ACS USNCO
U.S. National Chemistry Olympiad

2026 U.S. NATIONAL CHEMISTRY OLYMPIAD

NATIONAL EXAM PART I

Prepared by the American Chemical Society Chemistry Olympiad Examinations Task Force

OLYMPIAD EXAMINATIONS TASK FORCE

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DIRECTIONS TO THE EXAMINER

The USNCO Subgroup is conducting a survey in an effort to determine the impact of the Olympiad program on students. At the end of the exam there are four questions, which should be answered on the same answer sheet students use for the exam. These questions may be administered after the 90 minutes allotted for the exam; each student should be encouraged to answer these questions.

Part I of this test is designed to be taken with a answer answer sheet on which the student records their responses. Only this answer sheet is graded for a score on Part I. Testing materials, scratch paper, and the answer 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 21, 2026**, after which tests can be returned to students and their teachers for further study.

Allow time for students to read the directions, ask questions, and fill in the requested information on the answer 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 answer sheet, Part I of the testing materials, and all scratch paper.

There are three parts to the National Chemistry 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. The use of a programmable calculator, cell phone, watch, or any other device that can access the internet or make copies or photographs during the exam is grounds for disqualification.

DIRECTIONS TO THE EXAMINEE – DO NOT TURN THE PAGE UNTIL DIRECTED TO DO SO.

Answers to questions in Part I must be entered on an answer sheet to be scored. Be sure to write your name and assigned ID number on the answer sheet. **Make a record of this ID number because you will use the same number on 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.

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

CONSTANTS
$R = 8.314$ J mol^{-1} K^{-1}
$R = 0.08314$ L bar mol^{-1} K^{-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 = 1.013 bar = 760 mm Hg
Specific heat capacity of H_2O = 4.184 J g^{-1} K^{-1}

EQUATIONS

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

PERIODIC TABLE OF THE ELEMENTS

1 1A																	18 8A
1 **H** 1.008	2 **2A**											13 **3A**	14 **4A**	15 **5A**	16 **6A**	17 **7A**	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** 78.97	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** 95.95	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 **Nh** (286)	114 **Fl** (289)	115 **Mc** (289)	116 **Lv** (293)	117 **Ts** (294)	118 **Og** (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)**

DIRECTIONS

- When you have selected your answer to each question, blacken the corresponding space on the answer sheet using a soft, #2 pencil. Make a heavy, full mark, but no stray marks. If you decide to change an answer, erase the unwanted mark very carefully.
- There is only one correct answer to each question. Any questions for which more than one response has been blackened **will not be counted**.
- Your score is based solely on the number of questions you answer correctly. **It is to your advantage to answer every question.**

1. 10.00 g of blue copper sulfate pentahydrate, $CuSO_4 \cdot 5\ H_2O$, is heated strongly to drive off all the water of hydration. How much colorless anhydrous copper sulfate remains?

(A) 1.67 g **(B)** 3.61 g **(C)** 6.39 g **(D)** 8.99 g

2. Ethane reacts with oxygen according to the balanced equation below.

$$2\ C_2H_6(g) + 7\ O_2(g) \rightarrow 4\ CO_2(g) + 6\ H_2O(l)$$

A mixture of ethane and oxygen occupies 22.4 L at STP. The mixture is allowed to react as described above, and the gases then occupy 11.2 L at STP. How many moles of ethane were originally present?

(A) 0.20 mol

(B) 0.30 mol

(C) 0.40 mol

(D) It cannot be determined from the information given.

3. 0.2700 g of a white solid is titrated with 32.70 mL of 0.1834 M NaOH solution to achieve a phenolphthalein endpoint. Which is the molecular formula of the compound?

(A) CHO_2 **(B)** CH_2O_2

(C) $C_2H_2O_4$ **(D)** $C_2H_4O_4$

4. Aqueous sodium hydroxide solutions absorb carbon dioxide both because carbon dioxide has an appreciable solubility in water and because the hydroxide ions react very favorably with excess CO_2 to form bicarbonate ions. A rigid vessel with 10.00 L of headspace contains 1.00 L of 0.100 M NaOH and is maintained at 25 °C. Carbon dioxide is introduced into the headspace at a pressure of 1.33 atm, which decreases to 1.00 atm after absorption into the aqueous NaOH is complete. If the experiment is repeated with an initial CO_2 pressure of 1.50 atm, 1.00 L of what concentration of NaOH would be required to reduce the pressure of CO_2 to 1.00 atm?

