Name:

Unit Review:
Matter and Energy

Base your answers to questions 1 through 3 on the information below.

A student prepared two mixtures, each in a labeled beaker. Enough water at 20.°C was used to make 100 milliliters of each mixture.

Information about Two Mixtures at 20.°C

	Mixture 1	Mixture 2
Composition	NaCl in H_2O	Fe filings in H_2O
Student Observations	• colorless liquid • no visible solid on bottom of beaker	• colorless liquid • black solid on bottom of beaker
Other Data	• mass of NaCl(s) dissolved = 2.9 g	• mass of Fe(s) = 15.9 g • density of Fe(s) = 7.87 g/cm^3

1. Describe a procedure to physically remove the water from mixture 1.

2. Determine the volume of the Fe filings used to produce mixture 2.

3. Classify *each* mixture using the term "homogeneous" or the term "heterogeneous."

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1. - Heat mixture 1 until all the water evaporates. - Allow the water to evaporate.
2. - 2.02 cm^3
3. - Mixture 1: homogeneous - Mixture 2: heterogeneous
4. Acceptable responses include, but are not limited to: • homogeneous • solution
5. Acceptable responses include, but are not limited to: • Heat flows from the body to the cold pack from the area of higher temperature to the area of lower temperature
6. 188 K
7. evaporation of the water

Boil off the water.

Constructed Response

Base your answers to questions 4 and 5 on the information below.

Cold packs are used to treat minor injuries. Some cold packs contain $NH_4NO_3(s)$ and a small packet of water at room temperature before activation. To activate this type of cold pack, the small packet must be broken to mix the water and $NH_4NO_3(s)$. The temperature of this mixture decreases to approximately 2°C and remains at this temperature for 10 to 15 minutes.

4. Identify the type of mixture formed when the $NH_4NO_3(s)$ is completely dissolved in the water.

5. State the direction of heat flow that occurs when the activated cold pack is applied to the body.

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

Some Properties of Three Compounds at Standard Pressure

Compound	Boiling Point (°C)	Solubility in 100. Grams of H_2O at 20.°C (g)
ammonia	−33.2	56
methane	−161.5	0.002
hydrogen chloride	−84.9	72

Convert the boiling point of hydrogen chloride at standard pressure to kelvins.

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

An unsaturated solution is made by completely dissolving 20.0 grams of $NaNO_3$ in 100.0 grams of water at 20.0°C.

Identify one process that can be used to recover the $NaNO_3$ from the unsaturated solution.

Base your answers to questions 8 and 9 on on the information below.

In an investigation, a dripless wax candle is massed and then lighted. As the candle burns, a small amount of liquid wax forms near the flame. After 10 minutes, the candle's flame is extinguished and the candle is allowed to cool. The cooled candle is massed.

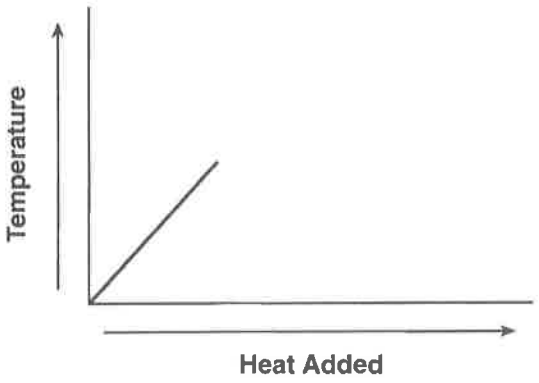
8. State *one* observation that indicates a chemical change has occurred in this investigation.

9. Identify *one* physical change that takes place in this investigation.

Base your answers to questions 10 and 11 on Heat is added to a sample of liquid water, starting at 80.°C, until the entire sample is a gas at 120.°C. This process, occurring at standard pressure, is represented by the balanced
equation below.

$$H_2O(\ell) + \text{heat} \rightarrow H_2O(g)$$

10. On the diagram below, complete the heating curve for this physical change.

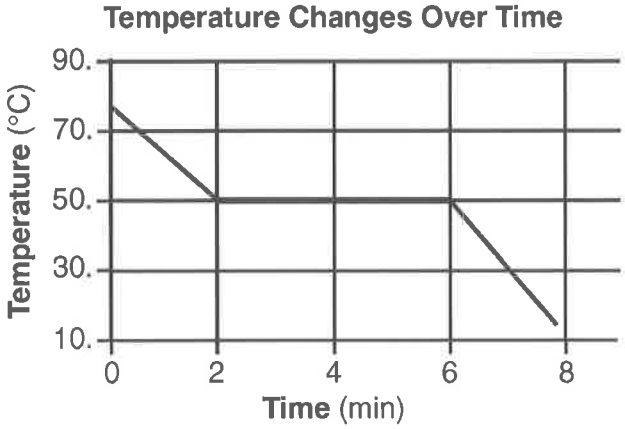


11. In the box below, using the key, draw a particle diagram to represent *at least five* molecules of the product of this physical change at 120.°C.

