2008 U. S. NATIONAL CHEMISTRY OLYMPIAD

NATIONAL EXAM – PART 1

Prepared by the American Chemical Society Olympiad Examinations Task Force

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DIRECTIONS TO THE EXAMINER–PART I

Part I of this test is designed to be taken with a Scantron® answer sheet on which the student records his or her responses. Only this Scantron sheet is graded for a score on **Part I**. Testing materials, scratch paper, and the Scantron sheet should be made available to the student *only* during the examination period. All testing materials including scratch paper should be turned in and kept secure until April 23, 2008, after which tests can be returned to students and their teachers for further study.

Allow time for the student to read the directions, ask questions, and fill in the requested information on the Scantron sheet. The answer sheet must be completed using a pencil, not pen. When the student has completed **Part I**, or after **one hour and thirty minutes** has elapsed, the student must turn in the Scantron sheet, **Part I** of the testing materials, and all scratch paper.

There are three parts to the National Olympiad Examination. You have the option of administering the three parts in any order, and you are free to schedule rest-breaks between parts.

Part I	**60 questions**	**single-answer multiple-choice**	**1 hour, 30 minutes**
Part II	**8 questions**	**problem-solving, explanations**	**1 hour, 45 minutes**
Part III	**2 lab problems**	**laboratory practical**	**1 hour, 30 minutes**

A periodic table and other useful information are provided on page 2 for student reference. Students should be permitted to use non-programmable calculators.

DIRECTIONS TO THE EXAMINEE–PART I

DO NOT TURN THE PAGE UNTIL DIRECTED TO DO SO. Answers to questions in **Part I** must be entered on a Scantron answer sheet to be scored. Be sure to write your name on the answer sheet; an ID number is already entered for you. **Make a record of this ID number because you will use the same number on both Parts II and III.** Each item in **Part I** consists of a question or an incomplete statement that is followed by four possible choices. Select the single choice that best answers the question or completes the statement. Then use a pencil to blacken the space on your answer sheet next to the same letter as your choice. You may write on the examination, but the test booklet will not be used for grading. Scores are based on the number of correct responses. When you complete **Part I** (or at the end of one hour and 30 minutes), you *must* turn in all testing materials, scratch paper, and your Scantron answer sheet. Do not forget to turn in your U.S. citizenship statement before leaving the testing site today.

Not valid for use as an USNCO Olympiad National Exam after April 23, 2008.

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

CONS

R = 8.314 J·mo

R = 0.0821 L·atm·mo

1 F = 96,500 C·mol^{-}

1 F = 96,500 J·V^{-1}·mol^{-1}

$N_A = 6.022 \times 10^{23}$ mol^{-1}

$h = 6.626 \times 10^{-34}$ J·s

$c = 2.998 \times 10^{8}$ m·s^{-1}

0 °C = 273.15 K

1 atm = 760 mmHg

EQUATIONS

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

PERIODIC TABLE OF THE ELEMENTS

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 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											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** (269)	111 **Rg** (272)	112 **Uub** (277)		114 **Uuq** (2??)		116 **Uuh** (2??)		118 **Uuo** (2??)

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)

 Not valid for use as a US National Chemistry Olympiad exam after April 23, 2008.

DIRECTIONS

- When you have selected your answer to each question, blacken the corresponding space on the answer sheet using pencil. Make a heavy, full mark, but no stray marks. If you decide to change an answer, erase the unwanted mark ve
- There is only one correct answer to each question. Any questions for which more than one response has been blackened **be counted**.
- Your score is based solely on the number of questions you answer correctly. **It is to your advantage to answer every question.**