(A) 0.112 M **(B)** 0.152 M

(C) 0.169 M **(D)** 0.204 M

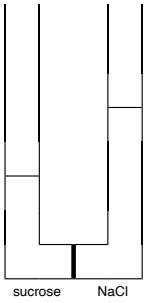
5. What is the concentration of chloride ion in a solution prepared by mixing 0.100 L of 0.100 M LiCl with 0.200 L of 0.200 M $BaCl_2$ and 0.300 L of 0.300 M $CeCl_3$?

(A) 0.200 M **(B)** 0.233 M

(C) 0.467 M **(D)** 0.600 M

6. A U-tube is divided into two compartments by a semipermeable membrane that allows only water to pass through. On the left side of the U-tube is added 10 mL of 0.20 M sucrose solution and on the right side is added 10 mL of 0.15 M sodium chloride solution. Which best represents the appearance of the U-tube after equilibrium is attained?

(A)



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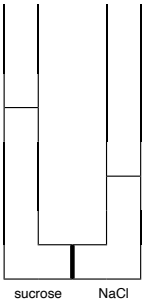

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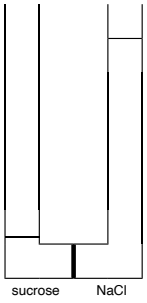

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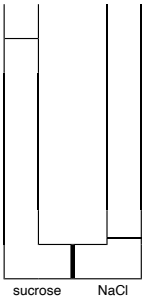


7. A gas mixture extinguishes a glowing splint and does not cause limewater to turn cloudy when bubbled through it. Which most accurately describes the gas mixture?

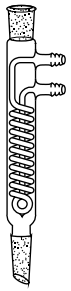
(A) It contains only carbon dioxide.

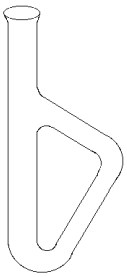
(B) It contains only oxygen.

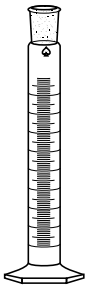
(C) It contains both carbon dioxide and oxygen.

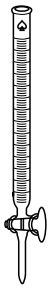
(D) It contains neither carbon dioxide nor oxygen.

8. Which laboratory glassware is most useful for determining the melting point of a solid organic compound?

(A) 

(B) 

(C) 

(D) 

9. Which gas can be condensed to a blue liquid?

(A) Carbon dioxide **(B)** Hydrogen

(C) Nitrogen dioxide **(D)** Ozone

10. Which liquids are miscible in all proportions?

(A) H_2O and CH_2Cl_2 **(B)** H_2O and $(CH_3)_2CO$

(C) C_6H_{12} and Hg **(D)** C_6H_{12} and CH_3OH

11. Which is the best way to prepare 0.5 L of a 1 M solution of sulfuric acid?

(A) 0.5 mol of concentrated sulfuric acid should be added to a 500 mL volumetric flask, followed by enough distilled water to fill the flask to the mark.

(B) 0.5 mol of concentrated sulfuric acid should be added slowly to about 300 mL of distilled water in a 1 L Erlenmeyer flask, then enough distilled water should be added to reach the 500 mL mark on the flask.

(C) 11.2 L of sulfur trioxide gas, measured at STP, should be bubbled through 500 mL of distilled water in a 1 L Erlenmeyer flask.

(D) To 0.5 mol of silver sulfate suspended in about 300 mL water in a 500 mL volumetric flask should be added 1.0 mol HCl (as a concentrated aqueous solution). The solution should be diluted to the mark with distilled water and then filtered to remove precipitated AgCl.

12. A chemist determines the fraction of magnesium that burns in air to make Mg_3N_2 by adding the ash formed from a known mass of Mg ribbon into water, distilling the mixture into a known excess of hydrochloric acid, and back-titrating the excess HCl with NaOH to a methyl orange endpoint. Which error will cause the calculated fraction of magnesium nitride to be too high?

