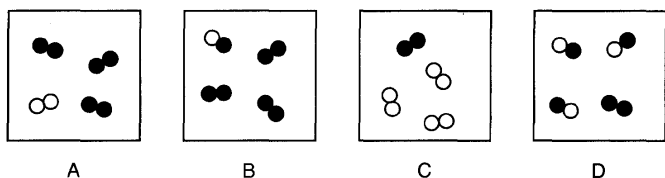
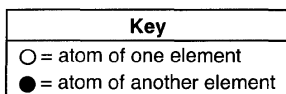


1. Which sample of  $\text{CO}_2$  has a definite shape and a definite volume?

- (A)  $\text{CO}_2(\text{aq})$                       (B)  $\text{CO}_2(\text{g})$   
(C)  $\text{CO}_2(\ell)$                         (D)  $\text{CO}_2(\text{s})$

2. Which two particle diagrams represent mixtures of diatomic elements?



- (A) A and B                              (B) A and C  
(C) B and C                              (D) B and D

3. Which substance can be broken down by chemical means?

- (A) CO    (B) Ce    (C) Ca    (D) Cu

4. Which grouping of the three phases of bromine is listed in order from left to right for increasing distance between bromine molecules?

- (A) gas, liquid, solid                      (B) liquid, solid, gas  
(C) solid, gas, liquid                      (D) solid, liquid, gas

5. Which 5.0-milliliter sample of  $\text{NH}_3$  will take the shape of and completely fill a closed 100.0-milliliter container?

- (A)  $\text{NH}_3(\text{s})$                               (B)  $\text{NH}_3(\ell)$   
(C)  $\text{NH}_3(\text{g})$                               (D)  $\text{NH}_3(\text{aq})$

6. Which formula represents a mixture?

- (A)  $\text{C}_6\text{H}_{12}\text{O}_6(\ell)$                               (B)  $\text{C}_6\text{H}_{12}\text{O}_6(\text{s})$   
(C)  $\text{LiCl}(\text{aq})$                                 (D)  $\text{LiCl}(\text{s})$

7. A mixture of crystals of salt and sugar is added to water and stirred until all solids have dissolved. Which statement best describes the resulting mixture?

- (A) The mixture is homogeneous and can be separated by filtration.  
(B) The mixture is homogeneous and cannot be separated by filtration.  
(C) The mixture is heterogeneous and can be separated by filtration.  
(D) The mixture is heterogeneous and cannot be separated by filtration.

8. A sample is prepared by completely dissolving 10.0 grams of  $\text{NaCl}$  in 1.0 liter of  $\text{H}_2\text{O}$ . Which classification best describes this sample?

- (A) homogeneous compound  
(B) homogeneous mixture  
(C) heterogeneous compound  
(D) heterogeneous mixture

---

9. An aqueous solution of sodium chloride is best classified as a

- Ⓐ homogeneous compound
- Ⓑ homogeneous mixture
- Ⓒ heterogeneous compound
- Ⓓ heterogeneous mixture

10. When a mixture of water, sand, and salt is filtered, what passes through the filter paper?

- Ⓐ water, only
- Ⓑ water and sand, only
- Ⓒ water and salt, only
- Ⓓ water, sand, and salt

11. Petroleum can be separated by distillation because the hydrocarbons in petroleum are

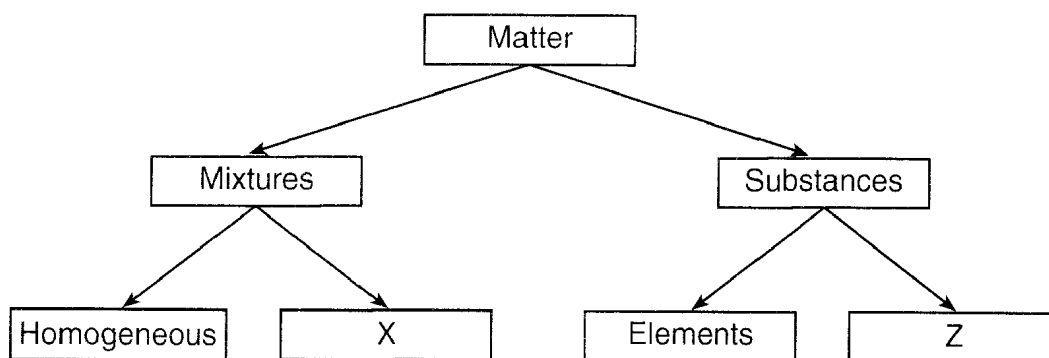
- Ⓐ elements with identical boiling points
- Ⓑ elements with different boiling points
- Ⓒ compounds with identical boiling points
- Ⓓ compounds with different boiling point

12. Which sample of matter can be separated into different substances by physical means?

- Ⓐ  $\text{LiCl}(\text{aq})$
  - Ⓑ  $\text{LiCl}(\text{s})$
  - Ⓒ  $\text{NH}_3(\text{g})$
  - Ⓓ  $\text{NH}_3(\ell)$
-

Base your answers to questions 13 through 15 on the diagram below concerning the classification of matter.

