Name: _____ **Class:** _____ **Date:** _____ **ID: P**

Thermodynamics Practice Test

Multiple Choice
Identify the choice that best completes the statement or answers the question.
**You will have 5 questions over last semester material.*
** You will also have questions from ch 13-14 called "Blast from the Past".*
** You will not be given the formula's only the constants.*

Important formulas and constants

$Q = m\Delta H_{vap}$ $m = \Delta H_{vap}$
$Q = m\Delta H_{fus}$ $m = \Delta H_{fus}$
$Q = mC\Delta T$

For Water

ΔH_{fus} = 6.01 kJ/mol or 334 J/g
ΔH_{vap} = 40.7 kJ/mol or 2260 J/g
c = 4.18 J/g°C

____ 1. The random molecular motion of a substance is greatest when the substance is
   a. a gas.
   b. condensed.
   c. frozen.
   d. a liquid.

____ 2. The direct change of a substance from a solid to a gas is called...
   a. sublimation
   b. condensation
   c. evaporation
   d. deposition

____ 3. A chunk of ice whose temperature is **-20 ^{0}C** is added to an insulated cup filled with water at **0 ^{0}C.** What happens in the cup?
   a. some of the water freezes, so the chunk of ice gets larger
   b. the water cools until it reaches the temperature of the ice.
   c. the ice melts until it reaches the temperature of the water

____ 4. Particles in a gas are best described as ____.
   a. hard spheres influenced by repulsive forces from other spheres
   b. small, hard spheres with insignificant volumes
   c. slow-moving, kinetic, hard spheres
   d. spheres that are in fixed positions when trapped in a container

____ 5. If you were to touch the flask in which an endothermic reaction were occurring, _____.
   a. the flask would probably feel cooler than before the reaction started
   b. the flask would feel the same as before the reaction started
   c. the flask would probably feel warmer than before the reaction started
   d. none of the above

____ 6. When the external pressure is 505 kPa, what is the vapor pressure of water at its boiling point?
   a. 505 kPa
   b. 1010 kPa
   c. 101.3 kPa
   d. 0 kPa

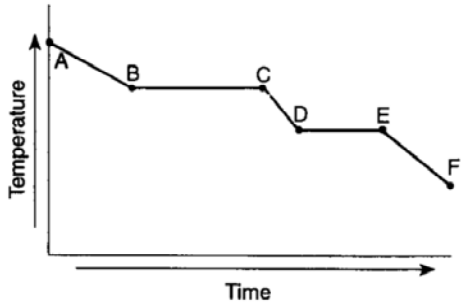
____ 7. How much heat must you add to **boil** 101 g of water at 100°C?

a. 3.34×10^4
b. 2.26×10^7 J
c. 4.18×10^4 J
d. 2.28×10^5 J

____ 8. When 45 g of an alloy, at 25°C, are dropped into 100.0 g of water, the alloy absorbs 956 J of heat. If the final temperature of the alloy is 37°C, what is its specific heat?

a. $9.88 \frac{\text{cal}}{\text{g°C}}$
b. $1.77 \frac{\text{cal}}{\text{g°C}}$
c. $0.423 \frac{\text{cal}}{\text{g°C}}$
d. $48.8 \frac{\text{cal}}{\text{g°C}}$

____ 9. The graph below represents the uniform cooling (freezing) of a substance, starting with the substance as a gas above its boiling point.



During which interval is the substance completely in the liquid phase?

a. AB
b. BC
c. CD
d. DE
e. EF

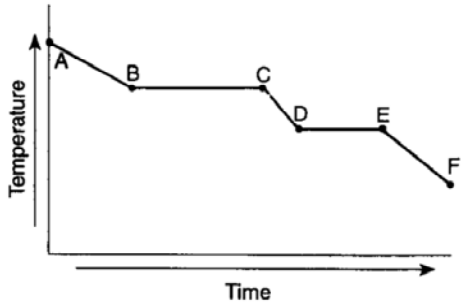
____ 10. During a phase change, the temperature of a substance ____.

a. may increase or decrease
b. remains constant
c. decreases
d. increases

____ 11. Which of the following statements is NOT true, according to the kinetic theory?

a. The particles of a gas collide with each other and with other objects.
b. Only particles of matter in the gaseous state are in constant motion.
c. There is no attraction between particles of a gas.
d. All of the statements are true.

