2014

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_____

Home Town, State & Zip_____

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 the Ashdown exam in a previous year? Yes No

If so, were you a prize winner? Yes No

Rules for the Examination

- There are 85 questions, and the exam will last 100 minutes.
- Absolutely **NO** cell phones, beepers or electronic messaging devices may be used in the test room. Any such devices that are used will be interpreted as cheating, and the user will be disqualified.
- **NO** cell phones, iPads or other devices which can communicate with the internet or with others may be used. Use of such devices will be interpreted as cheating and the user will be disqualified.
- When the proctor announced that time is up, you must **immediately** stop and turn in your bubble sheet.
- If you bring any books, papers, backpacks, etc. into the test room, deposit them against a wall.
- The only items allowed within your reach during the test are calculators, the exam, the bubble sheet, pencils, and erasers.
- ANY kind of calculator may be used as long as it is **only** a calculator. If you are using a graphing calculator, clear its memory **now**.
- ANY talking between students once the exam has begun will be interpreted as cheating, and all parties will be disqualified.
- Once the examination begins, you will not be allowed to leave the room.
- Students must remain seated during the exam. Once a student stands up, their exam must be turned in without any modifications.
- Nassiff's Test Taking Skill App: Cycle through the exam. Some questions are easier than others and the easy ones are scattered throughout. Do the easy stuff first and don't get stuck on the hard ones. Time is not your friend!

DIRECTIONS

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

  NAME__Your_Name___

  SUBJECT__School____

  PERIOD_____DATE_____Test Number____

- 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 sheets 1, 2, and 3, the periodic table.

- 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.

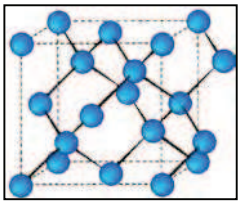
- Prize winners and qualifiers will be notified within 3 days or sooner.

- If you wish to continue as a qualifier for the U.S. Chemistry Olympiad, make sure you have filled out the official form.

- After the exam and after you have examined the answer key and if you feel that the answer key is incorrect, you have 72 hours to contact me for an appeal. My email is: nassiff@bpsk12.org
  Your appeal **must** include your justification.

- Good luck!

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



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

2. An atom with more protons than electrons is called:

A. an isotope
B. an anion
C. a cation
D. a molecule

3. Defined as the total set of greenhouse gas emissions caused by an organization, event, product or person, the image to the right represents a:

A. carbon footprint
B. water footprint
C. climate footprint
D. global footprint

4. The 10th most abundant element in the universe, a common component in minerals, spelled differently in England, a component of gunpowder, and called "brimstone" in Genesis in the Bible is:

A. sodium B. calcium C. phosphorus D. sulfur

5. The forms of matter is ordered from smallest to largest is:

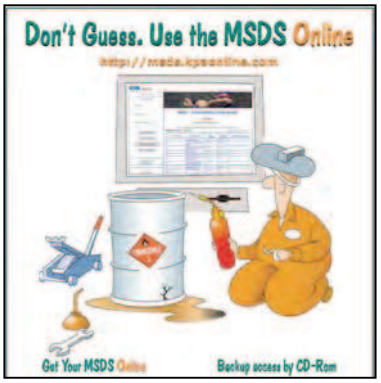
A. compound, polymer, neutron
B. proton, atom, electron
C. proton, polymer, atom
D. electron, atom, compound

6. When solid iodine is added to a potassium hydroxide solution, it dissolves forming iodine with two different oxidation states. Balance the equation below to the smallest whole number coefficients and select the answer.

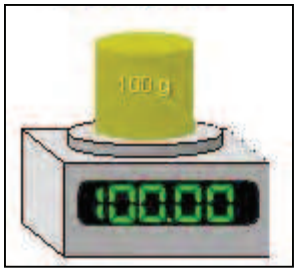
_____ $I_2(s)$ + _____ $KOH(aq)$ → _____ $KIO_3(aq)$ + _____ $KI(aq)$ + _____ $H_2O(l)$

A. 15 B. 18 C. 31 D. 36

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



A. Health hazards
B. Precautions for Safe Handling and Use
C. Fire and Explosion Hazard Data
D. All of the above



8. The mass measured in grams by the balance to the left with the correct number of significant figures is:

A. 100 g B. 100. g C. 100.0 g D. 100.00 g

9. 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. scrap shovel
B. spatula
C. spoon
D. thingamajig to scrap my sample from my beaker.

