Practice Exam

Questions on Days 19 and 20 make up a full AP exam practice.
It is highly recommended that you create an ideal testing conditions, and try to do all the questions on the same day. Follow the time limit allowed for each section, and use only Reference Materials that is allowed for each section.

Once done grading and scoring questions for both days, use the Scoring Worksheet below to determine your AP score. The Scoring Worksheet is based on the new format of determining AP score. The biggest change in scoring is in the multiple choice section. In the past, points were deducted for each incorrect answer, and the total score for this section was based on the number of correct answers minus fraction of a point for each incorrect answer. In the new scoring format, the total score in the multiple choice section is strictly based on the total number of correct answers out of a possible 75.

Practice Exam Scoring Worksheet:

Day 19: Section I: Multiple-Choice

_____ x 1.000 = _____

number correct (out of 75) — Weighted Section I Score

Day 20: Section II: Free Response Part A and B

Question 1: _____ x 1.665 = _____
Question 2: _____ x 1.500 = _____
Question 3: _____ x 1.665 = _____
Question 4: _____ x 0.500 = _____
Question 5: _____ x 1.250 = _____
Question 6: _____ x 1.315 = _____

Sum = _____

Weighted Section II score

AP score conversion chart:

Composite score range	Practice Exam AP Score
100 – 150	5
81 – 99	4
62 – 80	3
49 – 61	2
0 – 48	1

Composite Score

_____ + _____ = _____

Weighted Section I Score + Weighted Section II Score = Composite Score

Day 19: Practice Exam - Section 1

Section I: Multiple-Choice Questions

Time: 90 minutes

75 questions (75 points)

No calculators allowed
Use ONLY the Periodic Table Provided on page 337.

This section consists of 75 multiple-choice questions. Mark your answers carefully on the answer sheet.

General Instructions

Do not open this booklet until you are told to do so by the proctor. Be sure to write your answers for Section I on the separate answer sheet. Use the test booklet for your scratch work or notes, but remember that no credit will be given for work, notes, or answers written only in the test booklet. After you have selected an answer, blacken thoroughly the corresponding circle on the answer sheet. To change an answer, erase your previous mark completely, and then record your new answer. Mark only one answer for each question.

Example

Europe is
(A) a country
(B) a state
(C) a continent
(D) a city
(E) an hemisphere

Sample Answer

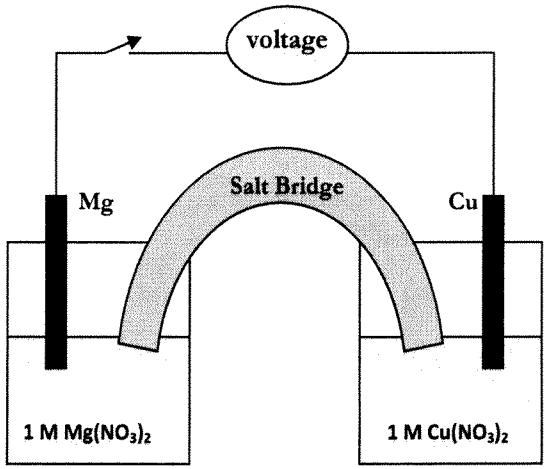
Because it is not expected that all test takers will complete this section, do not spend too much time on difficult questions. Answer first the questions you can answer readily, and then, if you have time, return to the difficult questions later. Don't get stuck on one question. Work quickly but accurately. Use your time effectively. The preceding table on page 337 is provided for your use in answering questions in Section I.

Day 19: Practice Exam Answer Sheet for the Multiple Choice

1. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	51. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	26. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
2. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	52. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	27. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
3. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	53. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	28. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
4. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	54. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	29. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
5. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	55. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	30. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
6. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	56. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	31. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
7. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	57. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	32. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
8. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	58. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	33. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
9. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	59. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	34. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
10. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	60. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	35. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
11. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	61. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	36. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
12. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	62. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	37. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
13. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	63. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	38. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
14. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	64. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	39. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
15. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	65. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	40. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
16. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	66. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	41. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
17. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	67. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	42. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
18. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	68. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	43. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
19. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	69. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	44. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
20. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	70. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	45. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
21. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	71. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	46. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
22. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	72. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	47. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
23. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	73. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	48. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
24. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	74. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	49. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
25. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	75. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	50. Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ

Day 19: Practice Exam Section 1

Questions 1 through 4 refer to the diagram below:
The spontaneous reaction that occurs when the cell operates is given below the diagram.



Cu^{2+} + Mg(s) ------ > Cu(s) + Mg^{2+}

(A) Voltage increases.
(B) Voltage decreases.
(C) Voltage becomes zero and remains at zero.
(D) No change in voltage occurs.
(E) Direction of voltage change cannot be predicted without additional information.

Which of the above occurs for each of the following circumstances?

1. A 50-milliliter sample of a 2-molar NaCl solution is added to the right beaker.

2. The salt bridge is removed.

3. 100 mL of water is added to the beaker on the left.

4. Current is allowed to flow for 10 minutes.

Questions 5 through 8 refer to aqueous solutions containing 1:1 mole ratios of the following pairs of substances. Assume all concentrations are 1 M.

(A) sodium hydroxide and ammonia
(B) sodium hydroxide and hydrochloric acid
(C) hydrobromic acid and potassium bromide
(D) acetic acid and sodium acetate
(E) methylamine and methylammonium chloride

5. A buffer with a pH less than 7

6. A buffer with a pH greater than 7

7. The solution with a pH of 7

8. The solution with the highest pH

Questions 9 through 13 refer to the following list of geometries:

(A) Linear
(B) Bent
(C) Trigonal planar
(D) Tetrahedral
(E) Trigonal bipyramidal

9. Characteristic of four electron pairs, two bonding and two nonbonding

10. Typical of *sp* hybridization

11. Accounts for the nonpolarity of SiF_4

12. Nitrate anion

13. PCl_5

Day 19: Practice Exam Section 1

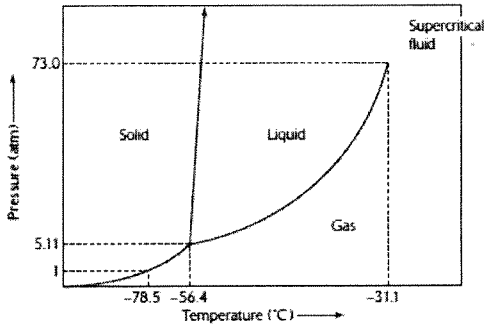
Questions 14 through 17

The choices listed below refer to n, the number of moles of electrons transferred in a reaction

