



Baltic Chemistry Competition

2012

Official sponsors:

Grindex

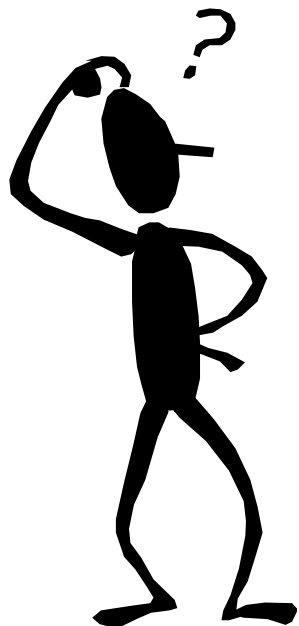
www.grindex.lv

BIO SAN

Medical - Biological Research and Technologies

www.biosan.lv

Competition structure 2012



Part I
General chemistry

Part II – Organic chemistry

Part II – Inorganic chemistry

Part II – Analytical chemistry

Part II – Physical chemistry

- The easiest part!!!
- 100 multiple choice questions
- One correct answer for each question.
- TOTAL – 50 points

- 3-5 problems, each discipline gives 25 max.
- TOTAL – $25 \times 4 = 100$ points

Together $50 + 100 = 150$ points.

Part I – General chemistry

- Answer next 100 questions, chose one correct or most appropriate answer for each question**
- Write your answers in specially designed answer sheets, fill obligatory fields about your name, surname, school and grade (answers without this information will not be graded)**
- Enjoy competition!**

1. If $\text{pK}_a(\text{NH}_4^+) = 9.25$, then pH of 0.100 M ammonia solution is :

A. 4.75

B. 9.25

C. 10.3

D. 11.1

E. 13.6

2. The most appropriate acid base indicator for titration of acetic acid with potassium hydroxide solution is :

- A. Methyl orange**
- B. Methyl red**
- C. Phenolphthalein**
- D. Litmuss paper**
- E. Potassium cianide**

3. Which of following reactions between calcium carbonate and nitric acid will occur at highest rate:

- A. Chalk powder with 2M acid at 40°C**
- B. Chalk powder with 0.5M acid at 40°C**
- C. Chalk powder with 2M acid at 20°C**
- D. Chalk pieces with 0.5 M acid at 40°C**

4. Correct IUPAC name for this organic compound is:

- A. sec-isoamyl alcohol**
- B. Isometan-1-ol**
- C. 3-Methyl-2-butanol**
- D. None of above**



5. Calculate EMF for Daniel cell if 1M copper(II) sulfate and 1M zinc sulfate solutions are used.

- A. 1.0V**
- B. 1.1V**
- C. 0.8V**
- D. 0.3V**
- E. 0.0V**
- F. None of above**

6. Which of following particles has the largest radius?

A. Ca^{2+}

B. K^{+}

C. Ar

D. Cl^{-}

E. S^{2-}

7. If 8.0 grams of gas occupies 22.4 L volume at 0°C temperature and 0.25 atm pressure, then molar mass of gas is:

- A. 8 g/mol**
- B. 16 g/mol**
- C. 32 g/mol**
- D. 64 g/mol**
- E. 128 g/mol**

8. Solutions of compounds given were prepared with equal molality. Which of these solutions has the lowest freezing point:

- A. Potassium Bromide**
- B. Sodium nitrate**
- C. Sodium acetate**
- D. Aluminium nitrate**
- E. Magnesium chloride**

9. Van der Waals equation is:

$$(p+n^2a/V^2)(V-nb)=nRT$$

Which of following gass will have largest b value?



10. Which of following is the pH of solution obtained by mixing 50.0 mL of 0.100 M acid HA and 50 mL 0.100 M NaOH solutions?

I. Neutral if HA is strong acid.

II. Basic if HA is weak acid.

III. Acidic if HA is strong acid. Correct

is...

A. Only I

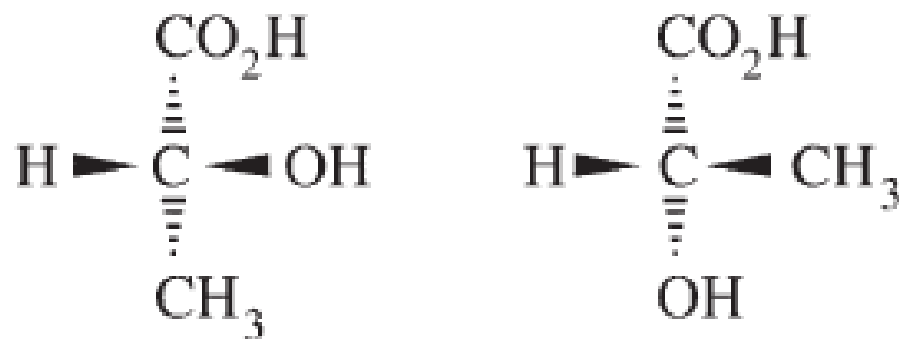
B. Only II

C. Only III

D. I and II

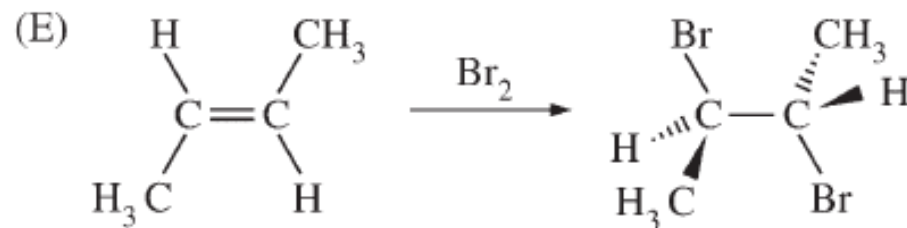
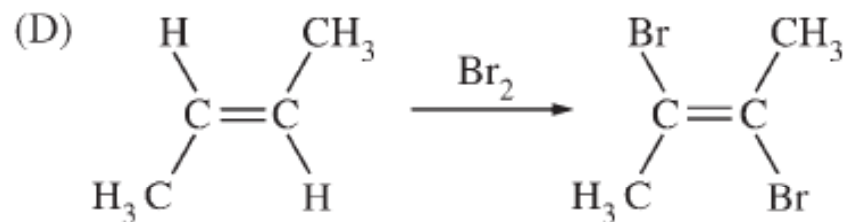
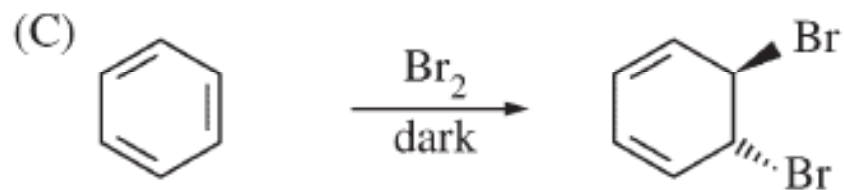
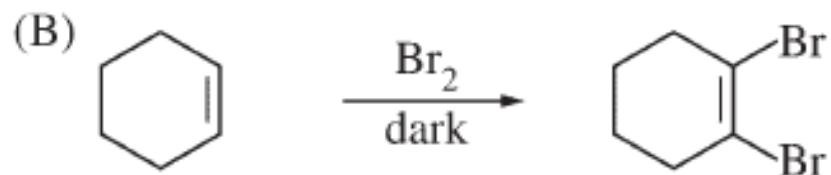
E. II and III

