

CHE 107

FINAL EXAMINATION

April 30, 2012

University of Kentucky

Department of Chemistry

READ THESE DIRECTIONS CAREFULLY BEFORE STARTING THE EXAMINATION!

It is *extremely* important that you fill in the answer sheet EXACTLY as indicated, otherwise your answer sheet may not be processed; ALL entries are to be made on **SIDE 1** of the answer sheet. Use a #2 pencil (or softer); fill in the circles completely and firmly. Erasures must be complete.

Use only the following categories:

NAME:	Print your name starting at the first space, LAST NAME first, then a space, followed by your FIRST NAME, then another space, followed by your MIDDLE INITIAL. Fill in the <u>correct circles</u> below your printed name corresponding to the letters of your name; for the spaces, fill in the top blank circle.
STUDENT NUMBER:	This is VERY IMPORTANT! Under IDENTIFICATION NUMBER, put in your 8 DIGIT STUDENT ID NUMBER (do not use the 9 at the beginning of your number) beginning in column A and continuing through column H, column I will be blank, (do NOT use column J at this time); be sure to fill in the correct circles (a common error to be avoided is mistaking "0" for "1").
TEST FORM:	Fill in the "4" blank in the J column under IDENTIFICATION NUMBER (to indicate Hour Examination IV).
SPECIAL CODES:	Use for course and section number; in positions K-P write in one of the following: Dr. Woodrum 107-001 Dr. Soult 107-002, 107-003 Dr. Ades 107-004, 107-401
SIGNATURE:	You MUST sign the examination answer sheet (bubble sheet) on the line directly above your printed name. Use your legal signature.

Answering Questions:

Starting with answer "1" on **SIDE 1**, fill in the circle indicating the one best answer for each of the **60 questions** in this examination. Your score is the sum of the appropriate credit for each response.

Grading and Reporting:

The examination scores will be posted in Blackboard as soon as possible after the examination. If an error has occurred in scoring your answers, inform your instructor within 48 hours of the posting of your score.

BE SURE THAT YOUR TEST HAS 60 QUESTIONS, A PERIODIC TABLE, AND TWO SHEETS OF SCRATCH PAPER. You may NOT use your own scratch paper during this examination. Cell phones, computer, and pagers are to be turned off and out of sight during the exam. **All** exam paper, scratch paper, and scantrons must be handed in at the end of the exam. You may **not** take any exam materials away from the exam room.

