



2013



NESACS Avery A. Ashdown High School Chemistry Examination Contest

Confidential

Identification Sheet

Test Number _____

Full Name _____

(Print) Last Name First Name Middle Initial

Home

Address _____

High

School _____

School

Address _____

Name of Local

Newspaper _____

Name of Chemistry

Teacher _____

Year of Graduation: _____ Home Phone: _____

e-mail _____

Number of Years of Chemistry (including this year): _____

Circle:

Have you taken this exam before? Yes No

If so, were you a previous winner? Yes No

DIRECTIONS

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

NAME Your Name

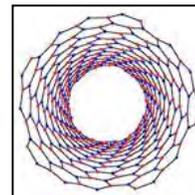
SUBJECT School

PERIOD _____ DATE Test Number

- If you are using a graphing calculator, clear its memory **now**.
- There are 85 questions, and the exam will last 100 minutes. This is 70 second per question.
- 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!
- **Dr. Nassiff's Helpful Hint:** Manage your time. You have a little over a minute per question. My hint is this:

The questions vary in difficulty. This means that hard ones and easy ones are dispersed throughout this exam. Don't get hung up on one or two of the hard questions early on and miss some of the easy ones later. A good strategy is to cycle through the exam, answering the easy ones first and then going back and answering the harder ones later.

Now, if **all** the questions are hard... Forget about it!



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

- A. charcoal B. diamond C. bucky ball D. nanotube

2. Which of the following statements is **NOT** true?

- A. Mixtures can be separated by physical processes while compounds cannot.
 B. Pure water is a compound but salt water is a mixture.
 C. Mixtures have definite chemical/physical properties, but compounds have variable chemical/physical properties.
 D. Mixtures have variable compositions while compounds have fixed composition.

3. Select the row which correctly names all of the following compounds:

	$\text{Fe}(\text{NO}_3)_3$	KBr	N_2O_3
A.	iron (III) nitrate	potassium bromate	dinitrogen oxide
B.	iron (III) trinitrate	potassium bromide	dinitrogen trioxide
C.	ferric trinitrate	potassium bromide	nitrogen oxide
D.	iron (III) nitrate	potassium bromide	dinitrogen trioxide

4. The symbol of the 6th most abundant element in the Earth's crust is related to the workers who installed pipes in ancient Rome is:

- A. Pb B. Cu C. Fe D. Zn

5. Ignition occurs when chlorine is passed into ammonia, forming nitrogen and ammonium chloride. Balance this equation to the smallest whole number coefficients and select the correct answer.



- A. 12 B. 16 C. 18 D. None of these

6. Which of the following will be found on a Material Safety Data Sheet (MSDS)?

- A. Fire and Explosion Hazard Data
 B. Health hazards
 C. Precautions for Safe Handling and Use
 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. Ring stand
 B. Support stand
 C. Jack stand
 D. Whatchamacallit thing that holds my iron ring



8. The ion that will produce a bright green color in a flame test is:

- A. K^+ B. Cu^{2+} C. Li^+ D. Ca^{2+}

9. In accordance with solubility rules, which of the following is true when aqueous solutions containing $\text{Pb}(\text{NO}_3)_2$ and KI are mixed?
- KNO_3 will precipitate; Pb^{2+} and I^- are spectator ions.
 - No precipitate will form.
 - $\text{Pb}(\text{NO}_3)_2$ will precipitate; K^+ and I^- are spectator ions.
 - PbI_2 will precipitate; K^+ and NO_3^- are spectator ions.

10. Using the following activity series, which of the following reactions will take place?

- $\text{Cu} + 2\text{H}^+ \rightarrow \text{Cu}^{2+} + \text{H}_2$
- $\text{Cr}^{3+} + 3\text{Ag} \rightarrow \text{Cr} + 3\text{Ag}^+$
- $2\text{Na} + 2\text{H}^+ \rightarrow 2\text{Na}^+ + \text{H}_2$
- $3\text{Ag}^+ + \text{Au} \rightarrow 3\text{Ag} + \text{Au}^{3+}$

Metal	Oxidation Reaction
Li	$\text{Li} \rightarrow \text{Li}^+ + \text{e}^-$
Na	$\text{Na} \rightarrow \text{Na}^+ + \text{e}^-$
Cr	$\text{Cr} \rightarrow \text{Cr}^{3+} + 3\text{e}^-$
Ni	$\text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^-$
H_2	$\text{H}_2 \rightarrow 2\text{H}^+ + 2\text{e}^-$
Cu	$\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$
Ag	$\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$
Au	$\text{Au} \rightarrow \text{Au}^{3+} + 3\text{e}^-$