10. The equation for the standard heat of formation, ΔH_f^o, of $AgNO_3(s)$ is:

A. $Ag(s) + \frac{1}{2} N_2(g) + 3/2\ O_2(g) \rightarrow AgNO_3(s)$
B. $2\ Ag(s) + N_2(g) + 3\ O_2(g) \rightarrow 2\ AgNO_3(s)$
C. $2\ Ag(s) + N_2(g) + 2\ O_3(g) \rightarrow 2\ AgNO_3(s)$
D. $Ag^+(aq) + NO_3^-(aq) \rightarrow AgNO_3(s)$

11. Which of the following is not a postulate of kinetic-molecular theory of gases?

A. Attractive and repulsive forces between gas molecules are negligible.
B. The volume of all the molecules of the gas is negligible.
C. Gas molecules collide frequently, and collisions are perfectly elastic.
D. At a given temperature, a gas with low molar mass has less kinetic energy than a gas with high molar mass.

12. The ion that will produce a bright green/blue color in a flame test is:

A. K^+ B. Cu^{2+} C. Cl^- D. Ba^{2+}

13. A high school senior was applying to colleges and wondered how many applications she needed. Her counselor said that with the excellent grade she received in chemistry she would probably be accepted to 1 school out of every 3 she applied. She realized that for each application she would have to write 3 essays, and each essay would require 2 hours of serious work. For each hour of essay writing, she would expend 500 calories which she could derive from her mother's apple pies, each containing 1000 calories. To get a single apple pie, she had to clean her bedroom 3 times. How many times would she have to clean her room in order to gain acceptance to 10 colleges? (What? Your mother doesn't reward you for cleaning your bedroom? Aren't there child labor laws?)

Equivalence Statements
3 applications = 1 acceptance
3 essays = 1 application
1 essay = 2 hours writing
500 calories = 1 hour writing
1 pie = 1000 calories
3 cleanings =1 apple pie

A. 60 B. 90 C. 180 D. 270

14. Use the data to the right to find the formula of the hydrate of $CaSO_4 \cdot xH_2O$. ($CaSO_4$ = 136.14, H_2O = 18.01)

Mass of hydrate	3.629 grams
Mass of anhydride	3.404 grams

A. $CaSO_4 \cdot \frac{1}{2}H_2O$ B. $CaSO_4 \cdot H_2O$ C. $CaSO_4 \cdot 2H_2O$ D. $CaSO_4 \cdot 6H_2O$

15. The empirical formula for an unknown compound composed of 38.3% potassium, 23.5% carbon, 1.65% hydrogen and 36.6% oxygen is: K = 39.1, O = 16.0, C = 12.0, H = 1.01

A. $KC_2H_3O_2$ B. $K_3C_6H_5O_7$ C. $K_2C_6H_5O_7$ D. $K_3C_6H_5O_6$

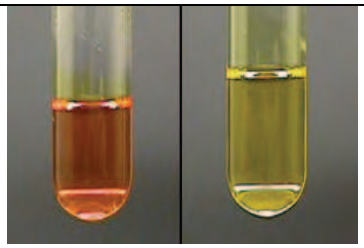
16. After 3.00 years 0.675 grams from a 1.000 gram sample of radioactive cobalt-60 remains. The half-life of Co-60 is:

A. 2.03 yr B. 4.44 yr C. 5.29 yr D. 9.85 yr

Use the following figures below to answer questions 17-20.

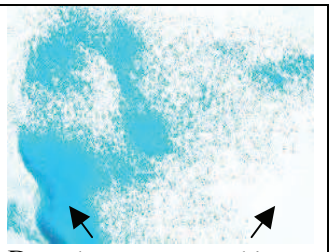
Chemistry teachers love to give demos that excite students, and chemistry students observe many memorable reactions when doing labs. Identify the following four laboratories from the images below:

A. Colorless Pink



B. Orange Yellow

C. Blue Colorless



D. Blue White

17. Kinetics involving the iodine clock reaction

18. Standardization of NaOH using phenolphthalein

19. LeChatelier's Principle examining the $CrO_4^{2-} \leftrightarrows Cr_2O_7^{2-}$ equilibrium

20. Water of hydration involving $CuSO_4$ and $CuSO_4 \cdot 5\,H_2O$

Use the following balanced equation to answer questions 21-23.