### Classification of Matter



13. Given a mixture of sand and water, state *one* process that can be used to separate water from the sand.

14. Explain, in terms of particle arrangement, why  $\text{NaCl(aq)}$  is a homogeneous mixture.

15. What type of mixture is represented by *X*?

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16. Object *A* at  $40^\circ\text{C}$  and object *B* at  $80^\circ\text{C}$  are placed in contact with each other. Which statement describes the heat flow between the objects?

- (A) Heat flows from object *A* to object *B*.
  - (B) Heat flows from object *B* to object *A*.
  - (C) Heat flows in both directions between the objects.
  - (D) No heat flow occurs between the objects.
-



24. Given the balanced equation:



As a sample of  $\text{I}_2(\text{s})$  sublimes to  $\text{I}_2(\text{g})$ , the entropy of the sample

- (A) increases because the particles are less randomly arranged
- (B) increases because the particles are more randomly arranged
- (C) decreases because the particles are less randomly arranged
- (D) decreases because the particles are more randomly arranged

25. Which 10-milliliter sample of water has the greatest degree of disorder?

- (A)  $\text{H}_2\text{O}(\text{g})$  at  $120^\circ\text{C}$
- (B)  $\text{H}_2\text{O}(\ell)$  at  $80^\circ\text{C}$
- (C)  $\text{H}_2\text{O}(\ell)$  at  $20^\circ\text{C}$
- (D)  $\text{H}_2\text{O}(\text{s})$  at  $0^\circ\text{C}$

26. A sample of chlorine gas is at 300. K and 1.00 atmosphere. At which temperature and pressure would the sample behave more like an ideal gas?

- (A) 0 K and 1.00 atm
- (B) 150. K and 0.50 atm
- (C) 273 K and 1.00 atm
- (D) 600. K and 0.50 atm

27. Which statement describes the particles of an ideal gas based on the kinetic molecular theory?

- (A) The gas particles are relatively far apart and have negligible volume.
- (B) The gas particles are in constant, nonlinear motion.
- (C) The gas particles have attractive forces between them.
- (D) The gas particles have collisions without transferring energy.

28. A 220.0-mL sample of helium gas is in a cylinder with a movable piston at 105 kPa and 275 K. The piston is pushed in until the sample has a volume of 95.0 mL. The new temperature of the gas is 310. K. What is the new pressure of the sample?

- (A) 51.1 kPa
- (B) 216 kPa
- (C) 243 kPa
- (D) 274 kPa

29. Which set of values represents standard pressure and standard temperature?

- (A) 1 atm and 101.3 K
- (B) 1 kPa and 273 K
- (C) 101.3 kPa and  $0^\circ\text{C}$
- (D) 101.3 atm and  $273^\circ\text{C}$

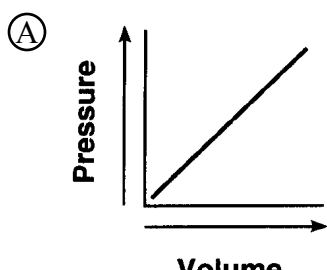
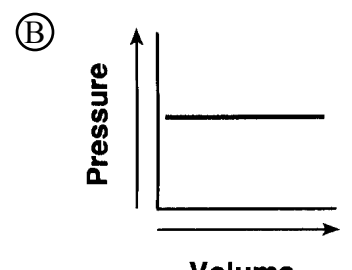
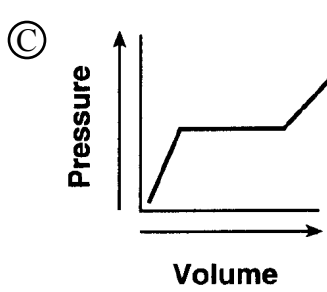
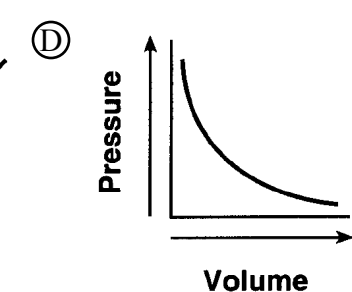
30. Which temperature change would cause a sample of an ideal gas to double in volume while the pressure is held constant?