1. Which substance has the highest melting point?

(A) Li_2O **(B)** MgO **(C)** CO_2 **(D)** N_2O_5

2. Which reagents produce a gas when combined?

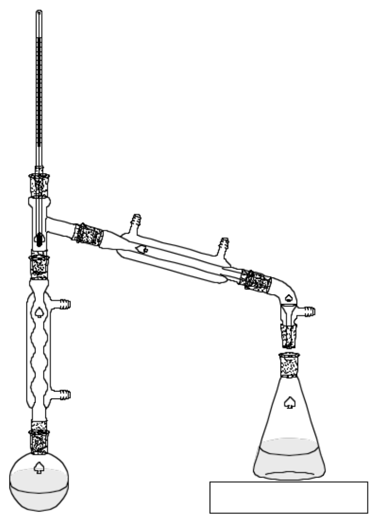
I.	HCl and Na_2SO_3
II.	NaOH and Al

(A) **I** only **(B)** **II** only

(C) Both **I** and **II** **(D)** Neither **I** nor **II**

3. A 1:1 mixture of pentane and hexane is separated by fractional distillation in the apparatus shown. At what temperature does the first drop of condensate appear on the thermometer?

Boiling point / ºC	
pentane	36
hexane	69



(A) less than 36 ˚C **(B)** 36 ˚C

(C) between 36 ˚C and 69 ˚C **(D)** more than 69 ˚C

4. Which nitrogen halide is least stable thermodynamically?

(A) NF_3 **(B)** NCl_3 **(C)** NBr_3 **(D)** NI_3

5. Cyclohexane and water can be separated by using a separatory funnel. Which property contributes to this separation?

(A) Cyclohexane and water are immiscible.

(B) Cyclohexane has a lower viscosity than water.

(C) Cyclohexane has a greater molar mass than water.

(D) Cyclohexane has a greater vapor pressure than water.

6. A NaOH solution is to be standardized by titrating it against a known mass of potassium hydrogen phthalate. Which procedure will give a molarity of NaOH that is too low?

(A) Deliberately weighing one half the recommended amount of potassium hydrogen phthalate.

(B) Dissolving the potassium hydrogen phthalate in more water than is recommended.

(C) Neglecting to fill the tip of the buret with NaOH solution before titrating.

(D) Losing some of the potassium hydrogen phthalate solution from the flask before titrating.

7. Which solute is least soluble in water?

(A) 1-butanol **(B)** ethanol

(C) methanol **(D)** 1-propanol

8. The mass of a single molecule of an allotrope of sulfur is $3.20{\times}10^{-22}$ g. How many sulfur atoms are present in a molecule of this allotrope?

(A) 4 **(B)** 6 **(C)** 8 **(D)** 12

9. 100. L of carbon dioxide measured at 740. mmHg and 50 ˚C is produced by the complete combustion of a sample of pentane.

$$2C_5H_{12} + 16O_2 \rightarrow 10CO_2 + 12H_2O$$

What mass of pentane reacted?

(A) 342 g **(B)** 265 g **(C)** 64.4 g **(D)** 53.0 g

10. Which 0.10 M aqueous solution has the smallest change in freezing point relative to pure water?

(A) $HC_2H_3O_2$ **(B)** HCl

(C) $CaCl_2$ **(D)** $AlCl_3$

11. Magnetite, Fe_3O_4, can be reduced to iron by heating with carbon monoxide according to the equation:

Molar Mass / g·mol^{-1}	
Fe_3O_4	232

$$Fe_3O_4 + 4CO \rightarrow 3Fe + 4CO_2$$

What mass of Fe_3O_4 is required in order to obtain 5.0 kg of iron if the process is 88% efficient?

(A) 6.1 kg **(B)** 6.9 kg **(C)** 7.9 kg **(D)** 18 kg

12. 40.0 g of a solute is dissolved in 500. mL of a solvent to give a solution with a volume of 515 mL. The solvent has a density of 1.00 g/mL. Which statement about this solution is correct?

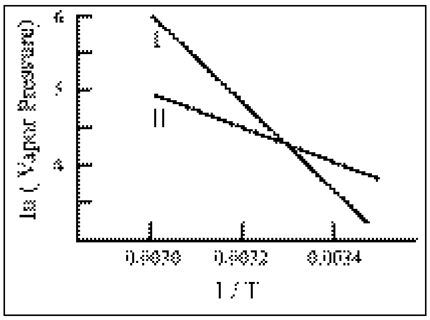
(A) The molarity is greater than the molality.

(B) The molarity is lower than the molality.

(C) The molarity is the same as the molality.