(A) The distillate is collected in a flask by itself and subsequently added to the HCl.

(B) Phenolphthalein is used as an indicator in place of methyl orange.

(C) The potassium hydrogen phthalate used to standardize the NaOH had absorbed some moisture from the air.

(D) When the HCl solution was drawn into the volumetric pipet used to dispense it, a large bubble was present.

13. H_2O has a higher normal boiling point than HF (100 °C vs. 20 °C). Which is the best explanation for this difference?

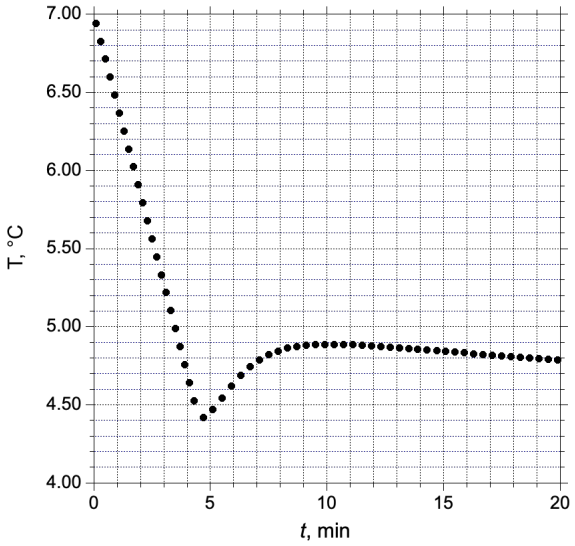
(A) H_2O has a larger dipole moment than HF.

(B) H_2O is more polarizable than HF.

(C) H_2O forms stronger hydrogen bonds than HF.

(D) H_2O forms more hydrogen bonds per mole than HF.

14. A solution of camphor in benzene is cooled slowly to determine its freezing point, resulting in the data shown below. What freezing point should be reported?



(A) 4.38 °C **(B)** 4.78 °C

(C) 4.88 °C **(D)** 4.98 °C

15. The vapor pressure of butane at 0 °C is 1 atm. A 0.100 mol sample of liquid butane at 0 °C is introduced into an evacuated, well-insulated 2.25 L container. Which statements correctly describe the system after it reaches equilibrium?

I. The temperature is lower than 0 °C.

II. All of the butane is in the gas phase.

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

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

16. The triple point of krypton is at 0.73 bar and 116 K. Which is true of a pure sample of Kr at equilibrium at 0.73 bar and 90 K?

(A) Only the gas phase is stable

(B) Only the solid phase is stable

(C) The solid and gas phases coexist

(D) The solid and liquid phases coexist

17. Which statements about relative boiling points are correct?

I. 2-Methylpropane has a higher normal boiling point than butane.

II. 2-Methyl-1-propanol has a higher normal boiling point than 1-butanol.

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

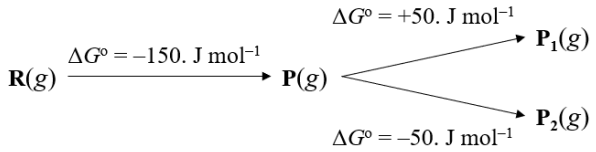
(C) Both I and II **(D)** Neither I nor II

18. Gold crystallizes in a face-centered cubic lattice with a density of 19.31 g cm^{-3}. What is the radius of a gold atom?

(A) 144.1 pm **(B)** 176.5 pm

(C) 203.8 pm **(D)** 288.2 pm

19. Substance **R**(*g*) reacts to form **P**(*g*), which then may isomerize to either $\mathbf{P_1}(g)$ or $\mathbf{P_2}(g)$. The diagram below shows $\Delta G°$ at 25° C.



In an experiment, 10.0 g of **R**(*g*) is placed in a sealed vessel. Which are true at equilibrium?

