaction 1, the pH of the glucose half-cell is changed to 11. The new half-cell reduction potential is:
A. 0.651 V B. 0.376V C. -0.276 V D. -0.601V

62. The silver electrode, equation 2 , is placed into an aqueous ammonia solution and the concentrations are adjusted so that a new standard half cell potential, shown in equation 3, results.

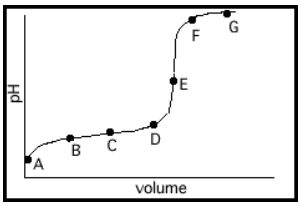
2. $Ag^+(aq) + e^- \rightarrow Ag$ $\quad E^o = 0.800$ V
3. $Ag(NH_3)_2^+(aq) + e^- \rightarrow Ag + 2NH_3(aq)$ $\quad E^o = 0.373$ V

From the above half cells, the K_f at 25°C for the reaction below is:

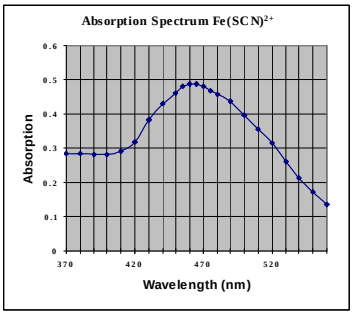
$$Ag^+ + 2NH_3 \rightleftharpoons Ag(NH_3)_2^+$$

A. 1.63×10^7 B. 2.66×10^{14} C. 6.52×10^{19} D. 4.25×10^{39}

63. A weak acid is titrated with a strong base, giving the titration curve to the right. The point on the curve that can be used for determining the pK_a of a weak acid without any calculation is
A. **A** B. **B** C. **C** D. **E**.



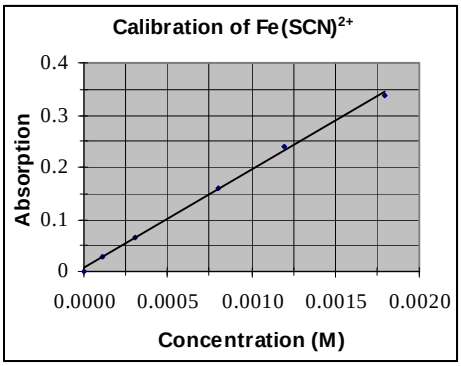
64. If the water molecule were linear rather than bent, you would expect:
A. Both the boiling and freezing points would be higher.
B. Both the boiling and freezing points would be lower.
C. The boiling point would be higher but the freezing point would be lower.
D. Salts would be even more soluble in the linear structure than the bent one.



For Questions 65 to 69 deal with the Fe(III)-SCN^- system.

The equilibrium constant, K_C, for the Fe(III)-SCN^- reaction, reaction shown below, was determined colorimetrically by measuring the absorption of the blood-red colored $Fe(SCN)^{2+}$ complex at 460 nm. The absorption curve and calibration plot are shown to the right.

$Fe^{3+}(aq) + SCN^-(aq) \rightleftharpoons Fe(SCN)^{2+}(aq)$
colorless colorless blood-red



65. A solution was prepared in which the initial concentrations were

$[Fe^{3+}]_o = [SCN^-]_o = 3.00 \times 10^{-3}$ M.

At 27°C (300 K), the absorption of the solution read 0.200. The equilibrium constant, K_C, is:
A. 0.0040 B. 111 C. 250 D. 2.22×10^4

66. What is the ΔG^o in kJ/mole for the reaction at 27°C? (R = 8.314 J/ mole·K)
A. -1.24 B. -11.7 C.-13.8 D. 136

67. The above solution was warmed to 67°C (340 K) and the absorbance now read (0.248). Using this measurement and the one in #65, the ΔH^o for the reaction in kJ/mole is: (R = 8.314 J/mole·K)
A. 0.15 kJ B. 1.25 kJ C. 4.5 kJ D. 10.4 kJ

68. Which of the following procedures would result in a calculated value of K_C which is too low?
I. The unknown concentration fades to a lighter color before the student makes a measurement.
II. After the calibration was determined at 450 nm, the student measured the complex at 420 nm .
III. The initial concentrations of $[Fe^{3+}]_o$ and $[SCN^-]_o$ were actually 5.0×10^{-3} M instead of 3.0×10^{-3} M.
IV. The colorimeter was misread. The actual absorbance was 0.05 higher than the misreading.

