

AMERICAN CHEMICAL SOCIETY
2013 VIRGINIA SECTION
CHEMISTRY OLYMPIAD
FIRST YEAR EXAM

DIRECTIONS TO THE EXAMINER

This test is designed to be taken with an answer sheet on which the student records their responses. All answers are to be marked on the answer sheet. Each student should be provided the test booklet, Periodic Table with explanation of abbreviations, constants and equations, answer sheet, and scrap paper, all of which must be turned in upon completion of the exam.

Students are allowed to use calculators (the calculator may be either programmable or non programmable) and the student should be given 90 minutes to complete the exam.

DIRECTIONS TO THE EXAMINEE

DO NOT TURN THE PAGE UNTIL DIRECTED TO DO SO

This is a 70 question multiple-choice exam with four or five choices for each question. There is only one correct or best answer to each question. When you select your answer, blacken completely the corresponding space on the answer sheet. If you wish to change an answer, be sure to erase your original answer completely. Any answer that has more than one blackened answer will be incorrect.

Turn in all exam materials when you have completed the exam.

The following information **MUST** be put on the answer sheet:

- a. Test, School and Teacher Name (Test code F = First, S = Second)
- b. Student's Last Name and Student's First Name as you would like it to appear on your certificate. Print neatly.

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

CONSTANTS
$R = 8.314 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$
$R = 0.0821 \text{ L}\cdot\text{atm}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$
$1 F = 96,500 \text{ C}\cdot\text{mol}^{-1}$
$1 F = 96,500 \text{ J}\cdot\text{V}^{-1}\cdot\text{mol}^{-1}$
$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$
$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$
$c = 2.998 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
$0^\circ\text{C} = 273.15 \text{ K}$
$1 \text{ atm} = 760 \text{ mmHg}$

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

PERIODIC TABLE OF THE ELEMENTS

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

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

Virginia Chemistry Olympiad First Year Exam

Directions for the First Year Virginia Olympiad Local Section Examination

When you have selected your answer to each question, blacken the corresponding space on the answer sheet using a #2 pencil. If you decide to change an answer, erase the unwanted mark very carefully, and remark the correct space. There is only one correct answer to each question. Any questions for which more than one response is given will not be counted.

Your score will be based on the number of correctly answered questions. It is to your advantage to answer every question.

- Which of the following activities is not a part of good science?
 - Proposing a theory
 - Designing experiments
 - Developing a hypothesis
 - Making quantitative observations
 - Indulging in speculation
- What name is given to the concept that different samples of a given compound always contain the same elements in the same mass ratio?
 - Ration Law
 - Law of Equality
 - 2nd Law of thermodynamics
 - Law of Definite Proportions
 - 1st Law of Thermodynamics
- Which of the following does not have a uniform composition throughout?
 - Solute
 - Heterogeneous mixture
 - Homogeneous mixture
 - Solvent
 - Compound
- The distinguishing characteristic of all electrolyte solutions is that they
 - contain molecules.
 - conduct electricity.
 - always contain acids.
 - conduct heat.
 - react with other solutions.
- Household sugar, sucrose, has the molecular formula $C_{12}H_{22}O_{11}$. What is the % of carbon in sucrose, by mass?
 - 26.7%
 - 33.3%
 - 41.4%
 - 42.1%
 - 52.8%
- Which of these chemical equations describes a *double replacement* or *precipitation reaction*?
 - $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
 - $CaBr_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + 2HBr(g)$
 - $2KNO_3(s) \rightarrow 2KNO_2(s) + O_2(g)$
 - $2KBr(aq) + Cl_2(g) \rightarrow 2KCl(aq) + Br_2(l)$
 - $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$
- The Lewis dot symbol consists of the symbol for the element surrounded by dot(s). What does the symbol represent?
 - Electron configuration
 - Atomic mass
 - Valence electrons
 - Atomic number
 - Nucleus and core electrons
- Which of the following is required for determination of the VSEPR model and the molecular shape?
 - Atomic mass
 - Lewis structure
 - Oxidation number
 - # of protons
 - None of the answers is correct.
- Which of these compounds is most likely to be ionic?
 - NCl_3
 - $BaCl_2$
 - CO
 - SO_2
 - SF_4
- What equipment is used to measure volume with the greatest precision?
 - a spectrophotometer
 - a 50 mL buret
 - a 100 mL graduated cylinder
 - a balance
 - a 1 mL plastic dropper