I. The mass of **R**(*g*) is 0.0 g.

II. The mass of $\mathbf{P_1}(g)$ is less than the mass of $\mathbf{P_2}(g)$.

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

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

20. 60.0 mL of 0.60 M HCOOH and 40.0 mL of 0.80 M CH_3NH_2, both initially at 22.0 °C, are mixed in a well-insulated container. The final temperature is 27.9 °C. What is $\Delta H°_{rxn}$ for the reaction of formic acid and methylamine? Assume that the densities and specific heat capacities of all solutions are the same as pure water.

$$HCOOH(aq) + CH_3NH_2(aq) \rightarrow HCOO^-(aq) + CH_3NH_3^+(aq) \qquad \Delta H°_{rxn} = ???$$

(A) –31 kJ mol^{-1} **(B)** –41 kJ mol^{-1}

(C) –69 kJ mol^{-1} **(D)** –77 kJ mol^{-1}

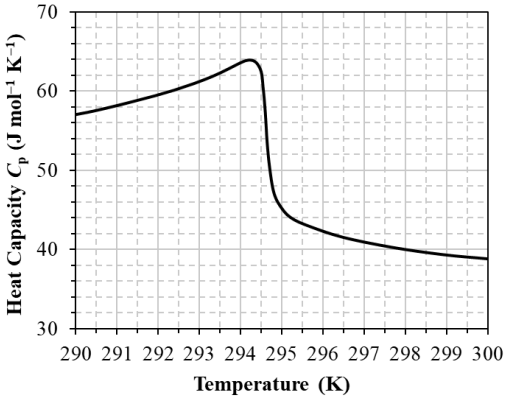
21. What is $S°$ for $O_2(g)$?

Species	$\Delta H°_f$ (kJ mol^{-1})	$S°$ (J mol^{-1} K^{-1})	$\Delta G°_f$, 298 K (kJ mol^{-1})
$H_2O(l)$	–290	70.	–240
$H_2O_2(l)$	–190	110.	–120

(A) 150 J mol^{-1} K^{-1} **(B)** 210 J mol^{-1} K^{-1}

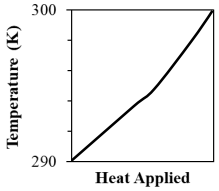
(C) 250 J mol^{-1} K^{-1} **(D)** 290 J mol^{-1} K^{-1}

22. Between 293 K and 295 K, Gd(*s*) transitions from a ferromagnetic to a paramagnetic state, causing a significant variation of the constant-pressure heat capacity with temperature as shown below.

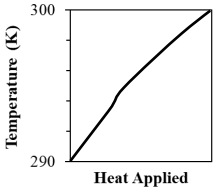


A 10.0 g sample of Gd(s), initially at 290 K, is gradually heated at a constant rate. Which curve best shows how temperature changes?

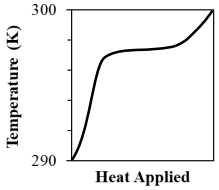
(A)



(B)



(C)



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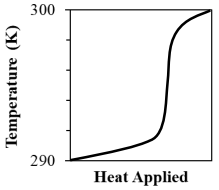


23. Which species has the greatest molar entropy $S°$ at 298 K?

(A) $H_2(g)$ **(B)** $He(g)$

(C) $Cl_2(g)$ **(D)** $Xe(g)$

24. In an adiabatic process, no heat is exchanged with the surroundings. Which must be true in a reversible adiabatic process?

I. $\Delta H = 0$ II. $\Delta S = 0$

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

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

25. The irreversible reaction of a compound A takes place with Rate = $k[A]^n$. The half-life of the reaction is independent of [A]. What is the value of n?

(A) 0

(B) 1

(C) 2

(D) It cannot be determined from the information given.

26. An acid-catalyzed reaction that is first-order in H^+ has a rate of 5.0×10^{-6} M s^{-1} when carried out in a buffer with pH = 5.0. What is the rate when the reaction is carried out with all reactant concentrations the same, but with the pH buffered at 5.5?

(A) 1.6×10^{-6} M s^{-1} **(B)** 4.5×10^{-6} M s^{-1}

(C) 5.5×10^{-6} M s^{-1} **(D)** 1.6×10^{-5} M s^{-1}

27. The decomposition of hydrogen peroxide to form water and oxygen in the presence of an iodide catalyst is studied, and the rate law is found to be Rate = $k[H_2O_2][I^-]$ with $k = 1.05$ M^{-1} min^{-1}. A reaction is carried out with the initial concentrations of both iodide and hydrogen peroxide equal to 0.300 M. What is the concentration of hydrogen peroxide after 5.00 min?