(A) n = 0
(B) n = 1
(C) n = 2
(D) n = 3
(E) n = 4

14. $2Fe^{3+} + Mg \text{ ----> } 2Fe^{2+} + Mg^{2+}$
15. $F_2 + 2Br^- \text{ -----> } 2F^- + Br_2$
16. $NH_3 + H_2O \text{ ----> } NH_4^+ + OH^-$
17. $MnO_4^- + Cr + 2H_2O \text{ ----> } MnO_2 + Cr^{3+} + 4OH^-$

Questions 18 through 20 *refer to the phase diagram below*



(A) –78.5°C
(B) –56.4°C, 5.11 atm
(C) – 31.1°C, 73.0 atm
(D) 31.1°C
(E) none of the above

18. What does the phase diagram above show to be the normal boiling point of carbon dioxide?

19. Which point represents the critical point?

20. Which point represents the triple point?

21. Which of the following compounds is least likely to form?

(A) $Na_2Cr_7O_2$
(B) $LiC_2H_3O_2$
(C) K_2CN
(D) $Rb_2C_2O_4$
(E) HNO_2

22. A hydrocarbon gas with an empirical formula CH_2 has a density of 1.3 grams per liter at 0°C and 1.00 atmosphere. A possible formula for the hydrocarbon is

(A) CH_2
(B) C_2H_4
(C) C_3H_6
(D) C_4H_8
(E) C_5H_{10}

23. A sample is confined in a 5-liter container. Which of the following will occur if the temperature of the container is increased?

I. The kinetic energy of the gas will increase
II. The pressure of the gas will increase
III. The density of the gas will increase

(A) I only
(B) II only
(C) I and II only
(D) I and III only
(E) I, II, III

24. The AsF_5 molecule has a trigonal bypyramidal structure. Therefore, the hybridization of As orbitals will be

(A) sp^2
(B) sp^3
(C) sp^2d
(D) sp^3d
(E) sp^3d^2

Day 19: Practice Exam Section 1

25. 1.0 mole of four different compounds containing element X were analyzed and found to contain 36.0 grams, 54.0 grams, 72.0 grams, and 108 grams, respectively. A possible atomic weight of X is

(A) 13.5
(B) 18.0
(C) 25.0
(D) 72.0
(E) 108

26. The proposed steps for a catalyzed reaction between X^{4+} and Z^+ are represented below.

Step 1: $X^{4+} + Y^{2+} \text{ -------- > } X^{3+} + Y^{3+}$
Step 2: $X^{4+} + Y^{3+} \text{ --------- > } X^{3+} + Y^{4+}$
Step 3: $Y^{4+} + Z^+ \text{ ---------- > } Z^{3+} + Y^{2+}$

The catalyst in this process is

(A) X^{4+}
(B) X^{3+}
(C) Y^{4+}
(D) Y^{2+}
(E) Z^+

27. Pressure cookers are used at high altitudes to cook food faster. Which of the following statements pertaining to this fact is true?

(A) The cooker holds water at a constant pressure at a higher atmosphere, resulting in hotter water
(B) The cooker lowers the pressure on the water causing it to boil at a higher temperature, allowing for hotter water
(C) The cooker raises the pressure on the water causing it to boil at a higher temperature, allowing for hotter water
(D) The cooker forces the water to contain higher concentration of dissolved gases, allowing for hotter water.
(E) The cooker forces the water to maintain constant density, allowing for hotter water

28. The net ionic equation for the reaction that occurs during the titration of chlorous acid with potassium hydroxide is

(A) $H^+ + OH^- \text{ -----> } H_2O$
(B) $HClO_2 + K^+ + OH^- \text{ ------> } KClO_2 + H_2O$
(C) $HClO_2 + OH^- \text{ --------> } ClO_2^- + H_2O$
(D) $HClO_2 + H_2O \text{ -----> } ClO_2^- + H_3O+$
(E) $HClO_2 + KOH \text{ -------> } K^+ + ClO_2^- + H_2O$

29. A mixture of nitrogen, hydrogen and ammonia gases are in a sealed container and are at equilibrium. Which of the following changes will affect the reaction quotient (Q_c) but not affect the equilibrium constant (K_c)?

(1) addition of argon to the system
(2) addition of a catalyst
(3) decrease the size of the sealed container
(4) add more hydrogen and nitrogen gases
(5) increase the temperature

(A) 1 and 2
(B) 2 and 3
(C) 1 and 3
(D) 3 and 4
(E) all of them

30. What is the boiling point of a 2 *m* solution of NaCl in water? (The boiling point elevation constant, k_f, for water is 0.5°C/m?

(A) 100°C
(B) 101°C
(C) 102°C
(D) 103°C
(E) 104°C

31. You study the following reaction: $W + X \text{ ----> } ZY + 2Z$

You vary the concentration of reactants W and X, and observe the resulting rates:

Experiment	*[W]* *(M)*	*[X]* *(M)*	*Rate* *(M/s)*
1	2.7×10^{-2}	2.7×10^{-2}	4.8×10^{6}
2	2.7×10^{-2}	5.4×10^{-2}	9.6×10^{6}
3	5.4×10^{-2}	2.7×10^{-2}	9.6×10^{6}

At what rate will the reaction occur in the presence of 1.3×10^{-2} *M* reactant W and 9.2×10^{-3} *M* reactant X?

(A) 7.9×10^{5} *M* /s
(B) 1.2×10^{-4} *M* /s
(C) 6.6×10^{9} *M* /s
(D) 8.6×10^{7} *M* /s
(E) 6.1×10^{7} *M/s*

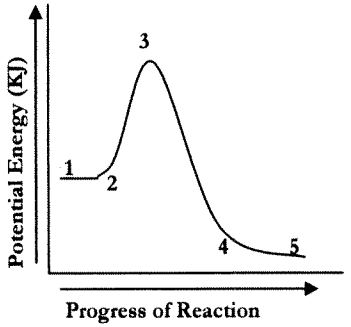
32. Element iodine (I_2) is more soluble in carbon tetrachloride (CCl_4) than it is in water (H_2). Which of the following statement is the best explanation for this?