11. Visible light, radio waves, microwave radiation, infrared, ultraviolet radiation, X-rays, and gamma rays all constitute the electromagnetic spectrum. What similar characteristic do all of these spectrums share?
- They all have the ability to generate heat in objects.
 - They all have the same frequencies.
 - They are all the transmission of energy in the form of waves.
 - They have equal energies.
 - They have the same electron spin state.
12. If two solutions are mixed together in a container and the container "feels hot", then
- the reaction is endothermic.
 - the reaction is exothermic.
 - the energy of the universe is increased.
 - the energy of both the system and the surroundings is decreased.
 - the energy of the system is increased.
13. According to the VSEPR theory, the molecular shape of SiCl_4 is
- linear.
 - trigonal planar.
 - bent.
 - tetrahedral.
 - trigonal pyramidal.
14. A flask containing neon gas is connected to an open-ended mercury manometer. The open end is exposed to the atmosphere, where the prevailing pressure is 745 mm Hg. The mercury level in the open arm is 50. mm below that in the arm connected to the flask of neon. What is the neon pressure, in torr?
- 50. Torr
 - 795 torr
 50. Torr
 - 695 torr
 - None of these choices is correct.
15. Bromine is the only nonmetal that is a liquid at room temperature. Consider the isotope bromine-81, $^{81}_{35}\text{Br}$. Select the combination which lists the correct atomic number, neutron number, and mass number, respectively.
- 35, 46, 81
 - 35, 81, 46
 - 81, 46, 35
 - 46, 81, 35
 - 35, 81, 116
16. Which one of the following is not a redox reaction?
- $2\text{H}_2(g) + \text{O}_2(g) \rightarrow 2\text{H}_2\text{O}(l)$
 - $\text{Zn}(s) + \text{H}_2\text{SO}_4(aq) \rightarrow \text{ZnSO}_4(aq) + \text{H}_2(g)$
 - $\text{H}_2\text{O}(l) + \text{NH}_3(g) \rightarrow \text{NH}_4^+(aq) + \text{OH}^-(aq)$
 - $6\text{FeSO}_4(aq) + \text{K}_2\text{Cr}_2\text{O}_7(aq) + 7\text{H}_2\text{SO}_4(aq) \rightarrow \text{Cr}_2(\text{SO}_4)_3(aq) + 3\text{Fe}_2(\text{SO}_4)_3(aq) + \text{K}_2\text{SO}_4(aq) + 7\text{H}_2\text{O}(l)$
 - $\text{Cl}_2(g) + 2\text{KBr}(aq) \rightarrow \text{Br}_2(l) + 2\text{KCl}(aq)$
17. What mass of lithium phosphate is needed to prepare 500. mL of a solution having a lithium ion concentration of 0.125 M?
- 6.75 g
 - 10.1 g
 - 19.3 g
 - 30.4 g
 - 2.41 g
18. What is the name given to the forces in a covalent compound that exists between molecules?
- Intramolecular forces
 - Intermolecular forces
 - Ionic forces
 - Molecular forces
 - Covalent forces
19. What law states that energy can be converted from one form to another, but cannot be created or destroyed?
- universal law
 - law of conservation of energy
 - 1st law of thermodynamics
 - law of constant energy
 - law of mass conservation
20. In the Periodic Table atoms are arranged in order of _____.
- atomic mass
 - periodicity
 - atomic numbers
 - chemical reactivities
 - physical properties
21. Dry ice (carbon dioxide) changes from a solid to a gas at -78.5°C . What is this temperature in $^\circ\text{F}$?
- -173°F
 - -12.6°F
 - -109°F
 - -75.6°F
 - None of the above are within 2°F of the correct answer.