(A) 0.00157 M **(B)** 0.0621 M

(C) 0.117 M **(D)** 0.145 M

28. The temperature dependence of the rate constant for the gas-phase reaction of acrolein with nitrate radical is measured, and the rate constant is found to be $k = (1.72 \times 10^{-13})e^{-1190/T}$, with k in units of cm^3 $molecule^{-1}$ s^{-1} and T in units of K. What is the activation energy of the reaction?

(A) 1.19 kJ mol^{-1} **(B)** 9.89 kJ mol^{-1}

(C) 36.4 kJ mol^{-1} **(D)** 143 kJ mol^{-1}

Questions 29-30 concern the mechanism of acid-catalyzed hydrolysis of methyl formate in aqueous solution shown below:

$$HCO_2CH_3(aq) + H^+(aq) \rightleftharpoons HC(OH)(OCH_3)^+(aq)$$
fast, unfavorable

$$HC(OH)(OCH_3)^+(aq) + H_2O(l) \rightarrow HC(OH)(OH_2)(OCH_3)^+(aq)$$
slow

$$HC(OH)(OH_2)(OCH_3)^+(aq) \rightarrow HC(OH)_2{}^+(aq) + CH_3OH(aq)$$
fast

$$HC(OH)_2{}^+(aq) \rightleftharpoons HCO_2H(aq) + H^+(aq)$$
fast, favorable

29. What rate law is predicted by this mechanism?

(A) Rate = $k[HCO_2CH_3]$

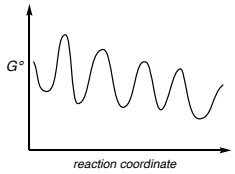
(B) Rate = $k[HCO_2CH_3][H^+]$

(C) Rate = $k[HCO_2CH_3]/[H^+]$

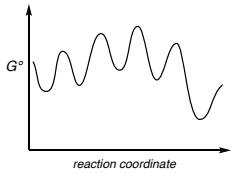
(D) Rate = $k[H^+]$

30. Which reaction coordinate diagram best corresponds to the proposed mechanism?

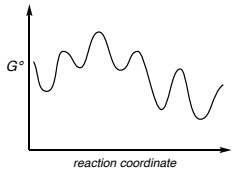
(A)



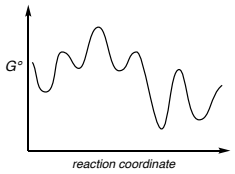
(B)



(C)



(D)



31. How much $NaH_2PO_4 \cdot 2H_2O$ must be added to 400.0 mL of 0.200 M H_3PO_4 to create a buffer solution with pH = 2.30? For H_3PO_4, $pK_{a1} = 2.12$, $pK_{a2} = 7.21$, and $pK_{a3} = 12.38$.

(A) 0.0144 mol **(B)** 0.0529 mol

(C) 0.121 mol **(D)** 0.303 mol

32. Gaseous PCl_5 is introduced into a container whose volume is adjustable. At equilibrium at a certain temperature, 20.0% of the PCl_5 has decomposed at equilibrium to form PCl_3 and Cl_2. Increasing the volume of the container by what factor will increase the percentage of decomposition to 50.0% at equilibrium at this temperature?

(A) 2.50 **(B)** 4.00

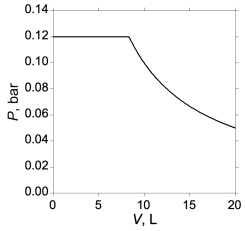
(C) 6.25 **(D)** 10.0

33. Solid calcium carbonate is in equilibrium with calcium oxide and carbon dioxide, with $K_p = 0.12$ bar at 1200 K.

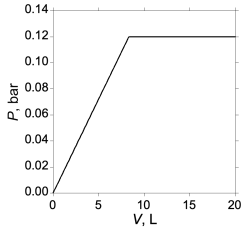
$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ $K_{eq} = 0.12$ at 1200 K

A 1.00 g sample of $CaCO_3$ ($M = 100.09$) is placed in an evacuated piston which is allowed to equilibrate at 1200 K. How will the pressure in the piston after equilibrium is attained depend on the volume of the piston?

