

INDIANA SECTION
AMERICAN CHEMICAL SOCIETY
High School Chemistry Scholarship Exam

April 9, 2005



1. The exam contains 100 questions. You have 2 hours and 30 minutes to complete the exam.
2. Choose the single *best* answer for each question and darken the corresponding letter on your answer sheet. The score is based on the number of correct answers: there is no penalty for incorrect guesses.
3. Scientific calculators are permitted. Graphing calculators, and/or those with stored programs and information, are not allowed.
4. You may write on this exam. The exam does not need to be returned.
5. Use of significant digits and correct units may be considered in the choice of the best answer.
6. A periodic table and a sheet of selected formulas are also provided.

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Section I: Measurement and Calculations in Science

- Which number has the greatest number of significant figures?
 - 965.
 - 0.440
 - 100.0
 - 0.00070
 - 2.22×10^1
- A buret that has volume markings at 0.1 mL intervals should be read to the nearest
 - mL.
 - half mL.
 - tenth of a mL.
 - hundredth of a mL.
 - thousandth of a mL.
- A digital analytical balance had a readout when “tared” of 0.0000 g. How many significant figures would your weight data permit if the object you were weighing had a mass greater than 1 g, but less than 10 grams?
 - 7
 - 6
 - 5
 - 4
 - 3
- The densities of ethylene glycol, water and wood alcohol are 1.11 g/mL, 1.00 g/mL and 0.79 g/mL respectively. Suppose an object floats in water and ethylene glycol but sinks when placed in wood alcohol. Which could be the density of the object?
 - 1.22 g/mL
 - 1.11 g/mL
 - 1.05 g/mL
 - 0.92 g/mL
 - 0.75 g/mL
- Evaluate the expression to the correct number of significant figures:

$$3.21 \times 10^{-2} \text{ mL} + 2.007 \times 10^{-2} \text{ mL} + 0.012 \text{ mL}$$

- $6. \times 10^{-2} \text{ mL}$
- $6.0 \times 10^{-2} \text{ mL}$
- $6.4 \times 10^{-2} \text{ mL}$
- $6.42 \times 10^{-2} \text{ mL}$
- $6.417 \times 10^{-2} \text{ mL}$

6. Iridium (symbol Ir, atomic weight 192.217 amu) consists of only two naturally occurring isotopes. One of these isotopes is iridium-191, accounting for 37% of the iridium on earth. Which must be the other isotope?
- Ir-77
 - Ir-189
 - Ir-190
 - Ir-192
 - Ir-193
7. The metric prefix deka- means 10^1 . From this information and your knowledge of other metric prefixes, which is the correct relationship between dekagrams and centigrams?
- 1 dekagram = 0.01 cg
 - 1 dekagram = 0.1 cg
 - 1 dekagram = 10 cg
 - 1 dekagram = 100 cg
 - 1 dekagram = 1000 cg
8. Calculate the mass of copper that occupies the same volume as 75.0 g of magnesium. The density of copper is 8.96 g/cm^3 . The density of magnesium is 1.74 g/cm^3 .
- 14.56 g
 - 14.6 g
 - 15 g
 - 386 g
 - 386.2 g
9. About how many hydrogen atoms are in 0.050 moles CH_4 gas?
- 1.2×10^{23}
 - 3.0×10^{22}
 - 4.8×10^{25}
 - 6.0×10^{23}
 - 7.5×10^{21}
10. The cholesterol concentration in normal human blood is about $2 \text{ }\mu\text{g}/\mu\text{L}$. How many grams of cholesterol would be in 50.0 mL of blood?
- 10 g
 - 1 g
 - $1 \times 10^{-1} \text{ g}$
 - $1 \times 10^{-2} \text{ g}$
 - $1 \times 10^{-3} \text{ g}$

Section 2: Chemical Composition and Stoichiometry

11. Which of the following is *not* a correct match of name and formula?
- Cs_2SO_4 , cesium sulfate
 - NH_4SO_3 , ammonium sulfate
 - PbCl_2 , lead(II) chloride
 - $\text{Fe}(\text{CH}_3\text{CO}_2)_3$, iron(III) acetate
 - All** of the above are correct.
12. Which of the following is a chemical process?
- sublimation of dry ice
 - refraction of light through germanium crystal
 - homogenization of raw milk
 - setting of concrete
 - gaseous diffusion of UF_6
13. Nitrogen gas and hydrogen gas react to form ammonia, NH_3 . How many moles of ammonia are produced by the reaction of 1.0 mol of nitrogen gas with 1.5 mol hydrogen gas?
- 1.0 mol ammonia
 - 1.25 mol ammonia
 - 1.5 mol ammonia
 - 2.0 mol ammonia
 - 2.3 mol ammonia
14. What is the molarity of pure methanol (CH_3OH)? The density of methanol is 0.79 g/mL.
- 18 M
 - 25 M
 - 31 M
 40. M
 - 45 M
15. Which has the greatest percent by weight nitrogen?
- NH_3
 - HCN
 - HNO_3
 - ammonium phosphate, $(\text{NH}_4)_3\text{PO}_4$
 - sodium nitrate, NaNO_3