11. Given structures are:

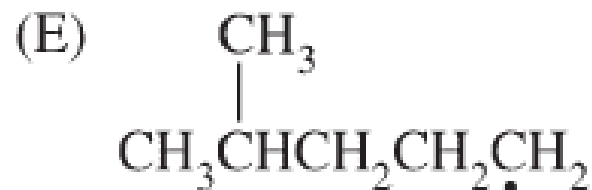
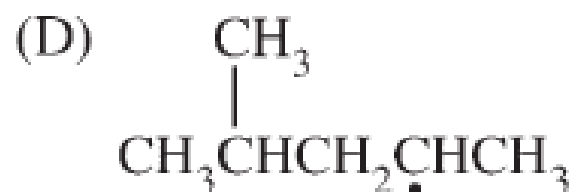
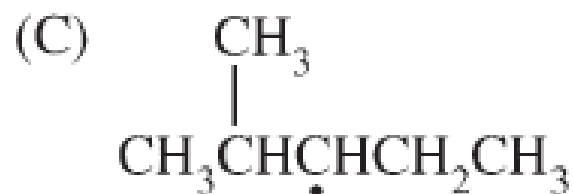
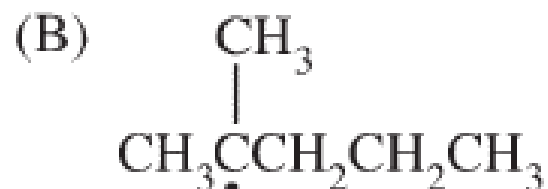
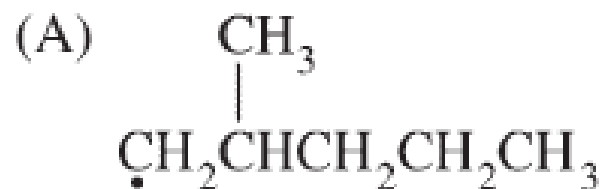


- A. Identical**
- B. Different conformations of same compound**
- C. Enantiomers**
- D. Diastereomers**
- E. Constitutional isomers**

12. Which of given reaction gives indicated product as major product?

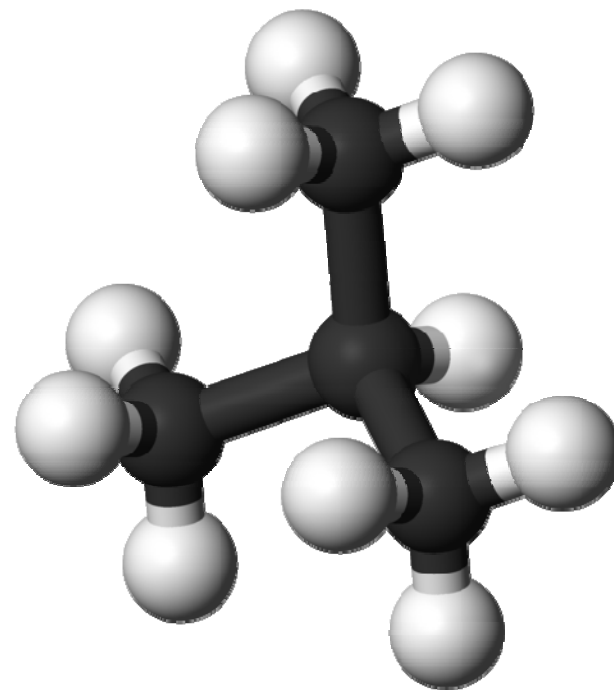


13. Reaction of 2-methylpentane with chlorine. Which of these intermediates forms with highest rate:



14. Main product of monobromination of shown alkane is:

- A. 2-bromo-2-methylpropane**
- B. 1-bromo-2-methylpropane**
- C. 2-chloro-2-methylpropane**
- D. 2-bromopropane**
- E. None of above**



15. Azide ion is isoelectronic with:



F. None of above

16. Which of following set of ΔH and ΔS values is correct for reaction which is spontaneous only in high temperature?

	ΔH	ΔS
A.	+60	+19
B.	+60	-19
C.	-60	-19
D.	-60	+19
E.	0	-19

17. Which of following comparisons of the average kinetic energies and the average molecular speeds of H_2 and O_2 gases at 298K are correct?

	Av.kinetic energy	Avg. molec.speed
A.	$\text{H}_2 = \text{O}_2$	$\text{H}_2 = \text{O}_2$
B.	$\text{H}_2 = \text{O}_2$	$\text{H}_2 > \text{O}_2$
C.	$\text{H}_2 = \text{O}_2$	$\text{H}_2 < \text{O}_2$
D.	$\text{H}_2 > \text{O}_2$	$\text{H}_2 = \text{O}_2$
E.	$\text{H}_2 < \text{N}_2$	$\text{H}_2 = \text{N}_2$

18. For triprotic acid abbreviated as H_3A $pK_{a_1}=2$, $pK_{a_2} = 6$ and $pK_{a_3} = 10.5$. The pH range in which H_2A^- is the dominant form is a pH between:

- A. 1 and 3**
- B. 3 and 5**
- C. 5 and 7**
- D. 7 and 9**
- E. 9 and 11**
- F. None of above**

19. The molecular geometry of XeOF_4 is:

- A. Trigonal**
- B. octahedral**
- C. Trigonal bipyramidal**
- D. Square pyramidal**
- E. Tetrahedral**
- F. None of above**