(A) I_2 is closer in molecular weight to CCl_4 than it is to H_2O.
(B) The freezing point of I_2 is closer to that of CCl_4 than it is to that of H_2O.
(C) I_2 and CCl_4 are nonpolar molecules, while H_2O is a polar molecule.
(D) The heat of formation of I_2 is closer to that of CCl_4 than it is to that of H_2O.
(E) CCl_4 has a greater molecular weight than does H_2O.

33. If 87.5 percent of a sample of pure Rh-99 decays in 48 days, what is the half life of Rh-99?

(A) 6 days
(B) 8 days
(C) 12 days
(D) 16 days
(E) 24 days

34. Which point on the graph below corresponds to activated complex or transitional state?



(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

35.Each of the following can act as both a Brönsted acid and a Brönsted base EXCEPT

(A) HSO_3^-
(B) HPO_4^{2-}
(C) NH_4^+
(D) H_2O
(E) HCO_3^-

36. For a substance that remains a gas under the conditions listed, deviation from the ideal gas law would be most pronounced at

(A) –100°C and 5 atm
(B) –100°C and 1.0 atm
(C) 0°C and 1.0 atm
(D) 100°C and 1.0 atm
(E) 100°C and 5.0 atm

37. One of the outermost electrons in a calcium atom in the ground state can be described by which of the following sets of four quantum numbers?

(A) 4, 2, 0, ½
(B) 4, 1, 1, ½
(C) 4, 1, 0, ½
(D) 4, 0, 1, ½
(E) 4, 0, 0, ½

38. A 0.25M solution has an [H+] of 4.2×10^{-6} M. What is its pH?

(A) 5.00
(B) 5.37
(C) 6.00
(D) 6.27
(E) 7.00

39. A study was made of the effect of the hydroxide concentration on the rate of the reaction

$$I^-(aq) + OCl^-(aq) \text{ ----- > } IO^-(aq) + Cl^-(aq)$$

The experimental rate law of the reaction is determined to be:

$$\text{Rate} = k[I^-][OCl^-][OH^-]$$

According to the rate law for the reaction, an increase in the concentration of hydroxide ion has what effect on this reaction?

(A) The rate of reaction increases.
(B) The rate of reaction decreases.
(C) The value of the equilibrium constant increases.
(D) The value of the equilibrium constant decreases.
(E) Neither the rate nor the value of the equilibrium constant is changed.

40. A chemist analyzed the C – C bond in C_2H_6 and found that it had a bond energy of 350 KJ/mol and a bond length of 1.5 angstroms. If the chemist performed the same analysis on the C – C bond in C_2H_2 how would the results compare?

(A) The bond energies and the lengths for C_2H_2 would be the same as those of C_2H_6
B) The bond energies for C_2H_2 would be smaller, and the bond length would be shorter.
C) The bond energies for C_2H_2 would be greater, and the bond length would be longer.
D) The bond energies for C_2H_2 would be smaller, and the bond length would be longer.
E) The bond energies for C_2H_2 would be greater, and the bond length would be shorter.

41. A 1.0 L sample of an aqueous solution contains 0.10 mol of $BaCl_2$ and 0.10 mol of $Ba_3(PO_4)_2$. What is the minimum number of moles of Na_2SO_4 that must be added to the solution in order to precipitate all of the Ba^{2+} as $BaSO_4(s)$? (Assume that $BaSO_4$ is insoluble.)

(A) 0.10 mol
(B) 0.20 mol
(C) 0.30 mol
(D) 0.40 mol
(E) 0.60 mol

42.Which of the following is a correct representation of the electron configuration for molybdenum?

(A) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}\,4p^6\,5s^2\,4d^4$
(B) $[Ar]\,5s^2\,4d^4$
(C) $[Ar]\,5s^1\,4d^5$
(D) $[Kr]\,5s^1\,4d^5$
(E) $[Kr]\,5s^2\,5d^4$

Day 19: Practice Exam Section 1

43. For the isoelectronic series S^{2-}, Cl^-, Ar, K^+, and Sc^{3+}, which species requires the least energy to remove an outer electron?

(A) S^{2-}
(B) Cl^-
(C) Ar
(D) K^+
(E) Sc^{3+}

44. The K_{eq} for the following reaction is 0.01

X + Y -------> 2Z

If the concentrations of X and Z are 5.0*M* and 1.0*M*, respectively, what must be the approximate concentration of Y in an equilibrium mixture?

(A) 5.0*M*
(B) 4.0*M*
(C) 1.0*M*
(D) 20.*M*
(E) 0.050*M*

45. A voltaic cell contains one half-cell with zinc electrode in a $Zn^{2+}(aq)$ solution and a copper electrode in a $Cu^{2+}(aq)$ solution. At standard condition. E° = 1.10 V. Which condition below would cause the cell potential to be greater than 1.10 V?

(A) 1.0 M $Zn^{2+}(aq)$, 1.0 M $Cu^{2+}(aq)$
(B) 5.0 M $Zn^{2+}(aq)$, 5.0 M $Cu^{2+}(aq)$
(C) 5.0 M $Zn^{2+}(aq)$, 1.0 M $Cu^{2+}(aq)$
(D) 0.5 M $Zn^{2+}(aq)$, 0.5 M $Cu^{2+}(aq)$
(E) 0.1 M $Zn^{2+}(aq)$, 1.0 M $Cu^{2+}(aq)$

46. When subjected to the flame test, a solution that contains Sr^{2+} ions produces the color

(A) yellow
(B) violet
(C) crimson
(D) green
(E) orange

47. Appropriate laboratory procedures include which of the following?

I. Calibrating a pH probe before using it.
II. Lubricating glass tubing before inserting it into a stopper.
III. For accurate results, waiting until warm or hot objects have reached room temperature before weighing them.