$$4\,NH_3(g) + 5\,O_2(g) \rightarrow 4\,NO(g) + 6\,H_2O(g)$$

In an experiment involving the above reaction, 25.5 grams of NH_3 reacted with 56.0 grams of O_2.
Use the following molar masses: $NH_3 = 17.04$, $O_2 = 32.00$, $NO = 30.01$, $H_2O = 18.02$

21. Assuming a theoretical yield, the grams of NO formed were:

A. 42.0 g B. 43.5 g C. 44.9 g D. 86.9 g

22. Assuming a theoretical yield, the amount of excess reactant remaining after the reaction was:

A. 1.69 g NH_3 left B. 3.84 g O_2 left C. 2.11g NH_3 left D. No excess reactants remained

23. The student only obtained 25.0 grams of NO. Thus, the % yield was:

A. 28.8 % B. 55.7 % C. 57.5 % D. 59.5 %

24. In the Bronsted-Lowry acid-base reaction below, the correct designation is

$$H_2O(l) + NH_3(aq) \leftrightarrows NH_4^+(aq) + OH^-(aq)$$

	Acid	Base	Conjugate Acid	Conjugate Base
A.	H_2O	NH_3	NH_4^+	OH^-
B.	H_2O	NH_3	OH^-	NH_4^+
C.	NH_3	H_2O	NH_4^+	OH^-
D.	NH_3	H_2O	OH^-	NH_4^+

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

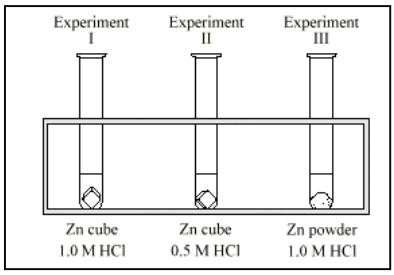
I. II. III. IV.

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

26. You want to cool 400.0 g of hot tea at 80.0 °C to make iced tea at 10.0 °C. The mass of ice at 0.0 °C required is: Ignore the melted ice warming to 10 °C. (For tea, C_s = 4.184 J/g·°C and for ice ΔH_{fusion} = 6.01 kJ/mol)

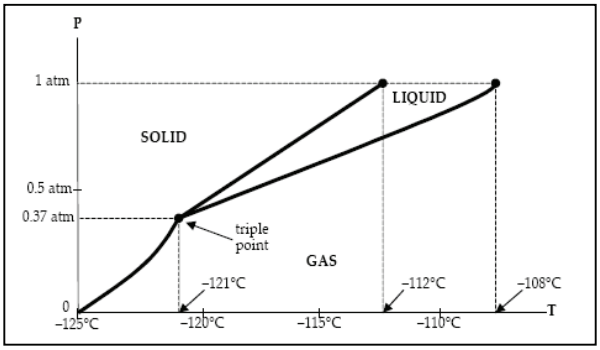
A. 19.5 g B. 351 g C. 401 g D. 1.95×10^4 g

27. In the experiment to the right, each involving equal masses of zinc and 10.0 mL of hydrochloric acid. The rate of reaction in order from **fastest** to slowest is:



A. I > II > III
B. II > I > III
C. III > I > II
D. III > II > I

28. Shown below is the phase diagram for xenon. If the pressure exerted on xenon sample is 0.75 atm, and the temperature is –114°C, in what phase(s) does the xenon exist?



A. solid B. liquid C. solid and liquid D. liquid and gas

29. In the reaction below,

$$2\ HBr(g) \rightarrow H_2(g) + Br_2(g)$$

In the first 15.0 seconds, the concentration of HBr dropped from 0.500 M to 0.455 M. The average rate of reaction in M/s during this time interval is:

A. 1.5×10^{-3} B. 3.0×10^{-3} C. 4.5×10^{-3} D. 6.0×10^{-3}

30. To find the empirical formula of MgO, a student weighed an empty crucible, added a strip of magnesium and reweighed the crucible. The crucible and magnesium were then heated with a Bunsen burner, igniting the Mg and forming a gray-white solid. After cooling, the crucible and solid were weighed. Analysis gave an empirical formula of Mg_5O_4. The student concluded that the observed Mg_5O_4 rather than the expected MgO was because:

    A. Some magnesium reacted with atmospheric nitrogen to produce magnesium nitride.
    B. A mixture of magnesium oxide and magnesium peroxide was formed during combustion.
    C. The some of the magnesium oxide (as a white vapor) was lost in the heating.
    D. The crucible and magnesium oxide were overheated.

