Part VI
Practice Test 2

AP® Chemistry Exam

SECTION I: Multiple-Choice Questions

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

At a Glance

Total Time
1 hour and 30 minutes
Number of Questions
60
Percent of Total Grade
50%
Writing Instrument
Pencil required

Instructions

Section I of this examination contains 60 multiple-choice questions. Fill in only the ovals for numbers 1 through 60 on your answer sheet.

CALCULATORS MAY NOT BE USED IN THIS PART OF THE EXAMINATION.

Indicate all of your answers to the multiple-choice questions on the answer sheet. No credit will be given for anything written in this exam booklet, but you may use the booklet for notes or scratch work. After you have decided which of the suggested answers is best, completely fill in the corresponding oval on the answer sheet. Give only one answer to each question. If you change an answer, be sure that the previous mark is erased completely. Here is a sample question and answer.

Sample Question

Chicago is a
(A) state
(B) city
(C) country
(D) continent

Sample Answer

Use your time effectively, working as quickly as you can without losing accuracy. Do not spend too much time on any one question. Go on to other questions and come back to the ones you have not answered if you have time. It is not expected that everyone will know the answers to all the multiple-choice questions.

About Guessing

Many candidates wonder whether or not to guess the answers to questions about which they are not certain. Multiple-choice scores are based on the number of questions answered correctly. Points are not deducted for incorrect answers, and no points are awarded for unanswered questions. Because points are not deducted for incorrect answers, you are encouraged to answer all multiple-choice questions. On any questions you do not know the answer to, you should eliminate as many choices as you can, and then select the best answer among the remaining choices.

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CHEMISTRY
SECTION I
Time—1 hour and 30 minutes

INFORMATION IN THE TABLE BELOW AND ON THE FOLLOWING PAGES MAY BE USEFUL IN ANSWERING THE QUESTIONS IN THIS SECTION OF THE EXAMINATION

DO NOT DETACH FROM BOOK.

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1.008																	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											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** 24.30											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.87	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** 65.38	31 **Ga** 69.72	32 **Ge** 72.63	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** (97)	44 **Ru** 101.1	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 ***La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **†Ac** (227)	104 **Rf** (267)	105 **Db** (270)	106 **Sg** (271)	107 **Bh** (270)	108 **Hs** (277)	109 **Mt** (276)	110 **Ds** (281)	111 **Rg** (282)	112 **Cn** (285)	113 **Uut** (285)	114 **Fl** (289)	115 **Uup** (288)	116 **Lv** (293)	117 **Uus** (294)	118 **Uuo** (294)

*Lanthanide Series:	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
†Actinide Series:	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	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)

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ADVANCED PLACEMENT CHEMISTRY EQUATIONS AND CONSTANTS

Throughout the test the following symbols have the definitions specified unless otherwise noted.

L, mL	= liter(s), milliliter(s)	mm Hg	= millimeters of mercury
g	= gram(s)	J, kJ	= joule(s), kilojoule(s)
nm	= nanometer(s)	V	= volt(s)
atm	= atmosphere(s)	mol	= mole(s)

ATOMIC STRUCTURE

$E = h\nu$

$c = \lambda\nu$

E = energy
ν = frequency
λ = wavelength

Planck's constant, $h = 6.626 \times 10^{-34}$ J s

Speed of light, $c = 2.998 \times 10^{8}$ m s^{-1}

Avogadro's number = 6.022×10^{23} mol^{-1}

Electron charge, $e = -1.602 \times 10^{-19}$ coulomb

EQUILIBRIUM

$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$, where $a\,A + b\,B \rightleftarrows c\,C + d\,D$

$K_p = \frac{(P_C)^c(P_D)^d}{(P_A)^a(P_B)^b}$

$K_a = \frac{[H^+][A^-]}{[HA]}$

$K_b = \frac{[OH^-][HB^+]}{[B]}$

$K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$ at 25°C

$= K_a \times K_b$

$pH = -\log[H^+]$, $pOH = -\log[OH^-]$

$14 = pH + pOH$

$pH = pK_a + \log\frac{[A^-]}{[HA]}$

$pK_a = -\log K_a$, $pK_b = -\log K_b$

Equilibrium Constants

K_c (molar concentrations)
K_p (gas pressures)
K_a (weak acid)
K_b (weak base)
K_w (water)

KINETICS

$\ln[A]_t - \ln[A]_0 = -kt$

$\frac{1}{[A]_t} - \frac{1}{[A]_0} = kt$

$t_{1/2} = \frac{0.693}{k}$

k = rate constant
t = time
$t_{1/2}$ = half-life

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GASES, LIQUIDS, AND SOLUTIONS

$$PV = nRT$$

$$P_A = P_{\text{total}} \times X_A, \text{ where } X_A = \frac{\text{moles A}}{\text{total moles}}$$

$$P_{total} = P_A + P_B + P_C + \ldots$$

$$n = \frac{m}{M}$$

$$\text{K} = \text{°C} + 273$$

$$D = \frac{m}{V}$$

$$KE \text{ per molecule} = \frac{1}{2}mv^2$$

Molarity, M = moles of solute per liter of solution

$$A = abc$$

P = pressure
V = volume
T = temperature
n = number of moles
m = mass
M = molar mass
D = density
KE = kinetic energy
v = velocity
A = absorbance
a = molar absorptivity
b = path length
c = concentration

Gas constant, $R = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$
$= 0.08206 \text{ L atm mol}^{-1}\text{K}^{-1}$
$= 62.36 \text{ L torr mol}^{-1}\text{K}^{-1}$
1 atm = 760 mm Hg
= 760 torr
STP = 273.15 K and 1.0 atm
Ideal gas at STP = 22.4 L mol^{-1}

THERMOCHEMISTRY/ ELECTROCHEMISTRY

$$q = mc\Delta T$$

$$\Delta S^\circ = \sum S^\circ \text{ products} - \sum S^\circ \text{ reactants}$$

$$\Delta H^\circ = \sum \Delta H_f^\circ \text{ products} - \sum \Delta H_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$
$$= -RT \ln K$$
$$= -nFE^\circ$$

$$I = \frac{q}{t}$$

q = heat
m = mass
c = specific heat capacity
T = temperature
S° = standard entropy
H° = standard enthalpy
G° = standard free energy
n = number of moles
E° = standard reduction potential
I = current (amperes)
q = charge (coulombs)
t = time (seconds)

Faraday's constant, F = 96,485 coulombs per mole of electrons

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$

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1. $NH_3(l) \rightarrow NH_3(g)$ $\Delta H_{vap} = 23.9$ kJ/mol

NH_3 has a boiling point of 239 K. Which of the following values would be closest to the entropy of vaporization for NH_3?

(A) 0.100 J/mol × K
(B) 100 J/mol × K
(C) 200 J/mol × K
(D) 260 J/mol × K

2.

