1. What is the total number of kiloJoules required to boil 100. grams of water at 100ºC and 1 atmosphere?

   A) 33.4 kJ   B) 334 kJ
   C) 22.6 kJ   **D) 226 kJ**

2. What occurs when a substance melts?

   A) It changes from liquid to solid, and heat is absorbed.
   B) It changes from liquid to solid, and heat is released.
   C) It changes from solid to liquid, and heat is released.
   D) It changes from solid to liquid, and heat is absorbed.

3. What is the minimum number of kiloJoules needed to change 40.0 grams of water at 100C to steam at the same temperature and pressure?

   A) 90.4 kJ   B) 2.26 kJ
   C) 1,810 kJ   D) .400 kJ

4. Which statement describes the transfer of heat energy that occurs when an ice cube is added to an insulated container with 100 milliliters of water at 25°C?

   A) Both the ice cube and the water lose heat energy.
   B) Both the ice cube and the water gain heat energy.
   C) The ice cube gains heat energy and the water loses heat energy.
   D) The ice cube loses heat energy and the water gains heat energy.

5. The heat of vaporization of a liquid is 1,340 Joules per gram. What is the minimum number of Joules needed to change 40.0 grams of the liquid to vapor at the boiling point?

   A) 33.5   B) 1,340
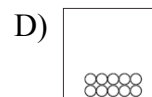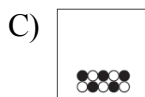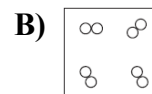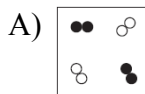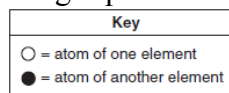   **C) 53,600**   D) 3,280

6. When 420 Joules of heat energy is added to 10. grams of water at 20.°C, the final temperature of the water will be
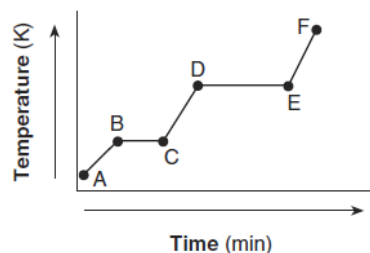
   A) 40.°C   **B) 30.°C**
   C) 10.°C   D) 100°C

7. Which change of phase is exothermic?

   A) $H_2O(s) \rightarrow H_2O(g)$ B) $CO_2(s) \rightarrow CO_2(\ell)$
   C) $NH_3(\ell) \rightarrow NH_3(g)$ **D) $H_2S(g) \rightarrow H_2S(\ell)$**

8. Which particle diagram represents one substance in the gas phase?

   Key
   O = atom of one element
   ● = atom of another element

   A)   B)

   C)   D)

9. The heating curve below represents a sample of a substance starting as a solid below its melting point and being heated over a period of time.

   Which statement describes the energy of the particles in this sample during interval *DE*?

   A) Both potential energy and average kinetic energy increase.
   B) Both potential energy and average kinetic energy decrease.
   C) Potential energy remains the same and average kinetic energy increases.
   D) Potential energy increases and average kinetic energy remains the same.

10. The graph below represents changes of state for an unknown substance.
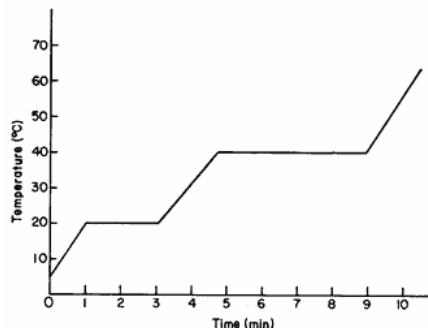
    What is the boiling temperature of the substance?

    A) 0°C   **B) 40°C**   C) 20°C   D) 70°C

11. Which statement explains why H_2O has a higher boiling point than N_2?

A) H_2O has greater molar mass than N_2.

B) H_2O has less molar mass than N_2.

C) H_2O has weaker intermolecular forces than N_2.

D) H_2O has stronger intermolecular forces then N_2.

