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5. A 16.2 gram sample of a radioactive nuclide decays to 2.9 grams in 14.9 seconds. What is the half-life of the nuclide? (21)

A. 93 seconds      B. 1.8 seconds      C. 6.0 seconds      D. 5.2 seconds      E. 12 seconds

6. How many grams of cesium hydrogen carbonate must be mixed with 64.0 grams of water in order to obtain a solution which has a mole fraction of cesium hydrogen carbonate equal to 0.156?

A.  $6.90 \times 10^2$  g      B.  $1.08 \times 10^2$  g      C.  $1.27 \times 10^2$  g      D.  $6.57 \times 10^{-1}$  g      E.  $1.18 \times 10^1$  g

7. The balanced equation for a given reaction is  $1 A + 1 B \rightarrow k \text{ products}$ . The following data regarding the rate at which the reaction occurs were collected in the lab.

Expt.	Rate*	(A)	(B)
1	$6.0 \times 10^{-3}$	0.500 M	0.400 M
2	$1.5 \times 10^{-3}$	0.250 M	0.400 M
3	$3.0 \times 10^{-3}$	0.250 M	0.800 M

\*rates are in M/sec

What is the order of the reaction with respect to A? (12A)

A. 0      B. 1      C. 2      D. 3      E. 4



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8. What is the pH of a solution which is 0.20 M in dimethylammonium iodide  $(\text{CH}_3)_2\text{NH}_2\text{I}$  and 0.10 M in dimethylamine  $(\text{CH}_3)_2\text{NH}$ ? (15A-4)
- A. 3.53                      B. 10.47                      C. 8.12                      D. 2.93                      E. 11.07

9. How many mL of 0.640 M hydroiodic acid are needed to completely neutralize 300.0 mL of 0.240 M strontium hydroxide? (4-10)
- A.  $3.00 \times 10^2$  mL    B.  $2.25 \times 10^2$  mL    C.  $1.60 \times 10^3$  mL    D.  $1.13 \times 10^2$  mL    E.  $5.63 \times 10^1$  mL

10. The  $K_{\text{sp}}$  of calcium carbonate is  $5.0 \times 10^{-9}$ . Calculate the solubility of calcium carbonate. (15B)
- A.  $1.1 \times 10^{-3}$  M    B.  $7.1 \times 10^{-5}$  M    C.  $3.7 \times 10^{-3}$  M    D.  $2.5 \times 10^{-17}$  M    E.  $1.7 \times 10^{-3}$  M

11. What is the amperage of a current if it causes 5.4 grams of iron to be plated out of a solution of iron(II) nitrate in 3.0 hours? (17)
- A.  $8.6 \times 10^{-1}$  amps    B.  $1.7 \times 10^0$  amps    C.  $5.2 \times 10^1$  amps    D.  $1.5 \times 10^2$  amps    E.  $9.3 \times 10^3$  amps



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12. What is the pH of a solution prepared by adding 25 mL of 0.23 M perchloric acid and 55 mL of 0.13 M strontium hydroxide? (14B,15A)
- A. 1.76                      B. 0.97                      C. 13.07                      D. 12.24                      E. 13.03
13. A certain reaction is found to proceed with an enthalpy change of 16 kcal and an entropy change of -10.0 cal/K. What is the free energy change for the reaction at 27°C? (16)
- A. 13 kcal                      B. 16 kcal                      C. 3 kcal                      D. 19 kcal                      E. 0.3 kcal
14. What is the pH of a 0.59 M solution of ethylamine  $\text{CH}_3\text{CH}_2\text{NH}_2$ ? (14B)
- A. 3.59                      B. 1.80                      C. 8.57                      D. 10.41                      E. 12.20
15. At a certain temperature, it is found that 0.30 moles of  $\text{N}_2\text{O}_4$  and 0.60 moles of  $\text{NO}_2$  are in equilibrium in a 3.0 liter container. What is the equilibrium constant for the reaction  $\text{N}_2\text{O}_4(\text{g}) = 2 \text{NO}_2(\text{g})$  ? (13)
- A. 0.40                      B. 2.5                      C. 0.50                      D. 0.17                      E. 1.2



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16. A reaction is found to be spontaneous at all temperatures. Which of the following is correct regarding this reaction? (16)

- A. The reaction is exothermic and proceeds so that order decreases.
- B. The reaction is endothermic and proceeds so that order decreases.
- C. The reaction is endothermic and proceeds so that order increases.
- D. The reaction is exothermic and proceeds so that order increases.
- E. It is not possible to select from the above answers on the basis of the information given.