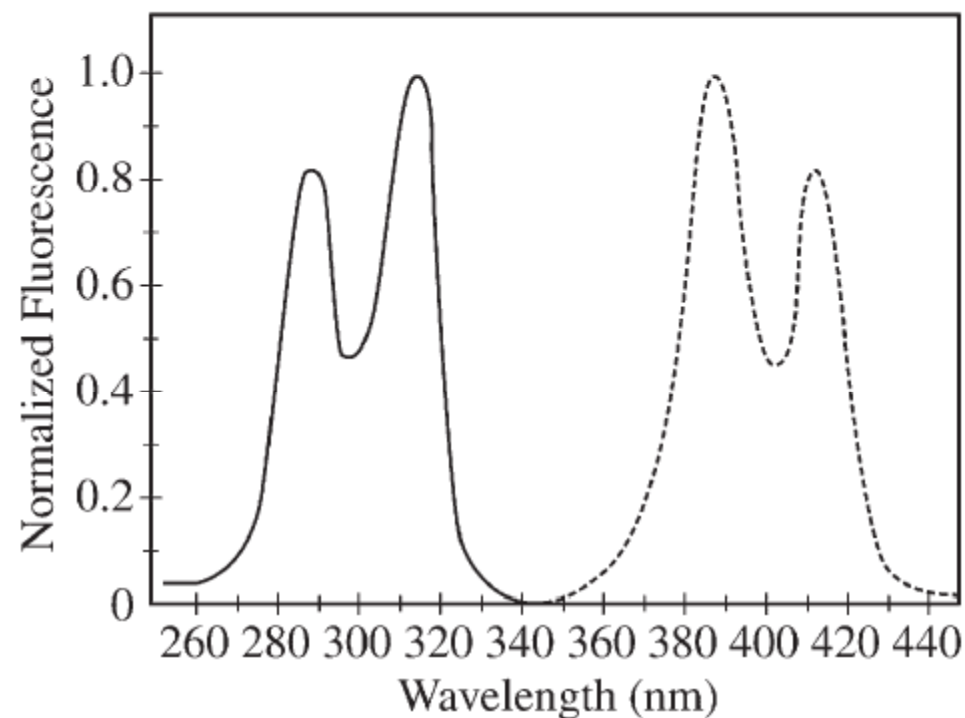
20. The structure of one metal is bcc. At the same temperature but at higher pressure metal changes phase to more dense one. Which of the following is likely structure at high pressure?

- A. Cubic close-packed**
- B. Amorphous**
- C. Primitive cubic**
- D. Primitive tetragonal**
- E. Primitive orthorombic**

21. Which of following molecules does NOT have a threefold rotational symmetry axis?

- A. BCl_3**
- B. CH_4**
- C. NH_3**
- D. CClF_3**
- E. ClF_3**
- F. None of above**

22. Based on the excitation and emission spectra for compound shown on the right side, what excitation and emission wavelengths λ (in nm) should be chosen to maximize the measured fluorescence intensity?



	<u>Excitation (in nm)</u>	<u>Emission (in nm)</u>
A.	290	420
B.	390	315
C.	415	290
D.	315	390
E.	315	415

23. Which of the following is classified as a random error in analytical measurements?

- A. A colorimetric reaction has not reached completion before absorbance of the product is measured.**
- B. An arithmetic mistake is made in computing the concentration of a measured substance.**
- C. A balance is incorrect by a constant amount of 0.10 g.**
- D. A blank used to correct for background interference is accidentally contaminated with the analyte.**
- E. A pipet is not handled quite the same way during the repetitions of a determination.**
- F. None of above**

24. The method of initial rates is used to determine the rate law for the reaction shown above. The following initial rates were determined.

Rate law is:

P_{NO} (torr)	P_{H_2} (torr)	Initial Rate (torr/s)
200	400	0.46
400	200	0.92
400	400	1.85

- A. $v = k * p(\text{NO})$
- B. $v = k * p(\text{NO}) * p(\text{H}_2)$
- C. $v = k * p(\text{NO}) * p(\text{H}_2)^2$
- D. $v = k * p(\text{NO})^2 * p(\text{H}_2)$
- E. $v = k * p(\text{NO})^2 * p(\text{H}_2)^2$
- F. None of above

25. A radioactive isotope of copper ^{64}Cu is a beta emitter. The half-life for the reaction is 12.8 hours. Starting with 100 g of ^{64}Cu , how much ^{64}Zn is produced in 25.6 hours?

- A. 12.5g**
- B. 20.0g**
- C. 50.0g**
- D. 75.0g**
- E. 100g**
- F. None of above**

26. If elementary step $A \rightarrow B$ has a reaction activation energy of 10 kJ and reaction enthalpy of -50 kJ, the activation energy for reverse reaction $B \rightarrow A$ is:

- A. 0kJ**
- B. 10kJ**
- C. 40kJ**
- D. 50kJ**
- E. 60kJ**
- F. None of above**

27. The reaction of dinitrogen tetroxide with water yields to formation of:

- A. HNO_3 only**
- B. HNO_2 only**
- C. HNO_3 and NO**
- D. NH_3 and H_2O_2**
- E. NH_3 and O_2**
- F. Both HNO_3 and HNO_2**
- G. None of above**

28. Which of the following compounds produces H_2 gas when added to water?

- A. LiH**
- B. CH_4**
- C. NH_3**
- D. PH_3**
- E. H_2S**
- F. None of above**

29. Which of the following partial derivatives is zero for ideal gas?

- A. $(dU/dT)_V$**
- B. $(dH/dT)_p$**
- C. $(dS/dT)_p$**
- D. $(dU/dV)_T$**
- E. $(dS/dV)_T$**
- F. None of above**

30. Given that $dU = TdS - pdV$ and $H = U + pV$, which of the following is true?

- A. $dH = TdS + Vdp$**
- B. $dH = SdT - VdP$**
- C. $dH = -SdT - pdV$**
- D. $dH = dU + pdV$**
- E. $dH = dU - TdS$**
- F. None of above**

31. A reaction is at equilibrium in a closed rigid vessel at constant temperature when:

A. $\Delta S = 0$

B. $\Delta H = 0$

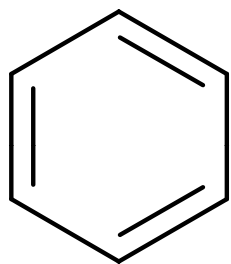
C. $\Delta U = 0$

D. $\Delta G = 0$

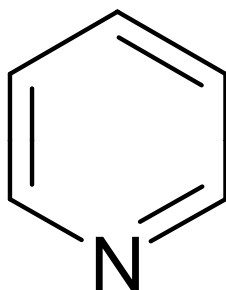
E. $\Delta A = 0$

F. None of above

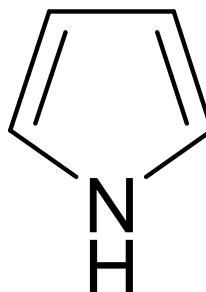
32. Which of the following is the strongest base?