22. In the quantum mechanical treatment of the hydrogen atom, which one of the following combinations of quantum numbers is not allowed?

	n	l	m_l
a.	3	0	0
b.	3	1	-1
c.	3	2	2
d.	3	2	-1
e.	3	3	2

23. Which of these covalent bonds is the *most polar* (i.e., highest percent ionic character)?

- a) Al - I b) Si - I c) Al - Cl
d) Si - Cl e) Si - P

24. Which of these compounds is a *nonelectrolyte*?

- a) NaF b) NaOH
c) HNO₃ d) CH₃COOH (acetic acid)
e) C₆H₁₂O₆ (glucose)

25. A sample of nitrogen gas has a volume of 32.4 L at 20°C. The gas is heated to 220°C at constant pressure. What is the final volume of nitrogen?

- a) 2.94 L b) 19.3 L c) 31.4 L
d) 54.5 L e) 356 L

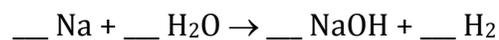
26. How many inches are in 382.5 cm? (1in = 2.54 cm)

- a) 150.6 in b) 6.641 x 10⁻³ in
c) 151 in d) 971.6 in
e) 972 in

27. Rutherford's experiment with alpha particle scattering by gold foil established that

- a) protons are not evenly distributed throughout an atom.
b) electrons have a negative charge.
c) electrons have a positive charge.
d) atoms are made of protons, neutrons, and electrons.
e) protons are 1840 times heavier than electrons.

28. What is the coefficient of H₂O when the following equation is properly balanced with the smallest set of whole numbers?



- a) 1 b) 2 c) 3 d) 4 e) 5

29. What is the approximate bond angle for CO₂?

- a) 90° b) 109.5° c) 120°
d) 107° e) 180°

30. Based on the solubility rules, which of these processes will occur when solutions of ZnSO₄(aq) and MgCl₂(aq) are mixed?

- a) ZnCl₂ will precipitate; Mg²⁺ and SO₄²⁻ will be spectator ions.
b) ZnSO₄ will precipitate; Mg²⁺ and Cl⁻ will be spectator ions.
c) MgSO₄ will precipitate; Zn²⁺ and Cl⁻ will be spectator ions.
d) MgCl₂ will precipitate; Zn²⁺ and SO₄²⁻ will be spectator ions.
e) No precipitate will form.

31. Alkali metals have similar physical and chemical properties; it also turns out that these metals have which of the following?

- a) Similar polar bond properties
b) Same valence electron configuration
c) Poor tolerance to extreme heat or cold
d) Low specific heat
e) None of these answers is correct.

32. If you have a graduated cylinder, containing 15.5 mL and this volume changes to 95.2 mL after a metal with a mass of 7.95g is dropped into the graduated cylinder then what is the density of this metal?

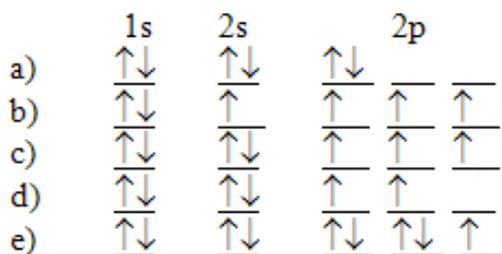
- a) 0.0835 g/mL
b) 10.0 g/mL
c) 0.513 g/mL
d) 9.97 x 10⁻² g/mL
e) 0.0718 g/mL

33. What is the oxidation number for iron in K₃Fe(CN)₆

- a) +3 b) -3 c) +4
d) -5 e) +1

34. Which statement is *false*?
- The average kinetic energies of molecules from samples of different "ideal" gases is the same at the same temperature.
 - The molecules of an ideal gas are relatively far apart.
 - All molecules of an ideal gas have the same kinetic energy at constant temperature.
 - Molecules of a gas undergo many collisions with each other and the container walls.
 - Molecules of greater mass have a lower average speed than those of less mass at the same temperature.