(A) I only
(B) II only
(C) I and II only
(D) I and III only
(E) I, II and III

48. Which of the following is the correct name for the compound with formula Ca_3P_2?

(A) Tricalcium diphosphorous
(B) Calcium phosphite
(C) Calcium Phosphate
(D) Calcium diphosphate
(E) Calcium phosphide

49. What number of moles of O_2 is needed to produce 25.5 grams of Al_2O_3 from solid Al? (Molecular weight Al_2O_3 =102)

(A) 0.125 mole
(B) 0.250 mole
(C) 0.375 mole
(D) 0.500 mole
(E) 1.00 mole

50. What is the ideal p*Ka* for an indicator in a titration when the pOH at the equivalence point is 9.8?

(A) 2.1
(B) 4.2
(C) 4.9
(D) 9.8
(E) 10

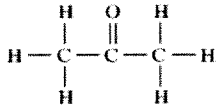
Day 19: Practice Exam Section 1

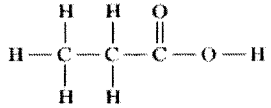
51. A sample of a radioactive material undergoing a decay is found to contain boron and carbon. The sample could be undergoing which of the following decay process?

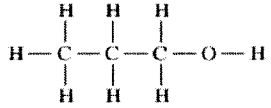
I. Alpha (α) decay
II. Beta (-β) decay
III. Electron capture

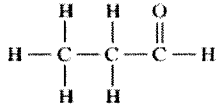
(A) I only
(B) II only
(C) I and II only
(D) II and III only
(E) I, II, III

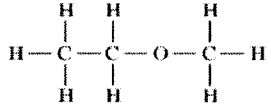
52. Which structure represents an ether?

(A) 

(B) 

(C) 

(D) 

(E) 

53. Which of the following equations represents the reaction between solid magnesium hydroxide and aqueous hydrochloric acid?

(A) $Mg(OH)_2(s) + 2HCl(l) \text{ ------ > } MgCl_2(aq) + H_2O(l)$
(B) $MgOH(s) + HCl(aq) \text{ ----- > } MgCl(aq) + 2H_2O(l)$
(C) $Mg(OH)_2(s) + 2HCl(aq) \text{ ---- > } MgCl_2(aq) + 2H_2O(l)$
(D) $Mg(OH)_2(s) + HCl(aq) \text{ ----- > } MgCl_2(aq) + H_2O(l)$
(E) $MgOH(s) + 2HCl(aq) \text{ ---- > } MgCl(aq) + 2H_2O(l)$

54. What would be the proper setup to determine the vapor pressure of a solution at 25°C that has 45 grams of $C_6H_{12}O_6$, glucose (MM = 180 g/mol), dissolved in 72 grams of H_2O? The vapor pressure of pure water at 25°C is 23.8 mmHg.

(A) 23.8 – (72/18) + (45/180)
(B) 23.8 – (0.0588)(23.8)
(C) (0.0588 + 23.8) / (72/18)
(D) ((72/18) + (45/180))/23.8
(E) none of the setups are correct

55. A characteristic that is unique to the alkali metals is

(A) their metallic character.
(B) the increase in atomic radius with increasing atomic number.
(C) the decrease in ionization energy with increasing atomic number.
(D) the noble gas electron configuration of the singly charged positive ion.
(E) None of these answer choices are correct.

56. Given the oxidation reaction below:

$$CH_3CH_2OH(g) + O_2(g) \text{ ------ > } CO_2(g) + H_2O(g)$$

How many moles of O_2 are required to oxidize 1 mole of CH_3CH_2OH?

(A) $^3/_2$ moles
(B) $^5/_2$ moles
(C) 3 moles
(D) $^7/_2$ moles
(E) 4 moles

Day 19: Practice Exam Section 1

57. A sulfide of copper is found to contain 20% sulfur. What is the formula of the compound?

(A) CuS
(B) CuS_2
(C) Cu_2S
(D) Cu_2S_2
(E) Cu_4S

For questions 58 and 59, consider the following molecules:

C_2Cl_2 C_2HCl $C_2H_2Cl_2$ C_2HCl_5

58. How many of the molecules contain two pi bonds between the carbon atoms?

(A) 0
(B) 1
(C) 2
(D) 3
(E) 4

59. How many of the molecules contain at least one sigma bond?

(A) 0
(B) 1
(C) 2
(D) 3
(E) 4

60. If the amount of energy required to melt 4.50 grams of ice at 0°C were used to heat 1 gram of water at 5°C, approximately how much steam could be produced? The heat of fusion for H_2O is 335 J/g and the heat of vaporization of water is 2260 J/g.

(A) 0 grams
(B) 0.5 grams
(C) 1.5 grams
(D) 2.5 grams
(E) 5 grams

61. Which of the following are true about Millikan oil drop experiment?

I. Positively and a negatively charged plates were used to hold oil droplets in the air.

II. X rays were used to charge the oil droplets with electrons

III. This experiment is famous for discovering the density of electrons

(A) I only
(B) I and III only
(C) I and II only
(D) II and III only
(E) I, II, III

62. Which of the following indicators would be the best choice to monitor a change that occurs at pH = 5.0?

(A) Bromophenol blue, p*Ka* = 4.0
(B) Phenolphthalein, p*Ka* = 7.9
(C) Thymol blue, p*Ka* = 9.3
(D) Methyl red, p*Ka* = 5.1
(E) Methyl orange, p*Ka* = 3.7

63. A yellow precipitate forms when 0.5 M KI(aq) is added to a 0.5 M solution of which of the following ions?

A) $Pb^{2+}(aq)$
B) $Cu^{2+}(aq)$
C) $C_2O_4^{2-}(aq)$
D) $SO_4^{2-}(aq)$
E) $Cl^-(aq)$

64. What is the charge of Zn in $Zn(H_2O)_3(OH)^+$?

(A) 0
(B) +1
(C) +2
(D) +3
(E) +5

65. When lithium chloride is added to a saturated aqueous solution of silver chloride, which of the following precipitate would be expected to appear?