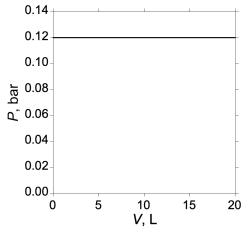
(A)



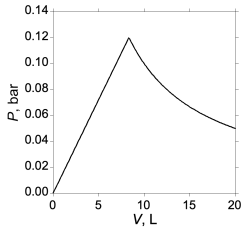
(B)



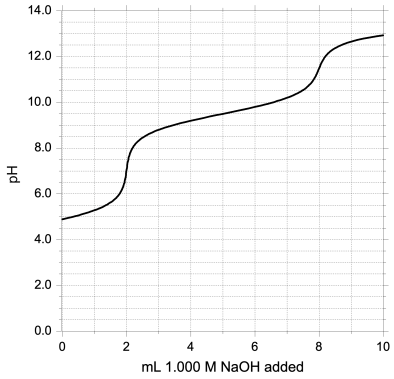
(C)



(D)



34. A mixture of the diprotic acid HOC_6H_4COOH and $Na[HOC_6H_4COO]$ is titrated with sodium hydroxide solution to give these data:



Which statement is correct?

(A) The ratio of $Na[HOC_6H_4COO]$ to HOC_6H_4COOH is 2:1.

(B) The total number of moles of $Na[HOC_6H_4COO]$ and HOC_6H_4COOH combined is 0.008.

(C) The pK_{a1} of HOC_6H_4COOH is 5.3.

(D) The pK_{a2} of HOC_6H_4COOH is 9.2.

35. 0.50 mol of solid silver chloride ($K_{sp} = 1.8 \times 10^{-10}$) is added to 1.0 L of a 0.100 M solution of sodium bromide. What is the concentration of silver ion in solution at equilibrium? The K_{sp} of AgBr is 4.9×10^{-13}.

(A) 4.9×10^{-12} M **(B)** 1.8×10^{-9} M

(C) 7.0×10^{-7} M **(D)** 1.3×10^{-5} M

36. A solution initially is 0.10 M in both Cd^{2+} and Tl^{+} and is kept saturated with hydrogen sulfide gas ($[H_2S] = 0.1$ M). In what pH range will one of the metal ions be precipitated quantitatively (> 99.9%) while the other remains completely in solution?

K_{sp} of CdS = 1.0×10^{-27} K_{sp} of Tl_2S = 6.0×10^{-22}
K_a of H_2S = 8.9×10^{-8} K_a of HS^- = 1.0×10^{-19}

(A) Between 0.5 and 6.8

(B) Between 2.0 and 3.9

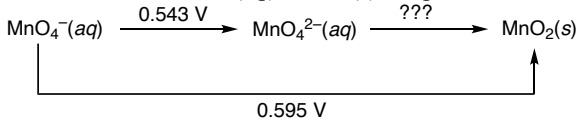
(C) Between 4.0 and 6.8

(D) There is no pH at which this is possible.

37. NO disproportionates into N_2O and NO_2^- in basic solution. When the equation for this reaction is balanced using smallest whole number coefficients, what is the coefficient of NO?

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

38. Given the standard reduction potentials in basic solution shown below, what is the value of the standard reduction potential of the $MnO_4^{2-}(aq)/MnO_2(s)$ couple?



(A) 0.052 V **(B)** 0.569 V

(C) 0.621 V **(D)** 0.647 V

39. For the voltaic cell $Cr|Cr^{3+}$ (1.0 M)$\|Ag^+$ (1.0 M)$|Ag$, which change will cause the cell potential to decrease?