For Questions 31-33, use the following information.

Blood is buffered by carbonic acid and the bicarbonate ion. Normal blood plasma is 0.024 M in HCO_3^- and 0.0012 M in H_2CO_3. The pK_a for H_2CO_3 at body temperature is 6.10. The volume of blood in a normal teenager is 5.0 L.

31. What is the pH of blood plasma?

    A. 7.20 B. 7.40 C. 7.60 D. 8.00

32. What mass of HCl could be neutralized by the blood's buffering system before the pH falls below 7.00 which would result in death? Molar mass of HCl = 36.45 g/mole

    A. 0.32 g B. 1.2 g C. 3.4 g D. 4.2 g

33. What mass of NaOH could be neutralized by the buffering system in blood before the pH rises above 7.80? Molar mass of NaOH = 40.00 g/mole

    A. 0.14 g B. 0.33 g C. 1.2 g D. 4.7 g

34. Consider a voltaic cell based on the following cell diagram:

    $Pt \mid Pu^{3+}(aq), Pu^{4+}(aq) \parallel Cl_2(g), Cl^-(aq) \mid Pt$

    E^o for the cell is 0.35V, and the standard reduction potential of chlorine is 1.36 V, that is:

    $\frac{1}{2}\ Cl_2(g) + e^- \rightarrow Cl^-(aq) \quad E^o = 1.36\ V$

    The standard reduction potential, E^o, for $Pu^{4+}(aq) + e^- \rightarrow Pu^{3+}(aq)$ is:

    A. 0.66 V B. 1.01 V C. 1.71 V D. 2.06 V

35. The ΔH for the reaction below, given the reactions and their ΔH values in the table below is:

    $N_2H_4(l) + CH_3OH(l) \rightarrow CH_2O(g) + N_2(g) + 3H_2(g)$

    A. -196.2 kJ B. -46.2 kJ C. 1.2 kJ D. 161.2 kJ

Reaction	$\Delta H_{reaction}$
$2\ NH_3(g) \rightarrow N_2H_4(l) + H_2(g)$	22.5 kJ
$2\ NH_3(g) \rightarrow N_2(g) + 3H_2(g)$	57.5 kJ
$CH_2O(g) + H_2(g) \rightarrow CH_3OH(l)$	81.2 kJ

36. Which sample has the most C atoms: $N_o = 6.0 \times 10^{23}$, C = 12.0, H = 1.01, O = 16.0, Na = 23.0 and Ca =40.1

    A. 3.00×10^{23} molecules of ethyl alcohol, C_2H_5OH
    B. 0.400 moles of sodium acetate, $NaC_2H_3O_2$
    C. 33.0 grams of CO_2
    D. 40.0 grams of CaC_2

37. For the following equilibrium:

$$H_2(g) + I_2(g) \leftrightarrows 2\ HI(g)$$

A 2.0 L container is initially filled with 0.070 mol of H_2 and 0.060 mol of I_2. At equilibrium there is 0.060 mol of HI. The value of the equilibrium constant, K, is:

A. 0.86 B. 3.0 C. 50. D. 1.0×10^2

38. Which of the following is not evidence for the "big bang" theory is:

A. Red shift spectra of galaxies.
B. The abundance of helium in the universe
C. Cosmic microwave background radiation.
D. All of the above are evidence for the "big bang" theory.

Use the following table and equation to answer questions 39-43.

$$2\ NO(g) + Br_2(g) \rightarrow 2\ NOBr(g)$$

Experiment	[NO]	[Br_2]	Initial rate of NOBr (M/sec)
1	0.020	0.020	9.6×10^{-3}
2	0.040	0.020	3.8×10^{-2}
3	0.020	0.040	1.9×10^{-2}