(A) Lithium
(B) Silver
(C) Chlorine
(D) Lithium chloride
(E) Silver chloride

66. According to the Law of Dulong and Petit, the best prediction for the specific heat of Vanadium atomic mass = 50.0 g is

(A) 0.10 J/g . °C
(B) 0.25 J/g . °C
(C) 0.50 J/g . °C
(D) 0.75 J/g . °C
(E) 1.00 J/g . °C

67. A Table of three acids and their dissociation constant, K_a, is given below:

Acid	Acid Dissociation Constant, K_a
H_3AsO_4	5×10^{-3}
$H_2AsO_4^-$	8×10^{-8}
$HAsO_4^{2-}$	6×10^{-10}

On the basis of the information on the table below a buffer with a pH = 11 can best be made by using

(A) pure NaH_2AsO_4
(B) $H_3AsO_4 + H_2AsO_4^-$
(C) $H_2AsO_4^- + AsO_4^{3-}$
(D) $H_2AsO_4^- + HAsO_4^{2-}$
(E) $HAsO_4^{2-} + AsO_4^{3-}$

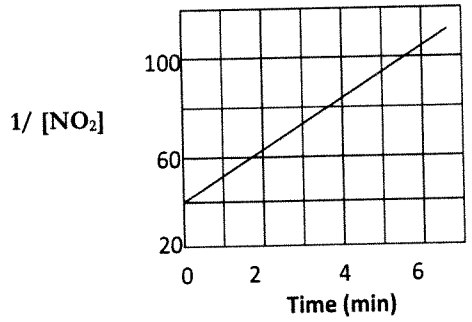
68. Given a molecule with the general formula AB_2, which one of the following would be the most useful in determining whether the molecule was bent or linear?

(A) ionization energies
(B) electron affinities
(C) dipole moments
(D) electronegativities
(E) bond energies

69. Data was obtained for the decomposition of NO_2 according to the following reaction

$$2NO_2(g) \text{ -----> } 2NO(g) + O_2(g)$$

and a plot of $1/[NO_2]$ vs. time produced the following slope.



The reaction is

(A) 0 order
(B) 1st order
(C) 2nd order
(D) 3rd order
(E) cannot be determined with information provided

Day 19: Practice Exam Section 1

70. If $\Delta H°$ and $\Delta S°$ are both negative, then $\Delta G°$ is

(A) always negative.
(B) always positive.
(C) positive at low temperatures and negative at high temperatures.
(D) negative at low temperatures and positive at high temperatures.
(E) zero.

71. Based on the standard reduction potentials listed below, which is the strongest oxidizing agent?

$Fe^{2+}(aq) + 2e^- \text{ -----> } Fe(s)$		$E°red = -0.44$
$Zn^{2+}(aq) + 2e^- \text{ -----> } Zn(s)$		$E°red = -0.76$
$Mn^{2+}(aq) + 2e^- \text{ -----> } Mn(s)$		$E°red = -1.18$
$Ni^{2+}(aq) + 2e^- \text{ ------> } Ni(s)$		$E°red = -0.25$
$2H^+(aq) + 2e^- \text{ ------> } H_2(g)$		$E°red = 0$

(A) Ni^{2+}
(B) Fe^{2+}
(C) Zn^{2+}
(D) Mn^{2+}
(E) H+

72. Methane combusts with oxygen to yield carbon dioxide and water vapor:

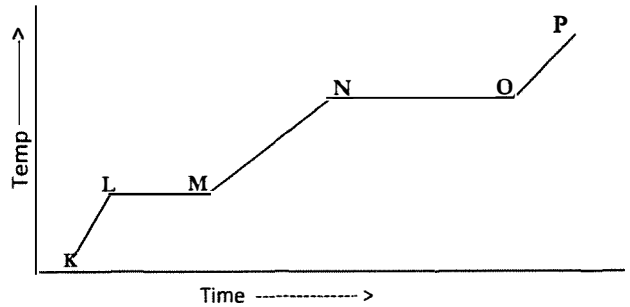
$$CH_4 + 2O_2 \text{ -----> } CO_2 + 2H_2O$$

If methane is consumed at 2.79 mole/s, what is the rate of change in the concentrations of carbon dioxide and oxygen?

(A) +2.79 mole/s CO_2 and +5.58mol/s O_2
(B) –2.79 mole/s CO_2 and –5.58mol/s O_2
(C) +5.58 mole/s CO_2 and –5.58mol/s O_2
(D) +2.79 mole/s CO_2 and –2.79mol/s O_2
(E) +2.79 mole/s CO_2 and –5.58mol/s O_2

Day 19: Practice Exam Section 1

Questions 73 through 75: Energy is added to a system at a constant rate as shown in the warming curve below.



73. Which of the following best represents the energy calculation involving segment MN of the graph?

(A) mass × H_{fus}
(B) mass × c_{vap} × ΔT
(C) mass × H_{vap}
(D) mass × c_{liq} × ΔT
(E) mass × H_{vap} × ΔT

74. Which of the following best represents the energy calculation involving segment NO of the graph?

(A) mass × H_{fus}
(B) mass × c_{vap} × ΔT
(C) mass × H_{vap}
(D) mass × c_{liq} × ΔT
(E) mass × H_{vap} × ΔT

75. Which segments on the curve would be eliminated if the substance sublimes at standard conditions?

(A) LM only
(B) MN only
(C) LM and MN only
(D) LM, MN and NO
(E) NO and OP only

STOP: IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS SECTION ONLY. DO NOT WORK ON ANY OTHER SECTION IN THE TEST.

Day 19: Practice Exam Section I Answers

Day 20: Practice Exam
Section II

(Total time—95 minutes)

Section II: 60 points

Part A

Time—55 minutes

YOU MAY USE YOUR CALCULATOR FOR PART A.

YOU MAY USE ANY REFERENCE MATERIALS PROVIDED ON PAGES 337-340

CLEARLY SHOW THE METHOD USED AND THE STEPS INVOLVED IN ARRIVING AT YOUR ANSWERS.

It is to your advantage to do this, since you may obtain partial credit if you do and you will receive little or no credit if you do not. Attention should be paid to significant figures.

Be sure to write all your answers to the questions on the blank pages following each questions.

Answer ALL three questions in this Part.

Day 20: Practice Exam

Section II Part A

1. **(10 points)**

The equation below shows a reaction between ethylamine and water.

$$C_2H_5NH_2(aq) + H_2O(l) \text{ ------ > } C_2H_5NH_3^+(aq) + OH\text{-}(aq)$$

The base-dissociation constant, K_b, for the ethylamine ion is 5.6×10^{-4}.

(a) Given a 80.4 mL sample of a 0.500 M solution of ethylamine.