A. I, II, and IV B. I and IV C. II and III D. All of the above.

69. The Banana Ranch Story: When I was a young boy, Uncle Wilber let me watch as he analyzed the iron content of a runoff from his banana ranch. Here were the steps he took:
- A 25.0 mL sample was acidified and treated with excess KSCN to produce the red $Fe(SCN)^{2+}$.
- This solution was diluted to 100.0 mL.
- A 10.0 mL standard containing 6.80×10^{-4} M of Fe^{3+} was acidified and treated with excess KSCN to produce the red $Fe(SCN)^{2+}$.
- This standard was diluted to 50.0 mL.
- When compared to the diluted standard, the diluted runoff needed a cell path length 2.48 **longer** than the diluted standard path length.

What was the iron concentration in Uncle Wilber's runoff?
A. 2.19×10^{-4} M B. 2.48×10^{-4} M C. 5.48×10^{-5} M D 1.35×10^{-3} M

70. With aqueous solutions of HNO_3, NaOH, $HC_2H_3O_2$, and $NaC_2H_3O_2$, the number of pairs that can be used to make a buffer is:
A. 1 B. 2 C. 3 D. 4

71. The Man in the Vat Problem: Long ago a workman at a dye factory fell into a vat containing a hot concentrated mixture of sulfuric and nitric acids. He dissolved completely! Because nobody had witnessed the accident, it was necessary to prove that he fell in so that the man's wife could collect his insurance.
    - The man weighed 70 kg.
    - The human body contains 6.3 parts per thousand phosphorus.
    - The vat contained 8.00×10^3 L of liquid and a 100.0 mL sample was analyzed.

    If the man fell in, what would be the expected quantity of phosphorus in <u>milligrams</u> in the 100.0 mL sample?
    A. 0.055 mg B. 0.441 mg C.4.4 mg D. 5.5 mg

72. The remnants of an ancient fire in a cave in Africa showed a ^{14}C decay rate of 3.1 counts per minute per gram of carbon. Assuming that the decay rate of ^{14}C in freshly cut wood is 13.6 counts per minute per gram of carbon, what is the approximate age of the remnants? The half-life of ^{14}C is 5730 years.
    A. 8470 years B. 11500 years C. 12200 years B. 25100 years

73. The rate law for the reaction below is: rate = $k[H_2][NO]^2$.

    $2H_2(g) + 2NO(g) \rightarrow N_2(g) + 2H_2O(g)$,

    This mechanism has been proposed:
    - Step 1: $H_2 + NO \rightarrow H_2O + N$
    - Step 2: $N + NO \rightarrow N_2 + O$
    - Step 3: $O + H_2 \rightarrow H_2O$

    This mechanism is consistent with the rate law if:
    A. Step 1 is the rate determining step.
    B. Step 2 is the rate determining step.
    C. Step 3 is the rate determining step.
    D. This mechanism can not be consistent with the rate law, regardless of which step is rate-determining.

74. The correct procedure for using a volumetric pipet is:
    A. Use a pipet bulb to draw the liquid up to the line and then squeeze the bulb to force all liquid into the flask.
    B. Add the liquid from the top of the pipet until it is filled to the line. Allow the liquid to drain into the flask and then blow on the pipet to get all the liquid into the flask.
    C. Use a pipet bulb to draw the liquid above the line on the pipet. Adjust the liquid until the curve of the meniscus is on the line. Place the tip of the pipet against the side of the flask and allow the liquid to drain.
    D. Draw the liquid above the line on the pipet by sucking on the open end of the pipet. Use your thumb to adjust the liquid until the curve of the meniscus is on the line. Place the tip of the pipet against the flask and let the liquid drain.