39. The rate law for this reaction is:

A. Rate = $k[NO][Br_2]$
B. Rate = $k[NO]^2$
C. Rate = $k[NO]^2[Br_2]$
D. Rate = $k[NO][Br_2]^2$

40. The rate constant, k, for the reaction is:

A. 22.5 $M^{-1}s^{-1}$ B. 1.2×10^3 $M^{-1}s^{-1}$ C. 1.2×10^3 $M^{-2}s^{-1}$ D. 2.4×10^3 $M^{-1}s^{-1}$

41. In experiment 2, concentration of [NO] remaining when half of the original [Br_2] was consumed is:

A. 0.010 M B. 0.020 M C. 0.040 M D. 0.060 M

42. If experiment 3 goes to completion, the final concentration of [NOBr] is:

A. 0.0032 M B. 0.010 M C. 0.020 M D. 0.030 M

43. The proposed mechanism below which is consistent with the rate law established in #39 most likely is:

A.	$2\ NO + Br_2 \rightarrow 2\ NOBr$	
B.	$2\ NO \leftrightarrows N_2O_2$ $N_2O_2 + Br_2 \rightarrow 2\ NOBr$	fast slow
C.	$NO + Br_2 \rightarrow NOBr + Br$ $NO + Br \rightarrow NOBr$	slow fast
D.	$NO + Br_2 \leftrightarrows NOBr_2$ $NO + NOBr_2 \rightarrow 2\ NOBr$	slow fast

44. The electron geometry, molecular geometry, and hybridization for IF_4^- are:

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

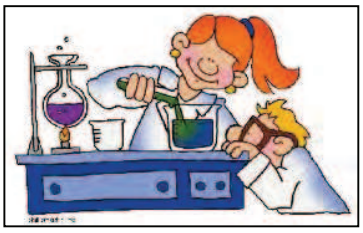
45. The element that has a melting point of 1414 °C, a density of 2.33 grams/cm^3, an electronegativity of 1.90, an atomic radius of 111 pm, an electron affinity of -134 kJ/mole and a first ionization energy of 786 kJ/mole is

A. Si B. Ca C. Sn D. Al

46. A rock contains 0.313 mg of lead-206 for each milligram of uranium-238. The half-life for the decay of uranium-238 to lead-206 is 4.5 x 10^9 years. How many years ago was the rock was formed?

A. 1.7 x 10^9 years B. 2.0 x 10^9 years C. 4.8 x 10^9 years D. 9.6 x 10^9 years

47. Your glassware is clean enough to eat off of, which is why you poured yourself a refreshing glass of water into a beaker to quench your thirst. Too bad you didn't label it. You should:



A. Go on with your business. Are you saying there is some safety issue here?
B. Just be really careful about keeping it separate from other beakers filled with clear liquids. There is a difference between HCl and H_2O. but I can smell the acid before I drink it.
C. Label which beaker it is before you forget. You're sure there are no residual chemicals in the glassware and positive nothing could accidentally splash into your drink.
D. You are really acting stupid. Food and drinks don't belong in the lab. Period!

48. The number of correct names in the table to the right for the given formulas is:

K_2O	dipotassium monoxide
C_3H_8	propane
$CuCO_3$	copper carbonate
HOCl	hypochloric acid

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

49. The correct answer for the calculation below with values that are obtained from scientific measurement is:

$$35.969 - 18.0035 + 8.26 \times 10^{-5}$$

A. 17.965 B. 17.966 C. 17.9656 D. 17.9655826

50. In hexane, acetone has an absorption maximum at 270 nm with a molar absorptivity of 12 $M^{-1}cm^{-1}$. A standard spectrophotometer can measure transmittance between 10% and 90% reliably. With a cell of 1.00 cm pathlength, the lowest acetone concentration that can be measured at 270 nm is:

A. 0.083 M B. 0.0038 M C. 0.046 M D. 0.55 M

51. Members of the organic functional group that are best known for their sweet smell is:

A. alcohols B. ethers C. esters D. ketones

52. The first ionization energy of nitrogen is more than that of oxygen because:

A. Nitrogen has half-filled p-orbital.
B. Nitrogen atom is smaller in size than oxygen atom.
C. Nitrogen atom is smaller in size than oxygen atom.
D. Nitrogen is less electronegative.

Use the following information for questions 53 and 54.

53. What is the pH of a solution that is made by mixing 50.0 mL of 0.0500 M sodium formate, $NaHCO_2$, with 75.0 mL of 0.0500 M formic acid, HCOOH. The pK_a of HCOOH is 3.744.

A. 2.744 B. 3.568 C. 3.744 D. 4.411

54. What is the final pH of the solution if 10.0 mL of 0.100 M NaOH is added?

A. 3.714 B. 3.744 C. 3.849 D. 5.017

55. From the standard half cell reduction potentials in the table below, the true statements (all species in standard conditions) are:

I. H_2O will spontaneously oxidize to $H_2C_2O_4$ to form CO_2.
II. O_2 gas will spontaneously oxidize to $H_2C_2O_4$ to form CO_2.
III. $H_2C_2O_4$ will spontaneously reduce O_2 gas to form H_2O.
IV. H^+ will spontaneously reduce $H_2C_2O_4$ to form CO_2.
V. CO_2 will spontaneously oxidize to H_2O to form O_2 gas.