(D) The molarity and molality cannot be compared without knowing the solute.

13. In the graph, the natural log of the vapor pressures of two substances are plotted versus 1/T. What can be concluded about the relative enthalpies of vaporization (ΔH_{vap}) of these substances?



(A) ΔH_{vap} of I is greater than ΔH_{vap} of II

(B) ΔH_{vap} of I is less than ΔH_{vap} of II

(C) ΔH_{vap} of I is is equal to ΔH_{vap} of II

(D) No conclusion can be drawn from this information alone.

14. For which two gases are the rates of effusion 2:1?

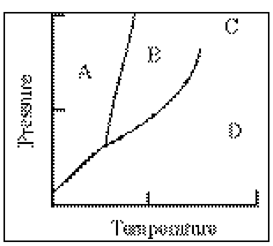
(A) H_2 and He **(B)** He and O_2

(C) Ne and Kr **(D)** N_2 and Ar

15. Which gas has a density of 0.71 g·L^{-1} at 0 ºC and 1 atm?

(A) Ar **(B)** Ne **(C)** CO **(D)** CH_4

16. Supercritical carbon dioxide exists at which point on the accompanying phase diagram?



(A) A **(B)** B **(C)** C **(D)** D

17. Which properties increase with an increase in intermolecular forces at 25 ˚C?

I.	surface tension
II.	vapor pressure

(A) **I** only **(B)** **II** only

(C) Both **I** and **II** **(D)** Neither **I** nor **II**

18. The atoms in crystals of silver metal are cubic closest packed structure. What is the this structure?

(A) body-centered cubic **(B)** face-centered

(C) hexagonal-close packed **(D)** simple cubic

19. Use the information provided to calculate the standard enthalpy of formation of acetylene, $C_2H_2(g)$, in kJ·mol^{-1}.

$C_2H_2(g) + 5/2O_2(g) \rightarrow 2CO_2(g) + H_2O(l)$	$\Delta H^\circ = -1299.5$ kJ
$C(s) + O_2(g) \rightarrow CO_2(g)$	$\Delta H^\circ = -393.5$ kJ
$H_2(g) + 1/2O_2(g) \rightarrow H_2O(l)$	$\Delta H^\circ = -285.8$ kJ

(A) –1978.8 **(B)** –1121.4

(C) 226.7 **(D)** 453.4

20. Which statement is always true for a spontaneous reaction?

(A) The entropy change for the system is negative.

(B) The enthalpy change for the system is negative.

(C) The entropy change for the universe is positive.

(D) The free energy change for the system is positive.

21. The heat of a reaction is measured in a bomb calorimeter. This heat is equal to which thermodynamic quantity?

(A) ΔE **(B)** ΔG **(C)** ΔH **(D)** ΔS

22. 84.12 g of gold at 120.1 ˚C is placed in 106.4 g of H_2O at 21.4 ˚C. What is the final temperature of this system?

Specific heat capacities / J·g^{-1}·°C^{-1}	
Au(s)	0.129
$H_2O(l)$	4.184

(A) 70.8 **(B)** 65.0 **(C)** 27.8 **(D)** 23.7

23. In order to calculate the lattice energy of NaCl using a Born-Haber cycle, which value is not needed?

(A) enthalpy of sublimation of Na(s)

(B) first ionization energy of Cl(g)

(C) bond dissociation energy of $Cl_2(g)$

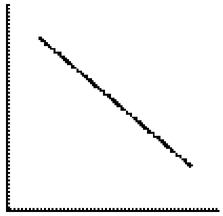
(D) enthalpy of formation of NaCl(s)

24. Liquid bromine boils at 332.7 K. Estimate the enthalpy of formation of $Br_2(g)$ in kJ·mol^{-1}.

S° / J·mol^{-1}·K^{-1}	
$Br_2(g)$	58.6
$Br_2(l)$	36.4

(A) 7.40 **(B)** 12.1 **(C)** 19.5 **(D)** 22.2

25. A student analyzed the data from a zero order reaction and obtained the graph shown. What labels should be attached to the X and Y axes, respectively?