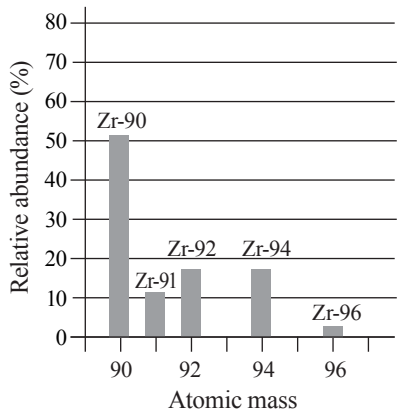
Substance	Boiling Point (°C)
C_6H_6	80.2
C_2H_5OH	78.4

Given the data in the above table, which substance would have a lower vapor pressure at 298 K, and why?

(A) C_6H_6, due to its more polarizable electron cloud
(B) C_6H_6, due to its lack of permanent dipoles
(C) C_2H_5OH, due to its hydrogen bonding
(D) C_2H_5OH, due to the presence of lone pairs on the oxygen

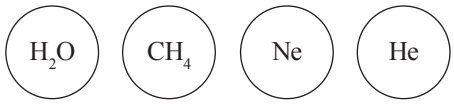
3. Which of the following 1.0 *M* aqueous solutions would experience the highest % ionization?

(A) HClO
(B) $HClO_2$
(C) HBrO
(D) $HBrO_2$



4. Based on the mass spectrum shown above, which of the following can be concluded about zirconium?

(A) The most common charge on a zirconium ion is +2.
(B) Zirconium nuclei can have different number of protons.
(C) The average atomic mass of a zirconium atom is 90 amu.
(D) The most common isotope of zirconium has 50 neutrons.



5. As shown above, four identical containers hold the same number of moles of four different gases at 298 K. If ideal behavior is NOT assumed, in which container would the pressure be the lowest?

(A) H_2O
(B) CH_4
(C) Ne
(D) He

Use the following information to answer questions 6-8.

The below **unbalanced** reaction occurs when a solution of potassium dichromate, $K_2Cr_2O_7$, is titrated into a solution containing aqueous Fe^{2+} ions.

$$\_\_\_\ Fe^{2+}(aq) + Cr_2O_7^{2-}(aq) + 14\ H^+ \rightarrow 7\ H_2O(l) + 2\ Cr^{3+}(aq) + \_\_\_\ Fe^{3+}(aq)$$

6. Which species is being oxidized, and which is being reduced?

	Oxidized	Reduced
(A)	$Cr_2O_7^{2-}$	H^+
(B)	Fe^{2+}	H^+
(C)	$Cr_2O_7^{2-}$	Fe^{2+}
(D)	Fe^{2+}	$Cr_2O_7^{2-}$

7. What must the coefficient in front of the iron on both sides of the reaction be in order to balance the reaction?

(A) 1
(B) 3
(C) 4
(D) 6

8. Which of the following corresponds to the electron configuration for Fe^{3+}?

(A) $[Ar]4s^23d^3$
(B) $[Ar]3d^5$
(C) $[Ar]4s^14d^3$
(D) $[Ar]4s^13d^4$

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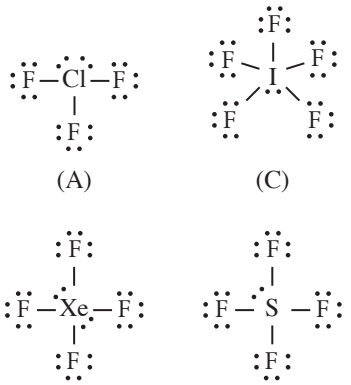
9. Which of the below molecules would have no dipole moment?



Sub-stance	Conductivity as solid	Conductivity as liquid	Conductivity in water
A	High	High	Chemical Reaction Occurs
B	Low	High	High
C	Low	Low	Does not dis-solve
D	Low	Low	Low

10. Data considering the conductivity of four different substances in their various phases is given in the table above. Of the four options, which substance is most likely to be NaCl?

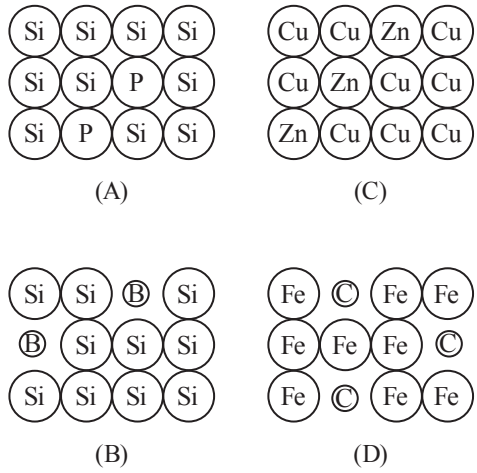
(A) Substance A
(B) Substance B
(C) Substance C
(D) Substance D

Co^{2+} Concentration (*M*)	Absorbance
0	0
0.025	0.13
0.050	0.25
0.075	0.38
0.100	0.50

11. The absorbance of Co^{2+} at several different concentrations was tested, yielding the above data. What is the molar absorptivity value for Co^{2+} under the given conditions if a cuvette with a 1.0 cm path length was used?

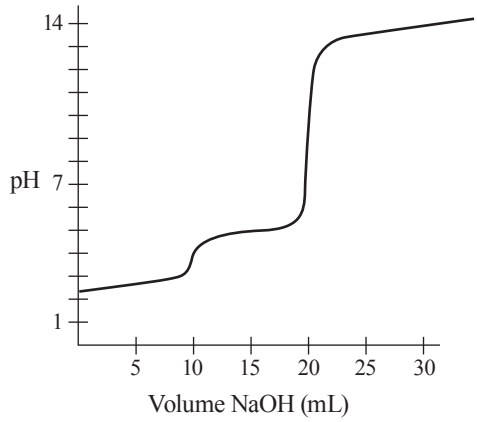
(A) 0.05 $M^{-1}cm^{-1}$
(B) 0.20 $M^{-1}cm^{-1}$
(C) 5.0 $M^{-1}cm^{-1}$
(D) 20.0 $M^{-1}cm^{-1}$

12. Which of the diagrams below most accurately represents a particulate representation of a substance that has undergone n-doping?



Use the following information to answer questions 13-16.

A 0.10 *M* solution of NaOH is titrated into 20 mL of $H_2C_2O_4$, a diprotic acid, of an unknown concentration. The pH of the $H_2C_2O_4$ solution is monitored as the NaOH is added to it, resulting in the below graph.



13. What is the concentration of the $H_2C_2O_4$ solution?

(A) 0.025 *M*
(B) 0.050 *M*
(C) 0.10 *M*
(D) 0.20 *M*

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14. At the point at which 20 mL of NaOH has been added, which of the following species is present in the greatest concentration in solution?

