

AMERICAN CHEMICAL SOCIETY
2012 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 at least 90 minutes to complete the exam.

DIRECTIONS TO THE TEST TAKER

DO NOT TURN THE PAGE UNTIL DIRECTED TO DO SO

This is a 60 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:

1. In Student name field
 - a. Test/School/Teacher code "space"
Test code F = First, S = Second
School/Teacher code will be announced by the proctor
i.e. The code maybe FAB, where F is first year, AB is the school/teacher code for the student's teacher
Follow the code with a "space"
 - b. Student's Last Name "space" Student's First Name. If your name is too long for the field, neatly continue writing your complete name in the margin.
2. No other fields are required to be completed for the first year examination.

| ABBREVIATIONS AND SYMBOLS | | | | CONSTANTS | |
|---------------------------|----------------------|---------------------------|----------|-------------------|----------|
| amount of substance | <i>n</i> | Faraday constant | <i>F</i> | molar mass | <i>M</i> |
| ampere | A | free energy | <i>G</i> | mole | mol |
| atmosphere | atm | frequency | <i>v</i> | Planck's constant | <i>h</i> |
| atomic mass unit | u | gas constant | <i>R</i> | pressure | <i>P</i> |
| Avogadro constant | <i>N_A</i> | gram | g | rate constant | <i>k</i> |
| Celsius temperature | °C | hour | h | reaction quotient | <i>Q</i> |
| centi- prefix | c | joule | J | second | s |
| coulomb | C | kelvin | K | speed of light | <i>c</i> |
| density | d | kilo- prefix | k | temperature, K | <i>T</i> |
| electromotive force | <i>E</i> | liter | L | time | <i>t</i> |
| energy of activation | <i>E_a</i> | measure of pressure mm Hg | Hg | vapor pressure | VP |
| enthalpy | <i>H</i> | milli- prefix | m | volt | V |
| entropy | <i>S</i> | molal | <i>m</i> | volume | <i>V</i> |
| equilibrium constant | <i>K</i> | molar | M | | |

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

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 | | | | | | | | | | | | | | | | 18 | | | |
|--------------------------------|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------|-------------------|
| 1 | | | | | | | | | | | 13 | 14 | 15 | 16 | 17 | 18 | | | |
| 1A | | | | | | | | | | | 3A | 4A | 5A | 6A | 7A | 8A | | | |
| 1 H 1.008 | 2 He 4.003 | | | | | | | | | | | 3 Li 6.941 | 4 Be 9.012 | 5 B 10.81 | 6 C 12.01 | 7 N 14.01 | 8 O 16.00 | 9 F 19.00 | 10 Ne 20.18 |
| 11 Na 22.99 | 12 Mg 24.31 | 3 3B | 4 4B | 5 5B | 6 6B | 7 7B | 8 8B | 9 8B | 10 8B | 11 1B | 12 2B | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.07 | 17 Cl 35.45 | 18 Ar 39.95 | | |
| 19 K 39.10 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.88 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.69 | 29 Cu 63.55 | 30 Zn 65.39 | 31 Ga 69.72 | 32 Ge 72.61 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.80 | | |
| 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.91 | 40 Zr 91.22 | 41 Nb 92.91 | 42 Mo 95.94 | 43 Tc (98) | 44 Ru 101.1 | 45 Rh 102.9 | 46 Pd 106.4 | 47 Ag 107.9 | 48 Cd 112.4 | 49 In 114.8 | 50 Sn 118.7 | 51 Sb 121.8 | 52 Te 127.6 | 53 I 126.9 | 54 Xe 131.3 | | |
| 55 Cs 132.9 | 56 Ba 137.3 | 57 La 138.9 | 72 Hf 178.5 | 73 Ta 180.9 | 74 W 183.8 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.1 | 79 Au 197.0 | 80 Hg 200.6 | 81 Tl 204.4 | 82 Pb 207.2 | 83 Bi 209.0 | 84 Po (209) | 85 At (210) | 86 Rn (222) | | |
| 87 Fr (223) | 88 Ra (226) | 89 Ac (227) | 104 Rf (261) | 105 Db (262) | 106 Sg (263) | 107 Bh (262) | 108 Hs (265) | 109 Mt (266) | 110 Ds (281) | 111 Rg (272) | 112 Cn (285) | 113 (Uut) (284) | 114 (Uuq) (289) | 115 (Uup) (288) | 116 (Uuh) (293) | 117 (Uus) (294) | 118 (Uuo) (294) | | |