(A) time, concentration **(B)** time, 1 / concentration

(C) time, ln (concentration) **(D)** 1/time, concentration

26. Under certain conditions the reaction of CO with NO_2 to give CO_2 and NO results in the rate law:

$$\text{rate} = k[\text{CO}][\text{NO}_2].$$

What are the units for the rate constant, k?

(A) $\text{mol·L}^{-1}\text{·min}^{-1}$ **(B)** $\text{L·mol}^{-1}\text{·min}^{-1}$

(C) $\text{mol}^2\text{·L}^{-2}\text{·min}^{-1}$ **(D)** $\text{L}^2\text{·mol}^{-2}\text{·min}^{-1}$

27. For the reaction: X + Y → Z, initial rate data are given in the table.

[X] / M	[Y] / M	Rate / $\text{mol·L}^{-1}\text{·s}^{-1}$
0.10	0.10	0.020
0.10	0.20	0.080
0.30	0.30	0.540

What is the rate law for this reaction?

(A) Rate = $k[X]^2$ **(B)** Rate = $k[Y]^2$

(C) Rate = $k[X][Y]$ **(D)** Rate = $k[X][Y]^2$

28. The rate of the reaction of chlorine gas with a liquid hydrocarbon can be increased by all of the changes except one. Which change will be ineffective?

(A) Use UV light to dissociate the Cl_2.

(B) Increase temperature at constant pressure.

(C) Divide the liquid into small droplets.

(D) Double the pressure by adding He gas.

29. One proposed mechanism of the reaction of HBr with O_2 is given here.

$HBr + O_2 \rightarrow HOOBr$	(slow)
$HOOBr + HBr \rightarrow 2HOBr$	(fast)
$HOBr + HBr \rightarrow H_2O + Br_2$	(fast)

What is the equation for the overall reaction?

(A) $HBr + O_2 \rightarrow HOOBr$

(B) $2HBr + O_2 \rightarrow Br_2 + H_2O_2$

(C) $4HBr + O_2 \rightarrow 2H_2O + 2Br_2$

(D) $2HOBr \rightarrow 2H_2O + Br_2$

30. For the reaction; A → B, the rate law i[...]f the reaction is 40.0% complete after 50.0 mi[...] the value of the rate constant, k?

(A) $8.00\times10^{-3}\ \text{min}^{-1}$ **(B)** 1.02×10^{-2} m[...]

(C) $1.39\times10^{-2}\ \text{min}^{-1}$ **(D)** $1.83\times10^{-2}\ \text{min}^{-1}$

31. When 2.00 mol each of $H_2(g)$ and $I_2(g)$ are reacted in a 1.00 L container at a certain temperature, 3.50 mol of HI is present at equilibrium. Calculate the value of the equilibrium constant, K_c.

(A) 3.7 **(B)** 14 **(C)** 56 **(D)** 2.0×10^2

32. For which equation is the equilibrium constant equal to K_a for the ammonium ion, NH_4^+?

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

(B) $NH_4^+(aq) + H_2O(l) \rightleftharpoons NH_3(aq) + H_3O^+(aq)$

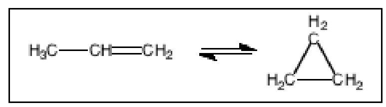
(C) $NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$

(D) $NH_3(aq) + H_3O^+(aq) \rightleftharpoons NH_4^+(aq) + H_2O(l)$

33. What is the pH of a solution prepared by mixing 45.0 mL of 0.184 M KOH with 65.0 mL of 0.145 M HCl?

(A) 1.07 **(B)** 1.13 **(C)** 1.98 **(D)** 2.92

34. The gas phase reaction shown is endothermic as written. Which change(s) will increase the quantity of $CH_3CH{=}CH_2$ at equilibrium?

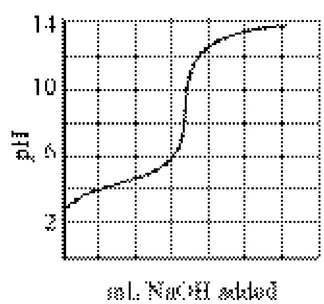


I.	increasing the temperature
II.	increasing the pressure

(A) I only **(B)** II only

(C) Both I and II **(D)** Neither I nor II

35. The curve represents the titration of a weak monoprotic acid. Over what pH range(s) will the acid being titrated serve as a buffer when mixed with its salt?