(A) H^+
(B) OH^-
(C) $HC_2O_4^-$
(D) $C_2O_4^{2-}$

15. Phenolphthalein is an acid-base indicator with a pK_a of 9.1. Its protonated form is often abbreviated as HIn, while its conjugate base is abbreviated as In^-. At the following volumes of NaOH added, select the option that accurately describes which form of the indicator will be present in a greater concentration.

	5 mL	**15 mL**	**25 mL**
(A)	HIn	HIn	In^-
(B)	HIn	In^-	In^-
(C)	In^{--}	In^-	HIn
(D)	In^-	HIn	HIn

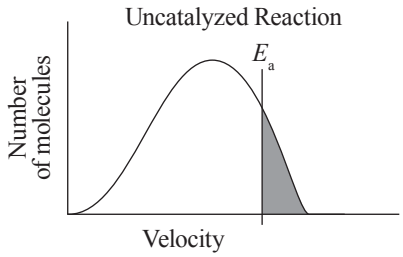
16. If the $H_2C_2O_4$ were to be replaced with an identical volume of H_2SO_4, what volume of NaOH would be required to fully neutralize the acid?

(A) 10 mL
(B) 20 mL
(C) 40 mL
(D) 60 mL

$$2\ Ag^+(aq) + Fe(s) \rightarrow Fe^{2+}(aq) + 2\ Ag(s) \quad E^o_{cell} = +1.24\ V$$

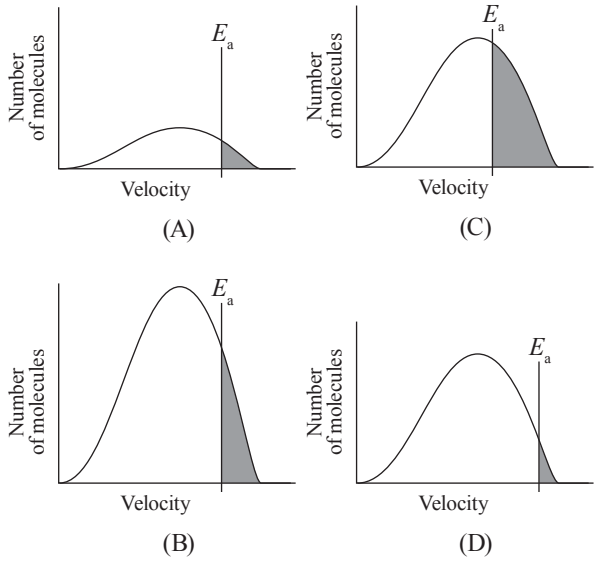
17. The above reaction takes places in a galvanic cell and has a standard reduction potential of +1.24 V at 25°C. Which of the following would decrease the voltage for the cell?

(A) Doubling the mass of the Fe(*s*) electrode
(B) Adding a catalyst
(C) Increasing the concentration of Ag^+
(D) Adding water



$$2\ H_2O_2(aq) \rightarrow 2\ H_2O(l) + O_2(g)$$

18. A sample of H_2O_2 is present in a flask. As time passes, the molecules may collide to form the indicated products. The shaded area under the graph represents the number of effective collisions which create products under standard conditions. Given the energy distributions curve for the uncatalyzed reaction, which curve would best represent the catalyzed reaction?



$$2\ CO(g) + 2\ NO(g) \rightarrow 2\ CO_2(g) + N_2(g)$$

19. CO(*g*) at a partial pressure of 2.0 atm and NO(*g*) at a partial pressure of 1.0 atm are mixed in an evacuated and sealed container where they react via the above equation. What is the total pressure of all gases present in the flask after the reaction goes to completion?

(A) 1.5 atm
(B) 2.5 atm
(C) 3.0 atm
(D) 2.0 atm

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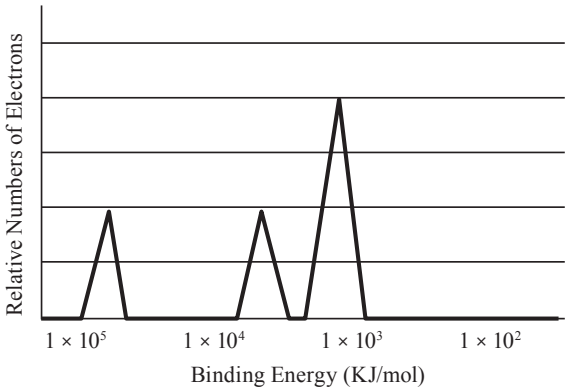
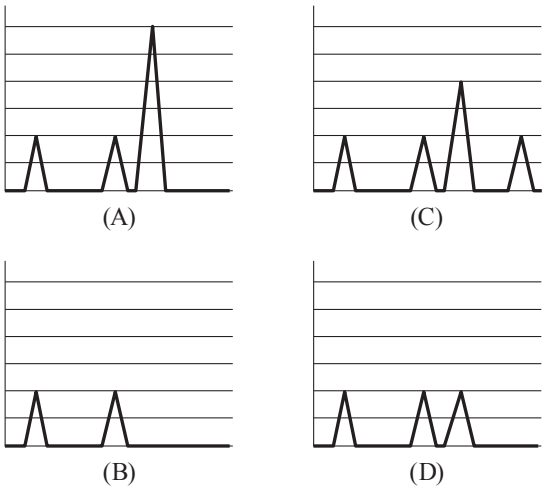


20. The photoelectron spectrum for an oxygen atom is shown above. Which of the diagrams below would be the correct spectrum for the oxide ion (O^{2-})?



21. The bond length between any two nonmetal atoms is achieved under which of the following conditions?

(A) Where the energy of interaction between the atoms is at its minimum value
(B) Where the nuclei of each atom exhibits the strongest attraction to the electrons of the other atom
(C) The point at which the attractive and repulsive forces between the two atoms are equal
(D) The closest point at which a valence electron from one atom can transfer to the other atom

22. Hydrogen fluoride, HF, is a liquid at 15°C. All other hydrogen halides (represented by HX, where X is any other halogen) are gases at the same temperature. Why?

(A) Fluorine has a very high electronegativity; therefore, the H–F bond is stronger than any other H–X bond.
(B) HF is smaller than any other H–X molecule; therefore, it exhibits stronger London dispersion forces.
(C) The dipoles in an HF molecule exhibit a particularly strong attraction force to the dipoles in other HF molecules.
(D) The H–F bond is the most ionic in character compared to all other hydrogen halides.

23.

	Initial pH	pH after NaOH addition
Acid 1	3.0	3.5
Acid 2	3.0	5.0

Two different acids with identical pH are placed in separate beakers. Identical portions of NaOH are added to each beaker, and the resulting pH is indicated in the table above. What can be determined about the strength of each acid?

(A) Acid 1 is a strong acid and acid 2 is a weak acid because acid 1 resists change in pH more effectively.
(B) Acid 1 is a strong acid and acid 2 is a weak acid because the NaOH is more effective at neutralizing acid 2.
(C) Acid 1 is a weak acid and acid 2 is a strong acid because the concentration of the weak acid must be significantly greater to have the same pH as the strong acid.
(D) Acid 1 is a weak acid and acid 2 is a strong acid because the concentration of the hydrogen ions will be greater in acid 2 after the NaOH addition.