____ 12. The graph below represents the uniform cooling (freezing) of a substance, starting with the substance as a gas above its boiling point.

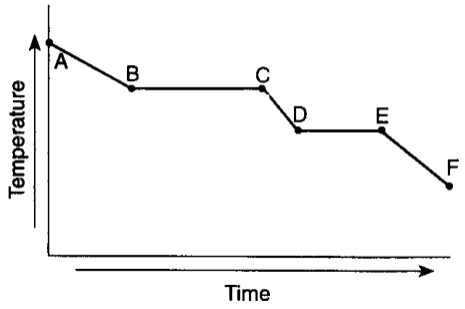


Choose the correct formula to find the amount of heat change from D to E.

a. $Q = m(-\Delta H_{fus})$
b. $Q = m\Delta H_{vap}$
c. $Q = m\Delta H_{fus}$
d. $Q = m(-\Delta H_{vap})$
e. $Q = mC\Delta T$

____ 13. A piece of metal is heated, then submerged in cool water. Which statement below describes what happens?

a. The temperature of the water will increase.
b. The temperature of the water will decrease.
c. The temperature of the water will increase and the temperature of the metal will decrease.
d. The temperature of the metal will increase.



____ 14.

According to the above figure, what is happening as a substance goes from point A to point B?

a. A gas is getting colder
b. Ice is melting
c. A solid is getting warmer
d. A gas is condensing

____ 15. What happens to the rate of evaporation of a liquid as the liquid is cooled?

a. It decreases.
b. It does not change.
c. The change cannot be determined.
d. It increases.

____ 16. Why is boiling a cooling process?

a. The particles with more potential energy leave the liquid first, leaving the remaining particles with less potential energy
b. The particles with less potential energy leave the liquid first, leaving the remaining particles with more potential energy
c. The particles with more kinetic energy leave the liquid first, leaving the remaining particles with less kinetic energy
d. The particles with less kinetic energy leave the liquid first, leaving the remaining particles with more kinetic energy

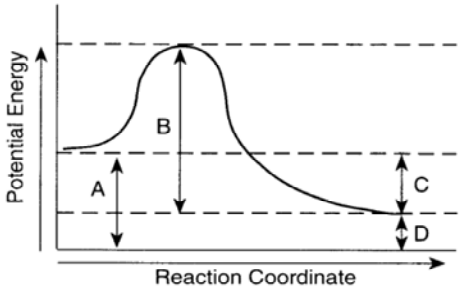
____ 17. How much heat needs to be absorbed by 100.0 g of water at 5.0°C to raise its temperature to 75.0°C?

a. 2.93×10^4 J
b. 1.57×10^5 J
c. 175 J
d. 4.18 J

____ 18. What must happen for liquid water to freeze?

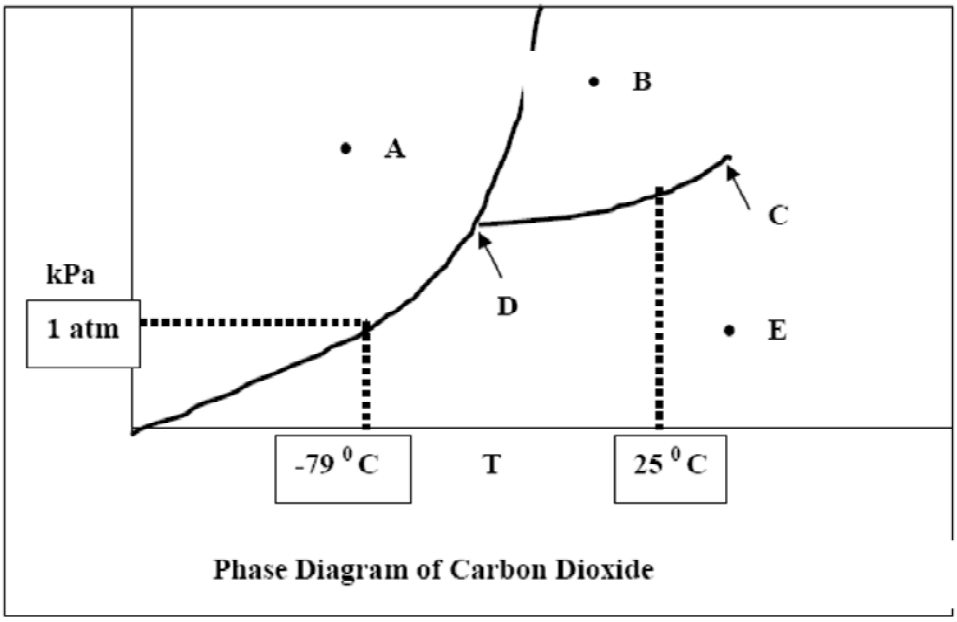
a. The water must absorb kinetic energy from the surroundings.
b. The water molecules must begin to move in random patterns.
c. The water molecules must begin to move faster
d. The water must release energy to the surroundings.