(i) Write the equilibrium expression for the reaction and calculate the OH- ion concentration.

(ii) Calculate the pOH of the solution.

(b) Calculate the % ionization of the ethylamine in the solution in part (a).

(c) What would be the pH of a solution made by adding 11.4 grams of ethylammonium bromide ($C_2H_5NH_3Br$) to 150. ml of a 0.200-molar solution of ethylamine?

d) A student adds 0.140 grams of solid silver nitrate to the solution in part (a)

(i) Calculate the concentration of the silver ion in the solution.

(ii) Will silver hydroxide form as a precipitate? Justify your answer with a calculation. (The value of K_{sp} for silver hydroxide is 1.52×10^{-8})

Day 20 Question 1: Space for Work and Answers

Day 20: Practice Exam

Section II Part A Continue

2. **(10 points)**

In two separate experiments, a sample of an unknown hydrocarbon was burned in air, and a sample of the same hydrocarbon was placed into an organic solvent.

(a) When the hydrocarbon sample was burned in a reaction that went to completion, 2.2 grams of water and 3.6 liters of carbon dioxide were produced under standard conditions. What is the empirical formula of the hydrocarbon?

(b) When 4.05 grams of the unknown hydrocarbon was placed in 100.0 grams of benzene, C_6H_6, the freezing point of the solution was measured to be 1.66°C. The normal freezing point of benzene is 5.50°C and the freezing-point depression constant for benzene is 5.12°C/m. What is the molecular weight of the unknown hydrocarbon?

(c) What is the molecular formula and the name of the hydrocarbon?

(d) Write the balanced equation for the combustion reaction that took place in (a)

(e) Draw two isomers for the hydrocarbon.

Day 20: Practice Exam

Section II Part A Continue

3. The following results were obtained in experiments designed to study the rate of the reaction below: **(10 points)**

$$A + 2B \text{ -----> } 2C$$

Experiment	*Initial Concentration* $(mol \cdot L^{-1})$		*Initial Rate of Disappearance of A* $(M \cdot sec^{-1})$
	A	*B*	
1	0.05	0.05	3.0×10^{-3}
2	0.05	0.10	6.0×10^{-3}
3	0.10	0.10	1.2×10^{-2}
4	0.20	0.10	2.4×10^{-2}

(a) Determine the order of the reaction with respect to each of the reactants, and write the rate law for the reaction.

(b) Calculate the value of the rate constant, *k*, for the reaction. Include the units.

(c) Another experiment is attempted with [A] and [B] both 0.02 molar, what would be the initial rate of disappearance of A?

(d) The following reaction mechanism was proposed for the reaction above:

$$A + B \text{ -----> } C + D$$
$$D + B \text{ -----> } C$$

(i) Show that the mechanism is consistent with the balanced reaction.

(ii) Show that the step is the rate determining step, and explain your choice.

STOP

If you finish before time is called, you may check your work on this part only.
Do not turn to the other part of the test until you are told to do so.

Day 20 Question 3: Space for Work and Answers

Day 20: Practice Exam

Section II Part B

Part B

Time—40 minutes

NO CALCULATORS MAY BE USED FOR PART B.
YOU MAY USE ANY REFERENCE MATERIALS PROVIDED ON PAGES 337-340

Question 4

For each of the following three reactions, write a balanced equation for the reaction in part (i) and answer the question about the reaction in part (ii). In part (i), coefficients should be in terms of lowest whole numbers.

Assume that solutions are aqueous unless otherwise indicated. Represent substances in solutions as ions if the substances are extensively ionized. Omit formulas for any ions or molecules that are unchanged by the reaction.

You may use the empty space at the bottom of the next page for scratch work, but only equations that are written in the answer boxes and the answers written in the lines provided will be scored.

Day 20: Practice Exam
Section II Part B

4. **(15 points)**

(a) Boron triiodide is reacted with ammonia

(i) Balanced equation:

(ii) Which species in the reaction is the Lewis acid? Explain.

(b) A piece of calcium carbonate is placed in excess nitric acid

(i) Balanced equation:

(ii) What will be the sign for ΔS° for the reaction? Explain.

(c) Chlorine gas is bubbled through a solution of lithium bromide.

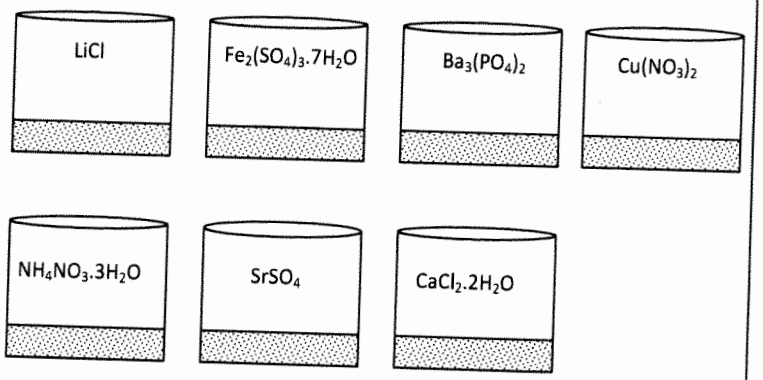
(i) Balanced equation:

(ii) Which species will be the reducing agent in the reaction? Justify your answer.

Day 20: Practice Exam
Section II Part B Continue

5. Answer all questions in the boxes provided. **(8 points)**

Seven solid compounds were placed in beakers as shown below.



An unknown compound is to be identified by students through observations and result of laboratory tests. The observations and test results are listed in order from (a) through (e). Write the formula(s) of compound(s) that should be eliminated in the box following each result.

(a) The unknown compound is white.

(b) The unknown compound dissolves readily in water.

(c) Forms a white precipitate when added to aqueous $AgNO_3$ solution.

(d) When heated, the mass of the compound after heating was less than the mass of the compound before heating.

(e) Below:

(i) Write the formula(s) of the compound(s) that has yet to be eliminated.

(ii) Describe any other test that could be done using only the substances in the beaker to confirm the identity of the unknown. Indicate the result of the test as well as formula of any products that is formed from your testing.

6. **(7 points)**

Answer the following questions about Lewis structure and shapes of compounds.

a) Draw Lewis structures for

(i) BF_3

(ii) $TiCl_3$

(b) Determine the molecular geometries including all idealized bond angles for ClNO where the N atom is in the center of the molecule.