35. The orbital diagram for a ground state carbon atom is



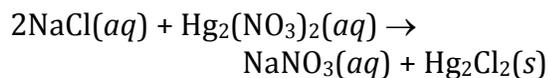
36. The total number of lone pairs in NCl_3 is ____.

- 6
- 8
- 9
- 10
- 13

37. Complete this sentence: The PCl_5 molecule has

- nonpolar bonds, and is a nonpolar molecule.
- nonpolar bonds, but is a polar molecule.
- polar bonds, and is a polar molecule.
- polar bonds, but is a nonpolar molecule.

38. Select the net ionic equation for the reaction between sodium chloride and mercury(I) nitrate.



- $\text{Na}^+(aq) + \text{NO}_3^-(aq) \rightarrow \text{NaNO}_3(aq)$
- $\text{Hg}_2^{2+}(aq) + 2\text{Cl}^-(aq) \rightarrow \text{Hg}_2\text{Cl}_2(s)$
- $\text{NaCl}(aq) \rightarrow \text{Na}^+(aq) + \text{Cl}^-(aq)$
- $\text{Hg}_2(\text{NO}_3)_2(aq) \rightarrow \text{Hg}_2^{2+}(aq) + 2\text{NO}_3^-(aq)$
- $\text{Hg}_2^{2+}(aq) \rightarrow \text{Hg}_2(s)$

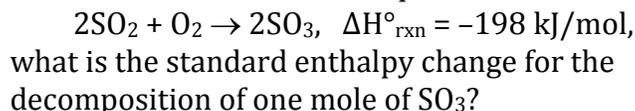
39. Ethylene glycol, used as a coolant in automotive engines, has a specific heat capacity of $2.42 \text{ J}/(\text{g}\cdot\text{K})$. Calculate q when 3.65 kg of ethylene glycol is cooled from 132°C to 85°C .

- -1900 kJ
- -420 kJ
- -99 kJ
- -0.42 kJ
- $-4.2 \times 10^{-6} \text{ KJ}$

40. During a titration, it is found that 53.5 mL of a solution of NaOH is needed to neutralize a solution that contains 1.86 g of HCl . What is the concentration in molarity of the NaOH solution?

- 0.051 M
- 0.686 M
- 1.05 M
- 0.035 M
- 0.953 M

41. Given the thermochemical equation



- 198 kJ/mol
- 396 kJ/mol
- 99 kJ/mol
- -99 kJ/mol
- -198 kJ/mol

42. What element is represented by the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$?

- Mn
- Ca
- K
- Cr
- V

43. What elements and groups have properties that are most similar to those of Chlorine?

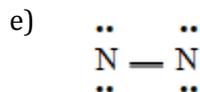
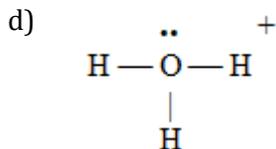
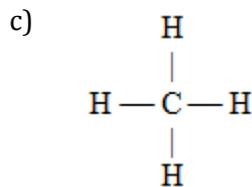
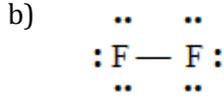
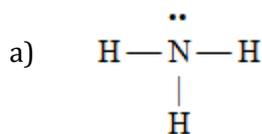
- F, Br, I, and nonmetals in group 7A
- Cl, K, C, and metals in group 1B
- N, P, As, and lanthanides
- He, Ne, Xe, and nonmetals in group 7A
- O, S, P

44. For which one of the following molecules is the indicated type of hybridization not appropriate for the central atom?