17. Will a precipitate form if 25.0 mL of  $1.2 \times 10^{-6}$  M sodium iodide is added to 43.0 mL of  $3.2 \times 10^{-7}$  M silver(I) nitrate? (15B)

- A.  $Q = 8.9 \times 10^{-14}$ , so a precipitate will form.
- B.  $Q = 8.9 \times 10^{-14}$ , so a precipitate will not form.
- C.  $Q = 3.8 \times 10^{-13}$ , so a precipitate will form.
- D.  $Q = 3.8 \times 10^{-13}$ , so a precipitate will not form.
- E. None of the above are correct.

18. If 56.0 mL of a solution of sulfuric acid is diluted to 286 mL, the concentration of the resulting solution is found to be 2.84 M. What is the concentration of sulfuric acid in the original stock solution?

- A. 0.556 M      B. 0.0689 M      C. 18.1 M      D. 14.5 M      E. 5.56 M



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19. What is the percent of potassium hydroxide in a solution which is 0.210 M in potassium hydroxide? The specific gravity of the solution is 1.09. (11A)
- A. 0.0408 %      B. 1.08 %      C. 4.08 %      D. 56.6 %      E. 2.16 %
20. Which of the following indicates what happens if potassium chloride sublimates at  $-52^{\circ}\text{C}$ ? Its melting point is  $776^{\circ}\text{C}$  and its boiling point is  $1500^{\circ}\text{C}$ . (16)
- A. Free energy decreases, enthalpy decreases, and entropy increases.  
B. Free energy decreases, enthalpy increases, and entropy decreases.  
C. Free energy increases, enthalpy increases, and entropy decreases.  
D. Free energy decreases, enthalpy decreases, and entropy decreases.  
E. Free energy increases, enthalpy increases, and entropy increases.
21. What is the pH of a 0.20 M solution of dimethylammonium iodide  $(\text{CH}_3)_2\text{NH}_2\text{I}$ ? (14B)
- A. 8.27      B. 5.73      C. 12.04      D. 11.47      E. 1.96
22. The solubility of copper(I) sulfide in water is  $8.5 \times 10^{-17}$  M. Calculate the  $K_{\text{sp}}$  of the substance. (15B)
- A.  $9.2 \times 10^{-9}$       B.  $6.2 \times 10^{-49}$       C.  $2.5 \times 10^{-48}$       D.  $2.8 \times 10^{-6}$       E.  $7.3 \times 10^{-33}$



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23. At a temperature where hydrogen, oxygen, and water are all stable in the gaseous state, the equilibrium constant for the reaction  $2 \text{H}_2 + \text{O}_2 = 2 \text{H}_2\text{O}$  is found to be 0.50. At the same temperature, which of the following is correct regarding the system obtained by mixing 8.0 moles of water with 6.0 moles of hydrogen and 2.0 moles of oxygen in a 10.0 liter container and allowing to react so as to reach equilibrium? (13)
- A.  $Q = 0.89$  and the system reaches equilibrium by increasing the amount of  $\text{H}_2\text{O}$ .
  - B.  $Q = 0.89$  and the system reaches equilibrium by decreasing the amount of  $\text{H}_2\text{O}$ .
  - C.  $Q = 8.9$  and the system reaches equilibrium by increasing the amount of  $\text{H}_2\text{O}$ .
  - D.  $Q = 8.9$  and the system reaches equilibrium by decreasing the amount of  $\text{H}_2\text{O}$ .
  - E. None of the above.
24. If a solution prepared by dissolving 4.12 g of a nonelectrolyte in 60.0 grams of water boils at  $100.15^\circ\text{C}$ , what is the molecular weight of the solute?  $K_f$  for water =  $1.86^\circ\text{C}/\text{m}$  and  $K_b$  for water =  $0.51^\circ\text{C}/\text{m}$ .
- A.  $2.3 \times 10^2$  g/mole
  - B.  $8.5 \times 10^2$  g/mole
  - C.  $4.3 \times 10^1$  g/mole
  - D.  $5.0 \times 10^1$  g/mole
  - E.  $5.3 \times 10^1$  g/mole
25. What would be the expected freezing point of a solution prepared by adding 25 grams of urea (gfw=60.0) to 125 mL of water?  $K_b$  of water is  $0.51^\circ\text{C}/\text{m}$  and  $K_f$  is  $1.86^\circ\text{C}/\text{m}$ . (11B)
- A.  $-6.2^\circ\text{C}$
  - B.  $-1.7^\circ\text{C}$
  - C.  $-0.16^\circ\text{C}$
  - D.  $1.7^\circ\text{C}$
  - E.  $-3.3^\circ\text{C}$