24. A stock solution of 12.0 *M* sulfuric acid is made available. What is the best procedure to make up 100.0 mL of 4.0 *M* sulfuric acid using the stock solution and water prior to mixing?

(A) Add 33.3 mL of water to the flask, and then add 66.7 mL of 12.0 *M* acid.
(B) Add 33.3 mL of 12.0 *M* acid to the flask, and then dilute it with 66.7 mL of water.
(C) Add 67.7 mL of 12.0 *M* acid to the flask, and then dilute it with 33.3 mL of water.
(D) Add 67.7 mL of water to the flask, and then add 33.3 mL of 12.0 *M* acid.

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Use the following data to answer questions 25-29.

The enthalpy values for several reactions are as follows:

(I) $CH_4(g) + H_2(g) \rightarrow C(s) + H_2O(g)$
$\Delta H = -131 \text{ kJ/mol}_{rxn}$

(II) $CH_4(g) + H_2O(g) \rightarrow 3H_2(g) + CO(g)$
$\Delta H = 206 \text{ kJ/mol}_{rxn}$

(III) $CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$
$\Delta H = -41 \text{ kJ/mol}_{rxn}$

(IV) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + H_2O(l)$
$\Delta H = -890 \text{ kJ/mol}_{rxn}$

25. In which of the reactions does the amount of energy released by the formation of bonds in the products exceed the amount of energy necessary to break the bonds of the reactants by the greatest amount?

(A) Reaction I
(B) Reaction II
(C) Reaction III
(D) Reaction IV

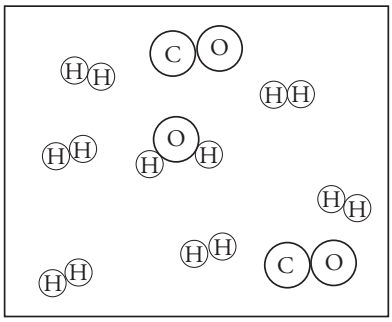
26. In which of the reactions is the value for ΔS the most positive?

(A) Reaction I
(B) Reaction II
(C) Reaction III
(D) Reaction IV

27. Regarding reaction I, how would the addition of a catalyst affect the enthalpy and entropy changes for this reaction?

	Enthalpy	Entropy
(A)	Decrease	Decrease
(B)	Decrease	No Change
(C)	No Change	Decrease
(D)	No Change	No Change

28.



Regarding reaction II, to achieve the products present in the above diagram how many moles of each reactant must be present prior to the reaction?

(A) 1.0 mol of CH_4 and 2.0 mol of H_2O
(B) 2.0 mol of CH_4 and 2.0 mol of H_2O
(C) 2.0 mol of CH_4 and 3.0 mol of H_2O
(D) 3.0 mol of CH_4 and 2.0 mol of H_2O

29. Regarding reaction IV, how much heat is absorbed or released when 2.0 mol of $CH_4(g)$ reacts with 2.0 mol of $O_2(g)$?

(A) 890 kJ of heat is released.
(B) 890 kJ of heat is absorbed.
(C) 1780 kJ of heat is released.
(D) 1780 kJ of heat is absorbed.

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30. London dispersion forces are caused by

(A) temporary dipoles created by the position of electrons around the nuclei in a molecule
(B) the three-dimensional intermolecular bonding present in all covalent substances
(C) the uneven electron-to-proton ratio found on individual atoms of a molecule
(D) the electronegativity differences between the different atoms in a molecule

31. What is the general relationship between temperature and entropy for diatomic gases?

(A) They are completely independent of each other; temperature has no effect on entropy.
(B) There is a direct relationship, because at higher temperatures there is an increase in energy dispersal.
(C) There is an inverse relationship, because at higher temperatures substances are more likely to be in a gaseous state.
(D) It depends on the specific gas and the strength of the intermolecular forces between individual molecules.

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32. Mixing equimolar amounts of which of the following solutions would create a buffer with a pH between 4 and 5?

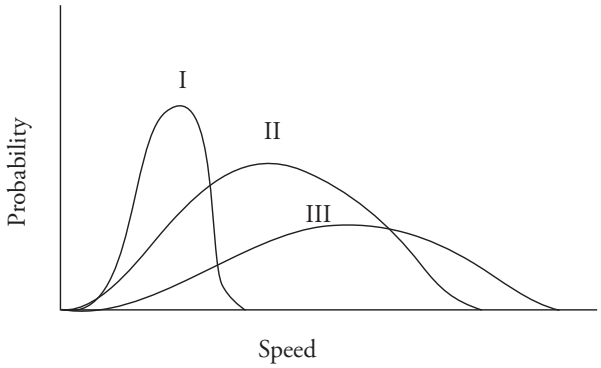
K_a for $HC_3H_2O_2 = 1.75 \times 10^{-5}$
K_a for $HPO_4^{2-} = 4.8 \times 10^{-13}$

(A) H_2SO_4 and H_2PO_4
(B) HPO_4^{2-} and Na_3PO_4
(C) $HC_3H_2O_2$ and $NaC_3H_2O_2$
(D) NaOH and $HC_2H_3O_2$

33. A solution contains a mixture of four different compounds: KCl (*aq*), $Fe(NO_3)_3$ (*aq*), $MgSO_4$ (*aq*), and N_2H_4 (*aq*). Which of these compounds would be easiest to separate via distillation?

(A) KCl (*aq*)
(B) $Fe(NO_3)_3$ (*aq*)
(C) $MgSO_4$ (*aq*)
(D) N_2H_4 (*aq*)

34.



Identify the three gases represented on the Maxwell-Boltzmann diagram above. Assume all gases are at the same temperature.

	I	II	III
(A)	H_2	N_2	F_2
(B)	H_2	F_2	N_2
(C)	F_2	N_2	H_2
(D)	N_2	F_2	H_2

35. A sample of solid $MgCl_2$ would be most soluble in which of the following solutions?

(A) LiOH (*aq*)
(B) CBr_4 (*aq*)
(C) $Mg(NO_3)_2$ (*aq*)
(D) $AlCl_3$ (*aq*)

36. Most transition metals share a common oxidation state of +2. Which of the following best explains why?

(A) Transition metals all have a minimum of two unpaired electrons.
(B) Transition metals have unstable configurations and are very reactive.
(C) Transition metals tend to gain electrons when reacting with other elements.
(D) Transition metals will lose their outermost *s*-block electrons when forming bonds.

37. $2Ag^+(aq) + Fe(s) \rightarrow 2Ag(s) + Fe^{2+}(aq)$

Which of the following would cause an increase in potential in the voltaic cell described by the above reaction?