Key
● = atom of hydrogen
○ = atom of oxygen

Base your answers to questions 12 through 14 on the information below.

The graph below shows a compound being cooled at a constant rate starting in the liquid phase at 75°C and ending at 15°C.



12. What kelvin temperature is equal to 15°C?

13. A different experiment was conducted with another sample of the same compound starting in the solid phase. The sample was heated at a constant rate from 15°C to 75°C. On the graph, draw the resulting heating curve.

14. State what is happening to the average kinetic energy of the particles of the sample between minute 2 and minute 6.

Base your answers to questions 15 and 16 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.

15. Describe a laboratory procedure that can be used to recover the solid solute from the aqueous solution.

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

Base your answers to questions 17 through 19 on the information below.

Heat is added to a 200.-gram sample of $H_2O(s)$ to melt the sample at 0°C. Then the resulting $H_2O(\ell)$ is heated to a final temperature of 65°C.

17. Compare the amount of heat required to vaporize a 200.-gram sample of $H_20(\ell)$ at its boiling point to the amount of heat required to melt a 200.-gram sample of $H_2O(s)$ at its melting point.

18. In the space below, show a numerical setup for calculating the total amount of heat required to raise the temperature of the $H_2O(\ell)$ from 0°C to its final temperature.

19. Determine the total amount of heat required to completely melt the sample.

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

A phase change for carbon dioxide that occurs spontaneously at 20.°C and 1.0 atmosphere is represented by the balanced equation below.

$$CO_2(s) + \text{energy} \rightarrow CO_2(g)$$

Write the name of this phase change.

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

At a pressure of 101.3 kilopascals and a temperature of 373 K, heat is removed from a sample of water vapor, causing the sample to change from time gaseous phase to time liquid phase. This phase change is represented by the equation below.

$$H_2O(g) \rightarrow H_2O(\ell) + \text{heat}$$

Determine the total amount of heat released by 5.00 grams of water vapor during this phase change.

Base your answers to questions 22 and 23 on the information below.

Carbon forms molecular compounds with some elements from Group 16. Two of these compounds are carbon dioxide, CO_2, and carbon disulfide, CS_2.

Carbon dioxide is a colorless, odorless gas at room temperature. At standard temperature and pressure, $CO_2(s)$ changes directly to $CO_2(g)$.

Carbon disulfide is formed by a direct reaction of carbon and sulfur. At room temperature, CS_2 is a colorless liquid with an offensive odor. Carbon disulfide vapors are flammable.

22. State what happens to the potential energy of CO_2 molecules during this phase change of CO_2.

23. Identify *one* physical property and *one* chemical property of CS_2.

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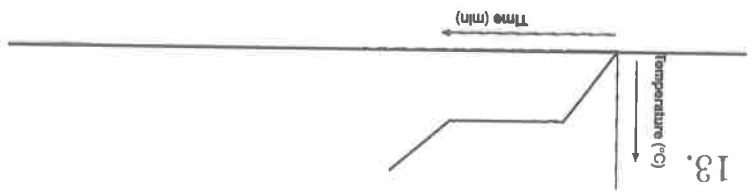
11. Five water molecules are drawn and all of the particles drawn represent the gas phase.

12. 288 K

13.



8. *Examples:* The burning candle releases heat and light. -A cobalt chloride test indicates water is produced. -A limewater test indicates carbon dioxide gas is produced.

9. *Examples:* -melting -vaporization -solidification

10. a line is drawn horizontally to represent the phase change and extending the line with a positive slope to represent the gas phase, only.