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No. in Q-Bank	No. on Test	Correct Answer
40	8	1 E
44	8	2 C
47	8	3 E
2	8	4 C
58	8	5 C
3	8	6 C
51	8	7 C
28	8	8 B
67	8	9 B
37	8	10 B
41	8	11 B
19	8	12 E
35	8	13 D
31	8	14 E
9	8	15 A
33	8	16 A
46	8	17 A
1	8	18 D
16	8	19 B
36	8	20 E
32	8	21 B
38	8	22 C
11	8	23 D
7	8	24 A
6	8	25 A



Each correct answer is worth 3 pts. Record your answers on the back of the Scantron sheet.

51. What is the pOH of a solution with a hydrogen ion concentration of  $10^{-3}$  M?  
A. 3                      B. 7                      C. 14                      D. 8                      E. 11
52. If 7 moles of X, 5 moles of Y and 4 moles of Z are placed in a container and allowed to reach equilibrium according to the equation  $3 X + 2 Y = 3 Z$ , how many moles of Y are there at equilibrium if there is 1 mole of Z at equilibrium? (11A)  
A. 7                      B. 10                      C. 3                      D. 2                      E. 0
53. Choose the correct statements from the following using K-TYPE answer format. **I.E. Mark "A" if a, b, and c are correct; "B" if a and c are correct; "C" if b and d are correct; "D" if d only is correct; and "E" if any other pattern is correct.**  
A.  $\text{CH}_3\text{NH}_2$  is a base related to the salt,  $\text{NH}_4\text{Cl}$ .  
B.  $\text{NH}_3$  and  $\text{H}_2\text{SO}_3$  react to produce  $(\text{NH}_4)_2\text{SO}_4$  and water.  
C. A solution prepared by adding one mole of HCl and 1/2 mole of  $\text{NH}_3$  would have buffer properties.  
D. A solution prepared from 0.1 mole  $\text{CH}_3\text{COOH}$  and 0.1 mole  $\text{NaCH}_3\text{COO}$  would be a buffer.
54. Which of the following is equivalent to the unknown in the following nuclear equation? (21)  
 ${}^{238}\text{U} + n \rightarrow {}^{58}\text{Fe} + 2 n + ?$   
A.  ${}^{234}\text{U}$                       B.  ${}^{179}\text{Ho}$                       C.  ${}^{179}\text{Tb}$                       D.  ${}^{181}\text{Dy}$                       E.  ${}^{179}\text{Dy}$



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55. **K-TYPE Answer Format:** Mark *a* if A, B, C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise. (17)

- A.  $\text{Cr}_2\text{O}_7^{2-}$  is a better oxidizing agent than  $\text{F}_2$ .
- B.  $\text{H}_2$  and Zn are common reducing agents.
- C. Fe is a better reducing agent than Mg.
- D. The oxidation number of S in  $\text{SO}_4^{2-}$  is +4.