(A) Increasing $[Fe^{2+}]$
(B) Adding more Fe (*s*)
(C) Decreasing $[Fe^{2+}]$
(D) Removing some Fe (*s*)

Use the following information to answer questions 38-41.

Consider the Lewis structures for the following molecules:

CO_2, CO_3^{2-}, NO_2^-, and NO_3^-

38. Which molecule would have the shortest bonds?

(A) CO_2
(B) CO_3^{2-}
(C) NO_2^-
(D) NO_3^-

39. Which molecules are best represented by multiple resonance structures?

(A) CO_2 and CO_3^{2-}
(B) NO_2^- and NO_3^-
(C) CO_3^{2-} and NO_3^-
(D) CO_3^{2-}, NO_2^-, and NO_3^-

40. Which molecule or molecules exhibit sp^2 hybridization around the central atom?

(A) CO_2 and CO_3^{2-}
(B) NO_2^- and NO_3^-
(C) CO_3^{2-} and NO_3^-
(D) CO_3^{2-}, NO_2^-, and NO_3^-

GO ON TO THE NEXT PAGE.

41. Which molecule would have the smallest bond angle between terminal atoms?

(A) CO_2
(B) CO_3^{2-}
(C) NO_2^-
(D) NO_3^-

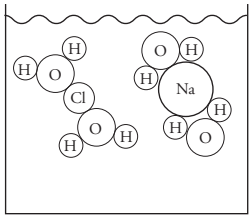
---

42. $NH_4^+(aq) + NO_2^-(aq) \rightarrow N_2(g) + 2H_2O(l)$

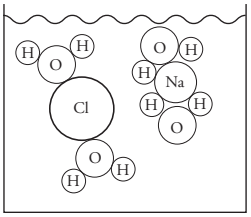
Increasing the temperature of the above reaction will increase the rate of reaction. Which of the following is NOT a reason that increased temperature increases reaction rate?

(A) The reactants will be more likely to overcome the activation energy.
(B) The number of collisions between reactant molecules will increase.
(C) A greater distribution of reactant molecules will have high velocities.
(D) Alternate reaction pathways become available at higher temperatures.

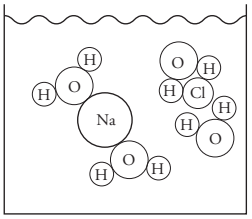
43. Which of the following diagrams best represents what is happening on a molecular level when NaCl dissolves in water?



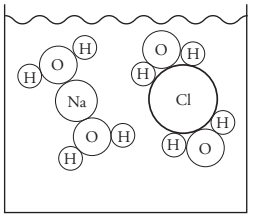
(A)



(C)



(B)



(D)

44. Nitrous acid, HNO_2, has a pK_a value of 3.3. If a solution of nitrous acid is found to have a pH of 4.2, what can be said about the concentration of the conjugate pair found in solution?

(A) $[HNO_2] > [NO_2^-]$
(B) $[NO_2^-] > [HNO_2]$
(C) $[H_2NO_2^+] > [HNO_2]$
(D) $[HNO_2] > [H_2NO_2^+]$

45. Which of the following processes is an irreversible reaction?

(A) $CH_4(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$
(B) $HCN(aq) + H_2O(l) \rightarrow CN^-(aq) + H_3O^+(aq)$
(C) $Al(NO_3)_3(s) \rightarrow Al^{3+}(aq) + 3NO_3^-(aq)$
(D) $2Ag^+(aq) + Ti(s) \rightarrow 2Ag(s) + Ti^{2+}(aq)$

Use the following information to answer questions 46-50.

A sample of H_2S gas is placed in an evacuated, sealed container and heated until the following decomposition reaction occurs at 1000 K:

$2H_2S\,(g) \rightarrow 2H_2\,(g) + S_2\,(g)$ $\qquad K_c = 1.0 \times 10^{-6}$

46. Which of the following represents the equilibrium constant for this reaction?

(A) $K_c = \dfrac{[H_2]^2[S_2]}{[H_2S]^2}$

(B) $K_c = \dfrac{[H_2S]^2}{[H_2]^2[S_2]}$

(C) $K_c = \dfrac{2[H_2][S_2]}{2[H_2S]}$

(D) $K_c = \dfrac{2[H_2S]}{2[H_2][S_2]}$

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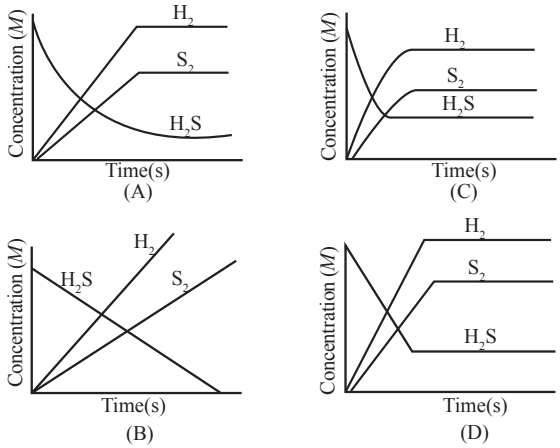
47. Which of the following graphs would best represent the change in concentration of the various species involved in the reaction over time?



48. Which option best describes what will immediately occur to the reaction rates if the pressure on the system is increased after it has reached equilibrium?

(A) The rate of both the forward and reverse reactions will increase.
(B) The rate of the forward reaction will increase while the rate of the reverse reaction decreases.
(C) The rate of the forward reaction will decrease while the rate of the reverse reaction increases.
(D) Neither the rate of the forward reaction nor the rate of the reverse reaction will change.

49. If, at a given point in the reaction, the value for the reaction quotient Q is determined to be 2.5×10^{-8}, which of the following is occurring?

(A) The concentration of the reactant is decreasing while the concentration of the products is increasing.
(B) The concentration of the reactant is increasing while the concentration of the products is decreasing.
(C) The system has passed the equilibrium point, and the concentration of all species involved in the reaction will remain constant.
(D) The concentrations of all species involved are changing at the same rate.

50. As the reaction progresses at a constant temperature of 1000 K, how does the value for the Gibbs free energy constant for the reaction change?

(A) It stays constant.
(B) It increases exponentially.
(C) It increases linearly.
(D) It decreases exponentially.

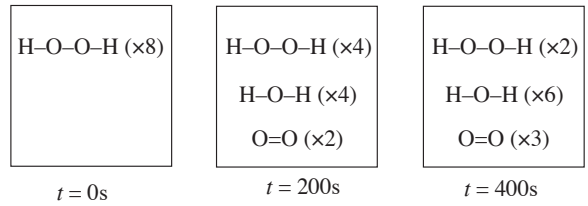
51. An unknown substance is found to have a high melting point. In addition, it is a poor conductor of electricity and does not dissolve in water. The substance most likely contains

(A) ionic bonding
(B) nonpolar covalent bonding
(C) covalent network bonding
(D) metallic bonding

52. Which of the following best explains why the ionization of atoms can occur during photoelectron spectroscopy, even though ionization is not a thermodynamically favored process?