| | | | | | | | | | | | | | |
|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|
| 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 2012 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 one of the following is an oxidation half reaction?
 - $O_2(g) + 4e^- \rightarrow 2 O^{2-}(aq)$
 - $2 Fe(s) + 3 H_2O \rightarrow Fe_2O_3(s) + 6 H^+ + 6 e^-$
 - $CO_2(g) + 2 H^+ + 2 e^- \rightarrow CO(g) + H_2O(l)$
 - $Fe(s) + 2 e^- \rightarrow Fe^{2+}(aq)$
 - $2 H^+ + O^{2-} \rightarrow H_2O(l)$
- Which of the following statements does not describe a physical property of chlorine?
 - Chlorine combines with sodium to form table salt.
 - The color of chlorine gas is green.
 - The density of chlorine gas at standard temperature and pressure is 3.17 g/L.
 - The freezing point of chlorine is $-101^\circ C$.
- Which one of the following is not an empirical formula?
 - CHO
 - CH₂O
 - C₂H₄O
 - C₂H₄O₂
- Which of the following statements does not describe a chemical property of oxygen?
 - Iron will rust in the presence of oxygen.
 - Oxygen combines with carbon to form carbon dioxide gas.
 - The pressure is caused by collision of oxygen molecules with the sides of a container.
 - When coal is burned in oxygen, the process is called combustion.
- Which of the following statements is false?
 - A catalyst increases the rate of the forward reaction, but does not alter the reverse rate.
 - A catalyst alters the mechanism of reaction.
 - A catalyst alters the activation energy.
 - A catalyst may be altered in the reaction, but is always regenerated.
 - A catalyst increases the rate of reaction, but is not consumed.
- In the following drawings, shaded spheres represent cations and unshaded spheres represent anions.

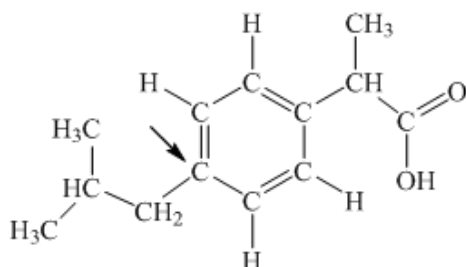
Which drawing represents the ionic compound CaCl₂?

 - drawing (a)
 - drawing (b)
 - drawing (c)
 - drawing (d)
- Chemical energy* is
 - the energy stored within the structural units of chemical substances.
 - the energy associated with the random motion of atoms and molecules.
 - solar energy, i.e. energy that comes from the sun.
 - energy available by virtue of an object's position.

8. Mendeleev proposed the existence of an unknown element that he called eka-aluminum. This element is now called

a. gallium. b. silicon.
c. magnesium. d. boron.
e. germanium.

9. Ibuprofen is used as an analgesic for the relief of pain, and also to help reduce fever. What is the hybridization state of carbon indicated by the arrow in the structure of ibuprofen shown below?

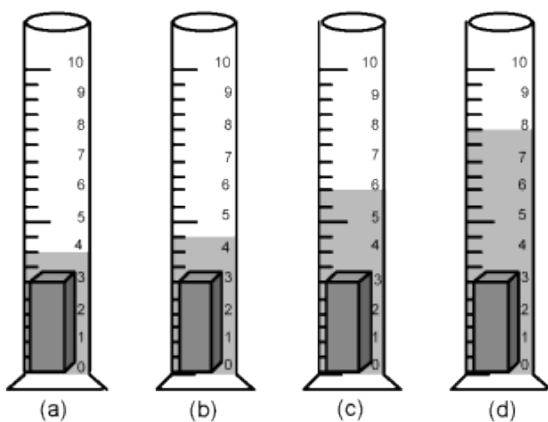


a. sp b. sp² c. sp³
d. sp³d e. sp³d²

10. What is the ground-state electron configuration of Co?

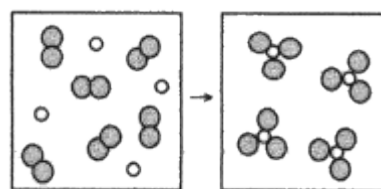
a. [Ar]3d⁹ b. [Ar]4s¹3d⁸
c. [Ar]4s²3d⁷ d. [Ar]4s²4p⁶4d¹