Ease of oxidation increases 

11. The piece of safety equipment pictured here is:

- an Eye wash station
- an Emergency shower
- a Safety blanket
- a Fire blanket

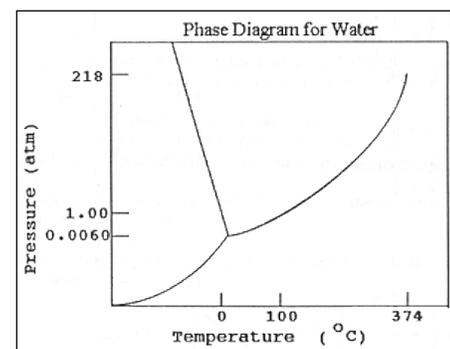


12. A white substance melts with some decomposition at 730°C . As a solid, it is a nonconductor of electricity, but it dissolves in water to form a conducting solution. The white substance is:

- a molecular solid.
- a covalent network solid.
- an ionic solid.
- a metallic solid.

13. What pressure is needed to liquefy (or condense) a sample of water vapor at 500°C ?

- 0.0060 atm
- 218 atm
- Some pressure higher than 218 atm but which cannot be determined from the phase diagram.
- No amount of pressure will cause H_2O vapor to liquefy at 500°C



14. The town of Natrium, West Virginia, derives its name from the sodium produced by electrolysis of molten NaCl mined from ancient salt deposits. If the applied emf is 4.50 V, the number of kilowatt-hours of electricity required to produce 4.60 kg of metallic sodium from electrolysis of molten NaCl is:

(1 Faraday = 96,500 coulombs/mole, $\text{Na} = 23.0 \text{ g/mole}$, $1 \text{ W} = \text{J/s}$, $\text{V} = \text{J/C}$)

- 24.1 kW-hrs
- 1.93×10^7 kW-hrs
- 5.36 kW-hrs
- 1.19×10^3 kW-hrs

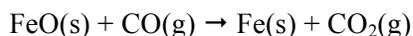
For questions 15-18, use the following information.

An old method of producing pure hydrogen sulfide, H_2S , in the laboratory was done by reacting aluminum sulfide with water by the following **unbalanced** reaction: The molar masses in g/mole are: $\text{Al}_2\text{S}_3 = 150.17$, $\text{H}_2\text{O} = 18.02$, $\text{Al}(\text{OH})_3 = 78.00$, $\text{H}_2\text{S} = 34.08$.



15. When the reaction above is balanced, the sum of the coefficients is:
- A. 9 B. 11 C. 12 D. 23
16. When 25.0 g of Al_2S_3 and 15.0 g of H_2O are reacted, the theoretical yield in grams of H_2S is:
- A. 11.0 g B. 14.2 g C. 17.0 g D. 32.8 g
17. The amount of excess reagent is:
- A. 1.3 g B. 2.8 g C. 4.2 g D. 6.0 g
18. Based on the theoretical yield, the volume of H_2S gas produced at 27°C and 0.993 atm (755 torr) is: ($R = 0.08206 \text{ L atm / mol K}$)
- A. 2.80 L B. 9.32 L C. 10.3 L D. 12.4 L

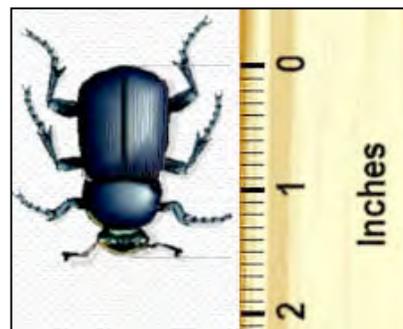
19. One reaction in the conversion of iron ore to iron metal is:



	Reaction	ΔH°
1.	$3 \text{Fe}_2\text{O}_3(\text{s}) + \text{CO}(\text{g}) \rightarrow 2 \text{Fe}_3\text{O}_4(\text{s}) + \text{CO}_2(\text{g})$	-47.0 kJ
2.	$\text{Fe}_2\text{O}_3(\text{s}) + 3 \text{CO}(\text{g}) \rightarrow 2 \text{Fe}(\text{s}) + 3 \text{CO}_2(\text{g})$	-25.0 kJ
3.	$\text{Fe}_3\text{O}_4(\text{s}) + \text{CO}(\text{g}) \rightarrow 3 \text{FeO}(\text{s}) + \text{CO}_2(\text{g})$	19.0 kJ

The standard enthalpy change for this reaction based on the reactions in the table is:

- A. 4.7 kJ B. -7.8 kJ C. -11.0 kJ D. -53 kJ
20. The length of the beetle's body to the right with the correct number of significant figures is:
- A. 1.5 in B. 1.6 in C. 1.54 in D. 1.545 in