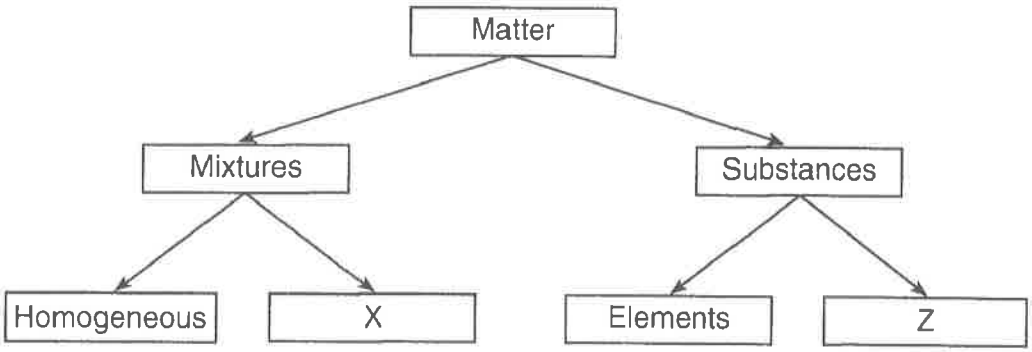
24. Base your answer to the following question on the following paragraph.

The boiling point of a liquid is the temperature at which the vapor pressure of the liquid is equal to the pressure on the surface of the liquid. The heat of vaporization of ethanol is 838 joules per gram. A sample of ethanol has a mass of 65.0 grams and is boiling at 1.00 atmosphere.

Calculate the minimum amount of heat required to completely vaporize this sample of ethanol. Your response must include *both* a correct numerical setup and the calculated result.

Base your answers to questions 25 through 28 on the diagram below concerning the classification of matter.

Classification of Matter



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

26. Explain, in terms of particle arrangement, why NaCl(aq) is a homogeneous mixture.

27. What type of substance is represented by *Z*?

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

Constructed Response

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

17. The heat necessary to vaporize 200 grams of water is about seven times larger than the heat necessary to melt 200 grams of ice. It takes more heat to vaporize the same amount of $H_2O(\ell)$

14. Examples: – The average kinetic energy of the particles remains the same. – KE remains constant. – no change

15. Gently heat the solution to evaporate the water until only solid KNO_3 remains. *or*

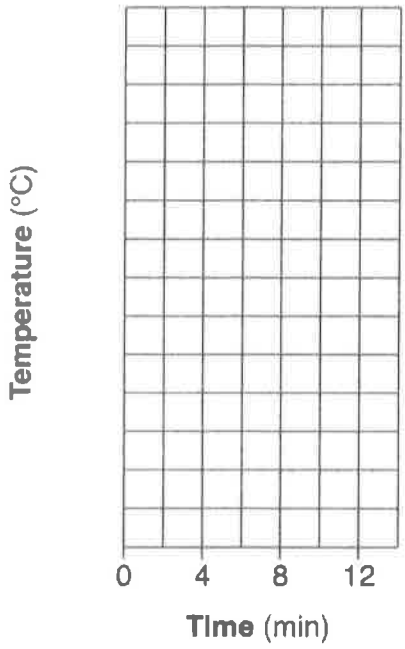
29. Base your answer to the following question on the information and chart below.

A 150.-gram liquid sample of stearic acid, $C_{17}H_{35}COOH$, is cooled at a constant rate. The temperature of the sample is recorded at 2-minute intervals in the data table below.

Cooling Data for Stearic Acid

Time (min)	**Temperature** (°C)
0	75.0
2	72.0
4	69.3
6	69.3
8	69.3
10.	69.3
12	65.0

Cooling Curve for Stearic Acid



Identify the physical change occurring during the time interval 4 minutes to 10. minutes.

Constructed Response

22. Examples: - The potential energy of the CO_2 molecules increases. - PE increases.

23. *Examples:* Physical property: - liquid at room temperature - colorless - odor - boiling point above room temperature Chemical property: - CS_2 can be decomposed into C and S. - flammable

24. *Examples:*
- (65)(838)
- 5.45×10^4 J - 54 500 J

18. $q = (200.\text{ g})(4.18\text{ J/g}\cdot^\circ\text{C})(65^\circ\text{C})$ *or* $(200)(4.18)(65)$