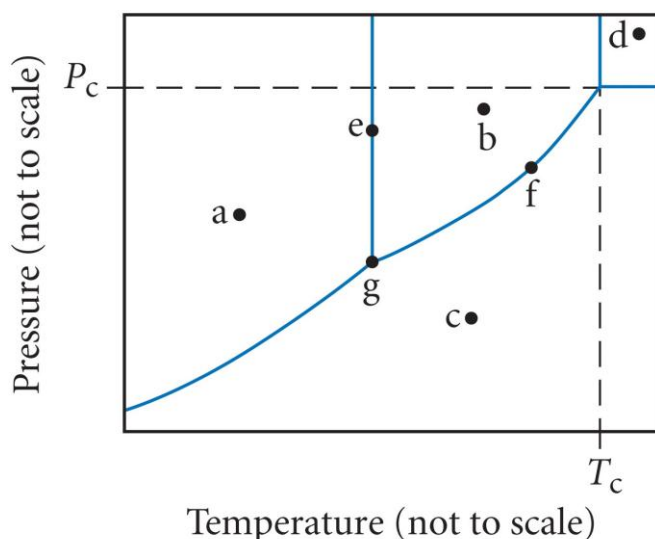
Questions 1 – 16 cover Exam I material

1. Which of the following is **true** regarding gases?
- A. Gas molecules are close together relative to the size of the molecules.
 - B. Ideal gases have intermolecular forces.
 - C. Gases are compressible.
 - D. The average kinetic energy of gas molecules decreases with an increase in temperature.
-
2. Select the pair that lists the compound with the strongest intermolecular force first.
- | | |
|--|---|
| A. $\text{CH}_3\text{CH}_2\text{OH} > \text{CH}_3\text{CH}_2\text{CH}_3$ | C. $\text{CH}_3\text{CH}_3 > \text{CH}_3\text{CH}_2\text{CH}_3$ |
| B. $\text{CH}_3\text{CH}_2\text{CH}_3 > \text{CH}_3\text{OCH}_3$ | D. $\text{CH}_3\text{OCH}_3 > \text{CH}_3\text{CH}_2\text{OH}$ |
-
3. Which one of the following is **true**?
- A. The species with the lower vapor pressure at a given temperature has stronger intermolecular forces than a species that has a higher vapor pressure.
 - B. Ethanol, whose normal boiling point is 78°C , will have a higher vapor pressure at 78°C than water will have at 100°C , the normal boiling point of water.
 - C. The vapor pressure of H_2CO is lower than the vapor pressure of CH_3OH at a given temperature.
 - D. $\text{CH}_3\text{CH}_2\text{OH}$ and CH_3OCH_3 have the same vapor pressure at 25°C since their molar mass is the same.
-
4. As the temperature of a pure liquid _____, the vapor pressure _____ so there are _____ molecules of vapor present.
- | | |
|-------------------------------|--------------------------------|
| A. decreases, decreases, more | C. decreases, increases, fewer |
| B. increases, increases, more | D. increases, increases, fewer |
-

5. How much energy is released when 325 g of acetone, C_3H_6O , is converted to a solid at its melting point of $-94.8^\circ C$? $\Delta H_{fus} = 7.27 \text{ kJ/mol}$ for acetone.

- A. 23.6 kJ
B. 531 kJ
C. 246 kJ
D. 40.7 kJ

6. At which point in the phase diagram below is the liquid phase the only phase present?



- A. a
B. b
C. c
D. d

7. Perovskite is a mineral discovered in 1839 in Russia. The unit cell of perovskite has a titanium atom in the center of the cell, oxygen atoms on each face, and calcium atoms on each corner. What is the formula for perovskite?

- A. $CaTiO_6$
B. $CaTiO$
C. Ca_2TiO_3
D. $CaTiO_3$
-

8. Which one of the following statements is **false**?

- A. Molecular solids are held together by intermolecular forces.
- B. Ionic solids have high melting points.
- C. Nonbonding atomic solids have high melting points.
- D. Network covalent solids are held together by covalent bonds.

9. Which correctly ranks the following compounds in order of **increasing** solubility in water? The temperature is the same for all solutions.



- A. $\text{KI} < \text{CH}_3\text{COOH} < \text{CH}_2\text{Br}_2 < \text{CBr}_4$
- B. $\text{CH}_2\text{Br}_2 < \text{CBr}_4 < \text{CH}_3\text{COOH} < \text{KI}$
- C. $\text{CH}_2\text{Br}_2 < \text{CBr}_4 < \text{KI} < \text{CH}_3\text{COOH}$
- D. $\text{CBr}_4 < \text{CH}_2\text{Br}_2 < \text{KI} < \text{CH}_3\text{COOH}$

10. At 20 °C, the solubility of KClO_3 is 7.0 g in 100. g of water. A solution is prepared which contains 9.0 g of KClO_3 is dissolved in 150. g of water. The solution is...

- A. unsaturated.
- B. saturated.
- C. supersaturated.
- D. supercritical.

11. The solubility of $\text{O}_2(\text{g})$ in water at 25°C is 1.01×10^{-3} mol/L at an O_2 partial pressure of 0.800 atm. What is the solubility at 25°C of $\text{O}_2(\text{g})$ in water when the partial pressure of $\text{O}_2(\text{g})$ above the solution is 7.25 atm?

- A. 9.15×10^{-3} M
 - B. 7.23×10^{-3} M
 - C. 1.39×10^{-4} M
 - D. 1.11×10^{-4} M
-

12. Which equation can be used to find the molality of an aqueous KNO_3 solution?

A. $\frac{\text{mol KNO}_3}{\text{kg soln}}$

C. $\frac{\text{mol KNO}_3}{\text{L soln}}$

B. $\frac{\text{mol KNO}_3}{\text{kg H}_2\text{O}}$

D. $\frac{\text{mol KNO}_3}{\text{L H}_2\text{O}}$

13. A 25.0 % by mass KCl solution contains

A. 25.0 g of water in 100.0 g of solution.

C. 25.0 g of KCl in 75.0 g of water.

B. 25.0 g of KCl in 100.0 g of water.

D. 25.0 g of KCl in 125 g of solution.

14. Determine the molarity of a 15.5 *m* hydrochloric acid solution. The density of the solution is 1.179 g/mL.

A. 15.5 M

C. 13.2 M

B. 10.6 M

D. 11.7 M

15. What is the vapor pressure at 40°C of a solution containing 5.00 mol glycerin, $\text{C}_3\text{H}_8\text{O}_3$, a nonvolatile, nonelectrolyte solute, in 50.0 mol of water? The vapor pressure of water at 40°C is 55.3 mmHg.