21. A metal, M, of atomic mass of 96 reacts with fluorine to form a salt, MF_x . To find the formula of the salt, a boiling point elevation was performed. A 9.18 g sample of the salt was dissolved in 100.0 g of water and the boiling point of the solution was 374.63 K. Use $K_b(\text{H}_2\text{O}) = 0.512 \text{ molal / K}$, boiling point of water = 373.16 K and $F = 19.0 \text{ g/mole}$. The formula of the salt is:
- A. MF_3 B. MF_3 C. MF_4 D. MF_5

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



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

23. Phosphorus pentachloride decomposes to phosphorus trichloride and chlorine at 250° C according to the equation below:



A flask initially contains only 0.125 M in PCl_5 . $K_C = 1.80$. At equilibrium the concentrations of each gas are:

- A. $[\text{PCl}_5] = 0.00765 \text{ M}$, $[\text{PCl}_3] = 0.117 \text{ M}$, and $[\text{Cl}_2] = 0.117 \text{ M}$
 B. $[\text{PCl}_5] = 0.0625 \text{ M}$, $[\text{PCl}_3] = 0.335 \text{ M}$, and $[\text{Cl}_2] = 0.335 \text{ M}$
 C. $[\text{PCl}_5] = 0.0125 \text{ M}$, $[\text{PCl}_3] = 0.150 \text{ M}$, and $[\text{Cl}_2] = 0.150 \text{ M}$
 D. $[\text{PCl}_5] = 1.80 \text{ M}$, $[\text{PCl}_3] = 1.80 \text{ M}$, and $[\text{Cl}_2] = 1.80 \text{ M}$

Use the following information to answer questions 24 and 25.

Strontium-90 is a harmful nuclide produced from nuclear fission bombs or reactors because if taken internally, it substitutes for calcium in the bones. Sr-90 decays by beta particle emission with a half-life of 28.79 years.

24. The product of the strontium-90 decay is:

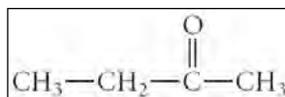
- A. Rb-90 B. Y-90 C. Kr-86 D. Zr-90

25. The years would it take for 99.0% of the strontium-90 released in an atmospheric test of an atomic bomb to decay is:

- B. 83 years B. 133 years C. 191 years D. 5.66×10^6 years

26. Name the following compound.

- A. 2-butanal
 B. 2-methyl-2-ethylbutanone
 C. 2-butanone
 D. 2-methylpropanone



27. Because you never learned dimensional analysis, you end up working at McDonald's. Each hour you wrap 150 burgers, you work 8 hours a day for 5 days for every week. You get paid every 2 weeks with a take home salary of \$850. How many million (M) hamburgers will you have to wrap to make your first million dollars?

- A. 1.02 M B. 1.88 M C. 7.06 M D. 14.1 M

28. A compound contains only C, H, N, and O. To find its empirical formula, two tests were performed. (Use molar masses: $\text{CO}_2 = 44.01$, $\text{H}_2\text{O} = 18.02$, $\text{NH}_3 = 17.03$, $\text{C} = 12.0$, $\text{H} = 1.01$, $\text{O} = 16.0$, $\text{N} = 14.0$)

Test 1: In a combustion analysis, 1.144 grams the unknown gave 2.456 g CO_2 and 0.420 g H_2O .

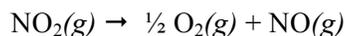
Test 2: In a separate experiment, nitrogen in a 1.432 g sample was converted to 0.198 g of NH_3 .

The empirical formula for unknown is:

- A. $\text{C}_6\text{H}_5\text{NO}_2$ B. $\text{C}_6\text{H}_6\text{N}_2\text{O}$ C. $\text{C}_5\text{H}_4\text{NO}_2$ D. $\text{C}_6\text{H}_{10}\text{NO}$

29. The rate law for the decomposition of NO_2 (equation shown below) at 300°C was examined and the kinetic data shown in the table was obtained. The rate law is: $\text{rate} = k[\text{NO}]^m$. The value of m is:

$[\text{NO}_2]$ M	Time, s
0.01000	0.0
0.00787	50.0
0.00649	100.0
0.00481	200.0
0.00380	300.0



- A. 0 B. 1 C. 2 D. 3

30. Eating and drinking is not permitted in the lab because:

- A. There would not be enough time to finish the experiment.
 B. The storeroom serves terrible appetizers.
 C. You could be poisoned.
 D. The lab would become quite messy with this type of activity.



31. Liquid phosphoric acid comes as a stockroom reagent that is 75.0% H_3PO_4 (98.00 g/mole) and whose density is 1.575 g/mL. How many milliliters of the 75.0% H_3PO_4 are needed to make 500. mL of 1.00 M H_3PO_4 ?