75. When a 2.855 g sample of $Co(NH_2CH_2CH_2NH_2)_2Cl_3$ is dissolved in 100.0 g of water, the solution's freezing point is -0.37°C. How many ions are produced per mole of compound? ($K_f(H_2O)$ = -1.86 °C/molal, $Co(NH_2CH_2CH_2NH_2)_2Cl_3$ = 285.5 grams/mole).
    A. 1 B. 2 C. 3 D. 4

76. Solid NaOH is not a primary standard, and NaOH solutions must be standardized. Select all the correct reasons why this is so.
    I. Solutions are too exothermic when dissolved in water.
    II. Solid NaOH absorbs water from the atmosphere.
    III. Solutions react with CO_2 in the air.
    IV. Reagent grade NaOH contain carbonates.

    A. I, II, and III B. II and III C. II, III and IV D. All of the above

77. Chemical syntheses of simple small organic molecules are considered essential in order for life to begin. Select all the correct answers below. Potentially important sources of organic compounds can be found in
    I. deep oceanic thermal vents (black smokers)
    II. tidal pools
    III. the solid crust
    IV. deep space
    A. I and II B. I, II, and III C. II only D. All of the above.

78. Polar solute molecules tend to be more soluble in polar solvents than non-polar solvents because:
    A. These solutes do not disrupt attractive forces between polar solvents.
    B. The attractive forces between polar solvent and solute molecules compensate for the disruptive attractions between polar solvents.
    C. Polar molecules tend to be arranged exclusively in completely ordered, non-random structures.
    D. Nonpolar solvents have a much stronger intermolecular attraction than polar solvents.

79. In the days of black and white photography, photographic plates were made with an emulsion of light-sensitive AgBr. During the development process, the unreacted AgBr was dissolved off the plate in hypo, an aqueous solution of sodium thiosulfate, $Na_2S_2O_3$. The overall reaction is:

    $$AgBr(s) + 2S_2O_3^{2-}(aq) \rightleftharpoons Ag(S_2O_3)_2^{3-}(aq) + Br^-(aq)$$

    The equilibra involved are:

    $$AgBr(s) \rightleftharpoons Ag^+(aq) + Br^-(aq) \qquad K_{sp} = 4.00 \times 10^{-13}$$
    $$Ag^+(aq) + 2S_2O_3^{2-}(aq) \rightleftharpoons Ag(S_2O_3)_2^{3-}(aq) \qquad K_f = 6.25 \times 10^{13}$$

    The solubility of AgBr in one liter of 1.00 M $Na_2S_2O_3$ solution is:
    A. 0.17 M B. 0.45 M C.0.55 M D. 0.83 M

For questions 80 to 82, use the standard enthalpies and entropies at 298 K given below for the following reaction:

$$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

Compound	ΔH^o(kJ/mole)	ΔS^o(J/mole·K)
$NaHCO_3(s)$	-950	100
$Na_2CO_3(s)$	-1130	135
$H_2O(g)$	-240	190
$CO_2(g)$	-395	215
For your calculations		

80. The above reaction is:
    A. spontaneous at all temperatures
    B. nonspontaneous at all temperatures
    C. nonspontaneous at lower temperatures but spontaneous at higher temperatures
    D. spontaneous at lower temperatures but nonspontaneous at higher temperatures

81. Assume that the above thermodynamic values are independent of temperature. The Celsius equilibrium temperature (°C) in which $NaHCO_3$ will begin to spontaneously decompose is:
    A. around 125°C B. around 400°C C. around 2250°C D. No fixed equilibrium temperature

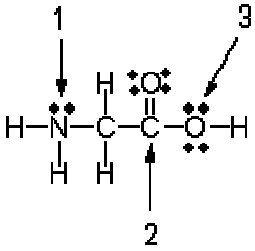
82. The equilibrium constant for the reaction at 298 K is (R = 8.314 J/mole·K):
    A. 2.2×10^{-24} B. 1.6×10^{-6} B. 1.0 D. 6.0×10^{5}