____ 19. The potential energy diagram of a chemical reaction is shown below.



Which letter represents the total amount of energy released in this exothermic reaction?

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



Phase Diagram of Carbon Dioxide

____ 20. What would happen to a sample of Carbon Dioxide at a constant pressure of 0.9 atm if it were heated from -100°C to 25°C?

a. It would melt
b. It would freeze
c. It would boil
d. It would sublime
e. It would condense

____ 21. When a substance condenses or freezes energy is _____ and when a substance evaporates or melts energy is _____.

a. absorbed, released
b. released, absorbed

____ 22. Freezing water is a(an) ____.
a. endothermic process
b. polythermic process
c. ectothermic process
d. exothermic process

____ 23. How much heat in kJ is absorbed when 50.0 g of ice at 0°C **melts**?
a. 0 J
b. 226 kJ
c. 16.7 kJ
d. 20.9 kJ

____ 24. A piece of candy has 5 Calories (or 5000 calories). If it could be burned, leaving nothing but carbon dioxide and water, how much heat would it give off?
a. Not enough information is given.
b. 5000 joules
c. 5 kilocalories
d. 500 calories

____ 25. Water could be made to boil at 95 °C instead of 100 °C by _____.
a. decreasing the air pressure above the water
b. decreasing the vapor pressure of the water
c. increasing the air pressure on the water
d. applying a great deal of heat

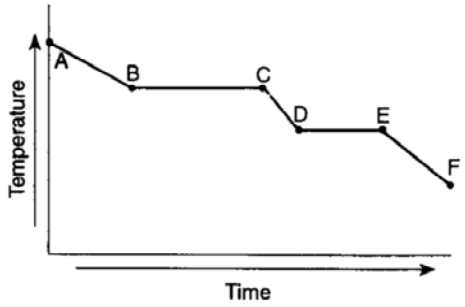
____ 26. Heat changes can occur when _____.
a. a substance vaporizes
b. a substance melts
c. a substance dissolves
d. a substance solidifies
e. all of the above

____ 27. The following equation shows the reaction that occurs when nitroglycerine explodes.

$$4\ C_3H_5O_9N_3 \rightarrow 12CO_2 + 6N_2 + O_2 + 10H_2O + 1725\ kJ$$

This reaction is _____.
a. endothermic
b. a combination reaction
c. exothermic
d. a combustion reaction

____ 28. The graph below represents the uniform cooling (freezing) of a substance, starting with the substance as a gas above its boiling point.



Choose the correct formula to find the amount of heat change from E to F.
a. $Q = m\Delta H_{fus}$
b. $Q = mC\Delta T$
c. $Q = m(-\Delta H_{vap})$
d. $Q = m(-\Delta H_{fus})$
e. $Q = m\Delta H_{vap}$

____ 29. The first particles to vaporize from a liquid that is boiling are _____.
a. those with the highest kinetic energy
b. those with the lowest kinetic energy
c. those farthest from the surface of the liquid

____ 30. Standard conditions when working with gases are defined as ____.
a. 0°C and 1 kPa
b. 0 K and 101.3 kPa
c. 0°C and 101.3 kPa
d. 0 K and 1 kPa

____ 31. Which of the following usually makes a substance dissolve faster in a solvent?
a. agitating the solution
b. increasing the particle size of the solute
c. lowering the temperature
d. decreasing the number of particles

____ 32. What is the molarity of a solution that contains 6 moles of solute in 2 liters of solution?
a. 6*M* c. 7*M*
b. 12*M* d. 3*M*

____ 33. What is the molarity of a solution containing 7.0 moles of solute in 569 mL of solution?
a. 81*M* c. 12*M*
b. 0.081*M* d. 4.0*M*

____ 34. What is the molarity of a solution containing 56 grams of solute in 959 mL of solution? (molar mass of solute = 26 g/mol)
a. 1.5*M* c. 2.1*M*
b. 2.2*M* d. 0.0022*M*