12. What is the total number of kiloJoules of heat energy absorbed when the temperature of 200 grams of water is raised from 10°C to 40°C?

A) 0.126 kJ   B) 0.840 kJ

C) 33.6 kJ   **D) 25.2 kJ**

13. Which equation represents sublimation?

A) $I_2(s) \rightarrow I_2(g)$ B) $I_2(s) \rightarrow I_2(\ell)$

C) $I_2(\ell) \rightarrow I_2(s)$ D) $I_2(\ell) \rightarrow I_2(g)$

14. A sample of water is heated from 10.0°C to 15.0°C by the addition of 126 Joules of heat. What is the mass of the water?

A) 5.00 g   B) 150.0 g

C) 6.00 g   D) 30.0 g

15. The temperature of 50.0 grams of water was raised to 50.0°C by the addition of 4200 Joules of heat energy. What was the initial temperature of the water?

A) 10.0°C   B) 20.0°C

C) 30.0°C   D) 60.0°C

16. The graph below represents the uniform heating of a substance from the solid to the gas phase.
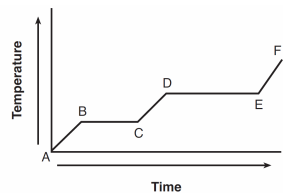
Which line segment of the graph represents boiling?

A) $\overline{AB}$ B) $\overline{BC}$ C) $\overline{CD}$ **D) $\overline{DE}$**

17. How many Joules of heat energy are absorbed in raising the temperature of 10. grams of water from 5.0°C to 20.°C?

A) 6.3×10^2   B) 2.1×10^2

C) 8.4×10^2 D) 1.1×10^3

18. A student observing the behavior of paradichlorobenzene first heats 10 grams of the substance in a hot water bath until it is completely liquefied. The following data are recorded as paradichlorobenzene cools.
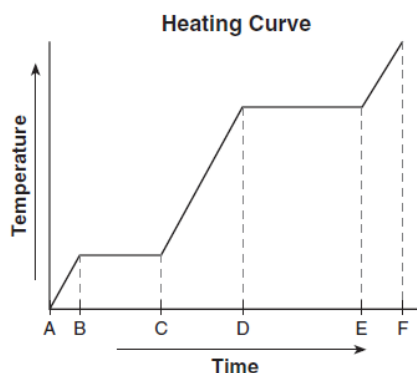
DATA TABLE

Time (minutes)	Temperature (°C)
0	65
1	58
2	52
3	53
4	53
5	53
6	53
7	53
8	51
9	47
10	42

What is the freezing point of paradichlorobenzene?

A) 42°C   **B) 53°C**   C) 58°C   D) 65°C

19. Given the diagram representing a heating curve for a substance:

During which time interval is the average kinetic energy of the particles of the substance constant while the potential energy of the particles increases?

A) CD **B) BC**   C) DF D) AC

Base your answers to questions **20** and **21** on the information below and on your knowledge of chemistry.

A sample of a substance is a liquid at 65°C. The sample is heated uniformly to 125°C. The heating curve for the sample at standard pressure is shown below.

Heating Curve
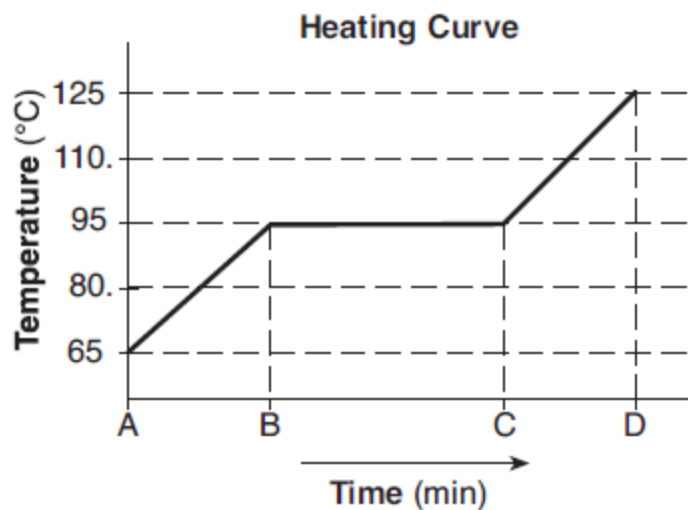
20. Determine the boiling point of the sample at standard pressure.