56. What is the pOH of a 0.00053 M solution of hydrochloric acid? (14B)

- A. 2.97
- B. 10.72
- C. 11.03
- D. 7.00
- E. 3.28

57. Choose the correct statements from the following using K-TYPE answer format. **I.E. Mark "A" if a, b, and c are correct; "B" if a and c are correct; "C" if b and d are correct; "D" if d only is correct; and "E" if any other pattern is correct.** (14A)

- A. According to Bronsted-Lowry, a base is a substance which donates an electron pair.
- B.  $\text{CH}_3\text{CH}_2\text{NH}^-$  is the conjugate base of  $\text{CH}_3\text{CH}_2\text{NH}_2$ .
- C. In the equation  $\text{HClO} + \text{H}_2\text{SO}_3 \rightarrow \text{H}_2\text{ClO}^+ + \text{HSO}_3^-$ ,  $\text{H}_2\text{SO}_3$  acts as a Bronsted-Lowry base.
- D. In the equation  $\text{CH}_3\text{COOH} + \text{NH}_3 \rightarrow \text{CH}_3\text{COO}^- + \text{NH}_4^+$ ,  $\text{NH}_4^+$  acts as a Bronsted-Lowry acid.



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58. **K-TYPE Answer Format:** Mark *a* if A, B, C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise. (16)

- A. The minimum work which can be done by a spontaneous reaction is equal to the change in free energy for the reaction.
- B. The Second Law of Thermodynamics tells us that the universe as a whole must increase in entropy in any spontaneous change.
- C. All reactions which occur rapidly have a negative enthalpy.
- D. Some reactions in which change in entropy is positive are spontaneous and some are not.

59. Choose the correct statements from the following using K-TYPE answer format. **I.E. Mark "A" if a, b, and c are correct; "B" if a and c are correct; "C" if b and d are correct; "D" if d only is correct; and "E" if any other pattern is correct.** (14A)

- A. HI is more acidic than HBr.
- B.  $\text{HBrO}_3$  is more acidic than  $\text{HBrO}_4$ .
- C.  $\text{NH}_3$  is less acidic than  $\text{H}_2\text{O}$ .
- D.  $\text{HBrO}_2$  is less acidic than  $\text{HIO}_2$ .

60. Given the reaction  $\text{Cd(s)} + \text{Ni}^{2+}(\text{aq}) \rightarrow \text{Ni(s)} + \text{Cd}^{2+}(\text{aq})$  Choose the correct statements using **K-TYPE Answer Format:** Mark *a* if A,B,C are correct; *b* if A, C; ; *c* if B, D; *d* if D only; *e* otherwise. (17)

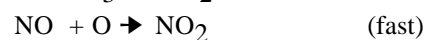
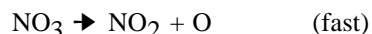
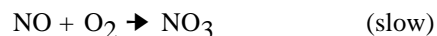
- A.  $\text{Cd(s)}$  is the reducing agent in the reaction above.
- B.  $\text{Ni}^{2+}(\text{aq})$  is oxidized in the reaction above.
- C.  $\text{Ni}^{2+}(\text{aq})$  gains electrons as the reaction above occurs.
- D. If the reaction  $\text{Z(s)} + \text{Y}^{2+}(\text{aq}) \rightarrow \text{Z}^{2+}(\text{aq}) + \text{Y(s)}$  proceeds spontaneously, then  $\text{Y(s)}$  is a better reducing agent than  $\text{Z(s)}$ .



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61. If the rate of a reaction at 45°C is  $3.2 \times 10^{-2}$  M/sec, at what temperature would its rate be  $1.6 \times 10^{-2}$  M/sec?
- A. 45°C                      B. 35°C                      C. 18°C                      D. 55°C                      E. 25°C

62. The mechanism for a certain reaction is



Choose the correct statements concerning using

**K-TYPE answer format:** Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise.

- A.  $\text{O}_2$  is a catalyst in the mechanism.
- B. The overall reaction is  $2 \text{NO} + \text{O}_2 \rightarrow 2 \text{NO}_2$ .
- C.  $\text{NO}_3$  is the only intermediate in the mechanism.
- D. If a reaction is third order with respect to (G) and second order with respect to (H), then its rate expression would be  $\text{rate} = k(\text{G})^3(\text{H})^2$ .
63. Choose the substances which are correctly described using **K-TYPE** answer format: Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise. (12B)
- A.  $\text{NH}_3(\text{aq})$  is a stronger base than  $\text{CH}_3\text{CH}_2\text{COO}^- (\text{aq})$ .
- B.  $\text{RbOH}$  is a strong base.
- C.  $\text{H}_2\text{S}$  is a weak acid.
- D.  $\text{HCN}$  acid is a polyprotic acid.