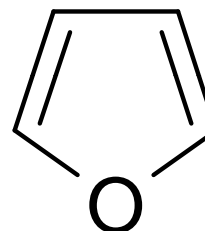
A



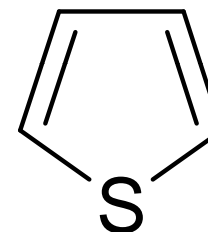
B



C

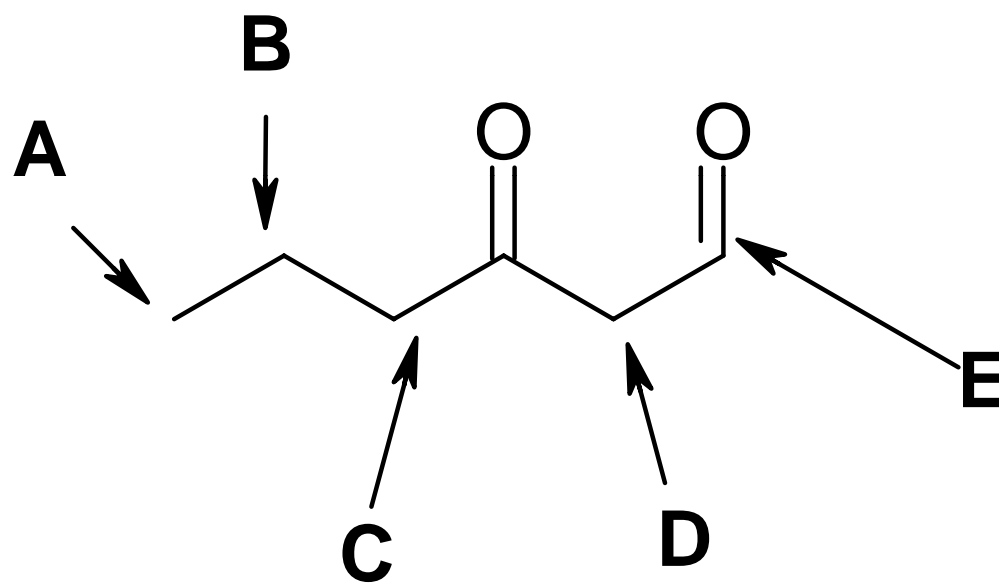


D



E

33. A hydrogen in which position in the structure shown above is most acidic?



34. HF behaves as a base in which of the following solvents?

- A. NH_3 (l)**
- B. H_2O (l)**
- C. CH_3COOH (l)**
- D. H_2SO_4 (l)**
- E. Aqueous 0.10 M NaOH**
- F. None of above**

35. Of the following materials, which contribute(s) most to the production of acid rain?

- A. Uranium hexafluoride**
- B. Ozone**
- C. Phosphate detergents**
- D. Nitric oxide**
- E. Chlorofluorocarbons**
- F. DDT**
- G. TNT**
- H. None of above**



**36. Bond enthalpies (in kJ/mol) are following
H-H 435; Cl-Cl 243; H-C 414; HCl 431; C-Cl
331. Based on these enthalpies, what is
value of ΔH for the reaction?**

- A. 275 kJ**
- B. 109 kJ**
- C. 83 kJ**
- D. -83 kJ**
- E. -109 kJ**
- F. None of above**

**37. If neon gas trapped in a cylinder with movable piston undergoes an adiabatic expansion, which of the following statements is true for the expansion?
(q = heat; w = work; ΔU = internal energy change)**

- A. $q = w$**
- B. $w = 2q$**
- C. $\Delta U = 0$**
- D. $\Delta U = q$**
- E. $\Delta U = w$**

38. The key components common to both HPLC (high performance liquid chromatography) and gas chromatographic system include all of the following EXCEPT:

- A. detector**
- B. mobile or eluent phase**
- C. stationary phase**
- D. device for temperature programming**
- E. Sample injector**

39. Which of the following molecules will exhibit a pure rotational absorption spectrum?

I – chlorine, II – HCl, III – methane, IV – PF₃

- A. II only**
- B. I and II only**
- C. I and III only**
- D. III and IV only**
- E. II and IV only**
- F. None of mentioned**

40. Which of the following molecules of hydrogen has the highest vibrational frequency? (D = deuterium, T = tritium)

A. H_2

B. HD

C. D_2

D. HT

E. T_2

F. All molecules has same frequency

41. Of the following metal ions, which has the largest magnetic moment in its low-spin octahedral complexes?

- A. Fe(III)**
- B. Co(III)**
- C. Co(II)**
- D. Sc(III)**
- E. Cr(II)**

42. What kind of reactive intermediate is formed in reaction between but-1-ene and bromine in sunlight?

- A. Carbanion**
- B. Carbocation**
- C. Bromonium ion**
- D. Bromide ion**
- E. Free radical**
- F. None of above**

43. Which of the following ligands forms complexes that are examples of linkage isomers?

- A. NH_3**
- B. NO_2^-**
- C. PF_3**
- D. $\text{NH}_2\text{-CH}_2\text{-CH}_2\text{-NH}_2$**
- E. SO_4^{2-}**
- F. None of above**

44. A weak acid HA, has pKa value of 5. If 0.100 mol of this acid is dissolved in one liter of water, the percentage of acid dissociated is closest to:

- A. 0.100%**
- B. 1.00%**
- C. 99.0%**
- D. 100%**
- E. None of above**

45. If 99.1% of a substance dissolved in 25.0 mL of water is extracted into 25.0 mL of organic solvent, then the distribution coefficient for the substance between organic solvent and water is:

- A. 1.01×10^{-4}**
- B. 1.10×10^{-2}**
- C. 1.00**
- D. 1.10×10^2**
- E. 1.10×10^4**
- F. None of above**

46. Which of the following electronic transitions is forbidden for a hydrogen-like atom?

- A. $2p \rightarrow 3p$**
- B. $2p \rightarrow 1s$**
- C. $2p \rightarrow 3s$**
- D. $2p \rightarrow 4s$**
- E. $2p \rightarrow 3d$**
- F. None of above**

47. Increase of boiling points in row from F_2 to iodine is due to:

- A. Ionic bonding**
- B. Covalent bond strength**
- C. Electron affinity**
- D. Van der Waals forces**
- E. Nuclear quadrupole moment**
- F. None of above**

48. Which of the following compounds forms the strongest hydrogen bonds with itself?

A. HF

B. HCl₃

C. PH₃

D. H₂S

E. CH₄

49. Which of the following is the strongest oxidizing agent?



50. Boron rich deposits on Earth appear to have formed by precipitation from an aqueous solution. In what form does boron exist in the deposits?

- A. Its elemental form**
- B. A sulfide**
- C. An oxide or hydroxide**
- D. Diborane**
- E. Boron nitride**

51. The energy levels of a particle in a cubic box are given by the expression below, in which $n_x, n_y, n_z = 1, 2, \dots$. The degeneracy of the $E = 14h^2/8ma^2$ level is:

A. 2

B. 3

C. 4

D. 5

E. 6

F. None of above

$$E_{n_x, n_y, n_z} = \frac{h^2}{8ma^2} (n_x^2 + n_y^2 + n_z^2)$$

52. The half life of ^{14}C is 5730 years. The ^{14}C activity of living material is approximately 920 decays per h per gram of carbon. A fragment of wool fabric from archaeological site has an activity of 680 decays per h per gram of carbon. The approximate date of the sample is:

- A. A.D.1950**
- B. 500 B.C.**
- C. 3700 B.C.**
- D. 5700 B.C.**
- E. 10 000 B.C.**
- F. None of above**

53. Second ionization constant K_{a2} for H_3PO_4 is 5.0×10^{-8} . How many mmol of K_2HPO_4 must be added to 100 mL of a 0.100 M KH_2PO_4 solution to obtain a solution with pH of 7.0?

- A. 1.0**
- B. 5.0**
- C. 10**
- D. 20**
- E. 25**
- F. None of above**

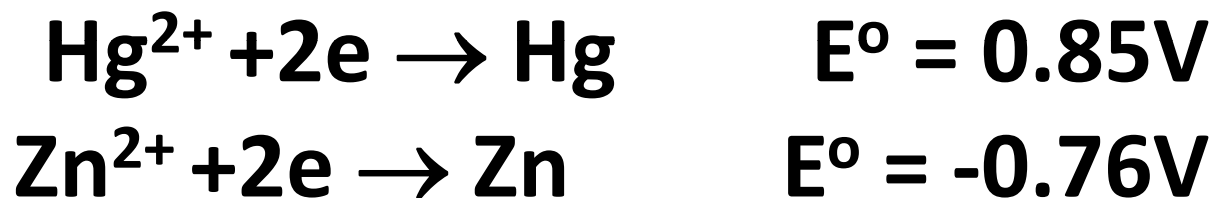
54. Which of the following complexes exists as a pair of enantiomers?

- A. Trans-[Co(H₂NCH₂CH₂NH₂)₂Cl₂]⁺**
- B. [Co(NH₃)₄Cl₂]⁺**
- C. [Co{P(C₂H₅)₃}₂ClBr]**
- D. [Pt{P(C₂H₅)₃}₂Cl₂]**
- E. [Cr(H₂NCH₂CH₂NH₂)₃]³⁺**
- F. None of above**

55. Which of the following is true for element xenon?

- A. It does not form chemical compounds**
- B. It exists as diatomic molecule Xe_2**
- C. It has lower 1st ionization energy than sodium.**
- D. It has an extensive organometallic chemistry.**
- E. It forms compounds with some electronegative elements.**
- F. None of above**

56. Given the cell potentials shown below, the equilibrium constant at 298K for the reaction $\text{Zn} + \text{Hg}^{2+} = \text{Zn}^{2+} + \text{Hg}$ is closest to which of the following?



- A. 54
- B. 2.5×10^{54}
- C. 1.6
- D. 1.6×10^{-2}
- E. 4.1×10^{-55}
- F. 3.2×10^5

57. Which of the following isomers of C_6H_{12} has the highest heat of combustion?

- A. Cyclohexane**
- B. Methylcyclopentane**
- C. Trans-1,2-dimethylcyclobutane**
- D. Ethylcyclobutane**
- E. 1,1,2-trimethylcyclopropane**

58. Cyanide ion can be determined by a complexonometric titration with silver nitrate that uses a color indicator to detect endpoint. If 20.00 mL of 0.100 M solution of silver nitrate is required to titrate 5.00 mL of CN^- solution, the concentration of CN^- solution is:

- A. 0.100 M**
- B. 0.200 M**
- C. 0.400 M**
- D. 0.800 M**
- E. 1.60 M**
- F. None of above**

59. When 0.001 M solution of each of the following compounds is prepared, which solution will have the greatest electrical conductivity?