- A. 6.77 mL B. 41.5 mL C. 65.6 mL D. 66.7 mL

32. The number of exceptions below to the octet rule are:

CO_2	NO_2	O_3	BF_3	PF_3	SF_4
---------------	---------------	--------------	---------------	---------------	---------------

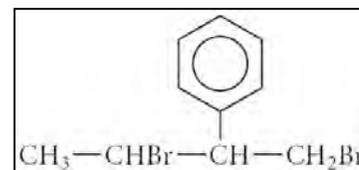
- A. 1 B. 2 C. 3 D. 4

33. Iron crystallizes in a body-centered cubic lattice. The density of iron is 7.86 g/cm^3 . The atomic radius of iron in picometers, pm, is: (1 pm = $10^{-12} \text{ m} = 10^{-10} \text{ cm}$; Avogadro's number = 6.022×10^{23})

- A. 101 pm B. 124 pm C. 157 pm D. 202 pm

34. Give the number of carbon(s) in the compound to the right that have chiral center(s):

- A. 1 B. 2 C. 3 D. 4



35. Which of the following groups of elements is arranged correctly in order of increasing first ionization energy?

- A. $\text{C} < \text{Si} < \text{Li} < \text{Ne}$ B. $\text{Ne} < \text{Si} < \text{C} < \text{Li}$ C. $\text{Li} < \text{Si} < \text{C} < \text{Ne}$ D. $\text{Ne} < \text{C} < \text{Si} < \text{Li}$

Use the following information for questions 36-38.

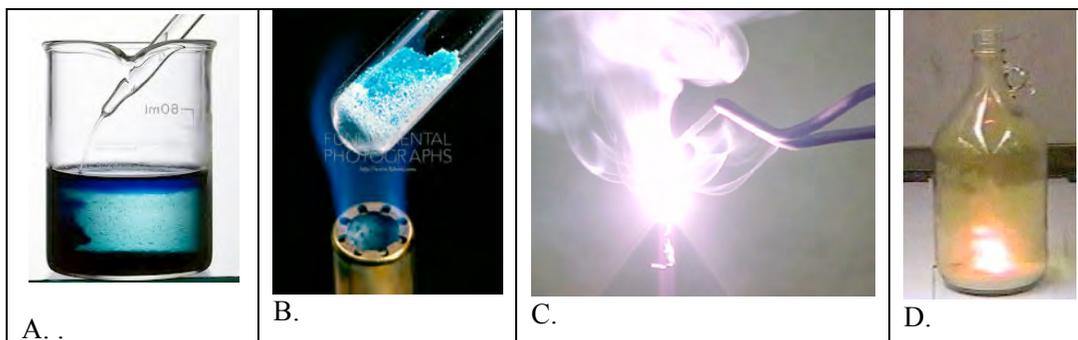
A student wanted to find out how much stomach acid would be neutralized by one TUMS antacid tablet whose active ingredient is CaCO_3 (100.8 g/mole). After weighing the tablets in one bottle, the student found that the average mass of TUMS tablet was 1.31 grams. Several TUMS antacid tablets were ground and a 0.200 g sample was placed in an Erlenmeyer flask and dissolved in 25.00 mL of simulated stomach acid, 0.120 M HCl. The mixture was stirred to simulate what goes on in the stomach and was then back-titrated with 0.150 M NaOH. It required 9.93 mL of the NaOH to reach the phenolphthalein end point.



36. The number of mmoles of HCl that were neutralized by the 0.200 g sample of the antacid were:
- A. 1.49 mmoles B. 1.51 mmoles C. 3.00 mmoles D. 4.50 mmoles
37. The percent of CaCO_3 in the tablet is:
- A. 7.4 B. 38.1 C. 75.5 D. 76.1
38. The milligrams of the active ingredient, CaCO_3 in one Tums tablet to 2 significant figures is:
- A. 100 mg B. 250 mg C. 500 mg D. 1000 mg

Use the following figures to answer questions 39-42.