Half Reaction	E^o
$O_2(g) + 4\ H^+ + 4\ e^- \rightarrow 2\ H_2O$	+1.23 V
$2\ CO_2(g) + 2\ H^+ + 2\ e^- \rightarrow H_2C_2O_4$	-0.49 V

A. II, IV, and V B. I, III, and IV C. II and III D. III and V

Use the following information to answer questions 56 and 57.

Ag_2SO_4 is a slightly soluble in water with a K_{sp} =1.50 x 10^{-5}. When two solutions, 20.00 mL of 0.450 M SO_4^{2-} and 20.00 mL of 0.500 M Ag^+ are mixed, at equilibrium,

56. the $[SO_4^{2-}]$ is:

A. 1.55 x 10^{-2} M B. 0.100 M C. 2.12 x 10^{-2} M D. 2.25 x 10^{-2} M

57. the $[Ag^+]$ is:

A. 3.75 x 10^{-5} M B. 1.50 x 10^{-4} C. 6.12 x 10^{-3} M D. 1.22 x 10^{-2} M

58. A current of 15.0 amperes electroplated 50.0 g of hafnium, Hf, from an aqueous solution in 2.00 hours. The oxidation number of hafnium is: (1 Faraday = 96,500 coulombs/mole, Hf = 178.5 g/mole)

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

59. Benzene has a heat of vaporization of 30.72 kJ/mole, a normal boiling point of 80.1 °C and a normal freezing point of 5.5 °C. The temperature benzene boils when the external pressure is 445 torr is:
(Clausius-Clapeyron equation: $P = A \exp(-\Delta H_{vap}/RT)$ with R = 8.314 J/mole ·K)

A. 1.8 °C B. 32.4 °C C. 43.6 °C D. 63.0 °C

60. Which photon has the highest speed?

A. gamma waves B. X-rays C. visible light D. all have the same speed.

Use the following information to answer 61-63.

For arsenic acid, H_3AsO_4, $pK_{a1} = 2.24$, $pK_{a2} = 6.96$, and $pK_{a3} = 11.50$.

61. The dominate form(s) of H_3AsO_4 at a pH of 6.80 is:

A. Na_2HAsO_4 C. NaH_2AsO_4 C. Na_3AsO_4 and Na_2HAsO_4 D. Na_2HAsO_4 and NaH_2AsO_4

62. The grams of Na_3AsO_4, 207.86 g/mole, when mixed with a specific volume in mL of 1.50 M HCl that is required to make 100.0 ml of a buffer solution with a pH of 6.80 and a $[H_2AsO_4^-] = 0.100$ M is:

A. 0.351 g B. 2.08 g C. 3.52 g D. 5.60 g

63. The volume of 1.50 M HCl that should be added to make the above buffer is:

A. 3.38 mL B. 11.3 mL C.17.9 mL D. 33.8 mL

64. A 3.00 kg Zn bar is attached to an iron pipe to prevent corrosion. A current of 0.020 A exists between the bar and pipe. The approximate number of years before the Zn bar is completely decomposed and is no longer protecting the pipe is: Zn = 65.4 g/mole, 1 Faraday = 96,500 coulombs/mole, 1 year = 3.156×10^7 seconds

A. 6.5 yrs. B. 7.0 yrs. C. 14. yrs. D. 60. yrs.

65. Geometric isomers differ from stereoisomers because:

A. Geometric isomers have different formulas; stereoisomers have the same formula.
B. Stereoisomers have different chemical and physical properties; geometric isomers have the same chemical and physical properties.
C. Stereoisomers' atoms are bonded in the same order; geometric isomers' have atoms are bonded in different order.
D. Geometric isomers require C=C double bonds or a rigid ring; stereoisomers don't.