A. 60.3 mmHg

C. 50.3 mmHg

B. 54.7 mmHg

D. 53.5 mmHg

16. The osmotic pressure of a solution containing 3.69 mg of an unknown protein per 10.0 mL of a solution is 2.75 torr at 25°C . Find the molar mass of the unknown protein. The protein is a nonelectrolyte.

A. 400. g/mol

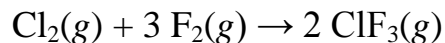
C. 1.50×10^4 g/mol

B. 2.49×10^3 g/mol

D. 596 g/mol

Questions 17 – 32 cover Exam II material

17. If F_2 disappears at a rate of 0.30 M/s at a particular moment during the reaction, what is the rate of appearance of appearance of ClF_3 at the same time?

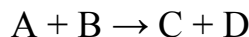


- A. 0.10 M/s
B. 0.60 M/s
C. 0.20 M/s
D. 0.45 M/s

-
18. A reaction is second order in reactant A and first order in reactant B. What is the effect on the rate when the concentrations of A and B are both tripled?

- A. The rate increases by a factor of 9.
B. The rate increases by a factor of 18.
C. The rate increases by a factor of 27.
D. The rate increases by a factor of 36.

-
19. Consider the reaction:



The initial rate of the reaction was measured at several different concentrations of the reactants with the following results:

[A], (M)	[B], (M)	Initial Rate (M/s)
0.015	0.040	0.0070
0.030	0.040	0.0139
0.030	0.080	0.0557

What is the order of reactant B?

- A. First order in B
B. Second order in B
C. Fourth order in B
D. Half order in B
-

20. What are the units of k for a zero order reaction?

A. $M^{-1}\cdot s^{-1}$

C. s^{-1}

B. $M\cdot s^{-1}$

D. $M\cdot s$

21. The initial mass of the reactant, A, in a reaction that obeys first order kinetics was 30.0 g. After 125 minutes, 2.50 g of the reactant remained. What is the half life of this first order reaction?

A. 42.7 min

C. 31.0 min

B. 34.9 min

D. 38.9 min

22. Calculate the activation energy for a reaction whose rate constant doubles when the temperature increases from 27 °C to 37 °C.

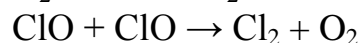
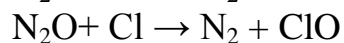
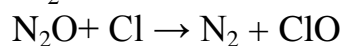
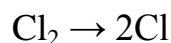
A. 12.6 kJ/mol

C. 53.7 kJ/mol

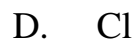
B. 1.26 kJ/mol

D. 5.37 kJ/mol

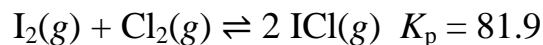
23. The following mechanism has been proposed for a gas phase reaction.



Which of the following is a reaction intermediate in the mechanism?



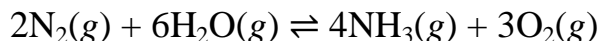
24. Consider the reaction:



When equal pressures of iodine and chlorine gas are placed in a reaction chamber and allowed to reach equilibrium, which statement is **true** concerning the equilibrium mixture?

- A. At equilibrium, the partial pressure of ICl is twice the partial pressure of Cl₂.
- B. At equilibrium, the partial pressure of I₂ is greater than the partial pressure of ICl.
- C. At equilibrium, the partial pressure of I₂ will equal the partial pressure of Cl₂.
- D. At equilibrium, the partial pressure of ICl will equal the sum of the pressures of I₂ and Cl₂

25. What is the equilibrium constant for the reaction

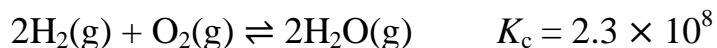


given the following information



- A. 5.92
- B. 1.03×10^6
- C. 0.169
- D. 4.48

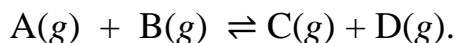
26. If 1.0 mol of H₂ is combined with 3.0 moles of O₂ in a 50.0 L container at 300°C, and reacts according to the following reaction



what will happen?