I.	pH 4 – 6
II.	pH 7 – 9
III.	pH 12 – 13

(A) I only **(B)** II only

(C) I and III only **(D)** I, II and III

36. The pH of a saturated solution of $Fe(OH)_2$ is 8.67. What is the K_{sp} for $Fe(OH)_2$?

(A) 5×10^{-6} **(B)** 2×10^{-11}

(C) 1×10^{-16} **(D)** 5×10^{-17}

37. In an operating voltaic cell electrons move through the external circuit and ions move through the electrolyte solution. Which statement describes these movements?

(A) Electrons and negative ions both move toward the anode.

(B) Electrons and negative ions both move toward the cathode.

(C) Electrons move toward the anode and negative ions move toward the cathode.

(D) Electrons move toward the cathode and negative ions move toward the anode.

38. The reduction potentials for the +2 cations, e.g. $A^{2+} + 2e^- \rightarrow A^o$, of four metals decrease in the order A, B, C, D. Which statement(s) is/are true?

I.	A^o reduces B^{2+}
II.	B^{2+} oxidizes C^o
III.	B^o oxidizes D^o

(A) II only **(B)** III only

(C) I and II only **(D)** I and III only

Questions 39 and 40 should be answered with reference to the reaction:
$2Ag^+(aq) + M(s) \rightarrow M^{2+}(aq) + 2Ag$ $E^\circ = 0.940$ V

39. What is the value of E° for the half reaction, $M^{2+}(aq) + 2e^- \rightarrow M(s)$?

E° / V	
$Ag^+(aq) + e^- \rightarrow Ag(s)$	0.799

(A) 0.658 V **(B)** 0.141 V

(C) –0.141 V **(D)** –0.658 V

40. Which change will cause the largest increase in the voltage of a cell based on the reaction above?

(A) Doubling the $[Ag^+]$ from 1M to 2M

(B) Doubling the amount of M(s)

(C) Doubling the volume of the 1M Ag^+ solution

(D) Reducing the $[M^{2+}]$ from 1M to 0.5M

41. If a voltaic cell has a positive E^o value, what can be concluded about the values of ΔG^o and K_{eq}?

(A) $\Delta G^o < 0, K_{eq} < 1$ **(B)** $\Delta G^o < 0, K_{eq} > 1$

(C) $\Delta G^o > 0, K_{eq} < 1$ **(D)** $\Delta G^o > 0, K_{eq} > 1$

42. A 3.00 amp current is used to electroly chlorides; $CaCl_2$, $MgCl_2$, $AlCl_3$, and FeC deposition of which mass of metal will requ longest electrolysis time?