16. The compounds XSO_4 and Na_2Y suggest the existence of:
- XY
 - YX
 - X_2Y
 - XY_2
 - XY_3
17. What is the mass of one molecule of $C_{12}H_{24}$?
- 188 g
 82. g
 - 2.8×10^{-22} g
 - 2.8×10^{-17} g
 - 4.6×10^{22} g
18. How many moles of nitrogen gas (N_2) could be produced in the complete decomposition of 4.0 moles of TNT, $C_7H_5N_3O_6$?
- 2.0 moles
 - 2.5 moles
 - 3.0 moles
 - 4.0 moles
 - 6.0 moles
19. If 8 mol of acetylene (C_2H_2) are combined with 10 mol of hydrogen gas to form ethane (C_2H_6), how many moles of a reactant remain if the reaction proceeds as fully as possible?
- Both reactants are completely consumed in the reaction.
 - 2 mol hydrogen remain
 - 3 mol hydrogen remain
 - 2 mol acetylene remain
 - 3 mol acetylene remain
20. About how much water must be added to 100 mL 2 M HCl to dilute it to 0.5 M?
- 100 mL
 - 200 mL
 - 300 mL
 - 400 mL
 - 500 mL

21. Suppose 88.24 mL of 0.1005 M $\text{HCl}(aq)$ is required to neutralize 100. mL $\text{Ca}(\text{OH})_2(aq)$. What is the concentration of the calcium hydroxide solution?
- 0.04434 M
 - 0.08868 M
 - 0.1774 M
 - 0.1005 M
 - 0.2010 M
22. Toluene is a gas additive used to improve octane rating. If 22.0 mL toluene (C_7H_8 , $D = 0.867$ g/mL) are burned in excess oxygen, how many water molecules are produced in the process?
- 4.0×10^{23}
 - 5.0×10^{23}
 - 6.0×10^{23}
 - 7.0×10^{23}
 - 8.0×10^{23}
23. Calculate the number of moles of oxygen atoms in 2 mol of the hydrate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.
- 4 mol
 - 5 mol
 - 8 mol
 - 9 mol
 - 18 mol

Section 3: Atomic Theory, Periodicity and Bonding

24. The energy of a photon is
- proportional to the square of its velocity.
 - proportional to its wavelength.
 - proportional to its velocity.
 - proportional to its wave amplitude.
 - inversely proportional to its wavelength.
25. Arrange the following in order of increasing mass:
- | | | | |
|-------------|----------------|-----------------------|----------------------|
| proton
I | electron
II | alpha particle
III | deuterium atom
IV |
|-------------|----------------|-----------------------|----------------------|
- $\text{II} < \text{I} < \text{III} < \text{IV}$
 - $\text{II} < \text{I} < \text{IV} < \text{III}$
 - $\text{I} < \text{II} < \text{III} < \text{IV}$
 - $\text{II} < \text{IV} < \text{I} < \text{III}$
 - $\text{IV} < \text{II} < \text{I} < \text{III}$

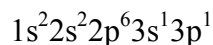
26. A doubly charged ion has the following properties:

- full 3d and 4d orbitals
- no 5p electrons
- ion in the ground electronic state

The ion could be:

- S^{2-}
- Sn^{2+}
- Cr^{2+}
- Se^{2-}
- Ba^{2+}

27. A neutral atom has the electron configuration:



- The atom is in an excited electronic state.
- This atom cannot be identified by its electronic configuration.
- This configuration violates the Pauli Exclusion Principle.
- This configuration cannot exist since it is not a noble gas configuration.
- Atoms with this configuration can be found in both Group 2A(12) and 3A(13).

28. An ion has 2 more electrons than protons. The ion could be either

- Be^{2+} or Mg^{2+} .
- Ne or Ar.
- O^{2-} or S^{2-} .
- an alpha particle or a beta particle.
- $^{12}C^+$ and $^{14}C^+$.

29. Atomic orbitals in order of increasing energy are:

- $3s < 4s < 5s$
- $4s < 4p < 4d$
- $2p < 3p < 4p$
- $4s < 3d < 4p$
- All** of these are correct.