- A. The reaction proceeds to the right because $Q < K$.
 - B. The reaction is at equilibrium.
 - C. The reaction proceeds to the left because $Q < K$.
 - D. The reaction proceeds to the right because $Q > K$.
-

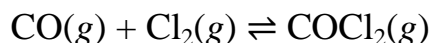
27. At 25 °C, $K = 144$ for the reaction



Initially 2.00 mol of A(g) and 2.00 mol of B(g) are injected into a 1.00 L reaction vessel. What is the concentration of D(g) when the reaction has come to equilibrium at 25°C?

- A. 1.71 M
B. 0.55M
C. 1.55 M
D. 1.85 M

28. Consider the endothermic reaction at equilibrium:



Which statement is **false**?

- A. An increase in the concentration of CO will produce more COCl₂.
B. Removal of Cl₂ will shift the reaction to the left.
C. The removal of COCl₂ gas will shift the reaction to the right.
D. Decreasing the temperature will shift the reaction to the right.

29. Which of the following are conjugate acid/base pairs?

- A. H₂PO₄⁻ and HPO₄²⁻
B. H₃PO₄ and HPO₄²⁻
C. H₂SO₄ and H₂SO₃
D. OH⁻ and H⁺

30. Which statement is **true** concerning pure water *at all temperatures*?

- A. pH + pOH = 14.00
B. [H⁺] = [OH⁻]
C. pH = 7.00
D. pOH = 7.00
-

31. A 0.00010 M aqueous solution of an unknown substance was determined to have a pH = 4.00. Therefore the solution is a

- A. strong acid
B. weak acid
C. strong base
D. weak base

32. A 0.0500 M solution of a weak monoprotic acid has a pH of 2.23. What is the percent ionization of the acid?

- A. 11.8%
B. 13.4%
C. 2.24%
D. 0.589%

Questions 33 – 48 cover Exam III material

33. What is the K_b for the anion in NaClO? K_a for HClO = 2.9×10^{-8} .

- A. 2.9×10^{-8}
B. 5.9×10^{-4}
C. 3.0×10^{-6}
D. 3.4×10^{-7}

34. Which one of the following will form a basic solution when dissolved in water?

- A. KNO_3
B. NH_4Cl
C. $\text{Sr}(\text{ClO})_2$
D. $\text{C}_5\text{H}_5\text{NHBr}$

35. Which one of the following has the stronger acid listed first?

- A. H_2O , HF
B. H_2O , H_2Se
C. H_2O , H_2S
D. HBr, HCl
-

36. Which of the following cannot form a buffer with Na_2HPO_4 ?

- | | |
|------------------------------|------------------------------|
| A. Na_3PO_4 | C. $\text{K}_3(\text{PO}_4)$ |
| B. NaH_2PO_4 | D. H_3PO_4 |

37. What is the pH of 2.00 L of a solution containing 1.00 mol $\text{C}_6\text{H}_5\text{NH}_2$, aniline, and 2.00 mol $\text{C}_6\text{H}_5\text{NH}_3\text{Br}$, anilinium bromide? K_b for aniline is 3.9×10^{-10} .

- | | |
|---------|---------|
| A. 4.29 | C. 9.18 |
| B. 4.70 | D. 9.41 |

38. A buffer is prepared that is 1.00 M in acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$, and 2.50 M in sodium acetate, $\text{NaC}_2\text{H}_3\text{O}_2$. What is the pH of the buffer after 10.0 mL of 2.00 M HCl is added to 100.0 mL of the original buffer? K_a of acetic acid is 1.8×10^{-5}

- | | |
|---------|---------|
| A. 5.03 | C. 7.25 |
| B. 3.97 | D. 5.40 |

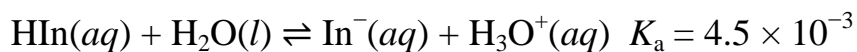
39. Which one of the following mixtures would be best for preparing a buffer of pH = 3.25?