____ 35. What mass of sucrose, $C_{12}H_{22}O_{11}$, is needed to make 500.0 mL of a 0.200*M* solution?
a. 34.2 g c. 17.1 g
b. 100 g d. 68.4 g

____ 36. How many mL of a 2.0*M* NaBr solution are needed to make 200.0 mL of 0.50*M* NaBr?
a. 25 mL c. 100 mL
b. 50 mL d. 150 mL

____ 37. The volume of 6.00*M* HCl needed to make 319 mL of 6.80*M* HCl is ____.
a. 0.128 mL c. 281 mL
b. 7.8 mL d. 362 mL

____ 38. To 225 mL of a 0.80*M* solution of KI, a student adds enough water to make 1.0 L of a more dilute KI solution. What is the molarity of the new solution?
a. 180*M* c. 0.35*M*
b. 2.8*M* d. 0.18*M*

____ 39. The volume of 400 mL of chlorine gas at 400 mm Hg is decreased to 200 mL at constant temperature. What is the new gas pressure?
a. 400 mm Hg c. 800 mm Hg
b. 300 mm Hg d. 650 mm Hg

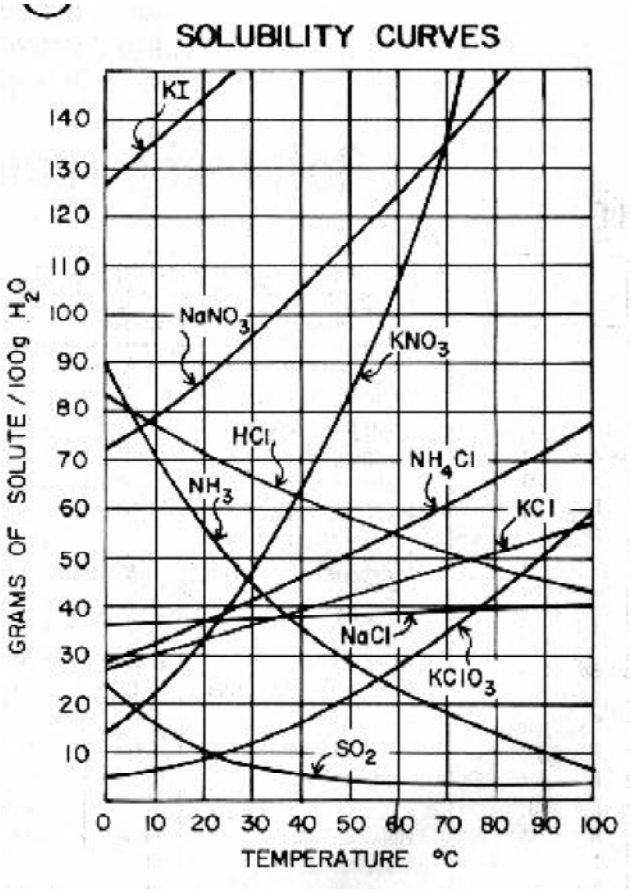
SOLUBILITY OF SUBSTANCES IN WATER @ 20 °C		
Substance	**Formula/State**	**Solubility** (g/100g H_2O)
Magnesium chloride	$MgCl_2$ / solid	54.6
Ammonia	NH_3 / gas	34.0
Ethanol	CH_3CH_2OH / liquid	infinite
Benzoic Acid	C_6H_5COOH / solid	0.29

____ 40. Which of the substances in the table can act as either the solute or the solvent when mixed with 100 grams of water at 20 °C?
a. NH_3 c. $MgCl_2$
b. C_6H_5COOH d. CH_3CH_2OH

____ 41. Which of these is an example of an exothermic chemical process?
a. evaporation of water c. photosynthesis of glucose
b. melting ice d. combustion of gasoline