(A) Decreasing the pH of the silver half-cell by adding concentrated nitric acid (assuming a negligible change in volume)

(B) Bubbling $NH_3(g)$ through the silver half-cell (assuming a negligible change in volume)

(C) Adding water to the chromium half-cell

(D) Increasing the size of the silver electrode

40. What is the molar solubility of lead sulfate at 298 K?

Half-reaction	$E°$, V
$Pb^{2+}(aq) + 2\ e^- \rightarrow Pb(s)$	–0.126
$PbSO_4(s) + 2\ e^- \rightarrow Pb(s) + SO_4^{2-}(aq)$	–0.359

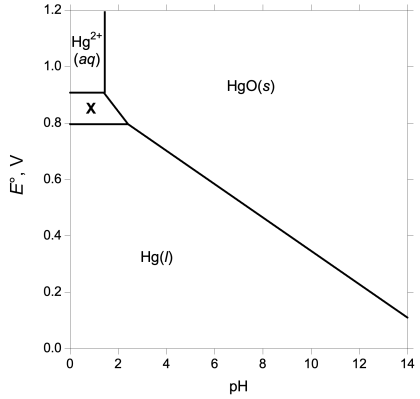
(A) 1.31×10^{-8} mol L^{-1} **(B)** 8.46×10^{-7} mol L^{-1}

(C) 5.46×10^{-5} mol L^{-1} **(D)** 1.14×10^{-4} mol L^{-1}

41. A solution containing a metal ion is electrolyzed, with 1.50 g of the metal being deposited at the cathode. Concurrently, 0.265 L of dry oxygen gas is collected at the anode (measured at STP). What is the metal?

(A) Al **(B)** Cu **(C)** Sn **(D)** U

42. A diagram showing the thermodynamic stability of mercury-containing species as a function of pH and reduction potential (Pourbaix diagram) is shown below. What is **X**?



(A) $Hg_2^{2+}(aq)$ **(B)** $Hg_2O(s)$

(C) $Hg(OH)^+(aq)$ **(D)** $Hg(O)(OH)(s)$

43. In which are the first ionization energies listed in increasing order?

(A) N < O < P < S **(B)** P < S < N < O

(C) P < N < S < O **(D)** S < P < O < N

44. The Balmer series consists of emission lines that correspond to changes in electron configuration of the hydrogen atom from some initial value of the principal quantum number n to a final value of $n = 2$. The longest-wavelength member of the Balmer series has $\lambda = 656$ nm. Which is not a member of the Balmer series?

(A) 410 nm **(B)** 434 nm

(C) 486 nm **(D)** 545 nm

45. The melting points of the group 6 elements increase in the order Cr (2180 °C) < Mo (2896 °C) < W (3695 °C). Which is the best explanation for this trend?

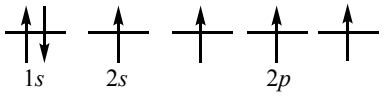
(A) The degree of covalency increases down the group.

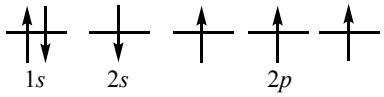
(B) The partial positive charge on the metal atoms in the lattice increases down the group.

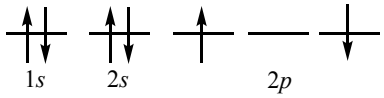
(C) The valence orbitals become increasingly contracted down the group due to relativistic effects.

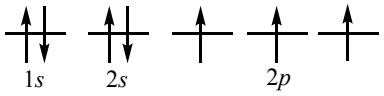
(D) The packing density of the metals increases down the group as the lattice changes from simple cubic to body-centered cubic to face-centered cubic.

46. Which is the best representation of the lowest-energy excited state of a carbon atom?

(A) 

(B) 

(C) 

(D) 

47. Which statements regarding the standard reduction potentials of the group 14 element dioxides XO_2 are correct?

$XO_2 + 4\ H^+(aq) + 4\ e^- \rightarrow X(s) + 2\ H_2O(l)$ $E°(X)$

I. $E°(C) < E°(Si)$ II. $E°(Sn) < E°(Pb)$

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

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

48. By which mode does ^{92}Tc undergo radioactive decay?

(A) α decay **(B)** β^- decay

(C) γ decay **(D)** Positron emission

49. Which gas-phase molecules are linear?

I. CO_2 II. ClO_2

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

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

50. Which best describes the formal charge on nitrogen in Lewis structures of the nitrite ion, NO_2^-?

(A) 0

(B) +1

(C) –1

(D) 0 or –1, depending on the resonance structure

51. Which species have a bond order of 3?

I. CO II. CN^-

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

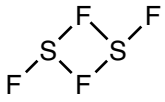
(C) Both I and II **(D)** Neither I nor II

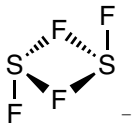
52. How many σ and π bonds are there in a molecule of allene, H_2CCCH_2?