(A) It is an exothermic process due to the release of energy as an electron is liberated from the Coulombic attraction holding it to the nucleus.
(B) The entropy of the system increases due to the separation of the electron from its atom.
(C) Energy contained in the light can be used to overcome the Coulombic attraction between electrons and the nucleus.
(D) The products of the ionization are at a lower energy state than the reactants.

53. $2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g)$



The above diagrams show the decomposition of hydrogen peroxide in a sealed container in the presence of a catalyst. What is the overall order for the reaction?

(A) Zero order
(B) First order
(C) Second order
(D) Third order

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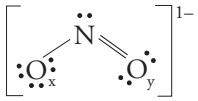
54.



One of the resonance structures for the nitrite ion is shown above. What is the formal charge on each atom?

	O_x	N	O_y
(A)	–1	+1	–1
(B)	+1	–1	0
(C)	0	0	–1
(D)	–1	0	0

Use the following information to answer questions 55-57.

Atoms of four elements are examined: carbon, nitrogen, neon, and sulfur.

55. Atoms of which element would have the strongest magnetic moment?

(A) Carbon
(B) Nitrogen
(C) Neon
(D) Sulfur

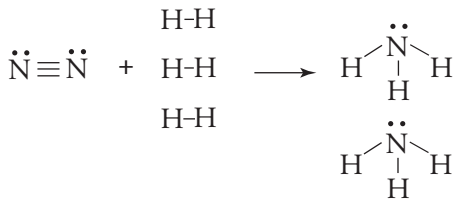
56. Atoms of which element are most likely to form a structure with the formula XF_6 (where X is one of the four atoms)?

(A) Carbon
(B) Nitrogen
(C) Neon
(D) Sulfur

57. Which element would have a photoelectron spectra in which the peak representing electrons with the lowest ionization energy would be three times higher than all other peaks?

(A) Carbon
(B) Nitrogen
(C) Neon
(D) Sulfur

58. The diagram below supports which of the following conclusions about the reaction shown below?



(A) There is an increase in entropy.
(B) Mass is conserved in all chemical reactions.
(C) The pressure increases after the reaction goes to completion.
(D) The enthalpy value is positive.

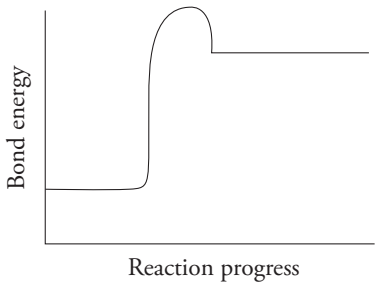
59.

$NO_2 + O_3 \rightarrow NO_3 + O_2$	slow
$NO_3 + NO_2 \rightarrow N_2O_5$	fast

A proposed reaction mechanism for the reaction of nitrogen dioxide and ozone is detailed above. Which of the following is the rate law for the reaction?

(A) Rate = $k[NO_2][O_3]$
(B) Rate = $k[NO_3][NO_2]$
(C) Rate = $k[NO_2]^2[O_3]$
(D) Rate = $k[NO_3][O_2]$

60.



The concentrations of the reactants and products in the reaction represented by the above graph are found to be changing very slowly. Which of the following statements best describes the reaction given that the reaction is exergonic? ($\Delta G < 0$)

(A) The reaction is under kinetic control.
(B) The reaction has reached a state of equilibrium.
(C) The reaction is highly exothermic in nature.
(D) The addition of heat will increase the rate of reaction significantly.

END OF SECTION I

INFORMATION IN THE TABLE BELOW AND ON THE FOLLOWING PAGES MAY BE USEFUL IN ANSWERING THE QUESTIONS IN THIS SECTION OF THE EXAMINATION

DO NOT DETACH FROM BOOK.

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1.008																	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											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** 24.30											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.87	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** 65.38	31 **Ga** 69.72	32 **Ge** 72.63	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** (97)	44 **Ru** 101.1	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 ***La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **†Ac** (227)	104 **Rf** (267)	105 **Db** (270)	106 **Sg** (271)	107 **Bh** (270)	108 **Hs** (277)	109 **Mt** (276)	110 **Ds** (281)	111 **Rg** (282)	112 **Cn** (285)	113 **Uut** (285)	114 **Fl** (289)	115 **Uup** (288)	116 **Lv** (293)	117 **Uus** (294)	118 **Uuo** (294)

*Lanthanide Series:	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
†Actinide Series:	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	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)

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ADVANCED PLACEMENT CHEMISTRY EQUATIONS AND CONSTANTS

Throughout the test the following symbols have the definitions specified unless otherwise noted.

L, mL	= liter(s), milliliter(s)	mm Hg	= millimeters of mercury
g	= gram(s)	J, kJ	= joule(s), kilojoule(s)
nm	= nanometer(s)	V	= volt(s)
atm	= atmosphere(s)	mol	= mole(s)

ATOMIC STRUCTURE

$E = h\nu$

$c = \lambda\nu$

E = energy
ν = frequency
λ = wavelength

Planck's constant, $h = 6.626 \times 10^{-34}$ J s

Speed of light, $c = 2.998 \times 10^{8}$ m s^{-1}

Avogadro's number = 6.022×10^{23} mol^{-1}

Electron charge, $e = -1.602 \times 10^{-19}$ coulomb

EQUILIBRIUM

$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$, where $a\,A + b\,B \rightleftarrows c\,C + d\,D$

$K_p = \frac{(P_C)^c(P_D)^d}{(P_A)^a(P_B)^b}$

$K_a = \frac{[H^+][A^-]}{[HA]}$

$K_b = \frac{[OH^-][HB^+]}{[B]}$

$K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$ at 25°C

$= K_a \times K_b$

$pH = -\log[H^+]$, $pOH = -\log[OH^-]$

$14 = pH + pOH$

$pH = pK_a + \log\frac{[A^-]}{[HA]}$

$pK_a = -\log K_a$, $pK_b = -\log K_b$

Equilibrium Constants

K_c (molar concentrations)
K_p (gas pressures)
K_a (weak acid)
K_b (weak base)
K_w (water)

KINETICS

$\ln[A]_t - \ln[A]_0 = -kt$

$\frac{1}{[A]_t} - \frac{1}{[A]_0} = kt$

$t_{1/2} = \frac{0.693}{k}$

k = rate constant
t = time
$t_{1/2}$ = half-life

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GASES, LIQUIDS, AND SOLUTIONS

$$PV = nRT$$

$$P_A = P_{total} \times X_A, \text{ where } X_A = \frac{\text{moles A}}{\text{total moles}}$$

$$P_{total} = P_A + P_B + P_C + \ldots$$

$$n = \frac{m}{M}$$

$$K = {}^\circ C + 273$$

$$D = \frac{m}{V}$$

$$KE \text{ per molecule} = \frac{1}{2}mv^2$$

Molarity, M = moles of solute per liter of solution

$$A = abc$$

P = pressure
V = volume
T = temperature
n = number of moles
m = mass
M = molar mass
D = density
KE = kinetic energy
v = velocity
A = absorbance
a = molar absorptivity
b = path length
c = concentration