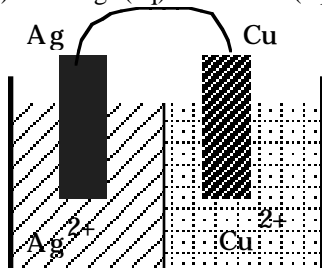
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64. The half-life for the reaction of a substance X by a 1st order process is 3 weeks. If one has 90 grams of the substance today, how much will remain in 3 months (= 12 weeks) ? (12A)

A. 90 g                      B. 5.6 g                      C. 0 g                      D. 11 g                      E. 45 g

65. **K-TYPE Answer Format:** Mark *a* if A, B, C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise.

Choose the correct statements concerning the cell diagrammed below using K-TYPE answer format. (17-4,10)

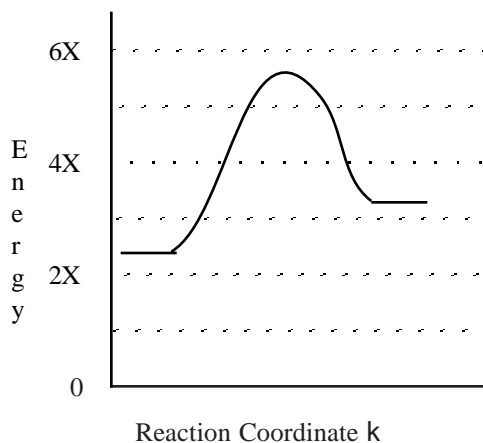


- A. The Ag electrode is the cathode.  
 B.  $\text{Ag}^+$  ions flow toward the Ag electrode as the battery operates.  
 C. The electrons move from the Cu electrode to the Ag electrode through the wire.  
 D. If pure silver(I) nitrate is added the silver half-cell, the voltage of the cell decreases.



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66. **X = 50 J** in the diagram. Choose the correct statements regarding the reaction represented by the diagram using **K-TYPE answer format**: Mark **a** if A, B, & C are correct; **b** if A & C are correct; **c** if B & D are correct; **d** if D only is correct; **e** otherwise.



- A. The energy of the activated complex is approximately 160 J.  
 B. The energy change for the reaction is approximately 155 J.  
 C. The energy of the reactants is approximately 275 J.  
 D. The activation energy for the reaction is approximately 155 J.

67. Choose the correct statements from the following using K-TYPE answer format. **I.E. Mark "A" if a, b, and c are correct; "B" if a and c are correct; "C" if b and d are correct; "D" if d only is correct; and "E" if any other pattern is correct.** (13,14)
- A. If K for a reaction is  $10^{-20}$ , then you would expect to find a relatively large amount of reactants in a system at equilibrium.  
 B. A reaction with  $K = 10^{19}$  would occur very rapidly.  
 C. Urea is probably more soluble in hot water than in cold water.  
 D. Ammonium nitrate does not break into ions if dissolved in water.



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68. Given the reaction  $2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g}) = 2 \text{SO}_3(\text{g})$ , what happens overall if  $\text{SO}_3$  is removed from a system in which the reaction is at equilibrium? (13)
- A. The amounts of  $\text{SO}_3$  and  $\text{SO}_2$  decrease, the amount of  $\text{O}_2$  increases.
  - B. The amount of  $\text{SO}_3$  decreases, the amounts of  $\text{SO}_2$  and  $\text{O}_2$  increase.
  - C. The amounts of  $\text{SO}_3$ ,  $\text{SO}_2$ , and  $\text{O}_2$  all decrease.
  - D. The amount of  $\text{SO}_3$  decreases, while the amounts of  $\text{O}_2$  and  $\text{SO}_2$  remain constant.
69. **K-TYPE answer format:** Mark *a* if A,B,C are correct; *b* if A, C; *c* if B, D; *d* if D only; *e* otherwise. (15B)
- A. If it appears in an aqueous solution alone,  $\text{Na}^+$  might be a solid.
  - B.  $\text{CaSO}_3$  is probably soluble in water.
  - C.  $\text{Sr}(\text{OH})_2$  is less soluble in pure water than in 0.5 M KOH.
  - D.  $\text{PbCl}_2$  is probably about equally soluble in water and 0.1 M acid solution.
70. What is the rate of appearance of water for the reaction  $2 \text{H}_2 + 1 \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$  when the rate of disappearance of  $\text{O}_2$  is 0.002 M/sec?
- A. 0.002 M/sec
  - B. 0.004 M/sec
  - C. 0.001 M/sec
  - D. 0.005 M/sec
  - E. 0.088 M/sec