66. A solution contains 0.005 M AsO_4^{3-}, 0.005 M I^- and 0.005 M CO_3^{2-}. When $AgNO_3$ is slowly added, the order the silver salts precipitate, using the Roman numeral designation in the table to the right, is:

	Salt	K_{sp}
I	Ag_3AsO_4	1.0×10^{-22}
II	AgI	8.3×10^{-17}
III	Ag_2CO_3	8.1×10^{-12}

A. II first, then I, then III B. I first, then II, then III C. III first, then II, then I D. I first, then III, then II

67. There are three possible resonance structures for the cyanate ion, NCO^-, shown below:

I. $[N - C \equiv O]^-$
II. $[N = C = O]^-$
III. $[N \equiv C - O]^-$

The one expected to have the largest contribution on the basis of formal charge is:

A. I B. II C. III D. All contribute equally

68. A compound, used in hair dyes, contains only C, H, O, and Cl. In order to find its formula, two tests given below were done. Use: CO_2 = 44.01, H_2O = 18.02, AgCl = 143.31, C = 12.0, H = 1.01, O = 16.0, Cl = 35.45

    Test 1: In combustion analysis 0.2417 grams of the compound is burned in oxygen yielding 0.4964g of CO_2 and 0.0846g of H_2O.
    Test 2: A separate 0.1696g sample is fused with sodium metal and then dissolved in water. The chloride was quantitatively precipitated with $AgNO_3$ to yield 0.1891g of AgCl.

    The empirical formula for the compound is:

    A. $C_6H_5O_2Cl$ B. C_6H_5OCl C. $C_{12}H_{10}O_2Cl$ D. $C_{12}H_{10}OCl$

Use the following information to answer questions 69-72.

Nitric oxide is an important air pollutant and is formed from when N_2 is oxidized at high temperatures in automobile engines. Equilibrium constants for the reaction below are shown in the table to the right. R = 8.314 J/mole·K

Temperature	K_p
298 K	4.5×10^{-31}
800 K	2.9×10^{-11}
900 K	6.7×10^{-10}
1000 K	7.0×10^{-9}
2000 K	4.1×10^{-4}
2300 K	1.7×10^{-3}

$$N_2(g) + O_2(g) \leftrightarrows 2\,NO(g)$$

69. When 0.4 moles of N_2, 0.1 moles of O_2, and 0.02 moles of NO are placed in a 1.0-liter container at 2000 K and allowed to reach equilibrium:

    A. [NO] will decrease; both $[N_2]$ and $[O_2]$ will increase.
    B. [NO] will increase; both $[N_2]$ and $[O_2]$ will decrease.
    C. [NO] will decrease; both $[N_2]$ and $[O_2]$ will remain unchanged.
    D. The concentrations will remain the same.

70. The value of ΔG^o for the reaction is:

    A. -170 kJ B. -26 kJ C. 70 kJ D. 170 kJ

71. Using the table above, the value of ΔH^o for the reaction is:

    A. -178 kJ B. 21.7 kJ C. 170 kJ D. 180 kJ

72. Using the table, the value of ΔS^o for the reaction is:

    A. -25 J/K B. 3 J/K C. 25 J/K D. 52 J/K

73. A metal nitride crystallizes in a cubic lattice and has a nitrogen atom at each corner and a metal atom on each edge. The formula for the metal nitride is:

    A. Ba_3N_2 B. Na_3N C. AlN D. Ti_2N_3

74. A saturated aqueous solution of an insoluble salt MX_2 has a freezing point of –0.028 °C. The K_{sp} of the solid is: (K_f = 1.86 °C/m)

    A. 5.1×10^{-7} B. 3.4×10^{-6} C. 1.4×10^{-5} D. 3.7×10^{-3}

75. Enzymes are biological catalysts. In the human body (T = 37.0 °C) biological reactions are very slow without an enzyme. Assuming the collision factors are the same for the uncatalyzed and catalyzed reactions, how much must the enzyme lower the activation energy to get a 100,000 fold increase in the reaction rate? R = 8.314 J/mole·K

A. 12.9 kJ B. 23.7 kJ C. 29.7 kJ D. 39.2 kJ

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

$Cu(NO_3)_2$	$PbCl_2$	$CaSO_4$	$(NH_4)_2CO_3$	$Al(OH)_3$

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

77. $C_{10}H_{16}$ and $C_{10}H_{18}O$ are two of many compounds used in perfumes to provide a fresh pine scent. At 69.0 °C the pure substances have vapor pressures given in the table. A solution is made containing equal masses of these compounds at 69.0 °C. The mole fraction of $C_{10}H_{18}O$ in the vapor is:

Compound	Molar Mass	Vapor Pressure
$C_{10}H_{16}$	136.2 g/mole	100.3 torr
$C_{10}H_{18}O$	154.2 g/mole	9.8 torr