Teachers just love to give demos that excite students, and chemistry students observe many memorable reactions in the laboratory. Identify the following four reactions from the images below



39. copper(II) sulfate and ammonia \rightarrow
40. copper(II) sulfate pentahydrate and heat \rightarrow
41. magnesium in air \rightarrow
42. sodium and chlorine \rightarrow
43. The balanced chemical equation for the addition of HBr to $\text{CH}_2=\text{CHCH}_2\text{CH}_3$ is:
- A. $\text{CH}_2=\text{CHCH}_2\text{CH}_3 + \text{HBr} \rightarrow \text{CH}_3\text{BrCH}_2\text{CH}_2\text{CH}_3$
- B. $\text{CH}_2=\text{CHCH}_2\text{CH}_3 + 2 \text{HBr} \rightarrow 2 \text{CH}_2\text{BrCH}_3$
- C. $\text{CH}_2=\text{CHCH}_2\text{CH}_3 + 2 \text{HBr} \rightarrow \text{CH}_3\text{Br} + \text{CH}_2\text{BrCH}_2\text{CH}_3$
- D. $\text{CH}_2=\text{CHCH}_2\text{CH}_3 + \text{HBr} \rightarrow \text{CH}_3\text{CHBrCH}_2\text{CH}_3$

44. The number of the compounds below that are more soluble in acidic solution than in pure water is:

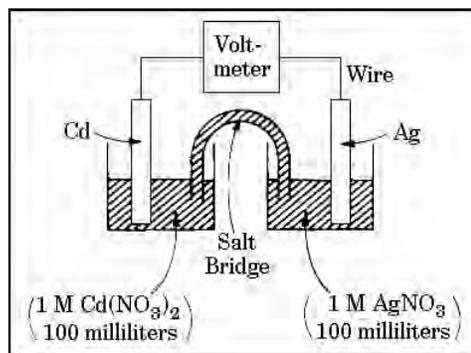
Ag ₂ S	CaF ₂	PbI ₂	CuCO ₃	PbSO ₄	FePO ₄	Co(ClO ₄) ₂
-------------------	------------------	------------------	-------------------	-------------------	-------------------	------------------------------------

- A. 3 B. 4 C. 5 D. 6

Use the following information to answer questions 45-50.

The spontaneous reaction that occurs when the cell below operates is: $2\text{Ag}^+(\text{aq}) + \text{Cd}(\text{s}) \rightarrow 2\text{Ag}(\text{s}) + \text{Cd}^{2+}(\text{aq})$

The Nernst Equation is: $E = E^\circ - 0.0592/n \log Q$



Reaction	$E^\circ_{1/2}$ (V)
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$	0.799 V
$\text{Cd}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cd}(\text{s})$	-0.403 V

45. The cell's voltage, E° , under standard conditions is:

- A. 0.396 V B. 1.195 V C. 1.202 V D. 2.001 V

Use the following responses for 45-49

- A. Voltage increases.
 B. Voltage decreases.
 C. Voltage drops to zero and remains at zero.
 D. No change in voltage occurs.

Which of the above occurs for each of the following circumstances?

46. A 50 mL of 2.0 M Cd(NO₃)₂ is added to the left beaker.

47. The silver electrode is made larger.

48. The salt bridge is replaced by a platinum wire.

49. Current is allowed to flow for 5 minutes

50. A 50 mL of 1.0 M KI is added to the right beaker.

51. The numbers below come from scientific measurements. The scientifically calculated answer is:

$$(2.0944 + (0.0003233 \times 4.6) + 12.22 - 7.001)$$

- A. 7.31 B. 7.314 C. 7.3149 D. 7.314887

52. Give the electron geometry, molecular geometry, and hybridization for IF_4^+ .

	electron geometry	molecular geometry	hybridization
A.	tetrahedral	tetrahedral	sp^3
B.	octahedral	square planar	d^2sp^3
C.	trigonal bipyramidal	seesaw	dsp^3
D.	octahedral	seesaw	d^2sp^3

53. At 200 °C, sodium bicarbonate rapidly decomposes as shown in the equation below:



At constant temperature, ΔH , the change in enthalpy for the reaction above, is approximately equal to:

- A. $\Delta H = \Delta E - 2RT$
- B. $\Delta H = \Delta E - RT$
- C. $\Delta H = \Delta E + RT$
- D. $\Delta H = \Delta E + 2RT$

54. Which photon has the highest speed?

- A. radio waves
- B. blue light
- C. X-rays
- D. All travel at the same speed.

55. Exactly 34.65 mL of 0.1010 $\text{Ca}(\text{OH})_2$ was needed to titrate to the equivalence point with a 20.10 mL of an unknown concentration of H_3PO_4 . What is the molarity of the H_3PO_4 solution?