(A) 100 g Ca **(B)** 50 g Mg

(C) 75 g Al **(D)** 125 g Fe

43. Which set of quantum numbers corresponds to an electron in a 4d orbital?

(A) $n = 4, \ell = 1, m_\ell = -1, m_s = 1/2$

(B) $n = 4, \ell = 2, m_\ell = -2, m_s = -1/2$

(C) $n = 4, \ell = 3, m_\ell = 3, m_s = 1/2$

(D) $n = 4, \ell = 3, m_\ell = -1, m_s = -1/2$

44. What is the energy of a photon from a laser that emits light at 632.8 nm?

(A) 3.14×10^{-19} J **(B)** 1.26×10^{-31} J

(C) 2.52×10^{-33} J **(D)** 4.19×10^{-40} J

45. How many unpaired electrons are in a gaseous Co^{2+} ion in its ground state?

(A) 1 **(B)** 3 **(C)** 5 **(D)** 7

46. Which ion is **not** isoelectronic with Ar?

(A) S^{2-} **(B)** K^+ **(C)** Sc^{2+} **(D)** Ti^{4+}

47. Which process releases the most energy?

(A) $Mg^{2+}(g) + e^- \rightarrow Mg^+(g)$

(B) $Mg^+(g) + e^- \rightarrow Mg(g)$

(C) $Na^{2+}(g) + e^- \rightarrow Na^+(g)$

(D) $Na^+(g) + e^- \rightarrow Na(g)$

48. In which list are the ions arranged in order of increasing size?

(A) $F^- < S^{2-} < Al^{3+} < Mg^{2+}$

(B) $F^- < S^{2-} < Mg^{2+} < Al^{3+}$

(C) $Mg^{2+} < F^- < Al^{3+} < S^{2-}$

(D) $Al^{3+} < Mg^{2+} < F^- < S^{2-}$

49. Molecules with non-zero dipole moments include which of those listed?

I.	H_2C=CHCl
II.	cis - ClHC=CHCl
III.	trans - ClHC=CHCl

(A) I only **(B)** III only

(C) I and II only **(D)** I, II and III

50. Which species is diamagnetic?

(A) NO **(B)** N_2^+ **(C)** O_2 **(D)** O_2^{2-}

51. What is the I-I-I bond angle in the I_3^- ion?

(A) 180° **(B)** 120° **(C)** 90°

(D) more than 90° but less than 120°

52. Which species has the shortest nitrogen-oxygen bond?

(A) NO^+ **(B)** NO_2^+ **(C)** NO_2^- **(D)** NO_3^-

53. Which substance will form hydrogen bonds to water molecules but will not form hydrogen bonds with its own molecules?

(A) HF **(B)** C_2H_5OH

(C) CH_3NH_2 **(D)** CH_3OCH_3

54. In the gas phase PCl_5 exists as individual molecules but in the solid it takes on the ionic structure $PCl_4^+PCl_6^-$. What are the geometries of these three species

	PCl_5	PCl_4^+	PCl_6^-
(A)	trigonal bipyramidal	see-saw	octahedral
(B)	trigonal bipyramidal	tetrahedral	octahedral
(C)	trigonal bipyramidal	square planar	distorted octahedral
(D)	square pyramidal	see-saw	square planar

55. Which molecule contains exactly eight carbon atoms?

(A) benzoic acid **(B)** 2,3-dimethylhexane

(C) 3-ethylpentane **(D)** 3-methyloctane

56. Which formula represents an alkyne? (Assume all are noncyclic.)

(A) C_2H_2 **(B)** C_2H_4 **(C)** C_5H_{10} **(D)** C_8H_{18}

57. How many compounds have the formula $C_2H_3Cl_3$?

(A) 2 **(B)** 3 **(C)** 4 **(D)** 5

58. Which is a condensation polymer?

(A) polyethylene **(B)** polyvinylchloride

(C) polystyrene **(D)** polyethylene terephthalate

59. What is the number of pi (π) bonds in trans-butenedioic acid ($C_4H_4O_4$)?

(A) 1 **(B)** 2 **(C)** 3 **(D)** 4

60. Cellulose and starch are biological po[illegible]s are able to digest starch but not cellulose. Th[illegible] due **primarily** to a difference in the

(A) identity of the monomers in the two polym[illegible]

(B) number of monomer units in the two polymers.

(C) orientation of the bonds joining the monomers.

(D) percentage of carbon in the two polymers.

END OF TEST

Olympiad 2008 National Part I

KEY

Number	Answer	Number	Answer
1.	B	31.	D
2.	C	32.	B
3.	B	33.	C
4.	D	34.	D
5.	A	35.	A
6.	C	36.	D
7.	A	37.	D
8.	B	38.	A
9.	D	39.	C
10.	A	40.	A
11.	C	41.	B
12.	B	42.	C
13.	A	43.	B
14.	C	44.	A
15.	D	45.	B
16.	C	46.	C
17.	A	47.	C
18.	B	48.	D
19.	C	49.	C
20.	C	50.	D
21.	A	51.	A
22.	D	52.	A
23.	B	53.	D
24.	A	54.	B
25.	A	55.	B
26.	B	56.	A
27.	D	57.	A
28.	D	58.	D
29.	C	59.	C
30.	B	60.	C