A. CH_3COOH

B. CH_3OH

C. NH_3

D. SO_3

E. HCOOH

F. All solutions have same conductivity

60. According to molecular-orbital theory, which of the following species has the highest bond order?

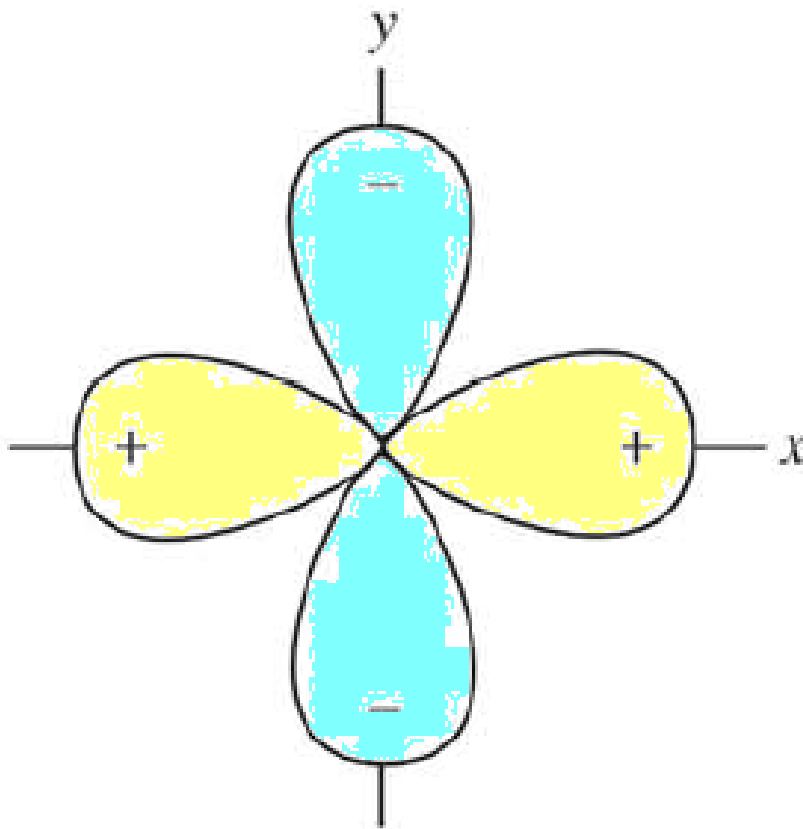


61. According to 18-electron rule, which of the following is not a correct formula for a stable metal carbonyl?

- A. $[\text{V}(\text{CO})_6]^-$**
- B. $[\text{Mn}(\text{CO})_5]^-$**
- C. $[\text{Fe}(\text{CO})_4]^{2-}$**
- D. $[\text{Co}(\text{CO})_4]^+$**
- E. $[\text{Ni}(\text{CO})_4]$**

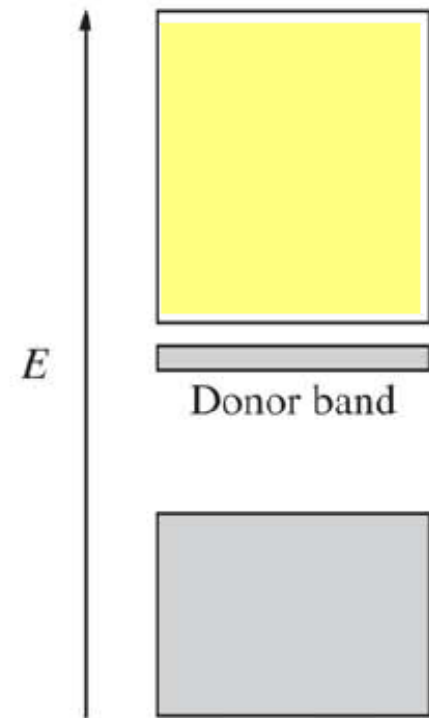
62. What type of orbital is shown above?

- A. $3p_x$
- B. $3p_y$
- C. $3d_{xy}$
- D. $3d_{x^2-y^2}$
- E. $3d_{z^2}$
- F. None of above



63. Which type of semiconductor (SC) is represented by the band structure shown below?

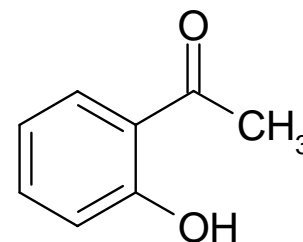
- A. An intrinsic SC as in pure Si**
- B. An n-type SC as in Ga-doped Si**
- C. An n-type SC as in P-doped Si**
- D. A p-type SC as in Ga-doped Si**
- E. A p-type SC as in P-doped Si**
- F. None of above**



64. What is the primary advantage of a hollow-cathode lamp used in atomic absorption spectroscopy?

- A. It has high intensity**
- B. It emits a complete UV spectrum**
- C. It has narrow line width**
- D. It allows direct applitation to nonmetal analysis**
- E. It eleminates the need for an ionization suppressor**
- F. None of above**

65. What infrared absorptions are most affected by intramolecular hydrogen bonding in the compound shown on right side?



- A. Methyl-group C-H stretching**
- B. Hydroxyl group O-H stretching**
- C. Aromatic ring C-H bending**
- D. Aromatic ring C-H stretching**
- E. Aromatic ring C-C stretching**
- F. None of above**

66. At 25°C and 100 kPa, most of the known elements are:

- A. Monoatomic gases**
- B. Diatomic gases**
- C. Liquids**
- D. Metallic solids**
- E. Non-metallic and semi-metallic solids**
- F. None of above**

67. Which of the following atoms has electrons in its outermost shell arranged in the configuration $4s^2 4p^3$?

- A. Rb**
- B. Kr**
- C. As**
- D. Cr**
- E. Sb**
- F. None of above**

68. In a particular solution bromide ion concentration is 0.020 mol/L and chromate ion concentration is 0.0030 M. Silver nitrate solution is slowly added to the mentioned solution. What is bromide ion concentration when silver(I) chromate starts to precipitate?

$$K_{sp} \text{ Ag}_2\text{CrO}_4 = 1.9 * 10^{-12}$$

$$K_{sp} \text{ AgBr} = 5.2 * 10^{-13}$$

- A. $2,1 * 10^{-8} \text{ M}$
- B. $6,0 * 10^{-8} \text{ M}$
- C. $2,7 * 10^{-7} \text{ M}$
- D. $5,2 * 10^{-13} \text{ M}$
- E. $6,4 * 10^{-4} \text{ M}$
- F. None of above

69. Which of the following ions has the smallest tendency to be protonated when dissolved in liquid acetic acid solution?

- A. OH-**
- B. F-**
- C. Cl-**
- D. Br-**
- E. I-**
- F. None of above**

70. The strongest oxidizing agent is:

- A. HCl**
- B. HClO**
- C. HClO₂**
- D. HClO₃**
- E. HClO₄**
- F. All these are reducing agents**

71. Which of the following contains only single bonds?



72. What is the empirical formula of an organic compound that contain 7.45% (by mass) hydrogen and 25.91% nitrogen?

- A. $\text{C}_3\text{H}_4\text{N}$**
- B. $\text{C}_3\text{H}_4\text{N}_2$**
- C. $\text{C}_3\text{H}_3\text{N}$**
- D. $\text{C}_4\text{H}_4\text{N}$**
- E. $\text{C}_4\text{H}_3\text{N}_2$**
- F. None of above**

73. Which of the following bonds is most polar?

- A. B-O**
- B. B-F**
- C. C-O**
- D. C=O**
- E. C-F**
- F. C-N**
- G. C-Cl**

74. A solution in which the bromide concentration is 2.0×10^{-9} M is in equilibrium with solid AgCl. What is the concentration of iodide ions?