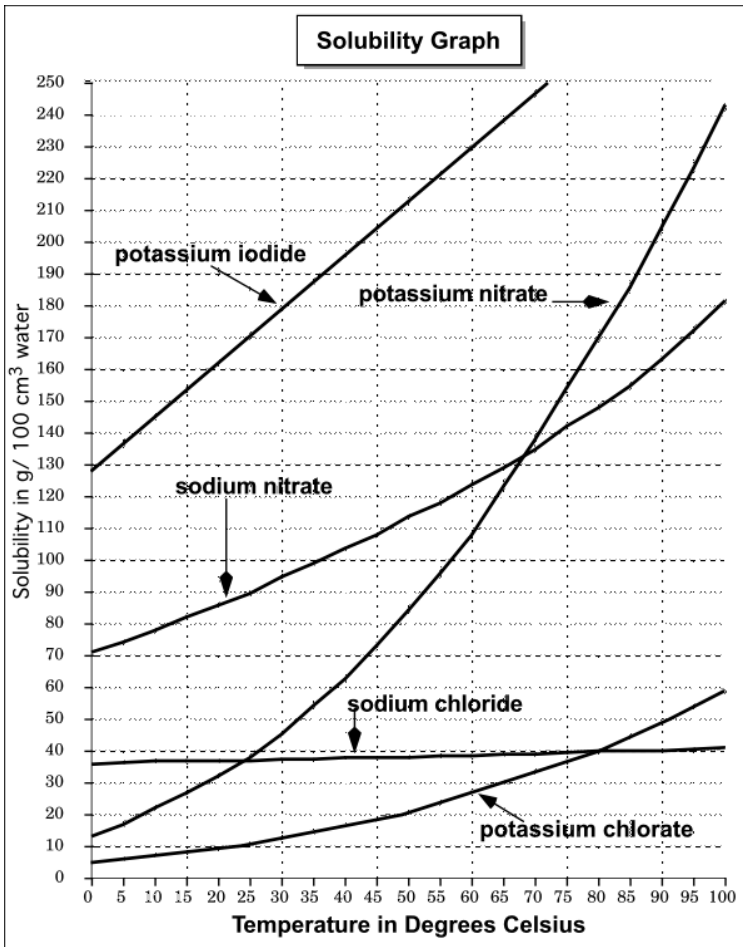
____ 42. How much energy is released when 752 g of water at its freezing point freezes?

a. 4.18 kJ
b. 3.14 kJ
c. 251 kJ
d. 752 kJ



____ 43. Based on the above graph, which of the following substances show an inverse relationship between temperature and solubility?

a. KCl
b. SO_2
c. NH_4Cl
d. KNO_3



____ 44.

At what temperature will 1600 g of potassium nitrate dissolve in 1.0 L of water?

a. 75°C
b. 100°C
c. 0°C
d. 50°C

____ 45. A 25.0 g sample of water at 100°C has an energy change of -1670 J. What is the new temperature of the water?

a. 116°C
b. 84.0°C
c. 104.18°C
d. 58.5°C

____ 46. 64.0 g of a gas occupies 50.0 L at a pressure of 121 kPa and a temperature of 298 K. What is the molar mass of the gas?

a. 1.28 g/mol
b. 32.0 g/mol
c. 154 g/mol
d. 26.2 g/mol

____ 47. A cylindrical coffee can is welded shut at 20°C at sea level (1.0 atm). Its height is 20 cm and its radius is 15 cm. If the bursting strength of its "tin" plate is 4.00 atm, to what temperature may it be heated before bursting?

a. 720°C
b. 1272 °C
c. 80 °C
d. 899°C

____ 48. A sample of a gas with a volume of 3.9 L at 27°C and 1.00 atm is cooled at a constant pressure until the temperature is 11°C. Calculate the new volume.

a. 1.4 L
c. 3.7 L
b. 5.1 L
d. 4.0 L

____ 49. How many liters of NH_3, at STP, will react with 5.3 g O_2 to form NO_2 and water?

$4NH_3(g) + 7O_2(g) \rightarrow 4NO_2 + 6H_2O(g)$

a. 0.004 23 L
c. 3.03 L
b. 2.12 L
d. 6.49 L

____ 50. What type of reaction is the reaction below?

$Fe_2O_3 \rightarrow Fe + O_2$

a. Synthesis/Combination
c. Combustion
b. Decomposition
d. Single Replacement

____ 51. P_4O_{10} + H_2O --> H_3PO_4

How many molecules of water are needed to produce 66.8 g of phosphoric acid?

a. 2.74×10^1
c. 6.16×10^{23}
b. 6.16×10^1
d. 61.6×10^{-23}

____ 52. Select the set of coefficients that properly balance the equation below.

__ $Pb(NO_3)_2$ + __ NH_4Cl → __ $PbCl_2$ + __ NH_4NO_3

a. 1, 2, 1, 2
c. 2, 1, 2, 1
b. 1, 2, 2, 1
d. 1, 2, 2, 2

____ 53. What is the correct name for $Sn_3(PO_4)_2$?

a. tritin diphosphate
c. tin(III) phosphate
b. tin(II) phosphate
d. tin(IV) phosphate