- A. 0.0879
- B. 0.1161 M
- B. 0.1741 M
- B. 0.2612 M

56. We wish to prepare a buffer of pH 10.00 using common laboratory reagents. How many mL of 6M HCl would we have to add to a solution prepared by adding 100 mL of 15M NH_3 to 200 mL of water?

$$K_a \text{ of } \text{NH}_4^+ = 5.70 \times 10^{-10}, \text{ p}K_a = 9.24.$$

- A. 12.8 mL
- B. 37.0 mL
- C. 216 mL
- D. 222 mL

57. Calculate the cell potential for the following reaction that takes place in an electrochemical cell at 25°C.



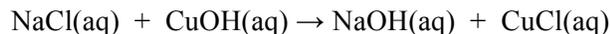
The Nernst Equation is: $E = E^\circ - 0.0592/n \log Q$

- A. -0.0052 V
- B. +0.052 V
- C. +0.093 V
- C. +0.19 V

58. The correct interpretation of the results of Rutherford's experiments in which gold atoms were bombarded with alpha particles is:

- A. Atoms have equal numbers of positive and negative charges.
- B. Electrons in atoms are arranged in shells.
- C. Neutrons and protons in atoms have nearly equal mass.
- D. The positive charge of an atom is concentrated in a small region.

59. A student mixed 50.0 mL of a 1.50 M solution of CuOH at 21.0 °C with 150.0 mL of a 0.40 M solution of NaCl at 21.0 °C in a Styrofoam coffee cup calorimeter. The temperature of the resulting solution increased to 25.4 °C. What is the ΔH of the reaction? Specific heat of $H_2O = 4.18 \text{ J/g } ^\circ\text{C}$ and the density of $H_2O = 1.00 \text{ g/mL}$



- A. -18.0 kJ B. $\Delta H = -26.6 \text{ kJ}$ C. $\Delta H = -47.9 \text{ kJ}$ D. $\Delta H = -59.9 \text{ kJ}$

60. Determining the level of phosphorus in urine is an important health indicator. For adults it is 13-42 mmoles of PO_4^{3-} per day. The phosphate is reacted with a molybdenum compound to form a colorful blue compound that absorbs at 690 nm. A patient produced 1350 mL of urine in a day. A one mL sample of this was treated and diluted to 100.0 mL. This colorful, diluted solution gave an absorbance reading of 0.685. A blank solution had an absorbance of 0.015. (Molar absorptivity, $\epsilon = 5110 \text{ M}^{-1}\text{cm}^{-1}$.) How many mmoles are in the urine sample?

- A. 0.018 B. 13 C. 18 D. 30

61. Given the following experimental data, find the rate law for the reaction:



- A. Rate = $k[\text{NO}][\text{NO}_2][\text{O}_2]$
 B. Rate = $k[\text{NO}][\text{NO}_2]^2[\text{O}_2]$
 C. Rate = $k[\text{NO}][\text{NO}_2]^2$
 D. Rate = $k[\text{NO}][\text{NO}_2]$

Run #	$[\text{NO}]_0$	$[\text{NO}_2]_0$	$[\text{O}_2]_0$	Initial Rate
1	0.10 M	0.10 M	0.10 M	0.021 M/s
2	0.20 M	0.10 M	0.10 M	0.042 M/s
3	0.20 M	0.30 M	0.20 M	0.126 M/s
4	0.10 M	0.10 M	0.20 M	0.021 M/s

62. When burning a solid hydrocarbon, which set of values would be most likely?

- A. $-\Delta H, -\Delta S, -\Delta G$ B. $-\Delta H, -\Delta S, +\Delta G$ C. $-\Delta H, +\Delta S, -\Delta G$ D. $+\Delta H, +\Delta S, -\Delta G$

63. In general, when comparing ions to their atoms, what trend is observed?

- A. Positive ions are smaller and negative ions are larger than their corresponding atoms.
 B. Positive ions are smaller and negative ions are smaller than their corresponding atoms.
 C. Positive ions are larger and negative ions are larger than their corresponding atoms.
 D. Positive ions are larger and negative ions are smaller than their corresponding atoms.

64. At a particular pressure and temperature, it takes 10.0 min for a 4.50 L sample of N_2 (28.02 g/mole) to effuse through a porous membrane. How long would it take for the same volume of I_2 gas (253.8 g/mole) to effuse under the same conditions?

- A. 13.5 min B. 30.1 min C. 201 min D. 447 min

65. Carbon tetrachloride has a vapor pressure of 213 torr at 40.0 °C and $\Delta H_{\text{vap}} = 31.4 \text{ kJ/mole}$. The normal boiling point of CCl_4 in °C is: ($R = 8.314 \text{ J/K mol}$)