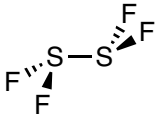
(A) 5 σ, 1 π **(B)** 5 σ, 2 π

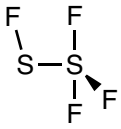
(C) 6 σ, 1 π **(D)** 6 σ, 2 π

53. Which best describes the arrangement of the atoms in space in S_2F_4?

(A) 

(B) 

(C) 

(D) 

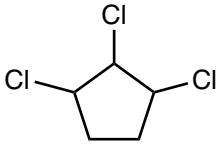
54. Which species have an octahedral geometry?

I. $W(CO)_6$ II. XeF_6

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

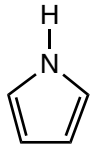
(C) Both I and II **(D)** Neither I nor II

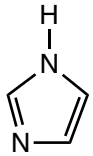
55. How many stereoisomers of 1,2,3-trichlorocyclopentane are possible?

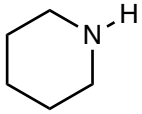


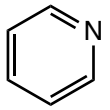
(A) 3 **(B)** 4 **(C)** 6 **(D)** 8

56. Which compound is the weakest base?

(A) 

(B) 

(C) 

(D) 

57. Which reaction of cyclohexene proceeds via a carbocation intermediate?

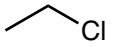
(A) Reaction with HBr in the dark

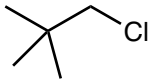
(B) Reaction with HBr in the presence of benzoyl peroxide

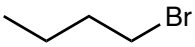
(C) Reaction with Br_2 in methanol solution

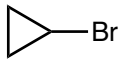
(D) Reaction with Br_2 in carbon tetrachloride under UV illumination

58. Which alkyl halide undergoes nucleophilic substitution by CN^- in acetone at the fastest rate?

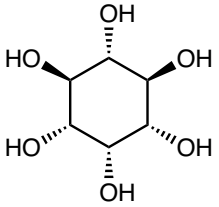
(A) 

(B) 

(C) 

(D) 

59. How many hydroxyl groups are equatorial in the most stable chair conformation of *myo*-inositol?



myo-inositol

(A) 3 **(B)** 4 **(C)** 5 **(D)** 6

60. Which amino acid $H_2NCHRCOOH$ residue is most likely to be found in the interior of a folded globular protein at pH 7 rather than at its surface?

(A) Arginine, R = $CH_2CH_2CH_2NHC(NH)(NH_2)$

(B) Glutamic acid, R = CH_2CH_2COOH

(C) Lysine, R = $CH_2CH_2CH_2CH_2NH_2$

(D) Methionine, R = $CH_2CH_2SCH_3$

END OF TEST

PLEASE ANSWER THE FOLLOWING FOUR QUESTIONS

THANK YOU!

When you have finished answering this examination or time has been called by the Examiner, please provide responses to the following 4 items. Your answers will not affect your score on the exam but will help with a study being conducted by the U.S. National Chemistry Olympiad (USNCO) Subgroup.

61. The amount of time I spend doing experiments in the laboratory per week on average during my chemistry course was/is?

(A) less than ½ hour
(B) between ½ and 1 hour
(C) between 1 and 2 hours
(D) more than 2 hours

Olympiad 2026
USNCO National Exam
KEY

Number	Answer
1.	C
2.	D
3.	C
4.	C
5.	D
6.	A
7.	D
8.	B
9.	D
10.	B
11.	B
12.	D
13.	D
14.	D
15.	A
16.	B
17.	D
18.	A
19.	B
20.	D
21.	B
22.	A
23.	C
24.	B
25.	B
26.	A
27.	B
28.	B
29.	B
30.	C

Number	Answer
31.	C
32.	D
33.	A
34.	A
35.	B
36.	B
37.	C
38.	C
39.	B
40.	D
41.	B
42.	A
43.	D
44.	D
45.	B
46.	C
47.	B
48.	D
49.	A
50.	A
51.	C
52.	D
53.	D
54.	A
55.	B
56.	A
57.	A
58.	C
59.	C
60.	D