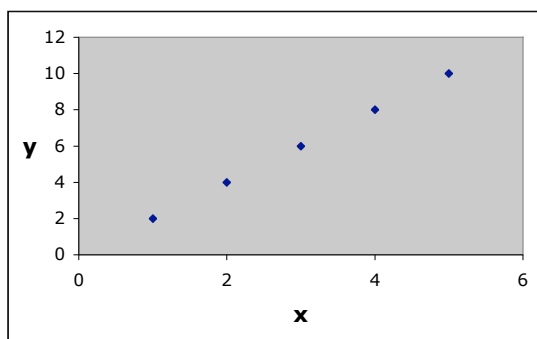
30. A species, isoelectronic to Ar, is smaller than the Cl^- ion, but bigger than the Ca^{2+} ion. The species could be

- S^{2-}
- Na^+
- K^+
- P^{3-}
- Ra^{2+}

31. An electron is labeled by quantum number $n = 3$, $l = 2$, and $m_l = 0$. That electron could be identified as a
- 3s electron.
 - 2s electron.
 - 3p electron.
 - 2p electron.
 - 3d electron.
32. An atom, about the same size as a cobalt atom, is larger than a silver atom. It could be
- Ni
 - Pd
 - Fe
 - Cd
 - Zn
33. Which of the following has the greatest covalent character?
- AgCl
 - SCl₂
 - HCl
 - PbCl₂
 - Li₂O
34. Which can be described as containing both significant covalent and ionic bonding?
- Na₃PO₄
 - NaCN
 - KNO₃
 - (NH₄)₂CO₃
 - All** of the above contain examples of covalent and ionic bonding.
35. The bond order of the nitrogen - oxygen bond in the nitrate ion, NO₃⁻, is about
- one and a third.
 - one.
 - two.
 - three.
 - four.
36. Which of the following has an undistorted tetrahedral structure?
- methane
 - NH₄⁺
 - SiH₄
 - CF₄
 - All** of the above are tetrahedrally-shaped molecules.

37. Acetone has the formula CH_3COCH_3 where the three carbons form a chain. The best bonding description of the central carbon atom to the oxygen atom is
- single bond: pi type above and below plane of molecule
 - double bond: one sigma and one pi type
 - double bond: two pi bonds
 - double bond: two sigma bond
 - triple bond: one sigma, two pi
38. Of the following molecules, which two have the same geometry (shape)?
- | | | | | |
|--|---------------|--------------|-----------------------|---------------|
| | CO_2 | O_3 | CH_2O | SO_2 |
|--|---------------|--------------|-----------------------|---------------|
- CO_2 and O_3
 - O_3 and CH_2O
 - O_3 and SO_2
 - CO_2 and SO_2
 - CO_2 and CH_2O
39. Which molecule contains a bond angle closest to 120° ?
- H_2O
 - BF_3
 - PCl_3
 - H_2O_2
 - CH_4
40. What are the hybrid orbitals of iodine in the molecule IF_3 ?
- sp
 - sp^2
 - sp^3
 - sp^3d
 - sp^3d^2

Section 4: Gases, Liquids, Solids and Solutions



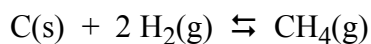
41. Which could produce the data points shown on this graph?
- $y = \text{pressure}$ and $x = \text{volume}$ (gas experiment, fixed n and T)
 - $y = \text{temperature}$ and $x = \text{volume}$ (gas experiment, fixed n and P)
 - $y = \text{pressure}$ and $x = \text{temperature}$ (gas experiment, fixed n and V)
 - both a and b
 - both b and c
42. A balloon occupies 4.0 L at 20°C . How cold must it be to reduce the volume to one fourth the original size? Assume the pressure stays the same.
- 0°C
 - 0.25°C
 - 5°C
 - 20 K
 - 73 K
43. If a 1.0 L flask contains 42.9 g of a gas at a pressure of 4.0 atm at 100. K, what is the molecular weight of the gas?
- 22.4 g/mol
 - 42.9 g/mol
 - 86 g/mol
 - 88 g/mol
 90. g/mol
44. A mixture of He and Ar, whose mole fraction of He is 0.400, is collected over water at 29°C (vapor pressure 30.0 mm Hg). If the total pressure exerted by the gas mixture is 1.00 atm, what is the partial pressure of Ar in mm Hg?
- 438
 - 292
 - 456
 - 316
 - 474