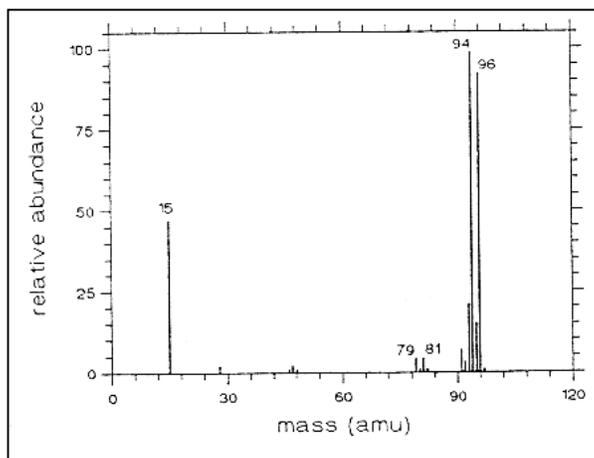
- A. 62.4 °C B. 76.8 °C C. 79.5 °C D. 116 °C

66. Which CO_2 sample contains the most oxygen atoms? $N_0 = 6.02 \times 10^{23}$, Molar volume (STP) = 22.4 L

- A. 11.0 grams CO_2 B. 0.24 moles CO_2 C. 2.0×10^{23} molecules CO_2 D. 5.6 liters CO_2 at STP

67. A mass spectrometer fractures molecules into pieces and separates the pieces by their individual masses (Actually mass-to-charge ratio). The spectrum to the right is the record of the number of pieces of a particular mass and peak heights are proportional to the number of ions of each mass. The highest mass is the "parent" ion. The simplified mass spectrum of the organic compound shown is:

A. CH_3Br B. $\text{C}_6\text{H}_5\text{OH}$ C. $\text{C}_6\text{H}_5\text{NH}_2$ D. $\text{C}_2\text{H}_2\text{Cl}_2$



68. A first-order reaction has a rate constants measured a different temperatures as given in the table to the right. The activation energy, E_a , is: ($R = 8.314 \text{ J/K mol}$)

A. 10.8 kJ B. 74.2 kJ C. 89.2 kJ D. 212 kJ

Rate Constant, k	Temperature, K
135 s^{-1}	300
9460 s^{-1}	350

Use the following information for questions 69-71.

A compound of boron and fluorine is 22.1% boron. When 0.146 grams of the compound is dissolved in 10.0 grams of benzene, the vapor pressure is 94.16 torr at 25 °C. The vapor pressure of pure benzene is 95.26 torr at 25 °C. $B = 10.8 \text{ g/mole}$, $F = 19.0 \text{ g/mole}$, benzene = $\text{C}_6\text{H}_6 = 78.1 \text{ g/mole}$

69. The empirical formula of the compound is:

A. BF_2 B. BF_3 C. B_2F_3 D. B_3F_2

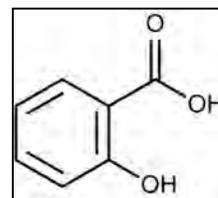
70. What is the mole fraction of the boron compound in the benzene solution?

A. 0.0116 B. 0.0146 C. 0.128 D. 0.989

71. The molecular formula of the compound is:

A. BF_2 B. BF_3 C. B_2F_4 D. B_3F_6

72. Aspirin, acetylsalicylic acid, may be used to relieve your headache after this exam. However, it is not aspirin that works but salicylic acid. in the stomach. Aspirin breaks down to the active ingredient, salicylic acid. If you have salicylic acid in your stomach which has a pH of 2.0, what percentage will be in the form of the anion, $\text{C}_6\text{H}_4(\text{OH})\text{COO}^-$? $K_a = 1.07 \times 10^{-3}$, $\text{p}K_a = 3.00$



A. 1% B. 10% B. 50% C. 100%

73. You are trying to determine the identity of an aqueous solution of a single substance, one of which is given in the answers, A through D, below. The solution is odorless and colorless and when 0.20 M H_2SO_4 was added to a portion of it, there was no precipitate or bubbling. The dissolved "unknown" substance in the solution is:

A. BaCl_2 B. Na_2CO_3 C. $\text{Fe}(\text{C}_2\text{H}_3\text{O}_2)_3$ D. $\text{Zn}(\text{NO}_3)_2$



74. In the good old days when photography involved film, "fixing" the image, i.e., making it permanent, involved removing the unexposed AgBr from the photographic film by forming a complex with thiosulfate, $S_2O_3^{2-}$. The soluble complex, $Ag(S_2O_3)_2^{3-}$, can be readily washed away leaving only the dark silver metal image. This process forms the negative in conventional black-and-white photography; light shining through the negative produces the final photograph (the positive) using this same chemistry. The solubility of AgBr in a solution of 1.0 M $Na_2S_2O_3$ is:

A. 0.43 M B. 0.48 M C. 0.50 M D. 0.77 M

$K_{sp} AgBr$	5.4×10^{-13}
$K_f (Ag(S_2O_3)_2^{3-})$	2.0×10^{13}

75. You are assigned the task of standardizing a NaOH solution that was prepared by the technician who quit his job the day before you started work. You decide to use the titration technique and make a list of measurements and information that you will need to accomplish the assignment. Which of the following will you need to complete the calculations for the assignment?