____ 54. What is the formula for phosphoric acid?

a. H_2PO_3
c. HPO_2
b. H_3PO_4
d. HPO_4

____ 55. What is the correct formula for Carbonic Acid?

a. HCO_3
b. H_2CO_3
c. HC_2O_4
d. $H_2C_2O_4$

____ 56. The correct name for HBr is:

a. hydrobromic acid
c. hydrogen monobromide
b. hydrogen bromide
d. monohydrobromic acid

____ 57. What is the correct formula for barium chlorate?

a. $Ba(ClO)_2$
c. $Ba(ClO_3)_2$
b. $Ba(ClO_2)_2$
d. $BaCl_2$

____ 58. Sketch a phase change diagram for water starting at 120 ^{0}C & increasing to -60 ^{0}C.

Consider the change in temerpature for your graph. Choose the best desription.

a. ΔT and Endothermic
b. ΔT and Exothermic
c. $-\Delta T$ and Endothermic
d. $-\Delta T$ and Exothermic
e. ΔT Niether Exothermic or Endothermic

Multiple Response
Identify one or more choices that best complete the statement or answer the question.

____ 59. Choose which example/s below are exothermic. Choose all the apply.

a. burning hydrogen gas
b. condensing steam
c. melting ice
d. burning wood
e. boiling water

Short Answer

60. It takes 770 joules of energy to raise the temperature of 50.0 g of mercury by 110 °C. What is the specific heat of mercury?

61. How much heat is required to raise the temperature of 5.5×10^2 g of aluminum by 10°C? (specific heat of aluminum = 0.21 $\frac{\text{cal}}{\text{g°C}}$)

62. A 55.0-g piece of copper wire is heated, and the temperature of the wire changes from 19.0 °C to 86.0°C. The amount of heat absorbed is 343 cal. What is the specific heat of copper?

63. What is a pressure of 0.520 atm equal to in mm of Hg?

True/False
Indicate whether the statement is true or false.

____ 64. The melting point and the freezing point of a water occur at the same temperature.

Thermodynamics Practice Test
Answer Section

MULTIPLE CHOICE

1. ANS: A
   St. 4b, 7a

   PTS: 1 STA: 4b, 7a
2. ANS: A PTS: 1
3. ANS: A PTS: 1
4. ANS: B PTS: 1 DIF: L2 REF: p. 385
   OBJ: 13.1.1 STA: Ch.4.b
5. ANS: A PTS: 1
6. ANS: A PTS: 1 DIF: L2 REF: p. 394
   OBJ: 13.2.4 STA: Ch.4.d
7. ANS: D PTS: 1
8. ANS: B PTS: 1 DIF: L2 REF: p. 509
   OBJ: 17.1.3 STA: Ch.7.d
9. ANS: C PTS: 1
10. ANS: B PTS: 1 DIF: L1 REF: p. 520
    OBJ: 17.3.1 STA: Ch.7.d
11. ANS: B PTS: 1 DIF: L2 REF: p. 385
    OBJ: 13.1.1 STA: Ch.4.b
12. ANS: A PTS: 1
13. ANS: C PTS: 1 DIF: L1 REF: p. 506
    OBJ: 17.1.1 STA: Ch.7.a
14. ANS: A PTS: 1
15. ANS: A PTS: 1 DIF: L2 REF: p. 391
    OBJ: 13.2.2 STA: Ch.7.a
16. ANS: C PTS: 1
17. ANS: A PTS: 1
18. ANS: D
    St. 7c

    PTS: 1
19. ANS: C PTS: 1
20. ANS: D PTS: 1
21. ANS: B PTS: 1
22. ANS: D PTS: 1 DIF: L1 REF: p. 506
    OBJ: 17.1.2 STA: Ch.7.b
23. ANS: C PTS: 1
24. ANS: C PTS: 1 DIF: L2 REF: p. 507
    OBJ: 17.1.2 STA: Ch.7.d
25. ANS: A PTS: 1
26. ANS: E PTS: 1
27. ANS: C PTS: 1