- A. 2.6×10^{-8} M**
- B. 5.8×10^{-9} M**
- C. 1.5×10^{-16} M**
- D. 7.5×10^{-12} M**
- E. 2.9×10^{-4} M**
- F. None of above**

$$K_{sp} \text{ AgBr} = 5.2 \times 10^{-12}$$

$$K_{sp} \text{ AgI} = 1.5 \times 10^{-16}$$

75. Consider the hydrogen halides HF, HCl, HBr and HI. Which of the statements about them are true?

- A. They all are strong acids**
- B. They all are weak acids**
- C. They all are Lewis bases**
- D. The boiling point increases with molar mass**
- E. The bond dissociation energy increases with molar mass**
- F. None of above**

76. For the reaction below $K_c = 1.0 \times 10^{-20}$.



In an experiment, 1.0 mol each of A, B and C are placed in an empty 1.0 L container and then the container is quickly sealed. When equilibrium is established, which of the following will be true?

- A. $[A] < [B] < [C]$**
- B. $[A] > [B] > [C]$**
- C. $[A] = [B] = [C]$**
- D. $[A] = [B] < [C]$**
- E. $[A] = [B] > [C]$**
- F. None of above**

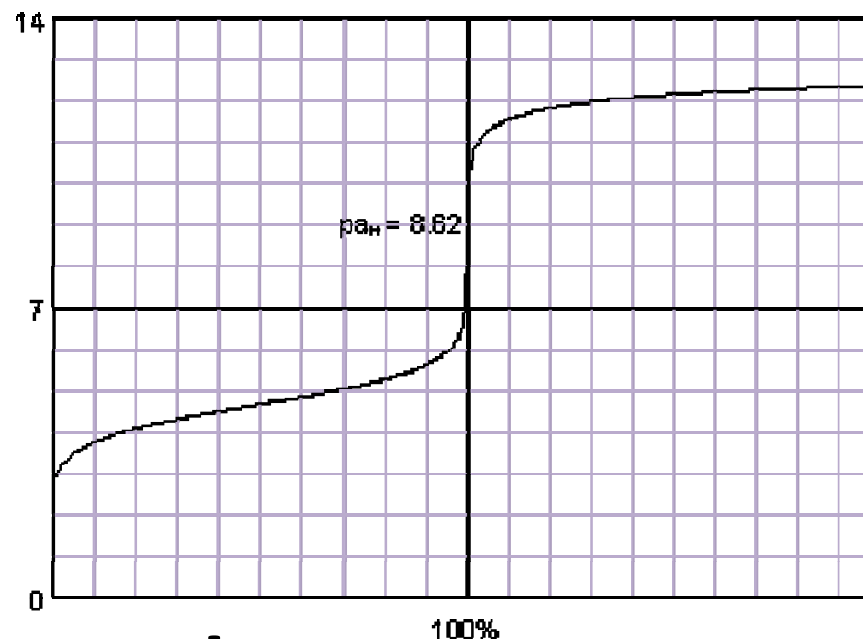
77. What percentage of molecules of acetic acid are ionized in 1.8×10^{-5} M $\text{CH}_3\text{COOH}_{(\text{aq})}$?

$$K_a(\text{CH}_3\text{COOH}) = 1.8 \times 10^{-5}$$

- A. 1.8%**
- B. 4.2%**
- C. 42%**
- D. 62%**
- E. Almost 100%**
- F. Less than 1%**

78. A technician recorded the following curve during a titration.

The curve represents the titration of a:



- A. weak acid with strong base**
- B. Strong acid with weak base**
- C. Strong base with weak acid**
- D. Strong acid with strong base**
- E. Weak base with strong acid**
- F. None of above**

79. Which of the following is the strongest oxidizing agent under standard conditions? Use internet if you need additional information.



80. What is EMF at standard conditions for reaction $2\text{H}_{2(g)} + \text{O}_{2(g)} \rightarrow 2\text{H}_2\text{O}_{(l)}$? Use internet if additional information is necessary.

- A. 1.23 V**
- B. 0.24 V**
- C. 4.06 V**
- D. -0.43V**
- E. 2.06 V**
- F. None of above**

81. Consider ions K^+ , Ca^{2+} , Cl^- and S^{2-} . In which series are the species listed in order of decreasing radius? (from largest to smallest)

- A. $S^{2-} > Cl^- > K^+ > Ca^{2+}$**
- B. $K^+ > Ca^{2+} > S^{2-} > Cl^-$**
- C. $S^{2-} > Ca^{2+} > Cl^- > K^+$**
- D. $Ca^{2+} > K^+ > Cl^- > S^{2-}$**
- E. $Ca^{2+} > K^+ > S^{2-} > Cl^-$**

82. A solution prepared by completely dissolving solid mixture of NaOH and $\text{Mg}(\text{OH})_2$ in water. For the resulting solution, which of the following conditions must be satisfied?

- A. $[\text{Na}^+] = [\text{Mg}^{2+}] = [\text{OH}^-]$**
- B. $[\text{Na}^+] = [\text{Mg}^{2+}] = 3[\text{OH}^-]$**
- C. $[\text{Na}^+] + [\text{Mg}^{2+}] = 3[\text{OH}^-]$**
- D. $[\text{Na}^+] + 2[\text{Mg}^{2+}] = [\text{OH}^-]$**
- E. $[\text{Na}^+] + [\text{Mg}^{2+}] = [\text{OH}^-]$**
- F. None of above**

83. What is the minimum volume of water needed to dissolve completely 1.0 g of SrF_2 ?

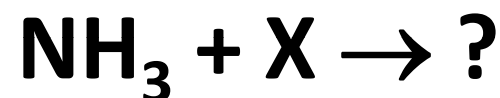
$$K_{\text{sp}}(\text{SrF}_2) = 2.8 \times 10^{-9}$$

- A. 9.0 L**
- B. 150 L**
- C. 10.5 L**
- D. 5.6 L**
- E. 2.8 L**
- F. None of above**

84. What is the molecular geometry of SF₄?

- A. T-shaped**
- B. Tetrahedral**
- C. See-saw**
- D. Square planar**
- E. Square pyramidal**
- F. None of above**

85. In the incomplete equation below, NH_3 acts as Bronsted-Lowry base and “X” represents a Bronsted-Lowry base. What is the conjugate base of NH_3 ?