- I. Balanced chemical equation for reaction between acid and base
- II. Mass and chemical formula of a known acid
- III. Mass and MW of NaOH the technician used to prepare the solution
- IV. Total volume of NaOH solution that the technician prepared
- V. Volume of NaOH solution needed to turn the solution pink



A. II and IV B. I, III, and IV C. I, II, and V D. All the above would be needed.

76. You were given an unknown metal sulfide of formula M_2S_3 . When 7.200 grams of this compound was heated in oxygen, it lost 0.500 g to form only MO_2 . After some calculations and pondering, you found the metal, M, is:

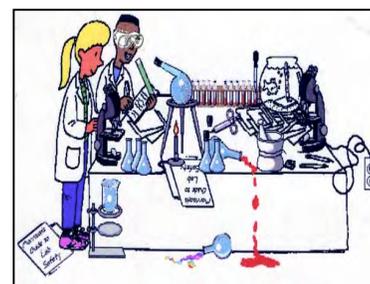
A. Al B. Ge C. Mn D. W

77. A student determined the value of K_{sp} for a saturated solution of borax at several different temperatures. The value for ΔS° for the dissolution of borax in water can be determined from:

- A. The slope of the line resulting from a plot of $\ln K_{sp}$ versus $(1/T)$.
- B. The y-intercept of the line resulting from a plot of $\ln K_{sp}$ versus T.
- C. The slope of the line resulting from a plot of K_{sp} versus $(1/T)$.
- D. The y-intercept of the line resulting from a plot of $\ln K_{sp}$ versus $(1/T)$.

78. What is the correct procedure for students to follow if a chemical is spilled:

- A. Stand back and advise the teacher of the spill.
- B. Run madly about the room.
- C. Splash large amounts of water onto the spill.
- D. Immediately ask to go to the restroom.

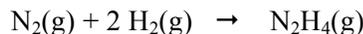


79. How many of the following molecules have at least one bond angle of approximately 180° ?

SO ₃	CO ₂	XeF ₄	BF ₃	H ₂ O	CH ₄	SF ₄
-----------------	-----------------	------------------	-----------------	------------------	-----------------	-----------------

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

80. The enthalpy change, ΔH° , for the following reaction is 95.4 kJ/mole. Using bond energies in the table, find the N-H bond energy in N₂H₄(g), in kJ/mole:



- A. 258 B. 306 C. 390 D. 437

Bond	Bond Energy	Bond	Bond Energy
H-H	436 kJ/mol	N-N	163 kJ/mol
H-O	463 kJ/mol	N=N	418 kJ/mol
H-C	413 kJ/mol	N≡N	945 kJ/mol

81. The number of the following compounds that are soluble in water are:

C ₁₂ H ₂₂ O ₁₁	AgC ₂ H ₃ O ₂	PbSO ₄	CoCO ₃	LiOH
---	--	-------------------	-------------------	------

- A. 1 B. 2 C. 3 D. 4

82. In each of the following below, classify the 0.01 M solution as acidic, basic, or neutral.

C ₂ H ₅ OH	NH ₄ NO ₃	KF	Al ₂ (SO ₄) ₃	Mg(ClO ₄) ₂	NaHPO ₄
----------------------------------	---------------------------------	----	---	------------------------------------	--------------------

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

83. A buffer solution of formic acid and sodium formate has a pH = 3.69. After the addition of 0.020 moles of [H⁺], the pH is now 3.59. $K_a = 1.8 \times 10^{-4}$, $pK_a = 3.74$. The initial molarity of the formic acid, is:

- A. 0.105 M B. 0.115 M C. 0.166 M D. 0.186 M

84. We assume erroneously that when we mix solvents, volumes are additive. A solution, prepared by mixing 710. mL of ethanol with 440. mL of water has a resulting solution that has a density of 0.900 g/mL. The molarity of the ethanol is:

- A. 10.6 M B. 10.9 M C. 11.1 M D. 12.2 M

	Density	Molar Mass
Ethanol	0.789 g/mL	46.07 g/mole
Water	1.000 g/mL	18.02 g/mole

85. Household Hazardous Wastes (HHW) are typically about 1 percent of all waste generated in the average American household. The average household generates about 30 pounds (about the weight of a medium-sized dog) of HHW per year, for an annual national total of about 1.6 million tons. Which of the following are considered as household hazardous products?

- A. Household maintenance items (paint, thinners, glues)
 B. Household batteries
 C. Personal care products
 D. All of the above are HHW.