- (A) from 400. K to 200. K
- (B) from 200. K to 400. K
- (C) from 400.°C to 200.°C
- (D) from 200.°C to 400.°C

31. At 25°C, gas in a rigid cylinder with a movable piston has a volume of 145 mL and a pressure of 125 kPa. Then the gas is compressed to a volume of 80. mL. What is the new pressure of the gas if the temperature is held at 25°C?

- (A) 69 kPa
- (B) 93 kPa
- (C) 160 kPa
- (D) 230 kPa

32. Which graph represents the relationship between pressure and volume for a sample of an ideal gas at constant temperature?

- (A) 
- (B) 
- (C) 
- (D) 

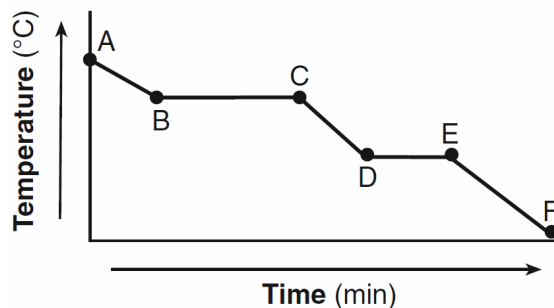
33. At which temperature is the vapor pressure of ethanol equal to the vapor pressure of propanone at 35°C?

- (A) 35°C
- (B) 60.°C
- (C) 82°C
- (D) 95°C

34. Which changes in pressure and temperature occur as a given mass of gas at 50.6 kPa and 546 K is changed to STP?

- (A) The pressure is doubled and the temperature is halved.
- (B) The pressure is halved and the temperature is doubled.
- (C) Both the pressure and the temperature are doubled.
- (D) Both the pressure and the temperature are halved.

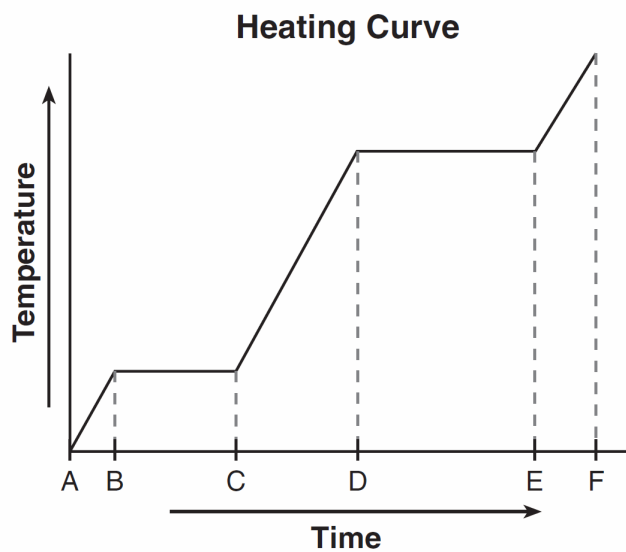
35. Given the cooling curve of a substance:



During which intervals is potential energy decreasing and average kinetic energy remaining constant?

- (A) AB and BC
- (B) AB and CD
- (C) DE and BC
- (D) DE and EF

36. 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?

- Ⓐ *AC*   Ⓑ *BC*   Ⓒ *CD*   Ⓓ *DF*

37. The table below shows the data collected by a student as heat was applied at a constant rate to a solid below its freezing point.

Time (min)	Temperature (°C)	Time (min)	Temperature (°C)
0	20	18	44
2	24	20	47
4	28	22	51
6	32	24	54
8	32	26	54
10	32	28	54
12	35	30	54
14	38	32	58
16	41	34	62

What is the boiling point of this substance?

- (A) 32°C      (B) 54°C      (C) 62°C      (D) 100°C
- 
38. The temperature of a sample of water changes from 10.°C to 20.°C when the water absorbs 420 Joules of heat. What is the mass of the sample?
- (A) 1.0 g      (B) 10. g  
(C) 100 g      (D) 1000 g
39. How many Joules of heat energy are released when 50. grams of water are cooled from 70.°C to 60.°C?
- (A) 42 J      (B) 210 J  
(C) 2100 J      (D) 4200 J
40. What is the minimum amount of heat required to completely melt 20.0 grams of ice at its melting point?
- (A) 20.0 J      (B) 83.6 J  
(C) 6,680 J      (D) 45,200 J
41. What is the total number of joules released when a 5.00-gram sample of water changes from liquid to solid at 0°C?
- (A) 334 J      (B) 1670 J  
(C) 2260 J      (D) 11 300 J



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42. How much heat energy must be absorbed to completely melt 35.0 grams of  $\text{H}_2\text{O}(\text{s})$  at  $0^\circ\text{C}$ ?