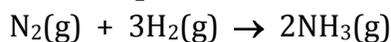
- | | |
|---------------------------|--------|
| a) BeCl_2 | sp^2 |
| b) SiH_4 | sp^3 |
| c) BF_3 | sp^2 |
| d) C_2H_2 | sp |
| e) H_2O | sp^3 |

45. What is defined as a fraction with equilibrium product concentrations in the numerator and equilibrium reactant concentrations in the denominator and each concentration raised to a power equal to the corresponding stoichiometric coefficient in the balanced chemical equation?
- Reversibility expression
 - Product quotient
 - Equilibrium expression
 - Reaction expression
 - Mass action
46. Two isotopes of an element differ only in their
- symbol.
 - atomic mass.
 - number of protons.
 - atomic number.
 - number of electrons.
47. Which one of these represents a *chemical* change?
- Boiling water to form steam
 - Turning hair yellow with bleach
 - Melting butter
 - Mixing powdered charcoal and oxygen at room temperature
 - Cutting a bar of sodium metal into pieces with a knife
48. Consider the element with the electron configuration $[\text{Kr}]5s^24d^7$. This element is
- a halogen.
 - an actinide element.
 - a transition metal.
 - a noble gas.
 - a nonmetal.
49. What is involved in the formation of chemical bonds?
- Valence electrons
 - Subatomic particles
 - Neutrons
 - Moles
 - Protons
50. After carrying out the operations below, how many significant figures are appropriate to show in the result?
- $$\frac{(13.7 + 0.027)}{8.221} =$$
- 1
 - 2
 - 3
 - 4
 - 5
51. Identify the *major* ions present in an aqueous HNO_3 solution.
- HN^+ , O^{2-}
 - H^+ , N^{3-} , O^{2-}
 - OH^- , NO_3^-
 - OH^- , NO
 - H^+ , NO_3^-
52. How does atomic radius increase or decrease horizontally or vertically across the periodic table?
- Atomic radius decreases moving from left to right across a period and increases from top to bottom.
 - Atomic radius increases moving left to right across a period and decreases from top to bottom.
 - Atomic radius is sporadic unless you are moving across a period.
 - Atomic radius increases diagonally across the periodic table.
 - None of the answers is correct.
53. Which of the following is not a colligative property?
- Vapor pressure lowering
 - Osmotic pressure
 - Atmospheric pressure
 - Freezing point depression
 - Boiling point elevation
54. Which of these choices is the electron configuration for the chloride ion?
- $[\text{Ne}]3s^23p^4$
 - $[\text{Ne}]3s^23p^7$
 - $[\text{Ar}]$
 - $[\text{Ar}]4s^1$
 - $[\text{Ne}]3s^23p^5$
55. Which pair of elements would be most likely to form an ionic compound?
- P and Br
 - Zn and K
 - F and Al
 - C and S
 - Al and Rb

56. Which of these Lewis structures is incorrect?



57. What is the volume of NH_3 produced in the following reaction when 3.0 L of N_2 reacts with 4.0 L of H_2 ?



- a) 1.5 L b) 2.66 L c) 0.66 L
d) 2.0 L e) 0.5 L

58. What is defined as the minimum amount of energy required to initiate a chemical reaction?

- a) Collision energy
b) Activation energy
c) Effective collision energy
d) Rate energy
e) Reaction energy

59. Aluminum sulfate, $\text{Al}_2(\text{SO}_4)_3$, is used in tanning leather, purifying water, and manufacture of antiperspirants. Calculate its molecular or formula mass.

- a) 450.06 g/mol b) 278.02 g/mol
c) 342.15 g/mol d) 74.98 g/mol
e) 315.15 g/mol

60. How many grams are present in 0.885 moles of manganese?

- a) 62.1 g b) 48.6 g c) 21.5 g
d) 27.5 g e) 0.016 g

61. The chemical formula for iron (II) nitrate is

- a) $\text{Fe}_2(\text{NO}_3)_3$ b) $\text{Ir}(\text{NO}_2)_2$
c) Fe_2N_3 d) $\text{Fe}(\text{NO}_3)_2$
e) $\text{Fe}(\text{NO}_2)_2$

62. You prepare 1000. mL of tea and transfer it to a 1.00 quart pitcher for storage. Which of the following statements is true? (1L = 1.06qt)

- a) The pitcher will be filled to 100% of its capacity with no tea spilled.
b) The pitcher will be filled to about 95% of its capacity.
c) The pitcher will be filled to about 50% of its capacity.
d) The pitcher will be completely filled and a small amount of tea will overflow.
e) The pitcher will be completely filled and most of the tea will overflow.