45. Since pressure and volume are inversely proportional to each other (for a fixed amount of gas at constant temperature) we mathematically say that:
- $P = k(1/V)$
 - $P = kV$
 - $P/V = k$
 - $1/k = P/V$
 - $P_1/V_1 = P_2/V_2$
46. When a gas condenses
- heat is absorbed and entropy decreases.
 - heat is released and entropy decreases.
 - heat is absorbed and entropy increases.
 - heat is released and entropy increases.
 - heat is neither absorbed or released.
47. Predict the physical state of water if the sample is at 100°C and the pressure is 3 atm.
- solid
 - liquid
 - gas
 - a mixture of gas and liquid
 - a mixture of solid and liquid
48. Which of the following, when placed in water, would likely result in an aqueous solution that readily conducts electricity?
- CH_3OH
 - BaSO_4
 - Na_3PO_4
 - AgCl
 - All** of the above
49. Which of the following is likely to be a soluble combination (at least to some significant extent)?
- CCl_4 and water
 - octane (C_8H_{18}) and water
 - NaCl and hexane (C_6H_{14})
 - MgSO_4 and CCl_4
 - hexane (C_6H_{14}) and CCl_4

50. Which will **lower** the vapor pressure of a solution that contains a non-volatile solute?
- raise its temperature
 - dilute the solution with more solvent
 - add more of the non-volatile solute
 - all** of the above
 - none** of the above
51. What is the approximate molarity of a solution of NaOH that is 5.0% w/v?
- 1.6 M
 - 1.25 M
 - 12.5 M
 - 0.039 M
 - 0.80 M
52. What is the concentration when 35 mg of lead is present in a 10,000 gram sample of water?
- 0.035 ppm
 - 0.70 ppm
 - 3.5 ppm
 - 350 ppm
 - 3.5×10^3 ppm
53. What is the simplest formula of a solid containing A, B and C atoms in a cubic lattice in which the A atoms occupy the corners, the B atoms the body-center position, and the C atoms the faces of the unit cell?
- ABC
 - ABC₃
 - ABC₆
 - A₈BC₆
 - A₄BC₃
54. Consider a face-centered cubic array of iodide ions ($r = 2.16 \text{ \AA}$). What is the maximum radius, in \AA , that a cation could have and still fit in the holes on the edges of the FCC unit cell?
- 0.90
 - 1.1
 - 1.8
 - 2.2
 - 2.7

Section 5: Chemical Equilibrium

55. What is the value of the equilibrium constant, K_c at 1000°C , for the reaction below:



The equilibrium amount of CH_4 is 0.050 M and H_2 is 0.45 M at 1000°C .

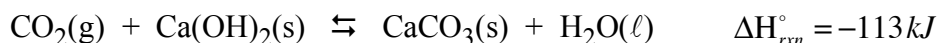
- a. 0.0159
- b. 0.247
- c. 127
- d. 3.82×10^3
- e. 5.14×10^4

56. What is the equilibrium concentration of F_2 at 100°C if the initial concentration of HF is 0.25 M and the K_c is 2.7×10^{-3} ?



- a. 2.7×10^{-5}
- b. 3.5×10^{-3}
- c. 1.2×10^{-2}
- d. 5.4×10^{-1}
- e. 4.8×10^2

57. What set of temperature and pressure conditions are required to drive the following reaction to produce products?



- a. increase in temperature and increase in pressure
- b. increase in temperature and decrease in pressure
- c. decrease in temperature and decrease in pressure
- d. decrease in temperature and increase in pressure
- e. This reaction cannot be forced to produce products.

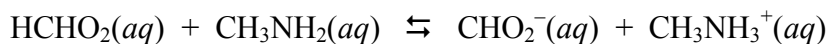
58. What is the pH of a $0.10 \text{ M HC}_4\text{H}_7\text{O}_2$ solution? The K_a of $\text{HC}_4\text{H}_7\text{O}_2$ is 1.5×10^{-5} ?

- a. 1.0
- b. 2.9
- c. 4.7
- d. 8.5
- e. 10.3

59. Which of the following will be acidic?

- a. $\text{NaOH}(aq)$
- b. $\text{NH}_3(aq)$
- c. $\text{NaCl}(aq)$
- d. $\text{NH}_4\text{Cl}(aq)$
- e. $\text{CH}_3\text{CONH}_2(aq)$

60. Identify the conjugate pairs in the following reaction:



- a. $\text{HCHO}_2/\text{CH}_3\text{NH}_2$
- b. $\text{HCHO}_2/\text{CHO}_2^-$
- c. $\text{CH}_3\text{NH}_2/\text{CHO}_2^-$
- d. $\text{CHO}_2^-/\text{CH}_3\text{NH}_3^+$
- e. None of the above are conjugate pairs.