28. ANS: B PTS: 1
29. ANS: A PTS: 1
30. ANS: C PTS: 1 DIF: L1 REF: p. 387
OBJ: 13.1.2 STA: Ch.4.d
31. ANS: A PTS: 1 DIF: L2 REF: p. 471 | p. 472
OBJ: 16.1.1 STA: Ch.6.b
32. ANS: D PTS: 1 DIF: L1 REF: p. 481
OBJ: 16.2.1 STA: Ch.6.d
33. ANS: C PTS: 1 DIF: L2 REF: p. 480 | p. 481
OBJ: 16.2.1 STA: Ch.6.d
34. ANS: B PTS: 1 DIF: L3 REF: p. 481
OBJ: 16.2.1 STA: Ch.6.d
35. ANS: A PTS: 1 DIF: L3 REF: p. 481 | p. 482
OBJ: 16.2.1 STA: Ch.6.d
36. ANS: B PTS: 1 DIF: L2 REF: p. 483 | p. 484
OBJ: 16.2.2 STA: Ch.6.d
37. ANS: D PTS: 1 DIF: L2 REF: p. 483 | p. 484
OBJ: 16.2.2 STA: Ch.6.d
38. ANS: D PTS: 1 DIF: L3 REF: p. 483 | p. 484
OBJ: 16.2.2 STA: Ch.6.d
39. ANS: C
St. 4c

PTS: 1 STA: 4c
40. ANS: D
St. 6a

PTS: 1 STA: 6a
41. ANS: D
St. 7b

PTS: 1
42. ANS: C
St. 7c

PTS: 1 STA: 7c
43. ANS: B
St.6c

PTS: 1 STA: 6c
44. ANS: A
St. 6c

PTS: 1 STA: 6c
45. ANS: B PTS: 1
46. ANS: D PTS: 1
47. ANS: D PTS: 1

48. ANS: C
St. 4c

PTS: 1 STA: 4c
49. ANS: B PTS: 1 DIF: L2 REF: p. 371
OBJ: 12.3.1 STA: Ch.3.d
50. ANS: B PTS: 1 STA: 3a KEY: Types of Reactions; Decomposition
51. ANS: C PTS: 1
52. ANS: A PTS: 1 STA: 3a KEY: Balancing Equations
53. ANS: B PTS: 1 DIF: L3 REF: p. 264 | p. 277
OBJ: 9.5.3 STA: Ch.2.b | Ch.5
54. ANS: B PTS: 1 DIF: L2 REF: p. 272
OBJ: 9.4.2 STA: Ch.5
55. ANS: B PTS: 1
56. ANS: A
ST 1A

PTS: 1
57. ANS: C PTS: 1 DIF: L3 REF: p. 257 | p. 264
OBJ: 9.2.2 | 9.5.2 STA: Ch.5
58. ANS: D PTS: 1

MULTIPLE RESPONSE

59. ANS: A, B, D PTS: 1

SHORT ANSWER

60. ANS:

$$\text{Specific heat} = \frac{770\ \text{J}}{50\ \text{g} \cdot 110°\text{C}} = 0.14\ \frac{\text{J}}{\text{g°C}}$$

PTS: 1 DIF: L2 REF: p. 512 OBJ: 17.2.1
STA: Ch.7.d
61. ANS:
Heat energy = mass × specific heat × temperature change

$$= 550\ \text{g} \times 0.21\ \frac{\text{cal}}{\text{g°C}} \times 10°\text{C}$$

$$= 1.2 \times 10^3\ \text{cal}$$

PTS: 1 DIF: L2 REF: p. 508 OBJ: 17.1.3
STA: Ch.7.d

62. ANS:
ΔT = 86.0°C – 19.0°C = 67.0°C

$$\text{specific heat} = \frac{\text{heat absorbed}}{\text{mass temperature change}}$$

$$= \frac{343\ \text{cal}}{55.0\ \text{g} \cdot 67.0°\text{C}}$$

$$= 9.31 \times 10^{-2}\ \frac{\text{cal}}{\text{g°C}}$$

PTS: 1 DIF: L2 REF: p. 509 | p. 510
OBJ: 17.1.3 STA: Ch.7.d

63. ANS:
0.520 atm × 760 mm Hg / 1 atm = 395 mm Hg

PTS: 1 DIF: L2 REF: p. 387 OBJ: 13.1.2
STA: Ch.4.d

TRUE/FALSE

64. ANS: T PTS: 1