- (A) 9.54 J                      (B) 146 J  
(C) 11 700 J                    (D) 79 100 J

43. At  $65^\circ\text{C}$ , which compound has a vapor pressure of 58 kilopascals?

- (A) ethanoic acid              (B) ethanol  
(C) propanone                  (D) water

44. According to Reference Table *H*, what is the boiling point of ethanoic acid at 80 kPa?

- (A)  $28^\circ\text{C}$                       (B)  $100^\circ\text{C}$   
(C)  $111^\circ\text{C}$                       (D)  $125^\circ\text{C}$

45. At 1 atmosphere of pressure, 25.0 grams of a compound at its normal boiling point is converted to a gas by the addition of 34,400 Joules. What is the heat of vaporization for this compound, in Joules per gram?

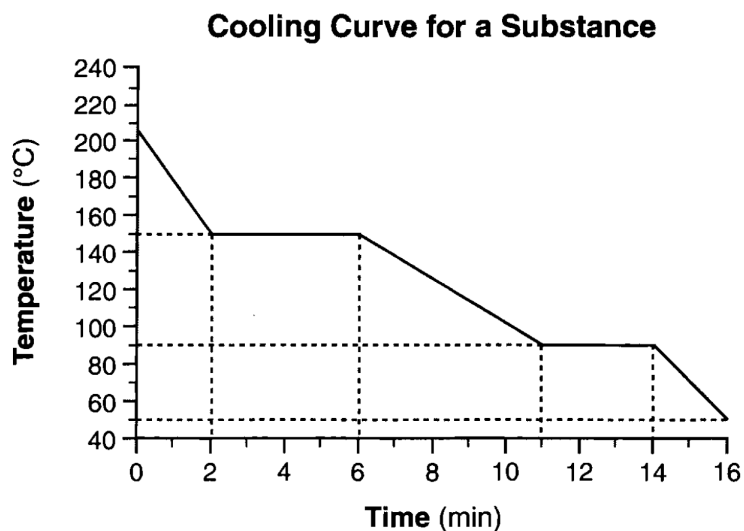
- (A) 25.0 J/g                      (B) 1376 J/g  
(C) 2,260 J/g                      (D) 34,400 J/g

46. What is the normal boiling point of ethanoic acid?

- (A)  $52^\circ\text{C}$                       (B)  $55^\circ\text{C}$   
(C)  $101.3^\circ\text{C}$                       (D)  $117.9^\circ\text{C}$
-

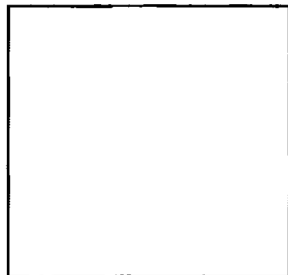
Base your answers to questions 47 through 49 on the information below.

Starting as a gas at 206°C, a sample of a substance is allowed to cool for 16 minutes. This process is represented by the cooling curve below.

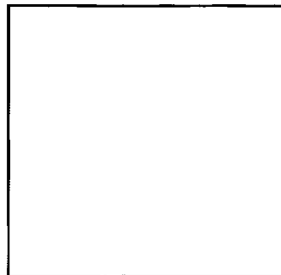


47. Using the key below, draw *two* particle diagrams to represent the *two* phases of the sample at minute 4. Your response must include *at least six* particles for *each* diagram.

Key
○ = particle of the substance



One phase of the sample at minute 4



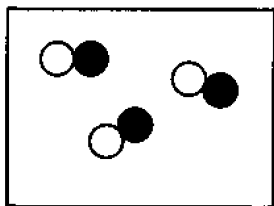
A different phase of the sample at minute 4

48. At what time do the particles of this sample have the *lowest* average kinetic energy?

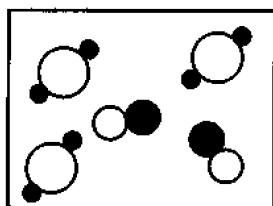
49. What is the melting point of this substance?

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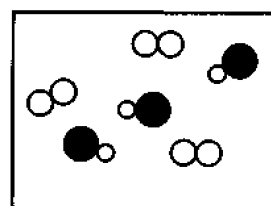
50. Base your answer to the following question on the pictures below:



**A**



**B**



**C**

Contrast sample *A* and sample *B*, in terms of *compounds* and *mixtures*. Include both sample *A* and sample *B* in your answer.