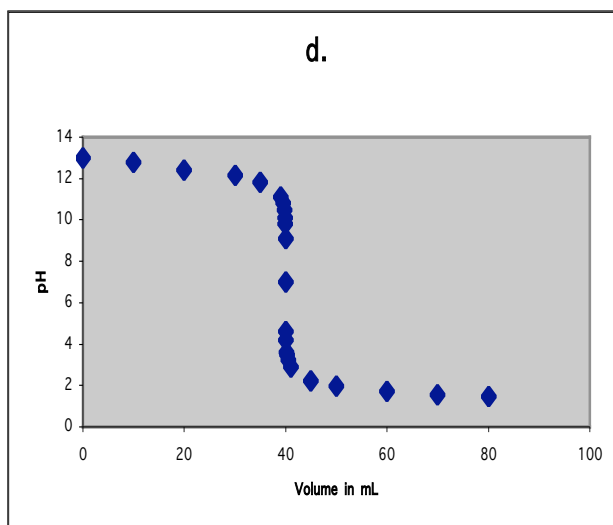
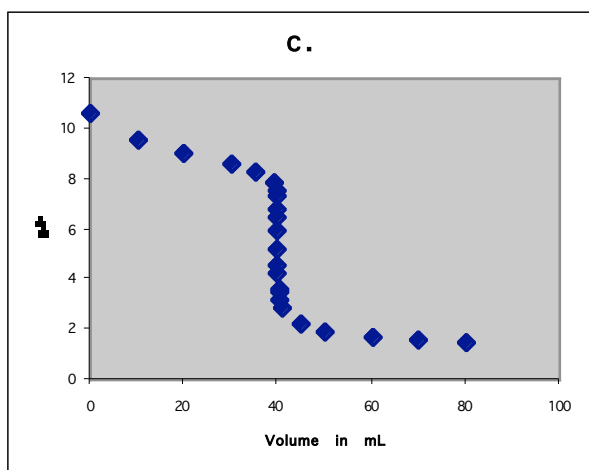
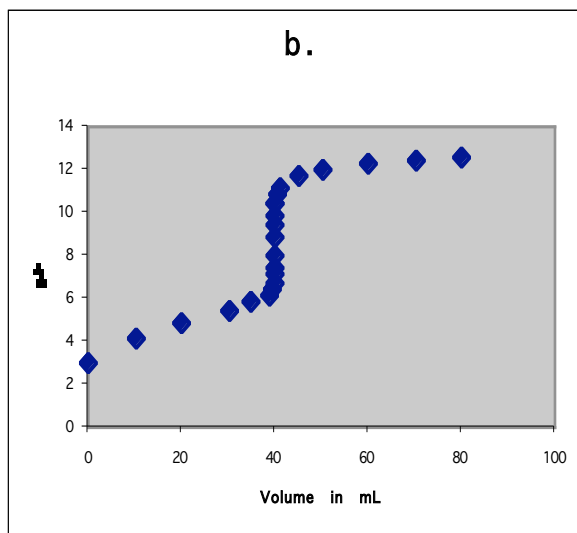
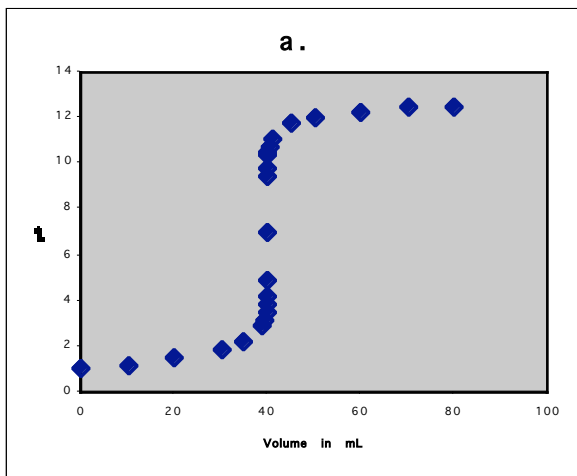
61. Given the titration of 0.15 M $\text{HC}_2\text{H}_3\text{O}_2$ with 0.10 M NaOH , will the pH at the equivalence point be acidic, basic or neutral?

- a. acidic
- b. basic
- c. neutral
- d. very slightly acidic
- e. impossible to determine

62. What would happen to the molar solubility, s , of lead(II) chloride if it were dissolved in an aqueous sodium chloride solution instead of water?