- A. X
- B. XH^+
- C. NH_4^+
- D. NH_2^-
- E. OH^-
- F. None of above

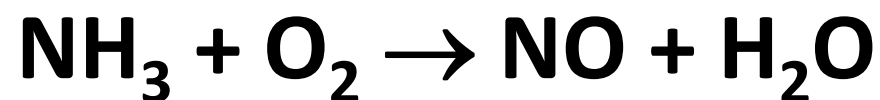
86. What is the hybridization of the sulfur atom in SO_3^{2-} ion?

- A. sp**
- B. sp^2**
- C. sp^3**
- D. sp^3d**
- E. sp_3d^2**
- F. None of above**

87. Consider phase diagram of unidentified substance. Which of the following statements is true?

- A. Liquid can be converted to solid by increasing pressure at constant temperature.**
- B. The melting temperature of solid increases rapidly as pressure decreases.**
- C. Solid cannot be converted into gas without first being converted to liquid.**
- D. There is only one combination of temperature and pressure for which solid, liquid and gas can coexist.**
- E. More than one of the statements above are true.**
- F. None of above**

88. When the following equation is balanced using smallest whole number coefficients, what is the coefficient of O₂?



- A. 1**
- B. 2**
- C. 3**
- D. 4**
- E. 5**
- F. 6**
- G. None of above**

89. What is $[\text{CH}_3\text{COOH}]$ at equilibrium if 0.10 moles of acetic acid and 0.15 moles of NaOH are dissolved in enough water to make 1.0 L of solution at 25°C? For acetic acid CH_3COOH , $K_a = 1.8 \times 10^{-5}$ at 25°C?

- A. 0 M**
- B. 1.8×10^{-5} M**
- C. 5.6×10^{-10} M**
- D. 1.1×10^{-9} M**
- E. 1.3×10^{-3} M**
- F. None of above**

90. Consider structure of benzene C_6H_6 . Which of the following statements concerning the structure of benzene is false?

- A. The double bonds oscillate rapidly back and forth between adjacent pairs of carbon atoms.**
- B. The H-C-C angles are 120° .**
- C. The carbon atoms form a flat hexagonal ring.**
- D. The oxidation state of carbon is -1.**
- E. The carbon-carbon bonds are all the same length.**
- F. None of above**

91. A particular substance X, decomposes such that its concentration decreases by factor of two every 35s. If initial concentration of X was 1.0 M, what is [X] after exactly 140 s?

- A. 0.33 M**
- B. 0.13 M**
- C. 0.25 M**
- D. 0.063 M**
- E. 0.67 M**
- F. None of above**

92. The bond dissociation energies for F_2 and Cl_2 are approximately 158 and 242 kJ/mol, respectively. Given that the enthalpy change for the reaction below is $\Delta H = -54$ kJ/mol, what is the bond dissociation energy for the F-Cl bond?

- A. 200 kJ/mol**
- B. 254 kJ/mol**
- C. 146 kJ/mol**
- D. 454 kJ/mol**
- E. 346 kJ/mol**
- F. None of above**

93. Which of the following has the greatest number of unpaired electrons in its ground state?

A. Al

B. Cl

C. Ti^{2+}

D. Zn^{2+}

E. S^{2-}

F. All particles has all electrons paired

94. Let HA represent a weak monoprotic acid with $K_a = 1.0 \times 10^{-5}$. In an experiment, a 50.0 mL sample of 0.10 M $\text{HA}_{(\text{aq})}$ is titrated with 0.10 M $\text{NaOH}_{(\text{aq})}$. At which point during titration are the equilibrium concentrations of H^+ and OH^- equal?

- A. After addition of 25.0 mL $\text{NaOH}_{(\text{aq})}$**
- B. After addition of slightly less than 50.0 mL of $\text{NaOH}_{(\text{aq})}$**
- C. After addition of 50 mL $\text{NaOH}_{(\text{aq})}$**
- D. After addition of more than 50 mL of $\text{NaOH}_{(\text{aq})}$**
- E. The equilibrium concentrations of H^+ and OH^- are never equal.**
- F. None of above**

95. Which of the following equations id not correct?

- A. $\text{H}_2(\text{g}) \rightarrow 2\text{H}(\text{g}) + \text{energy}$**
- B. $\text{Na}(\text{g}) + \text{e}^- \rightarrow \text{Na}^-(\text{g}) + \text{energy}$**
- C. $\text{Mg}(\text{g}) + \text{energy} \rightarrow \text{Mg}^{2+}(\text{g}) + 2\text{e}^-$**
- D. $\text{Cu}(\text{s}) + \text{energy} \rightarrow \text{Cu}(\text{l})$**
- E. $\text{Na}^+(\text{g}) + \text{energy} \rightarrow \text{Cu}(\text{l})$**
- F. All equations are correct**

96. Which substance, in the solid state, is likely to have the following characteristics: hard; brittle; soluble in water; high melting point?

- A. Cl_2**
- B. RbCl**
- C. $\text{C}(\text{diamond})$**
- D. Cu**
- E. IBr**
- F. None of above**

97. The covalent radius of hydrogen is 74 pm. Assume that hydrogen atoms could be arranged side by side in a single line. What is the mass of line of hydrogen atoms which is 10cm long?

- A. 7.3×10^{-10} g**
- B. 1.1×10^{-15} g**
- C. 2.3×10^{-15} g**
- D. 1.2×10^{-21} g**
- E. 7.4×10^{-11} g**
- F. None of above**

98. In which of the following molecules has the longest bond?

- A. I_2**
- B. IBr**
- C. ICl**
- D. Cl_2**
- E. Br_2**
- F. N_2**

99. Which of the following statements is true?

- A. Silicon conducts electricity better than aluminium**
- B. Sulfur is more electronegative than chlorine**
- C. The +1 oxidation state is common for aluminium, but not for thallium**
- D. The ionic radius of Cl^- is greater than that of S^{2-} .**
- E. The atomic radius of aluminium is greater than that of sodium.**
- F. None of above**

100. Which of the following atoms, in their ground electronic states, does not have a half filled subshell?

- A. H**
- B. Mn**
- C. K**
- D. As**
- E. Ga**
- F. None of above**