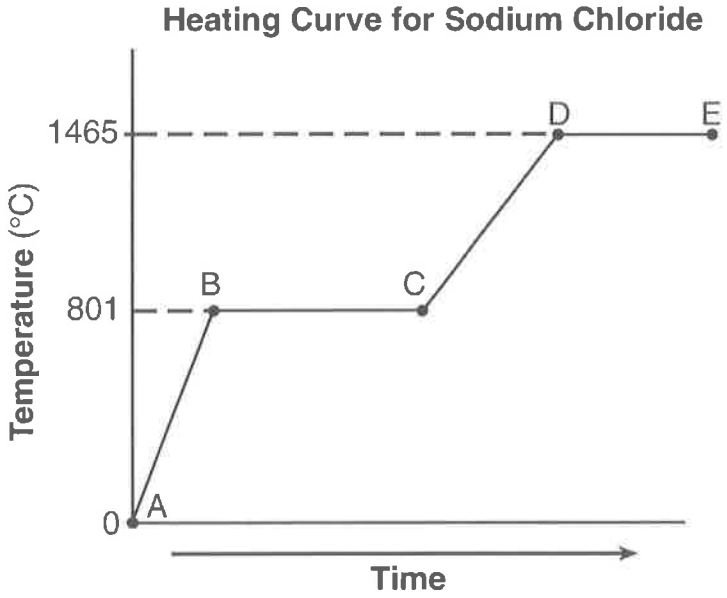
19. 66800 J *or* 6.68×10^4 J

20. sublimation

21. 11 300 J

Base your answers to questions 30 through 32 on on the information below.

A 100.0-gram sample of NaCl(s) has an initial temperature of 0°C. A chemist measures the temperature of the sample as it is heated. Heat is *not* added at a constant rate. The heating curve for the sample is shown below.



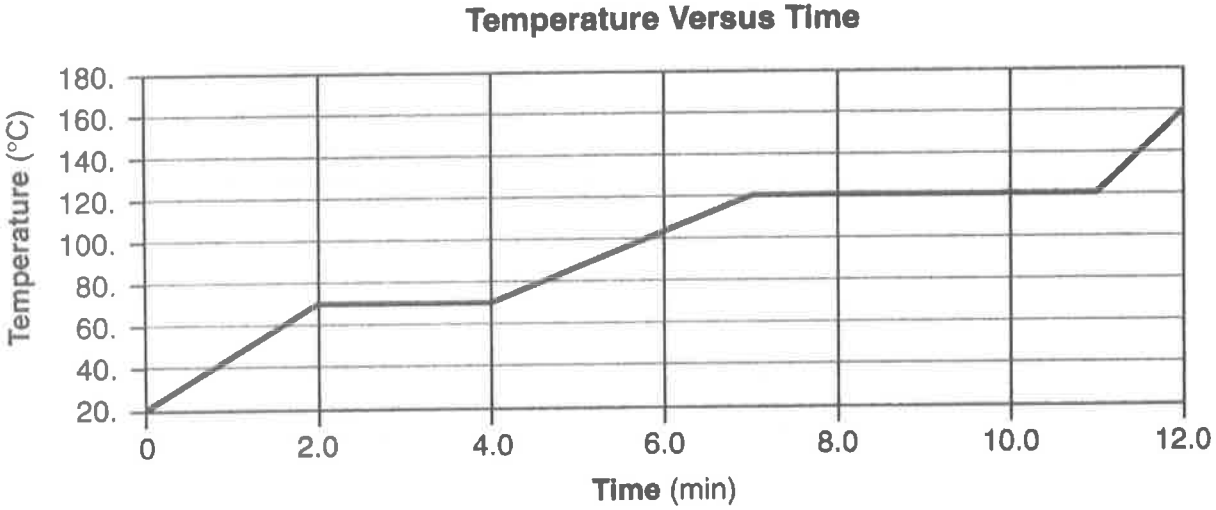
30. Identify *one* line segment on the curve where the NaCl sample is in a single phase and capable of conducting electricity.

31. Identify *one* line segment on the curve where the average kinetic energy of the particles of the NaCl sample is changing.

32. Determine the temperature range over which the entire NaCl sample is a liquid.

Base your answers to questions 33 through 36 on the information below.

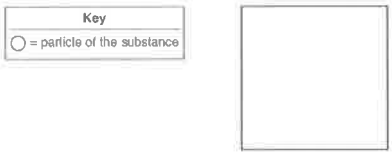
The temperature of a sample of a substance is increased from 20.°C to 160.°C as the sample absorbs heat at a constant rate of 15 kilojoules per minute at standard pressure. The graph below represents the relationship between temperature and time as the sample is heated.