11. A certain solid has a density of 8.0 g/cm³. If 4.0 g of this solid are poured into 4.00 mL of water, which drawing below most closely represents the volume of water after the solid is added?



a. drawing (a) b. drawing (b)
c. drawing (c) d. drawing (d)

12. What is the balanced chemical equation for the reaction of element A (unshaded spheres) with element B (shaded spheres) as represented below?



a. $A + B \rightarrow AB$ b. $2A + 3B \rightarrow 2AB$
c. $A + B_2 \rightarrow AB_3$ d. $2A + 3B_2 \rightarrow 2AB_3$

13. The reaction of $2 \text{HNO}_3(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow \text{Ba}(\text{NO}_3)_2(\text{aq}) + 2 \text{H}_2\text{O}(\text{l})$ is best classified as a(n)

a. acid-base neutralization reaction.
b. oxidation-reduction reaction.
c. precipitation reaction.
d. single replacement reaction.

14. As the frequency of an electromagnetic wave increases

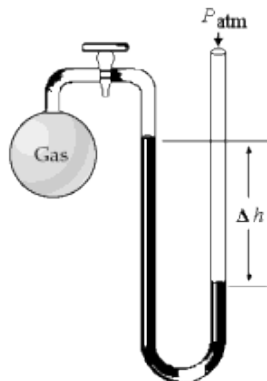
a. its speed must increase.
b. its wavelength must increase.
c. its amplitude must increase.
d. its energy must increase.

15. The gas Freon-11, CCl_3F , contains

a. C^{4+} , Cl^- , and F^- ions.
b. C^{4+} , Cl_3^- , and F^- ions.
c. C^{4+} and Cl_3F^{4-} ions.
d. CCl_3F molecules.

16. The chemical formula for sulfurous acid is

a. $\text{H}_2\text{S}(\text{aq})$. b. $\text{H}_2\text{SO}_3(\text{aq})$.
c. $\text{H}_2\text{SO}_4(\text{aq})$. d. $\text{H}_2\text{S}_2\text{O}_8(\text{aq})$.

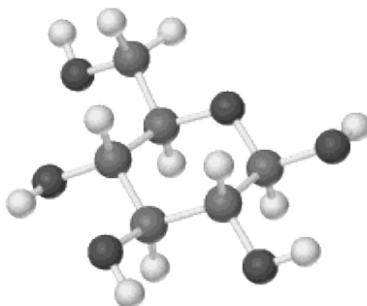


17. What is the pressure (in mm Hg) of the gas inside the above apparatus if the outside pressure, P_{atm} , is 745 mm Hg and the difference in mercury levels, h , is 25 mm Hg?
- 25 mm Hg
 - 720 mm Hg
 - 745 mm Hg
 - 770 mm Hg
18. 10 g of nitrogen is reacted with 5.0 g of hydrogen to produce ammonia according to the chemical equation shown below.
- $$\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightarrow 2 \text{NH}_3(\text{g})$$
- Which one of the following statements is false?
- 2.8 grams of hydrogen are left over.
 - Hydrogen is the excess reactant.
 - Nitrogen is the limiting reactant.
 - The theoretical yield of ammonia is 15 g.
19. Which of the following pairs of elements would be most likely to form an ionic compound?
- Cl and I
 - Al and K
 - Cl and Mg
 - C and S
 - Al and Mg
20. Which of the following substance is/are planar?
- (i) SO_3 (ii) SO_3^{2-} (iii) NO_3^- (iv) PF_3 (v) BF_3
- Only (i) and (ii)
 - only (i), (iii), and (v)
 - only (iv)
 - all are planar except (iv)
 - all are planar except (ii)
21. How many moles are there in 1.50 g of ethanol, $\text{CH}_3\text{CH}_2\text{OH}$?
- 0.0145 mol
 - 0.0326 mol
 - 30.7 mol
 - 69.0 mol
22. Express the fraction $1/23$ as a decimal to 4 significant figures.
- 0.0434
 - 0.0435
 - 0.04347
 - 0.04348
 - 0.04350
23. What is the identity of substance X if 0.380 mol of substance X weighs 17.5 g?
- NO_2
 - NO_3
 - N_2O
 - N_2O_4
24. Write a net ionic equation for the neutralization reaction of $\text{HCl}(\text{aq})$ with $\text{Ba}(\text{OH})_2(\text{aq})$.
- $2 \text{HCl}(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow \text{BaCl}_2(\text{s}) + 2 \text{H}_2\text{O}(\text{l})$
 - $2 \text{HCl}(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow \text{BaCl}_2(\text{aq}) + 2 \text{H}_2\text{O}(\text{l})$
 - $2 \text{H}^+(\text{aq}) + 2 \text{Cl}^-(\text{aq}) + \text{Ba}^{2+}(\text{aq}) + 2 \text{OH}^-(\text{aq}) \rightarrow 2 \text{Cl}^-(\text{aq}) + \text{Ba}^{2+}(\text{aq}) + 2 \text{H}_2\text{O}(\text{l})$
 - $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
25. Complete this sentence:
- Atoms emit visible and ultraviolet light**
- as electrons jump from lower energy levels to higher levels.
 - as the atoms condense from a gas to a liquid.
 - as electrons jump from higher energy levels to lower levels.
 - as they are heated and the solid melts to form a liquid
 - as the electrons move about the atom within an orbit.
26. Which of the following represents a pair of isotopes?
- $^{32}_{15}\text{P}$, $^{15}_7\text{N}$
 - $^{32}_{16}\text{S}$, $^{31}_{16}\text{S}$
 - $^{16}_8\text{O}_2$, $^{16}_8\text{O}_3$
 - ^1_1H , $^1_1\text{H}^{1+}$