(c) Classify XeF_4 as polar or nonpolar and explain why.

(d) Describe the orbital hybridization scheme used by the central atom in its sigma bonding for the following molecules. The central atom is underlined. How many pi bonds are contained in each molecule?

(i) XeF_4

(ii) XeF_2

STOP

END OF EXAM

STANDARD REDUCTION POTENTIALS IN AOUEOUS SOLUTIONS AT 25°C

Half-reaction			E°(V)
$F_2(g) + 2e^-$	→	$2F^-$	2.87
$Co^{3+} + e^-$	→	Co^{2+}	1.82
$Au^{3+} + 3e^-$	→	$Au(s)$	1.50
$Cl_2(g) + 2e^-$	→	$2Cl^-$	1.36
$O_2(g) + 4H^+ + 4e^-$	→	$2H_2O(l)$	1.23
$Br_2(l) + 2e^-$	→	$2Br^-$	1.07
$2Hg^{2+} + 2e^-$	→	Hg_2^{2+}	0.92
$Hg^{2+} + 2e^-$	→	$Hg(l)$	0.85
$Ag^+ + e^-$	→	$Ag(s)$	0.80
$Hg_2^{2+} + 2e^-$	→	$2Hg(l)$	0.79
$Fe^{3+} + e^-$	→	Fe^{2+}	0.77
$I_2(s) + 2e^-$	→	$2I^-$	0.53
$Cu^+ + e^-$	→	$Cu(s)$	0.52
$Cu^{2+} + 2e^-$	→	$Cu(s)$	0.34
$Cu^{2+} + e^-$	→	Cu^+	0.15
$Sn^{4+} + 2e^-$	→	Sn^{2+}	0.15
$S(s) + 2H^+ + 2e^-$	→	$H_2S(g)$	0.14
$2H^+ + 2e^-$	→	$H_2(g)$	0.00
$Pb^{2+} + 2e^-$	→	$Pb(s)$	−0.13
$Sn^{2+} + 2e^-$	→	$Sn(s)$	−0.14
$Ni^{2+} + 2e^-$	→	$Ni(s)$	−0.25
$Co^{2+} + 2e^-$	→	$Co(s)$	−0.28
$Cd^{2+} + 2e^-$	→	$Cd(s)$	−0.40
$Cr^{3+} + e^-$	→	Cr^{2+}	−0.41
$Fe^{2+} + 2e^-$	→	$Fe(s)$	−0.44
$Cr^{3+} + 3e^-$	→	$Cr(s)$	−0.74
$Zn^{2+} + 2e^-$	→	$Zn(s)$	−0.76
$2H_2O(l) + 2e^-$	→	$H_2(g) + 2OH^-$	−0.83
$Mn^{2+} + 2e^-$	→	$Mn(s)$	−1.18
$Al^{3+} + 3e^-$	→	$Al(s)$	−1.66
$Be^{2+} + 2e^-$	→	$Be(s)$	−1.70
$Mg^{2+} + 2e^-$	→	$Mg(s)$	−2.37
$Na^+ + e^-$	→	$Na(s)$	−2.71
$Ca^{2+} + 2e^-$	→	$Ca(s)$	−2.87
$Sr^{2+} + 2e^-$	→	$Sr(s)$	−2.89
$Ba^{2+} + 2e^-$	→	$Ba(s)$	−2.90
$Rb^+ + e^-$	→	$Rb(s)$	−2.92
$K^+ + e^-$	→	$K(s)$	−2.92
$Cs^+ + e^-$	→	$Cs(s)$	−2.92
$Li^+ + e^-$	→	$Li(s)$	−3.05

EQUATIONS AND CONSTANTS

ATOMIC STRUCTURE

$E = h\nu$ $\quad c = \lambda\nu$

$\lambda = \dfrac{h}{mv}$ $\quad p = mv$

$E_n = \dfrac{-2.178 \times 10^{-18}}{n^2}$ joule

E = energy $\quad v$ = velocity

ν = frequency $\quad n$ = principal quantum number

λ = wavelength $\quad m$ = mass

p = momentum

EQUILIBRIUM

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

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

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

$= K_a \times K_b$

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

$14 = pH + pOH$

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

$pOH = pK_b + \log\dfrac{[HB^+]}{[B]}$

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

$K_p = K_c(RT)^{\Delta n}$,

where Δn = moles product gas − moles reactant gas

THERMOCHEMISTRY/KINETICS

$\Delta S^\circ = \sum S^\circ$ products $- \sum S^\circ$ reactants

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

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

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

$= -RT \ln K = -2.303 RT \log K$

$= -n\mathcal{F}E^\circ$

$\Delta G = \Delta G^\circ + RT \ln Q = \Delta G^\circ + 2.303 RT \log Q$

$q = mc\Delta T$

$C_p = \dfrac{\Delta H}{\Delta T}$

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

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

$\ln k = \dfrac{-E_a}{R}\left(\dfrac{1}{T}\right) + \ln A$

E = energy $\quad v$ = velocity

ν = frequency $\quad n$ = principal quantum number

λ = wavelength $\quad m$ = mass

p = momentum

Speed of light, $c = 3.0 \times 10^8$ m s^{-1}

Planck's constant, $h = 6.63 \times 10^{-34}$ J s

Boltzmann's constant, $k = 1.38 \times 10^{-23}$ J K^{-1}

Avogadro's number $= 6.022 \times 10^{23}$ mol^{-1}

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

1 electron volt per atom = 96.5 kJ mol^{-1}

Equilibrium Constants

K_a (weak acid)

K_b (weak base)

K_w (water)

K_p (gas pressure)

K_c (molar concentrations)