- a. the molar solubility would increase
- b. the molar solubility would decrease
- c. the molar solubility would be unchanged
- d. the molar solubility would decrease at lower concentrations, and increase for higher concentrations
- e. impossible to determine

63. Which titration curve represents the titration of 0.10 M NH_3 with 0.10 M HCl ?

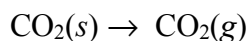


Section 6: Chemical Thermodynamics

64. Which of the following reactions is most likely endothermic?

- $\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(s)$
- $\text{CH}_4(g) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(g)$
- $\text{CO}_2(g) \rightarrow \text{CO}_2(s)$
- $\text{NaCl}(aq) + \text{H}_2\text{O}(l) \rightarrow \text{NaOH}(aq) + \text{HCl}(aq)$
- $\text{F}(g) + e^- \rightarrow \text{F}^-(g)$

65. The reaction



has a heat associated with the transformation termed the heat of

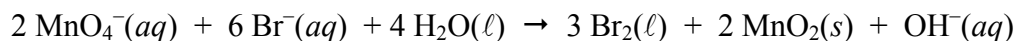
- deposition.
 - vaporization.
 - sublimation.
 - fusion.
 - crystallization.
66. Suppose two blocks of the same material, one 40 g and the other 80 g, are brought into thermal contact (with no heat lost to the surroundings). If the initial temperature of the small block is 100.°C, and the initial temperature of the larger block is 160°C, what is the final temperature of each block at thermal equilibrium?
- 120°C
 - 130°C
 - 140°C
 - 145°C
 - cannot be determined from given information
67. Which of the following variables does not depend on the path of the transformation?
- work, w
 - heat, q
 - enthalpy, ΔH
 - entropy, ΔS
 - Both enthalpy and entropy do *not* depend on path.
68. Predict which of the following reactions requires the most energy.
- $\text{Mg}(g) \rightarrow \text{Mg}^+(g) + e^-$
 - $\text{Mg}^+(g) \rightarrow \text{Mg}^{2+}(g) + e^-$
 - $\text{Mg}^{2+}(g) \rightarrow \text{Mg}^{3+}(g) + e^-$
 - $\text{Mg}(g) \rightarrow \text{Mg}^{2+}(g) + 2e^-$
 - All** of the above have about the same energy.
69. The heat of formation of acetaldehyde [$\text{CH}_3\text{CHO}(g)$] is -166 kJ/mol and acetic acid [$\text{CH}_3\text{COOH}(l)$] -487 kJ/mol . Use this information to predict the heat of reaction to oxidize a mole of acetaldehyde gas to liquid acetic acid.
- -321 kJ
 - $+321 \text{ kJ}$
 - $+653 \text{ kJ}$
 - -653 kJ
 - -1306 kJ

70. The conversion of hydrogen peroxide to water plus oxygen releases 98 kJ per mole of hydrogen peroxide. How much energy is released if 2 mol of water are formed?
- 49 kJ
 - 98 kJ
 - 147 kJ
 - 196 kJ
 - 245 kJ
71. The Gibbs Free Energy change at 298 K for the reaction: $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ is -141.6 kJ. The equilibrium constant for the reaction as written is:
- 7×10^{24}
 - 2×10^{12}
 - 57
 - 2×10^{-25}
 - 5×10^{-13}
72. At what temperature will a reaction become spontaneous if ΔH for the reaction is -75 kJ and ΔS is $+10.5$ J/K ?
- 7100 K
 - 7100 C
 - 0.710 K
 - The reaction is never spontaneous.
 - The reaction is spontaneous at all temperatures.
73. The reaction, $\text{N}_2\text{O}_5(\text{g}) \rightarrow 2\text{NO}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g})$, is endothermic, $\Delta H = +109.5$ kJ. However, it is spontaneous. Why might this be predicted?
- Work is negative and controls the spontaneity of the reaction.
 - The reaction transforms an ordered reactant into more disordered products.
 - It is an unexplainable quirk of nature.
 - It is spontaneous, but has very slow kinetics.
 - The Gibbs Free Energy change is positive.

Section 7: Electron Transfer Processes

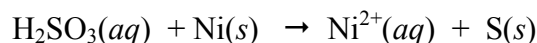
74. What is the oxidation number of Cr in $\text{K}_2\text{Cr}_2\text{O}_7$?
- +2
 - +4
 - +6
 - +8
 - +10

75. What is the reducing agent in the reaction below?



- a. MnO_4^-
- b. Br^-
- c. H_2O
- d. OH^-
- e. MnO_2

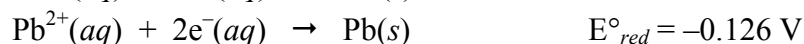
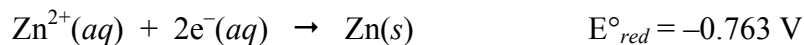
76. The reaction below occurs in acidic solution (unbalanced):



How many electrons are transferred per mole of H_2SO_3 ?