27. Which one of the following contains 35% carbon by mass?
- a. C_2H_2
 - b. CH_4
 - c. CH_3F
 - d. CO_2

28. According to the collision theory, all collisions do not lead to reaction. Which choice gives both reasons why not all collisions between reactant molecules lead to reaction?
- a. The total energy of two colliding molecules is less than some minimum amount of energy.
 - b. Molecules cannot react with each other unless a catalyst is present.
 - c. Molecules that are improperly oriented during collision will not react.
 - d. Solids cannot react with gases.

29. Glucose can be represented by the molecular model shown below.



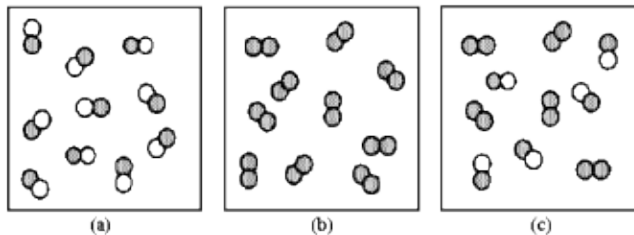
Glucose

- If 1.00 mol of glucose is submitted to combustion analysis, how many moles of CO_2 and how many moles of H_2O would be formed?
- a. 1.00 mol CO_2 and 2.00 mol H_2O
 - b. 6.00 mol CO_2 and 6.00 mol H_2O
 - c. 6.00 mol CO_2 and 12.0 mol H_2O
 - d. 12.0 mol CO_2 and 12.0 mol H_2O
30. Which of the following is the smallest volume?
- a. 44 cm^3
 - b. 1.0 dL
 - c. $5.5 \times 10^3\text{ mL}$
 - d. $1 \times 10^8\text{ nL}$
31. Which of the following elements has the least tendency to form an ion?
- a. Ca
 - b. K
 - c. Kr
 - d. Se

32. Which element, indicated by letter on the periodic table above, has the ground-state electron configuration $[Ar]4s^23d^2$?

- a. A
 - b. B
 - c. C
 - d. D
33. The alkali metal elements are found in _____ of the periodic table.
- a. Group 1A
 - b. Group 2A
 - c. Group 3A
 - d. Period 7
 - e. Period 1
34. Which of these statements is true about chemical equilibria in general?
- a. At equilibrium the total concentration of products equals the total concentration of reactants, that is, $[products] = [reactants]$.
 - b. Equilibrium is the result of the cessation of all chemical change.
 - c. There is only one set of equilibrium concentrations that equals the K_c value.
 - d. At equilibrium, the rate constant of the forward reaction is equal to the rate constant for the reverse reaction.
 - e. At equilibrium, the rate of the forward reaction is equal to as the rate of the reverse reaction.
35. The compound, NO_2 , is named
- a. nitrate.
 - b. nitrite.
 - c. nitrogen dioxide.
 - d. nitrogen(IV) oxide.