A. 0.0794 B. 0.0863 C. 0.324 D. 0.469

78. Classify the 0.01 M solutions shown below as acidic, basic, or neutral. Select the correct option.

CH_3OH	NH_4NO_3	NaF	$Al_2(SO_4)_3$	NaClO

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

79. To analyze Mn (54.94 g/mole) in steel, a 1.000 gram sample was dissolved in HNO_3, oxidized to MnO_4^-, and diluted to 1000.0 mL. Two 50.00 mL aliquots were taken, samples #1 and #2. To sample #2, 10.00 mL of 0.00250M of MnO_4^- was added. Then both were diluted to 100.0 mL. Finally, both were analyzed on a spectrometer; the absorbances are shown in the table. The % Mn in the steel is:

Sample	Mn added	Final Vol.	A
# 1	0.00 mL	100.0 mL	0.400
# 2	10.00 mL	100.0 mL	1.025

A. 0.352% B. 0.879 % C. 1.76 % D. 8.79 %

80. The complex ion formation constant for $AuCl_4^-$ from the standard reduction potentials in the table to the right is:

$Au^{3+}(aq) + 3e^- \rightarrow Au(s)$	$E^o = 1.50$ V
$AuCl_4^-(aq) + 3e^- \rightarrow Au(s) + 4\ Cl^-(aq)$	$E^o = 1.00$ V

A. 2.8×10^8 B. 1.0×10^{11} C. 1.2×10^{14} D. 2.4×10^{25}

81. The planet Aragonose, composed mainly of the mineral aragonite ($CaCO_3$) (picture to the right) has an atmosphere containing CH_4 and CO_2, each at a pressure of 0.10 atm. The oceans are saturated with aragonite and have $[H^+] = 1.8 \times 10^{-7}$ M. Given the equilibra below, calculate how many grams of Ca per liter are in Aragonose sea water. Ca = 40.08 g/mole

A. 0.11 g B. 0.28 g C. 0.39 g D. 3.62 g

$CaCO_3(s,\ aragonite) \leftrightarrows Ca^{2+}(aq) + CO_3^{2-}(aq)$	$K_{sp} = 6.0 \times 10^{-9}$
$CO_2(g) \leftrightarrows CO_2(aq)$	$K_{CO2} = 3.4 \times 10^{-2}$
$CO_2(aq) + H_2O(l) \leftrightarrows HCO_3^-(aq) + H^+(aq)$	$K_1 = 4.4 \times 10^{-7}$
$HCO_3^-(aq) \leftrightarrows H^+(aq) + CO_3^{2-}(aq)$	$K_2 = 4.7 \times 10^{-11}$

82. A solution contains 0.015 M Cu^{2+} and 0.015 M Ni^{2+}. The solution is then saturated with H_2S (0.10 M) and adjusted to pH = 2.00. Does a precipitate form? If so, is it CuS, NiS or both?

$H_2S(aq) \leftrightarrows H^+(aq) + HS^-(aq)$ $K_{a1} = 6.7 \times 10^{-8}$
$HS^-(aq) \leftrightarrows H^+(aq) + S^{2-}(aq)$ $K_{a2} = 1.5 \times 10^{-13}$
K_{sp} of CuS $= 6 \times 10^{-37}$
K_{sp} of NiS $= 3 \times 10^{-20}$

A. No precipitate forms B. Only CuS precipitates C. Only NiS precipitates D. Both precipitates form.

83. An atom, traveling at 1.00% of the speed of light, has a deBroglie wavelength of 3.31 x 10^{-3} pm. The element is: c = 3.00 x 10^8 m/s, h = 6.63 x 10^{-34} J·s, 1 pm = 10^{-12} m

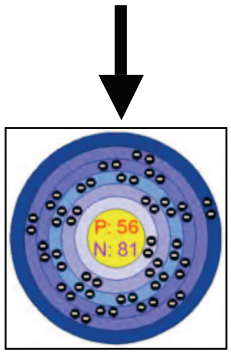
A. He B. C C. O D. Ca

84. Green chemists reduce risk by:

A. Reducing the hazard inherent in a chemical product or process
B. Minimizing the use of all chemicals
C. Inventing technologies that will clean up toxic sites
D. Developing recycled products

85. What should do you do with a dead vampire?

Hint



A. Ta
B. Pr
C. Cm
D. Ba