- | |
|---|
| A. $\text{C}_6\text{H}_5\text{NH}_2$ and $\text{C}_6\text{H}_5\text{NH}_3\text{Cl}$; K_b for $\text{C}_6\text{H}_5\text{NH}_2 = 3.9 \times 10^{-10}$ |
| B. HF and NaF; K_a for HF = 3.5×10^{-4} |
| C. CH_3NH_2 and $\text{CH}_3\text{NH}_3\text{Br}$; K_b for $\text{CH}_3\text{NH}_2 = 4.4 \times 10^{-4}$ |
| D. HClO and KClO; K_a for HClO = 2.9×10^{-8} |

40. What is the pH at the equivalence point when 25.0 mL of 0.200 M acetic acid is titrated with 0.200 M NaOH? K_a of acetic acid is 1.8×10^{-5}

- | | |
|----------|---------|
| A. 8.88 | C. 2.87 |
| B. 11.13 | D. 5.02 |
-

-
41. Consider the following equilibrium between the acid form of an indicator (HIn) which is red and its ionized form (In^-) which is yellow.



Which statement is **false**?

- A. As the pH decreases, the solution will become red.
- B. As base is added, the solution will become yellow.
- C. When the pH is at a level where $[\text{HIn}] = [\text{In}^-]$, the solution will be orange.
- D. At a neutral pH, the solution will be orange.

-
42. A sample of lead iodide is placed in water. What is the K_{sp} of PbI_2 if the $[\text{Pb}^{2+}]$ in the resulting solution is $1.51 \times 10^{-3} \text{ M}$?

- A. 6.89×10^{-9}
- B. 3.44×10^{-9}
- C. 1.38×10^{-8}
- D. 4.56×10^{-6}

-
43. Which of the following is **not** more soluble in acid solution than in water?

- A. PbBr_2
- B. AgCN
- C. $\text{Mn}(\text{OH})_2$
- D. CuS

-
44. The K_{sp} of magnesium hydroxide is 1.2×10^{-11} . As the pH of the solution _____, the concentration of the magnesium ion _____ and the molar solubility _____.

- A. increases, decreases, increases
 - B. decreases, increases, increases
 - C. decreases, decreases, decreases
 - D. increases, increases, increases
-

45. A solution is made that is 0.0250 M in $\text{Cu}(\text{NO}_3)_2$ and 0.500 M in NaCN? After the solution reaches equilibrium, what concentration of $\text{Cu}^{2+}(\text{aq})$ remains?
 K_f for $[\text{Cu}(\text{CN})_4]^{2-} = 1.0 \times 10^{25}$.

- A. 1.0×10^{-25} M
B. 3.8×10^{-26} M
C. 9.8×10^{-26} M
D. 3.3×10^{-26} M

46. Which one of the following changes has a negative entropy change?

- A. Mercury melting
B. Oxygen condensing
C. Ethanol evaporating
D. Sulfur boiling

47. Which of the following statements is **true**?

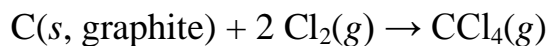
- A. Endothermic reactions are never spontaneous.
B. Some reactions are spontaneous at one temperature and non-spontaneous at another.
C. Exothermic reactions are always spontaneous.
D. Reactions are either always spontaneous or always non-spontaneous regardless of temperature.

48. What is the change in the entropy of the surroundings at 35 °C for a reaction whose enthalpy is -220 kJ/mol?

- A. 629 J/mol·K
B. 159 J/mol·K
C. 714 J/mol·K
D. 1400 J/mol·K
-

Questions 49 – 60 cover material after Exam III

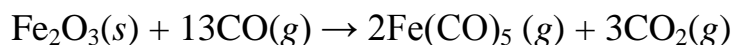
49. The following reaction is exothermic.



Which statement is true?

- A. The entropy change is positive and the reaction is spontaneous at all temperature.
- B. The entropy change is negative and the reaction is spontaneous at all temperatures.
- C. The entropy change is positive and the reaction is spontaneous at low temperatures.
- D. The entropy change is negative and the reaction is spontaneous at low temperatures.