36. Which of the above drawings represents a pure compound?

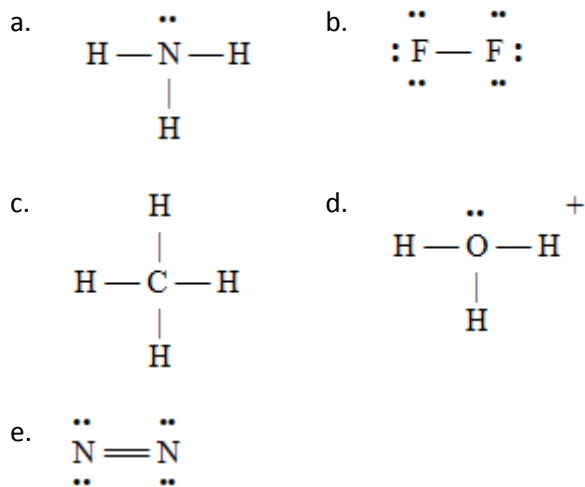


- a. drawing (a) b. drawing (b)
c. drawing (c) d. none of the drawings

37. Copper metal has a specific heat of $0.385 \text{ J/g}\cdot^\circ\text{C}$. Calculate the amount of heat required to raise the temperature of 22.8 g of Cu from 20.0°C to 875°C .

- a. $1.97 \times 10^{-5} \text{ J}$
b. $1.0 \times 10^{-2} \text{ J}$
c. 329 J
d. 7.51 kJ
e. 10.5 kJ

38. Which of the following Lewis structures is incorrect?



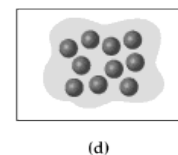
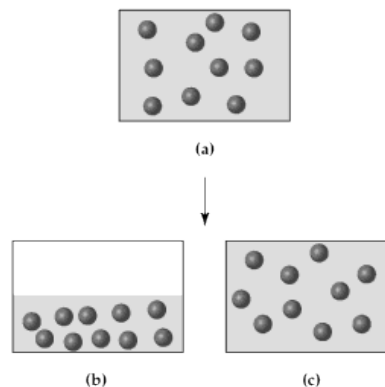
39. Which of the following volume instruments has the least uncertainty?

- a. buret, $\pm 0.01 \text{ mL}$
b. graduated cylinder, $\pm 0.5 \text{ mL}$
c. hypodermic syringe, $\pm 0.001 \text{ mL}$
d. volumetric flask, $\pm 0.05 \text{ mL}$
e. volumetric pipet, $\pm 0.1 \text{ mL}$

40. According to the kinetic molecular theory, the pressure of a gas in a container will decrease if the

- a. number of collisions with the container wall increases.
b. number of moles of the gas increases.
c. temperature of the gas decreases.
d. volume of the container decreases.

41. Assume that you have a sample of gas at 300 K in a sealed container, as represented in (a).



Which of the drawings (b)-(d) represents the gas after the temperature is raised from 300 K to 400 K?

- a. Drawing (a) – there is no change
b. drawing (b)
c. drawing (c)
d. drawing (d)

42. How many electrons are in the ion, P^{3-} ?

- a. 12 b. 18 c. 28 d. 34

43. What is the mass of 8.50×10^{22} molecules of NH_3 ?

- a. 0.00830 g b. 0.417 g
c. 2.40 g d. 120 g

44. Use the periodic table below to answer the following questions.

| | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | A | | | | | | | | | | | | B | C | D | | | | | | | | | | |
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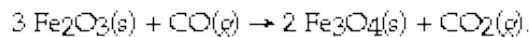
Which is the correct formula of the binary fluoride of element A?

- a. AF_2 b. AF_3 c. AF_5 d. AF_6
45. According to history, the concept that all matter is composed of atoms was first proposed by
- the Greek philosopher Democritus, but not widely accepted until modern times.
 - Dalton, but not widely accepted until the work of Mendeleev.
 - Dalton, but not widely accepted until the work of Einstein.
 - Dalton, and widely accepted within a few decades.
46. The bond angle in Cl_2O is expected to be approximately
- 90°
 - 109.5°
 - 120°
 - 145°
 - 180°
47. What is the molar mass of aspartic acid, $C_4O_4H_7N$?
- 43 g/mol
 - 70 g/mol
 - 133 g/mol
 - 197 g/mol
48. Which two electron configurations represent elements that would have similar chemical properties?
- (1) $1s^2 2s^2 2p^4$
 - (2) $1s^2 2s^2 2p^5$
 - (3) $[Ar]4s^2 3d^5$
 - (4) $[Ar]4s^2 3d^{10} 4p^5$
- (1) and (2)
 - (1) and (3)
 - (2) and (3)
 - (2) and (4)
 - (3) and (4)

49. A balloon contains 0.76 mol N_2 , 0.18 mol O_2 , 0.031 mol He and 0.026 mol H_2 at 739 mm Hg. What is the partial pressure of O_2 ?