Gas constant, $R = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$
$= 0.08206 \text{ L atm mol}^{-1}\text{K}^{-1}$
$= 62.36 \text{ L torr mol}^{-1}\text{K}^{-1}$
1 atm = 760 mm Hg
= 760 torr
STP = 273.15 K and 1.0 atm
Ideal gas at STP = 22.4 L mol^{-1}

THERMOCHEMISTRY/ ELECTROCHEMISTRY

$$q = mc\Delta T$$

$$\Delta S^\circ = \sum S^\circ \text{ products} - \sum S^\circ \text{ reactants}$$

$$\Delta H^\circ = \sum \Delta H_f^\circ \text{ products} - \sum \Delta H_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$
$$= -RT \ln K$$
$$= -nFE^\circ$$

$$I = \frac{q}{t}$$

q = heat
m = mass
c = specific heat capacity
T = temperature
S° = standard entropy
H° = standard enthalpy
G° = standard free energy
n = number of moles
E° = standard reduction potential
I = current (amperes)
q = charge (coulombs)
t = time (seconds)

Faraday's constant, F = 96,485 coulombs per mole of electrons

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$

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CHEMISTRY

Section II

7 Questions

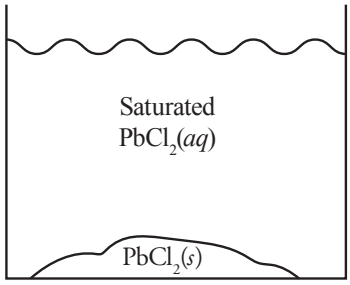
(Total time—1 hour and 45 minutes)

YOU MAY USE YOUR CALCULATOR FOR THIS SECTION.

Directions: Questions 1-3 are long free-response questions that require about 23 minutes each to answer and are worth 10 points each. Questions 4-7 are short free-response questions that require about 9 minutes each to answer and are worth 4 points each.

Write your response in the space provided following each question. Examples and equations may be included in your responses where appropriate. For calculations, clearly show the method used and the steps involved in arriving at your answers. You must show your work to receive credit for your answer. Pay attention to significant figures.

1. 5.00 g of $PbCl_2$ is added to 300 mL of water in a 400 mL beaker, which is then heated for 10 minutes. At the end of the heating period, some solid $PbCl_2$ is still present at the bottom of the beaker, and the solution is cooled to room temperature before being left out overnight.



(a) If 50 mL of water evaporates overnight at constant temperature, what would happen to the following values? Justify your answer.

(i) The concentration of the Pb^{2+} and Cl^- ions in solution

(ii) The mass of $PbCl_2(s)$ on the bottom of the beaker

The next day, 100 mL of the saturated solution is decanted into a separate 250 mL beaker, taking care not to transfer any remaining solid. 100 mL of 0.75 *M* KI solution is added, causing the following precipitation reaction to go to completion.

$$Pb^{2+} + 2I^- \rightarrow PbI_2(s)$$

(b) Given the following equipment, describe how to make up 100 mL of 0.75 *M* KI solution. You need not use all of the equipment listed.

250 mL Earlenmeyer flask	Stir station
50 mL buret	Hot plate
100 mL volumetric flask	Analytical balance
Solid KI	Weigh boats
100 mL graduated cylinder	Filter paper

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The PbI_2 is filtered out, dried, and massed. The mass of the precipitate is found to be 0.747 g.

(c) (i) How many moles of Pb^{2+} are in the PbI_2 precipitate?
(ii) What is the concentration of Pb^{2+} in the saturated solution that was decanted from the beaker?
(iii) Calculate the solubility product constant, K_{sp}, for $PbCl_2$.

(d) If the PbI_2 precipitate was not completely dried, how would that affect your calculated value for the K_{sp} of $PbCl_2$ in (c) (iii)? Justify your answer.

(e) Which salt would have a greater melting point: $PbCl_2$ or PbI_2? Justify your answer.

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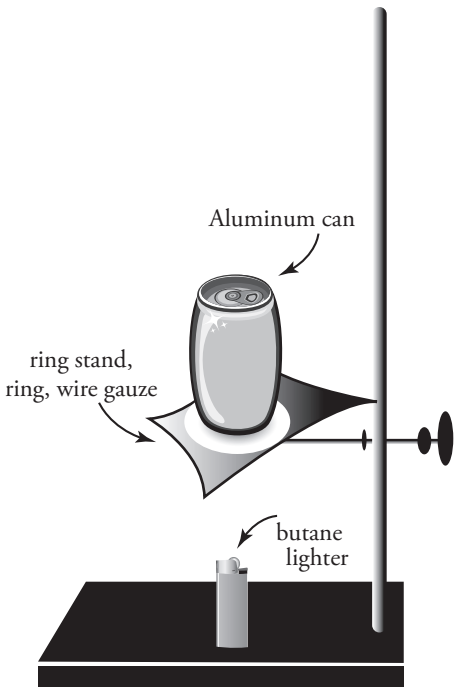

2. A sample of liquid butane (C_4H_{10}) in a pressurized lighter is set up directly beneath an aluminum can, as show in the diagram above. The can contains 100.0 mL of water, and when the butane is ignited, the temperature of the water inside the can increases from 25.0°C to 82.3°C. The total mass of butane ignited is found to be 0.51 g, the specific heat of water is 4.18 J/g·°C, and the density of water is 1.00 g/mL.

   (a) Write the balanced chemical equation for the combustion of one mole of butane in air.

   (b) (i) How much heat did the water gain?
   (ii) What is the experimentally determined heat of combustion for butane based on this experiment? Your answer should be in kJ/mol.

   (c) Given butane's density of 0.573 g/mL at 25°C, calculate how much heat would be emitted if 5.00 mL of it were combusted at that temperature.

   (d) The overall combustion of butane is an exothermic reaction. Explain why this is, in terms of bond energies.

   (e) One of the major sources of error in this experiment comes from the heat that is absorbed by the air. Why, then, might it not be a good idea to perform this experiment inside a sealed container to prevent the heat from leaving the system?