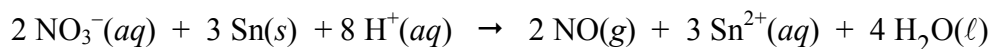
- a. 1 electron per mole H_2SO_3
- b. 2 electrons per mole H_2SO_3
- c. 4 electrons per mole H_2SO_3
- d. 8 electrons per mole H_2SO_3
- e. 10 electrons per mole H_2SO_3

77. What would act as the anode in a voltaic cell composed of zinc and lead?



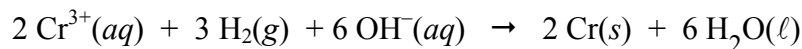
- a. The anode would be made of zinc.
- b. The anode would be made of lead.
- c. The anode could be made out of either zinc or lead.
- d. The anode would need to be made of an inert material, such as graphite.
- e. Impossible to determine

78. What is the standard cell potential, E°_{cell} , for the following reaction:



- a. +1.10 V
- b. -1.10 V
- c. +0.82 V
- d. -0.84 V
- e. -1.02 V

79. What is the standard Gibbs Free Energy change, ΔG_{rxn}° for the following reaction at 25°C? E°_{cell} for the reaction is 0.090V.



- a. -120 kJ
 - b. -76 kJ
 - c. -52 kJ
 - d. -37 kJ
 - e. -15 kJ
80. How much time would be required to plate 10.0 g of Cu from Cu^{2+} if a current of 4.0A is used?

$$1 \text{ F} = 96,500 \frac{\text{C}}{\text{mol } e^-} \text{ and } 1 \text{ Coulombs} = 1 \text{ amperes} \times \text{sec}$$

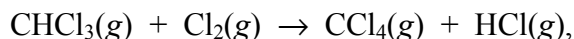
- a. 0.58 hr
- b. 2.1 hr
- c. 4.5 hr
- d. 6.3 hr
- e. 6.8 hr

Section 8: Chemical Kinetics

81. The reaction of $\text{NO}(g)$ and $\text{O}_2(g)$ to form $\text{NO}_2(g)$ is second order in NO and first order in oxygen. The rate law would be given by

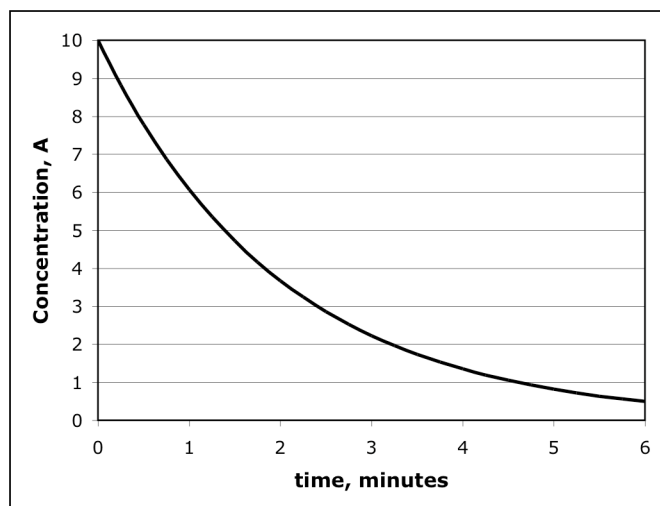
- a. $\text{rate} = k[\text{NO}][\text{O}_2]$
- b. $\text{rate} = k[\text{NO}]^2[\text{O}_2]$
- c. $\text{rate} = k[\text{NO}]^2[\text{O}_2]^2$
- d. $\text{rate} = k[\text{NO}_2]^2/[\text{NO}]^2[\text{O}_2]$
- e. $\text{rate} = k[\text{NO}_2]^2[\text{NO}]^2$

82. Predict the rate law governing the stoichiometric reaction:



- a. $\text{rate} = k[\text{CHCl}_3][\text{Cl}_2]$
- b. $\text{rate} = k[\text{CHCl}_3]^2[\text{Cl}_2]$
- c. $\text{rate} = k[\text{CHCl}_3][\text{Cl}_2]^2$
- d. $\text{rate} = k[\text{CHCl}_3]^{1/2}[\text{Cl}_2]$
- e. You cannot predict the rate law from the stoichiometric reaction.