21. State what happens to the potential energy of the particles of the sample during time interval BC.

22. In which equation does the term "heat" represent heat of fusion?

A) $H_2O(\ell) + HCl(g) \rightarrow H_3O^+(aq) + Cl^-(aq) + heat$
B) $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(\ell) + heat$
C) **NaCl(s) + heat → NaCl(ℓ)**
D) $H_2O(\ell) + heat \rightarrow H_2O(g)$

23. Base your answer to the following question on the information below and on your knowledge of chemistry.

A sample of a molecular substance starting as a gas at 206°C and 1 atm is allowed to cool for 16 minutes. This process is represented by the cooling curve below.

Cooling Curve for a Substance
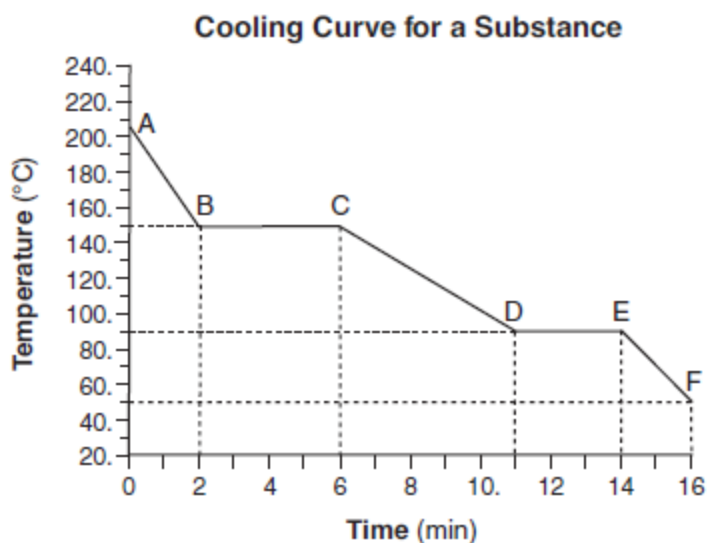
Describe what happens to the potential energy and the average kinetic energy of the molecules in the sample during interval *DE*.

24. Base your answer to the following question on the information below.

Natural gas is a mixture that includes butane, ethane, methane, and propane. Differences in boiling points can be used to separate the components of natural gas. The boiling points at standard pressure for these components are listed in the table below.

Data Table

Component of Natural Gas	Boiling Point at Standard Pressure (°C)
butane	−0.5
ethane	−88.6
methane	−161.6
propane	−42.1

List the *four components of natural gas in order of increasing strength of intermolecular forces.*

25. Base your answer to the following question on the information below.

In a laboratory, a student makes a solution by completely dissolving 80.0 grams of KNO$_3$(s) in 100.0 grams of hot water. The resulting solution has a temperature of 60.°C. The room temperature in the laboratory is 22°C.

Describe the direction of heat flow between the solution made by the student and the air in the laboratory.

Answer Key
Thermochem Practice Test

1. **D**

2. **D**

3. **A**

4. **C**

5. **C**

6. **B**

7. **D**

8. **B**

9. **D**

10. **B**

11. **D**

12. **D**

13. **A**

14. **C**

15. **C**

16. **D**

17. **A**

18. **B**

19. **B**

20. Any value from $94°C$ to $96°C$

21. — The potential energy of the particles increases during the interval BC. — The particles of the sample gain potential energy.

22. **C**

23. — Potential energy: decreases — Average kinetic energy: no change

    — Potential energy: There is a decrease.— Average kinetic energy: It remains the same.

24.

methane	ethane	propane	butane
Weakest intermolecular forces			Strongest intermolecular forces
CH_4	C_2H_6	C_3H_8	C_4H_{10}
Weakest intermolecular forces			Strongest intermolecular forces

25. Heat flows from the solution to the air in the laboratory. *or* The air gains heat from the solution.