63. The compound, P_4S_{10} , is used in the manufacture of safety matches. What is its name?

- a) phosphorus sulfide
b) tetraphosphorus decasulfide
c) phosphoric sulfide
d) phosphorus sulfite
e) phosphorus decasulfide

64. How many moles are in 8.73×10^{25} molecules of propane, C_3H_8 ?

- a) 145 moles b) 3.84×10^{27} moles
c) 1.45 moles d) 5.04×10^{-25} moles
e) 6.90×10^{-3} moles

65. Aluminum will react with bromine to form aluminum bromide (used as an acid catalyst in organic synthesis).



How many moles of Al are needed to form 2.43 mol of Al_2Br_6 ?

- a) 7.29 mol b) 4.86 mol
c) 2.43 mol d) 1.62 mol
e) 1.22 mol

66. The equilibrium constant expression for the reaction



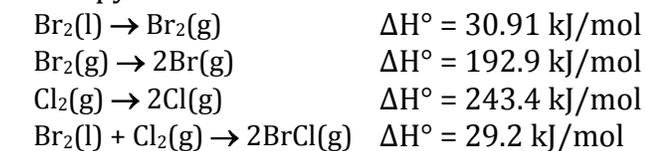
- a) $K_c = [\text{Br}_2] [\text{Cl}_2] / [\text{BrCl}_3]$
b) $K_c = [\text{BrCl}_3]^2 / [\text{Br}_2][\text{Cl}_2]^3$
c) $K_c = [\text{Br}_2] [\text{Cl}_2]^5 / [\text{BrCl}_3]^2$
d) $K_c = 2[\text{BrCl}_3]^2 / ([\text{Br}_2] \cdot 3[\text{Cl}_2]^3)$
e) $K_c = [\text{Br}_2] [\text{Cl}_2]^3 / [\text{BrCl}_3]^2$

67. What is the limiting reactant when 3.41 g of nitrogen react with 2.79g of hydrogen to produce ammonia, and how many grams of ammonia are produced?
- Hydrogen is the limiting reactant and 0.22 g of ammonia are produced.
 - Nitrogen is the limiting reactant and 2.07 g of ammonia are produced.
 - Nitrogen is the limiting reactant and 4.15 g of ammonia are produced.
 - Hydrogen is the limiting reactant and 23.5 g of ammonia are produced.
 - Hydrogen is the limiting reactant and 15.8 g of ammonia are produced.

68. The *bond enthalpy* of the Br–Cl bond is equal to ΔH° for the reaction



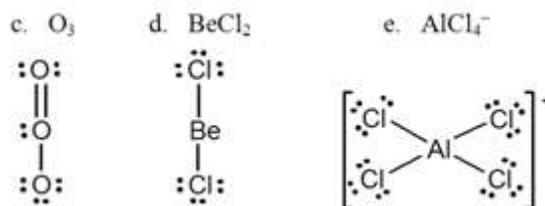
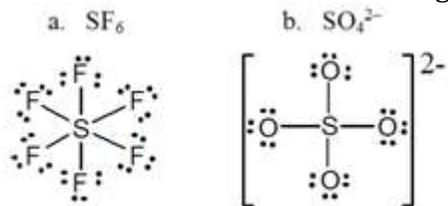
Use the following data to find the bond enthalpy of the Br–Cl bond



- 219.0 kJ/mol
- 438.0 kJ/mol
- 203.5 kJ/mol
- 407.0 kJ/mol
- 14.6 kJ/mol

69. Which of these elements has the highest first ionization energy?
- Cs
 - Ga
 - K
 - Bi
 - As

70. In which one of the following structures does the central atom have a formal charge of +2?



End of Exam

Return all test papers, answer sheet, and scrap paper to the proctor.