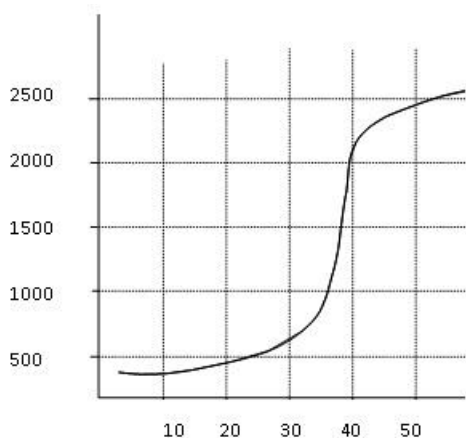
- 19 mm Hg
- 23 mm Hg
- 130 mm Hg
- 560 mm Hg

50. Use the given standard enthalpies of formation to calculate H for the following reaction



| Species | ΔH_f° , kJ/mol |
|--------------|-----------------------------|
| $Fe_2O_3(s)$ | -824.2 |
| $Fe_3O_4(s)$ | -1118.4 |
| $CO(g)$ | -110.5 |
| $CO_2(g)$ | -393.5 |

- 5213.4 kJ
 - 577.2 kJ
 - 47.2 kJ
 - +47.2 kJ
51. Choose the response that includes all the items listed below that are pure substances.
- orange juice
 - steam
 - ocean water
 - oxygen
 - vegetable soup
- i, iii, v
 - ii, iv
 - i, iii, iv
 - iv only
 - all of them are pure
52. Magnesium chloride is
- $MgCl_3$
 - Ma_2Cl
 - $MgCl_2$
 - MnC_2
 - MgC_2
53. Give the number of lone pairs around the central atom and the molecular geometry of SCl_2 .
- 0 lone pairs, linear
 - 1 lone pair, bent
 - 2 lone pairs, bent
 - 3 lone pairs, bent
 - 3 lone pairs, linear
54. The Transition metal in the IIIB group in the 4th period
- Sc
 - V
 - Ga
 - Ni



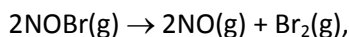
55. The above graph is a non-linear relationship between x and y . If $y = 1000$, what is the value of x ?

- a) 30 b) 40
c) 35 d) 45

56. A student prepared a stock solution by dissolving 50.0 g of KOH in enough water to make 250. mL of solution. What is the concentration of the stock solution?

- a) 0.00357 M b) 0.200 M
c) 0.891 M d) 3.57 M
e) 4.49 M

57. For the following reaction at equilibrium, which choice gives a change that will shift the position of equilibrium to favor formation of more products?



$$\Delta H_{\text{rxn}}^{\circ} = 30 \text{ kJ/mol}$$

- a) Increase the total pressure by decreasing the volume.
b) Add more NO.
c) Remove Br_2 .
d) Lower the temperature.
e) Remove NOBr selectively.

58. Which one of these statements about strong acids is *true*?

- a. All strong acids have H atoms bonded to electronegative oxygen atoms.
b. Strong acids are 100% ionized in water.
c. The conjugate base of a strong acid is itself a strong base.
d. Strong acids are very concentrated acids.
e. Strong acids produce solutions with a higher pH than weak acids.

59. According to the first law of thermodynamics:

- a. Energy is neither lost nor gained in any energy transformations.
b. Perpetual motion is possible.
c. Energy is conserved in quality but not in quantity.
d. Energy is being created as time passes. We have more energy in the universe now than when time began.

60. As the temperature of a reaction is increased, the rate of the reaction increases because the

- a. reactant molecules collide less frequently
b. reactant molecules collide more frequently
c. activation energy is lowered
d. reactant molecules collide more frequently and with greater energy

61. reactant molecules collide less frequently and with less energy

Which of the following ionic salts is most likely soluble in water?

- a) Ag_2SO_4 b) Hg_2Cl_2
c) PbBr_2 d) NH_4Cl
e) Fe_2S_3

End of Exam

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