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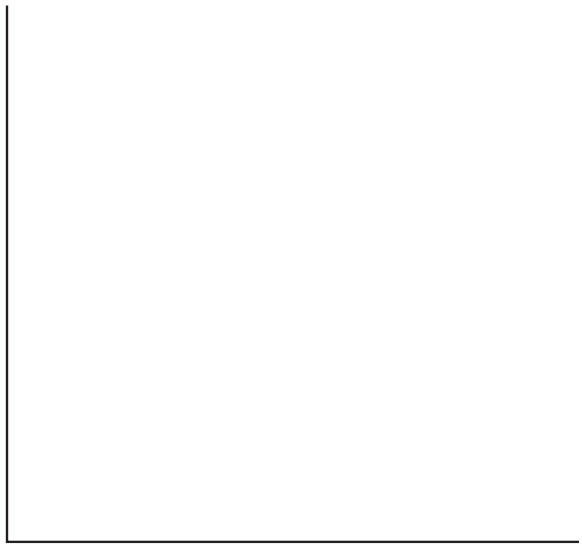
3. $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$

The data below was gathered for the decomposition of N_2O_5 at 310 K via the equation above.

Time (s)	$[N_2O_5]$ (*M*)
0	0.250
500.	0.190
1000.	0.145
2000.	0.085

(a) How does the rate of appearance of NO_2 compare to the rate of disappearance of N_2O_5? Justify your answer.

(b) The reaction is determined to be first order overall. On the axes below, create a graph of some function of concentration vs. time that will produce a straight line. Label and scale your axes appropriately.



(c) (i) What is the rate constant for this reaction? Include units.
(ii) What would the concentration of N_2O_5 be at t = 1500 s?
(iii) What is the half-life of N_2O_5?

(d) Would the addition of a catalyst increase, decrease, or have no effect on the following variables? Justify your answers.
(i) Rate of disappearance of N_2O_5
(ii) Magnitude of the rate constant
(iii) Half-life of N_2O_5

GO ON TO THE NEXT PAGE.

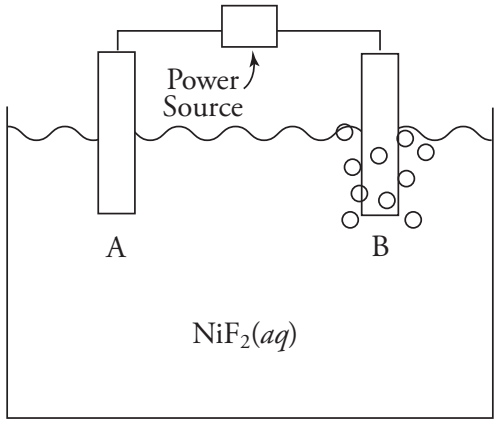
4. A single magnesium atom will be ionized when exposed to energy with a frequency of $1.86 \times 10^{15}\ s^{-1}$.

   (a) What wavelength of light, in nm, would be required to ionize a magnesium atom?

   (b) What is the first ionization energy, in kJ/mol, for magnesium?

   (c) How would the required frequency to ionize an atom of magnesium compare to the required frequency to ionize an atom of sodium? Justify your answer in terms of Coulombic attractions.

5. Current is run through an aqueous solution of nickel (II) fluoride, and a gas is evolved at the right-hand electrode, as indicated by the diagram below:



The standard reduction potential for several reactions is given in the following table:

Half-cell	E^{o}_{red}
$F_2(g) + 2e^- \rightarrow 2F^-$	+2.87 V
$O_2(g) + 4H^+ + 4e^- \rightarrow 2H_2O(l)$	+1.23 V
$Ni^{2+} + 2e^- \rightarrow Ni(s)$	–0.25 V
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-$	–0.83 V

(a) Determine which half-reaction is occurring at each electrode:
   (i) Oxidation
   (ii) Reduction

(b) (i) Calculate the standard cell potential of the cell.
   (ii) Calculate the Gibbs free energy value of the cell at standard conditions.

(c) Which electrode in the diagram (A or B) is the cathode, and which is the anode? Justify your answers.

GO ON TO THE NEXT PAGE.

6. Aniline, $C_6H_5NH_2$, is a weak base with $K_b = 3.8 \times 10^{-10}$.

   (a) Write out the reaction that occurs when aniline reacts with water.

   (b) (i) What is the concentration of each species at equilibrium in a solution of 0.25 *M* $C_6H_5NH_2$?
   (ii) What is the pH value for the solution in (i)?

7. A rigid, sealed 12.00 L container is filled with 10.00 g each of three different gases: CO_2, NO, and NH_3. The temperature of the gases is held constant 35.0°C. Assume ideal behavior for all gases.

   (a) (i) What is the mole fraction of each gas?
   (ii) What is the partial pressure of each gas?

   (b) Out of the three gases, molecules of which gas will have the highest velocity? Why?

   (c) Name one circumstance in which the gases might deviate from ideal behavior, and clearly explain the reason for the deviation.

STOP

END OF EXAM

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Completely darken bubbles with a No. 2 pencil. If you make a mistake, be sure to erase mark completely. Erase all stray marks.

1.

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(Print) Last First M.I.

SIGNATURE: _____ DATE: ___/___/___

HOME ADDRESS: _____
(Print) Number and Street

_____
City State Zip Code

PHONE NO.: _____

IMPORTANT: Please fill in these boxes exactly as shown on the back cover of your test book.

2. TEST FORM

3. TEST CODE

4. REGISTRATION NUMBER

3. TEST CODE					4. REGISTRATION NUMBER					
0	A	J	0	0	0	0	0	0	0	0
1	B	K	1	1	1	1	1	1	1	1
2	C	L	2	2	2	2	2	2	2	2
3	D	M	3	3	3	3	3	3	3	3
4	E	N	4	4	4	4	4	4	4	4
5	F	O	5	5	5	5	5	5	5	5
6	G	P	6	6	6	6	6	6	6	6
7	H	Q	7	7	7	7	7	7	7	7
8	I	R	8	8	8	8	8	8	8	8
9			9	9	9	9	9	9	9	9

6. DATE OF BIRTH

Month	Day		Year	
JAN		0		0
FEB	0	1	0	1
MAR	1	2	1	2
APR	2	3	2	3
MAY	3	4	3	4
JUN		5	4	5
JUL		6	5	6
AUG		7	6	7
SEP		8	7	8
OCT		9	8	9
NOV			9	
DEC				

7. GENDER

- MALE
- FEMALE

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5. YOUR NAME

First 4 letters of last name					FIRST INIT	MID INIT
A	A	A	A		A	A
B	B	B	B		B	B
C	C	C	C		C	C
D	D	D	D		D	D
E	E	E	E		E	E
F	F	F	F		F	F
G	G	G	G		G	G
H	H	H	H		H	H
I	I	I	I		I	I
J	J	J	J		J	J
K	K	K	K		K	K
L	L	L	L		L	L
M	M	M	M		M	M
N	N	N	N		N	N
O	O	O	O		O	O
P	P	P	P		P	P
Q	Q	Q	Q		Q	Q
R	R	R	R		R	R
S	S	S	S		S	S
T	T	T	T		T	T
U	U	U	U		U	U
V	V	V	V		V	V
W	W	W	W		W	W
X	X	X	X		X	X
Y	Y	Y	Y		Y	Y
Z	Z	Z	Z		Z	Z

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