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71. How does the pOH change when  $[\text{OH}^-]$  is decreased to 1/100 of its original value?
- A. It becomes 100 as large.
  - B. It is reduced to 1/100 of its original value.
  - C. It increases by 2 units.
  - D. It decreases by 2 units.
  - E. It is not affected.
72. A certain reaction is first order in (C). If the rate of the reaction is  $3.2 \times 10^{-3}$  M/sec when (C) is 0.1 M, what will be the rate when (C) is 0.3 M? (12A)
- A.  $9.6 \times 10^{-3}$  M/sec
  - B.  $2.9 \times 10^{-2}$  M/sec
  - C.  $8.6 \times 10^{-2}$  M/sec
  - D.  $3.2 \times 10^{-3}$  M/sec
  - E.  $1.1 \times 10^{-3}$  M/sec
73. **K-TYPE** answer format: *Mark a if A,B,C are correct; b if A,C; c if B,D; d if D only; e otherwise.* (11B)
- A. The vapor pressure of a 0.1 m solution of urea would be higher than that of a 0.2 m solution of urea.
  - B. The osmotic pressure of a 0.2 m solution of urea would be the same as that of a 0.2 m solution of sugar.
  - C. A 0.2 m solution of potassium bromide would have a higher boiling point than 0.2 m solution of sugar.
  - D. The freezing point of a 0.1 m solution of potassium nitrate would be lower than that of a 0.3 m solution of potassium nitrate.



Each correct answer is worth 3 pts. Record your answers on the back of the Scantron sheet.

74. Choose the correct statements from the following using K-TYPE answer format. I.E. Mark "A" if a, b, and c are correct; "B" if a and c are correct; "C" if b and d are correct; "D" if d only is correct; and "E" if any other pattern is correct. (14A)
- A. If  $\text{CH}_3\text{NH}_3\text{Cl}$  were dissolved in water, the resulting solution would have a pH of greater than 7.
  - B. If 1 mole of sugar were dissolved in 1 liter of water, the solution would contain a large number of ions.
  - C. A solution with a pH of 9.6 would turn litmus red.
  - D. If the pOH of a solution is 2.8, its pH would be 11.2 .
75. Choose the correct statements from the following using K-TYPE answer format. I.E. Mark "A" if a, b, and c are correct; "B" if a and c are correct; "C" if b and d are correct; "D" if d only is correct; and "E" if any other pattern is correct. (14A)
- A. In the equation  $\text{BF}_3 + \text{NH}_3 \rightarrow \text{BF}_3\text{NH}_3$ ,  $\text{NH}_3$  acts as a Lewis acid.
  - B. In the reaction  $\text{CN}^- + [\text{Fe}(\text{NH}_3)_6]^{2+} \rightarrow [\text{FeCN}(\text{NH}_3)_5]^+ + \text{NH}_3$ ,  $[\text{Fe}(\text{NH}_3)_6]^{2+}$  functions as a Lewis base.
  - C. A Lewis base is defined as a substance which accepts an electron pair during a reaction.
  - D. In  $\text{Al}^{3+} + 6 \text{H}_2\text{O} \rightarrow [\text{Al}(\text{H}_2\text{O})_6]^{3+}$ ,  $\text{Al}^{3+}$  acts like a Lewis acid.



Each correct answer is worth 3 pts. Record your answers on the back of the Scantron sheet.

No. in Q-Bank	No. on Test	Correct Answer
29	8	51 E
8	8	52 A
27	8	53 D
57	8	54 E
43	8	55 C
24	8	56 B
22	8	57 C
34	8	58 C
20	8	59 B
42	8	60 B
49	8	61 B
56	8	62 C
18	8	63 A
64	8	64 B
45	8	65 A
55	8	66 D
5	8	67 B
10	8	68 C
39	8	69 D
50	8	70 B
25	8	71 C
54	8	72 E
14	8	73 A
23	8	74 D
21	8	75 D