33. Determine the total amount of heat required to completely melt this sample at its melting point.

34. What is the total time this sample is in the liquid phase, only?

35. Use the key below to draw at least nine particles in the box, showing the correct particle arrangement of this sample during the first minute of heating.

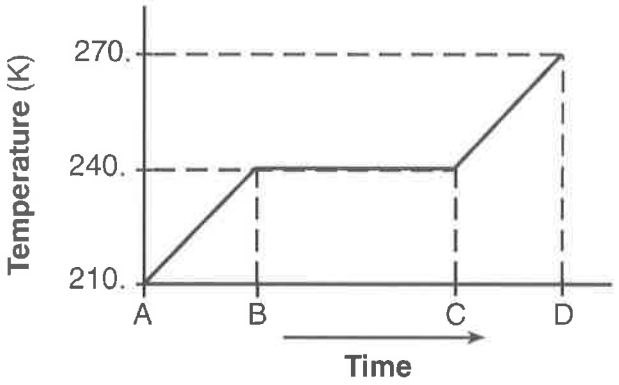


36. What is the boiling point of this sample?

Base your answers to questions 37 through 39 on the information below

A 5.00-gram sample of liquid ammonia is originally at 210. K. The diagram of the partial heating curve below represents the vaporization of the sample of ammonia at standard pressure due to the addition of heat. The heat is *not* added at a constant rate.

Partial Heating Curve for Ammonia



Some physical constants for ammonia are shown in the data table below.

Some Physical Constants for Ammonia

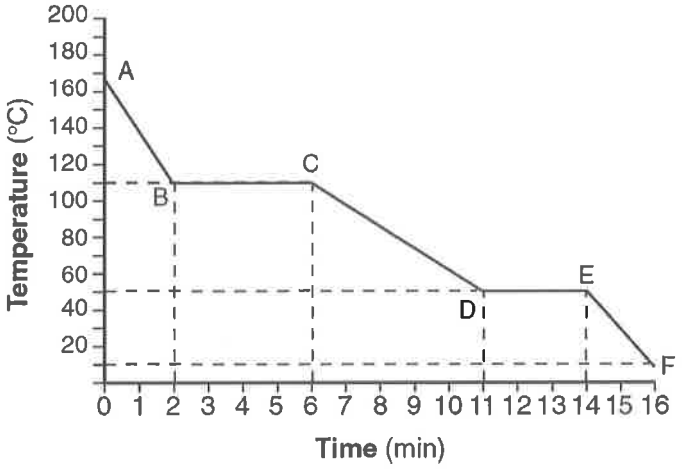
specific heat capacity of $NH_3(\ell)$	4.71 J/g•K
heat of fusion	332 J/g
heat of vaporization	1370 J/g

37. Determine the total amount of heat required to vaporize this 5.00-gram sample of ammonia at its boiling point.

38. Describe what is happening to *both* the potential energy and the average kinetic energy of the molecules in the ammonia sample during time interval *BC*. Your response must include *both* potential energy and average kinetic energy.

39. Calculate the total heat absorbed by the 5.00-gram sample of ammonia during time interval AB. Your response must include *both* a correct numerical setup and the calculated result.

40. Base your answer to the following question on the graph below, which represents the cooling of a substance starting at a temperature above its boiling point.



What is the melting point of this substance?

Answer Key
[New Exam]

25. Examples: - Evaporate the water. - Decant the water. -filtration

26. Examples: - The water molecules, sodium ions, and chloride ions are uniformly mixed together.
- All particles distribute evenly.

27. compound or compounds

28. Examples: - heterogeneous - nonuniform

29. *Examples:* - solidification - freezing - crystallization

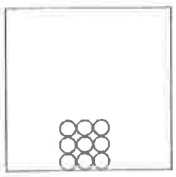
30. CD

31. AB
CD

32. 801°C to 1465°C

33. 30.kJ ± 3kJ

34. 3.0 min ± 0.2 min

35. 

36. 120.°C ± 2°C.

37. 6850 J

38. The potential energy of the ammonia molecules increases and the average kinetic energy of the ammonia molecules remains the same.

39. $q = mC\Delta T$ = (5.00 g)(4.71 J/g • K)(30. K)
(5)(4.71)(30)
710 J

40. 50°C