50. Determine ΔS° for the reaction below

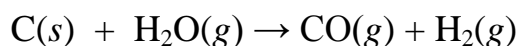


given the following information

	<u>S° (J/mol·K)</u>
$\text{Fe}_2\text{O}_3(s)$	87.4
$\text{Fe}(\text{CO})_5(g)$	445.2
$\text{CO}(g)$	197.6
$\text{CO}_2(g)$	213.6

- A. $-1125 \text{ J/mol}\cdot\text{K}$
- B. $-1570.2 \text{ J/mol}\cdot\text{K}$
- C. $373.8 \text{ J/mol}\cdot\text{K}$
- D. $1246.2 \text{ J/mol}\cdot\text{K}$

51. For the reaction

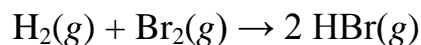


$\Delta H^\circ = 131.3 \text{ kJ}$ and $\Delta S^\circ = 133.9 \text{ J/K}$ at 25°C . What is ΔG° at 25°C for the reaction?

- A. -2.60 kJ
 - B. 91.4 kJ
 - C. 258.1 kJ
 - D. -94.8 kJ
-

52. Determine ΔG° for the following reaction at 1250 K.

At 1250 K, $\Delta H_{\text{rxn}}^\circ = -72.6 \text{ kJ}$ and $K_c = 3.9 \times 10^9$.



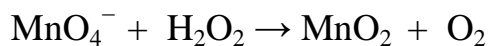
A. +73.9 kJ

C. -230. kJ

B. -945 kJ

D. -32.7 kJ

53. What is the coefficient for water when the following reaction is balanced in acid?



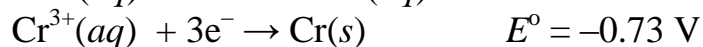
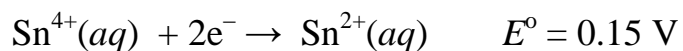
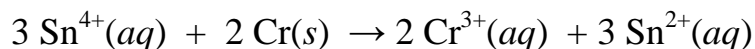
A. 2

C. 6

B. 4

D. 8

54. Using the standard reduction potentials listed below, calculate the equilibrium constant at 25°C for



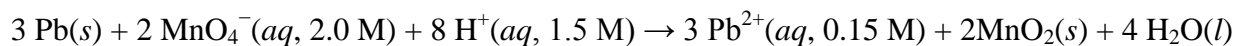
A. 8.8×10^{88}

C. 6.8×10^{89}

B. 1.9×10^{49}

D. 1.5×10^{89}

-
55. Determine the cell potential for the following reaction at 25 °C. Concentrations are provided within the reaction.

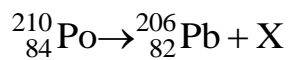


Reduction Half-Reaction	E°
$\text{Pb}^{2+}(aq) + 2e^- \rightarrow \text{Pb}(s)$	-0.13 V
$\text{MnO}_4^-(aq) + 4 \text{H}^+(aq) + 3 e^- \rightarrow \text{MnO}_2(s) + 2 \text{H}_2\text{O}(l)$	+1.68 V

- A. 1.81 V
B. 1.85 V
C. 1.68 V
D. 1.92 V
-
56. Electrolysis is carried out on molten aluminum chloride. What substance will be produced and collected at the anode?

- A. Elemental aluminum (Al)
B. Aluminum ions (Al^{3+})
C. Elemental Chlorine (Cl_2)
D. Chloride ions (Cl^-)

-
57. What is X in the following nuclear reaction?



- A. Alpha particle
B. Beta particle
C. Positron
D. Gamma ray
-
58. Nuclides above the valley of stability (belt of stability) can become more stable through which of the following processes?

- A. beta emission
B. gamma emission
C. alpha emission
D. positron emission
-

59. How long will it take for a 50.0 g sample to decay to a mass of 14.7 g given a half-life of 34.8 minutes?

A. 45.0 min

C. 70.1 min

B. 17.7 min

D. 61.5 min

60. A radioactive sample contains 16 g of an isotope with a half-life of 5.5 days. What mass of the isotope remains after 3 half-lives?

A. 8.0 g

C. 2.0 g

B. 4.0 g

D. 1.0 g

CHE 107 SPRING 2012 Final Exam Key

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

- 51. B
- 52. C
- 53. B
- 54. D
- 55. B
- 56. C
- 57. A
- 58. A
- 59. D
- 60. C