83. Given the graph below for a first order decay process, find the half-life of the species, A.



- a. 0.5 min
- b. 1 min
- c. 1.5 min
- d. 2 min
- e. 6 min

84. Which statement is generally true?

- a. A plot of $\ln k$ versus $\ln T$ is a straight line with slope E_a/R
- b. A plot of $\ln k$ versus $1/T$ is a straight line with slope E_a/R
- c. A plot of $\ln k$ versus T is a straight line with slope E_a/R
- d. A plot of $\ln k$ versus $\ln T$ is a straight line with slope $-E_a/R$
- e. A plot of $\ln k$ versus $1/T$ is a straight line with slope $-E_a/R$

85. Kinetic data for the reaction $X(g) + Y(g) \rightarrow Z(g)$ are given below:

	Initial [X], M	Initial [Y], M	Initial rate $M \text{ min}^{-1}$
Exp. #1	0.400	2.00	3.20×10^{-3}
Exp. #2	1.600	2.00	6.40×10^{-3}
Exp. #3	0.400	4.00	6.40×10^{-3}

Calculate the rate constant for this system.

- a. 2.5×10^{-3}
- b. 40.
- c. 4.0
- d. 4.0×10^{-1}
- e. 2.0×10^{-3}

86. Using the experimental data from the previous problem, calculate the initial rate in M/min if the initial concentrations of X is 0.80 M and Y is 0.40 M.
- 13
 - 1.3
 - 8.9×10^{-4}
 - 6.4×10^{-4}
 - 3.2
87. The half-life of ^{137}Cs is 30 years. If you started with 120. g of the isotope, how much would remain after 90 years?
60. g
 30. g
 15. g
 - 7.5 g
 - None, it would have completely disintegrated.

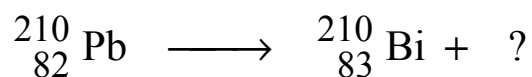
Section 9: Nuclear Chemistry

88. What is the name for the radiation particle symbolized below?



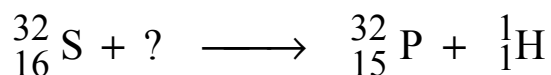
- beta
 - proton
 - positron
 - alpha
 - neutron
89. What radiation particle has a mass of 0 and a charge of +1?
- alpha
 - beta
 - positron
 - gamma
 - proton
90. Which type of radiation can penetrate a moderately thick piece of lead?
- proton
 - beta
 - alpha
 - positron
 - gamma

91. Identify the missing component in the nuclear reaction:



- a. gamma
- b. beta
- c. positron
- d. alpha
- e. proton

92. Identify the missing component in the nuclear reaction:



- a. proton
- b. neutron
- c. alpha
- d. positron
- e. beta

93. How much of the original isotope remains after 4 half-lives have elapsed?

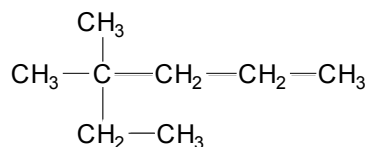
- a. 1/2
- b. 1/3
- c. 1/4
- d. 1/8
- e. 1/16

94. Calculate the nuclear binding energy of an isotope given the mass defect is 9.8940×10^{-5} kg/mol?
 $c = 2.9979 \times 10^8$ m/s

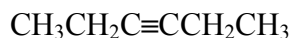
- a. 8.8921×10^{12} J/mol
- b. 1.0089×10^{-21} J/mol
- c. 9.8940×10^{-5} J/mol
- d. 3.3003×10^{-13} J/mol
- e. 9.0836×10^{20} J/mol

Section 10: Organic Chemistry

95. What is the correct IUPAC name for this molecule?



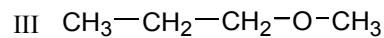
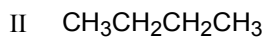
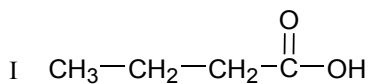
- 2-ethyl-1-methylpentane
 - 2-methyl-1-ethylpentane
 - 3,3-dimethylhexane
 - 1,1-dimethyl-1-ethylpropane
 - 2,2-dimethylheptane
96. How many hydrogen atoms would be needed to convert this molecule to an alkane?



- 0
 - 1
 - 2
 - 4
 - 6
97. What functional group is in the following molecule?



- alcohol
 - amine
 - ester
 - ether
 - amide
98. Rank the following molecules in order of *increasing* boiling point.



- II < III < I
- III < II < I
- III < I < II
- I < III < II
- I < II < III

99. How many hydrogen atoms are present in a cyclic hydrocarbon containing 8 carbons and two double bonds?

- a. 6
- b. 8
- c. 9
- d. 10
- e. 12

100. Which could be used as a color test to distinguish between propane and propyne?

- a. HCl
- b. Cl₂
- c. Cl₂ and heat
- d. Cl₂ and Fe
- e. Br₂