83. A solution containing 1.0 M Al^{3+} and 1.0 M Cu^{2+} is buffered to a pH of 4.00. What is the ratio of the ions, Cu^{2+}/Al^{3+}, left in solution?
    A. 1.00 B. 333 C. 1.18×10^{4} D. 7.33×10^{12}

K_{sp} of $Cu(OH)_2$	2.20×10^{-20}
K_{sp} of $Al(OH)_3$	3.00×10^{-33}

84. The substance with highest boiling point is:
    A. carbon tetrachloride, CCl_4 (Molar mass = 154 grams/mole)
    B. octane, C_8H_{18} (Molar mass = 114 grams/mole)
    C. ethylene glycol, HOC_2H_4OH (Molar mass = 62 grams/mole)
    D. diethyl ether, $C_2H_5OC_2H_5$ (Molar mass = 74 grams/mole)

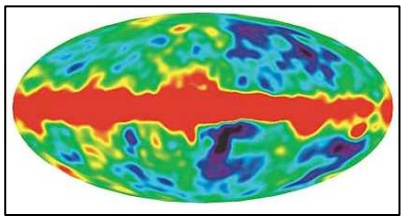
85. The Lewis structure for the amino acid glycine is given below. Give the hybridization and bond angle about each of the labeled atoms.



A.	N_1 - sp^2, 120°	C_2 - sp^3, 109.5°	O_3 - sp, 180°
B.	N_1 - sp^3, 109.5°	C_2 - sp^2, 120°	O_3 - sp^3, 109.5°
C.	N_1 - sp^2, 120°	C_2 - sp^2, 120°	O_3 - sp, 180°
D.	N_1 - sp^3, 109.5°	C_2 - sp^3, 109.5°	O_3 - sp^3, 109.5°

86. The element with the electron configuration $1s^2 2s^2 2p^4$ has:
    A. 2 bonded electron pairs and 4 unpaired electrons
    B. 3 bonded electron pairs and 3 unpaired electrons
    C. 3 bonded electron pairs and 2 unpaired electrons
    D. 4 bonded electron pairs and 0 unpaired electrons

87. The image to the right shows:
    A. a picture of the infant universe
    B. the cigar galaxy, M82 (NGC 3034)
    C. a supernova remnant nebula
    D. an orbital path of black-hole



88. A person's blood alcohol, C_2H_5OH, (Molar mass = 46.0 grams/mole) may be determined by titrating a sample of blood plasma with a potassium dichromate, $K_2Cr_2O_7$, solution. The balanced reaction is:

$$16H^+(aq) + 2Cr_2O_7^{2-}(aq) + C_2H_5OH(aq) \rightarrow 4Cr^{3+}(aq) + 2CO_2(g) + 11H_2O(l)$$

    If 27.27 mL of 0.0550 M $K_2Cr_2O_7$ solution is needed to titrate 40.0 grams of blood plasma, what is the mass percent of alcohol in the blood?
    A. 0.0345% B. 0.0862% C. 1.87% D. 3.45 %

89. Aspirin, acetylsalicylic acid, has a pK_a of 2.96. The physiological effectiveness depends upon how much is in the conjugate base form, acetylsalicylate. What is the ratio of acetylsalicylate to acetylsalicylic acid when a small amount of aspirin is dissolved in a solution buffered at pH = 3.00?
    A. 0.04 B. 0.67 C. 0.91 D. 1.10

90. The number of acidic, basic, or neutral solutions resulting when the following salts are dissolved in water is:

KNO_3	NH_4NO_3	$NaNO_2$	$Fe(NO_3)_3$	Na_2CO_3

	Acidic	Basic	Neutral
A.	2	2	1
B.	1	2	2
C.	0	2	3
D.	2	1	2