S° = standard entropy

H° = standard enthalpy

G° = standard free energy

E° = standard reduction potential

T = temperature

n = moles

m = mass

q = heat

c = specific heat capacity

C_p = molar heat capacity at constant pressure

E_a = activation energy

k = rate constant

A = frequency factor

Faraday's constant, $\mathcal{F} = 96{,}500$ coulombs per mole of electrons

Gas constant, $R = 8.31$ J mol^{-1} K^{-1}

$= 0.0821$ L atm mol^{-1} K^{-1}

$= 62.4$ L torr mol^{-1} K^{-1}

$= 8.31$ volt coulomb mol^{-1} K^{-1}

GASES, LIQUIDS AND SOLUTIONS

$$PV = nRT$$

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

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

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

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

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

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

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

$$u_{rms} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}}$$

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

$$KE \text{ per mole} = \frac{3}{2}RT$$

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

molarity, M = moles solute per liter solution

molality = moles solute per kilogram solvent

$$\Delta T_f = iK_f \times \text{molality}$$

$$\Delta T_b = iK_b \times \text{molality}$$

$$\pi = iMRT$$

$$A = abc$$

P = pressure
V = volume
T = temperature
n = number of moles
D = density
m = mass
v = velocity

u_{rms} = root-mean-square speed
KE = kinetic energy
r = rate of effusion
M = molar mass
π = osmotic pressure
i = van't Hoff factor
K_f = molal freezing-point depression constant
K_b = molal boiling-point elevation constant
A = absorbance
a = molar absorptivity
b = path length
c = concentration
Q = reaction quotient
I = current (amperes)
q = charge (coulombs)
t = time (seconds)
E° = standard reduction potential
K = equilibrium constant

OXIDATION-REDUCTION; ELECTROCHEMISTRY

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

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

$$E_{cell} = E^\circ_{cell} - \frac{RT}{n\mathcal{F}}\ln Q = E^\circ_{cell} - \frac{0.0592}{n}\log Q \text{ @ } 25^\circ\text{C}$$

$$\log K = \frac{nE^\circ}{0.0592}$$

Gas constant, R = 8.31 J mol^{-1} K^{-1}
= 0.0821 L atm mol^{-1} K^{-1}
= 62.4 L torr mol^{-1} K^{-1}
= 8.31 volt coulomb mol^{-1} K^{-1}

Boltzmann's constant, $k = 1.38 \times 10^{-23}$ J K^{-1}

K_f for H_2O = 1.86 K kg mol^{-1}

K_b for H_2O = 0.512 K kg mol^{-1}

1 atm = 760 mm Hg
= 760 torr

STP = 0.00 °C and 1.0 atm

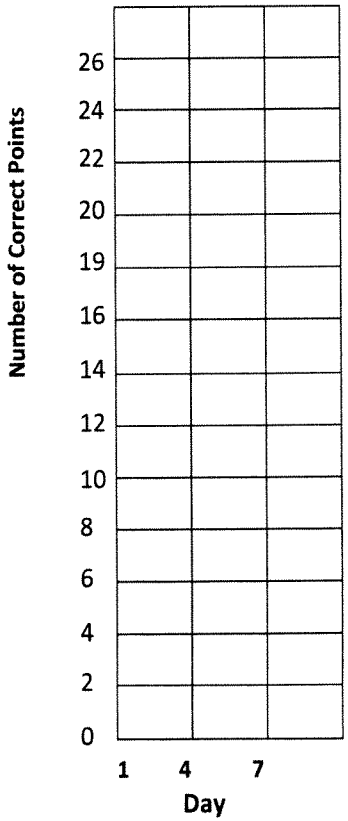
Faraday's constant, $\mathcal{F}$ = 96,500 coulombs per mole of electrons

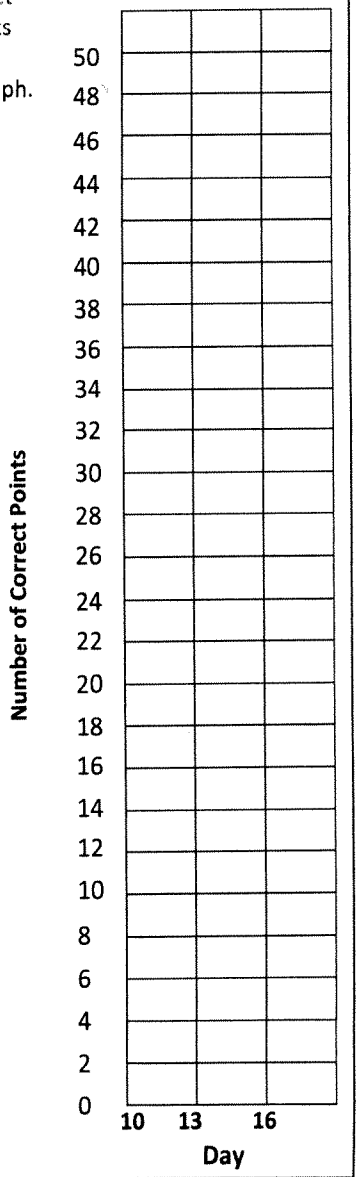
Track Your Progress

Use the grids on these two pages to plot the number of points you got correct for each question set to better see your progress and improvements in each question category.
You hope to see an upward trend on each graph.

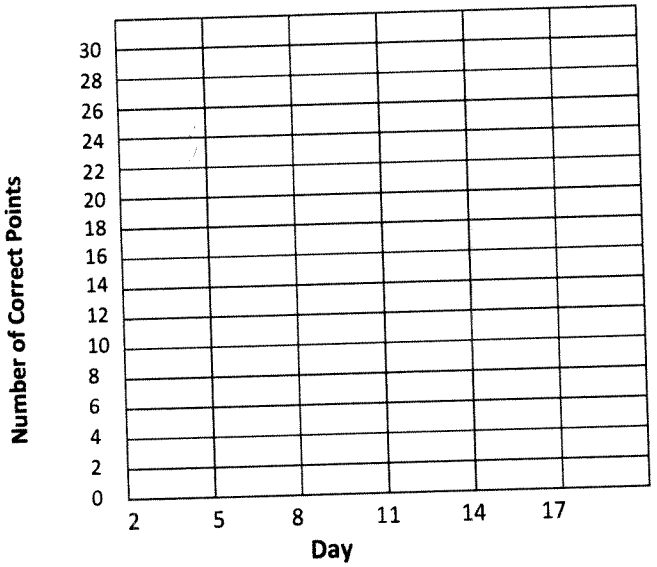
Multiple Choice Questions:

Section I Part A and B Practice





Free Response Questions: Section II Part A Practice (30 points max)



Free Response Questions: Section II Part B Practice (23 points max)