6.1 Questions

1. Differentiate between temperature and thermal energy. K/U
2. Describe how the kinetic molecular theory explains the changes of state in substances. K/U
3. How does a mercury or an alcohol thermometer work? K/U
4. Copy **Table 1** in your notebook and fill in the missing values. K/U T/I

Table 1 Boiling Points of Various Substances

Substance	Boiling point (°C)	Boiling point (K)
sodium	882.9	
helium		4.22
copper	2567	
mercury		630

5. Research to find out more about how the caloric theory was disproved. T/I
6. Why does the volume of alcohol in a thermometer decrease when the thermometer is moved from a warm environment into a colder environment? K/U
7. What is the relationship between the freezing point and the melting point of most substances? K/U

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6.2 Questions

1. How do thermal energy, temperature, and heat differ? K/U
2. Define thermal conduction, convection, and radiation. K/U
3. Why does a tile floor feel much colder to your bare feet than a thick carpet does? K/U
4. If the efficiency of an electric furnace is 96 %, then 96 % of the input electrical energy is transformed into thermal energy. What is the other 4 % of the electricity transformed into? A
5. Are the following materials used because they are a good thermal conductor or a good thermal insulator? Explain why. K/U
   (a) copper pot
   (b) wooden spoon
   (c) metal ice-cube tray
   (d) down-filled sleeping bag

6.3 Questions

1. What is specific heat capacity? What does it tell you? K/U
2. Calculate the amount of thermal energy required to increase the temperature of 25.0 g of silver from 50.0 °C to 80.0 °C. K/U T/I
3. Calculate the amount of thermal energy released when 260.0 g of ice cools from −1.0 °C to −20.0 °C. K/U T/I
4. A 50.0 g sample of metal releases 1520 J of thermal energy when its temperature drops from 100.0 °C to 20.0 °C. What is the metal? K/U T/I
5. Calcium has a specific heat capacity of 6.3×10^2 J/(kg•°C). Determine the final temperature of a 60.0 g sample of calcium if it starts at 10.0 °C and absorbs 302 J of thermal energy. K/U T/I
6. A bar of pure gold is heated to 95.0 °C. The specific heat capacity of gold is 1.29×10^2 J/(kg•°C). The gold is placed into 500.0 mL of ethyl alcohol initially at a temperature of 25.0 °C. The final temperature of the mixture is 27.0 °C. What is the mass of the gold? K/U T/I
7. Danielle cools a 2.0 kg metal object to a temperature of −25.0 °C. She places the metal in 3.0 L of pure water initially at a temperature of 40.0 °C. The final temperature of the mixture is 36.0 °C. What is the specific heat capacity of the metal? K/U T/I
8. A 1.50×10^2 g piece of brass (specific heat capacity 3.80×10^2 J/(kg•°C)) is submerged in 400.0 mL of water at 27.7 °C. What is the original temperature of the brass if the mixture has a temperature of 28.0 °C? K/U T/I
9. Explain why temperature changes are important for civil engineers to consider when designing and evaluating building structures. K/U A
10. Research more about thermal expansion and contraction and how it is dealt with in the design of homes, schools, or other structures. Choose one innovation related to this topic and write a brief report. T/I C

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6.4 Questions

1. (a) Describe each part of the graph in **Figure 9** in terms of the states of matter.
   (b) What type of graph is this, a heating graph or a cooling graph? How can you tell? K/U T/I

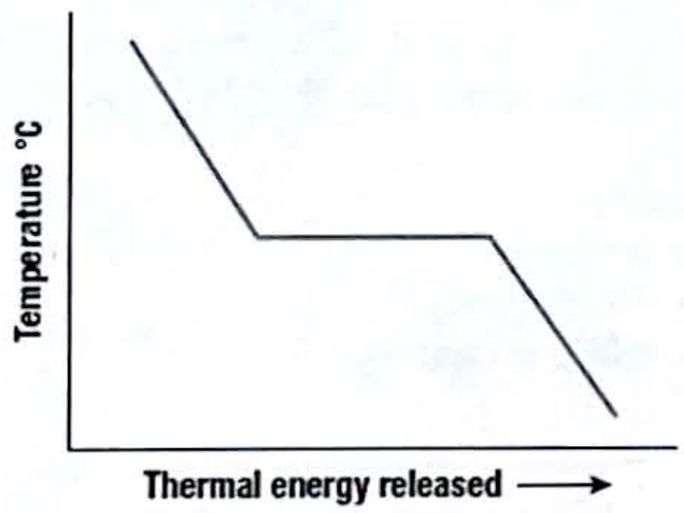

Figure 9

2. (a) Use **Table 2** to graph a heating curve.
   (b) Label the appropriate parts of the graph with the following: solid, liquid, gas, melting, evaporation.
   (c) Determine the melting point and boiling point of the substance. T/I
3. Describe what would happen if you were to heat liquid water to a temperature of 110 °C. K/U
4. Explain the terms "latent heat of fusion" and "latent heat of vaporization." K/U
5. To prevent fruit on trees from freezing and becoming inedible, fruit farmers in Ontario often spray their crops with water if they know the temperatures are going to drop below zero. Use your knowledge of latent heat to explain why this will help prevent the fruit from freezing. K/U A
6. Calculate the latent heat of fusion for 2.40 kg of gold as it changes from a molten liquid into a solid bar. T/I
7. How much thermal energy is needed to change 100 g of ice at −20 °C into steam at 110 °C? T/I
8. While forming a 1.50 kg aluminum statue, a metal smith heats the aluminum to 2700 °C, pours it into a mould, and then cools it to a room temperature of 23.0 °C. Calculate the thermal energy released by the aluminum during the process. T/I
9. What makes water different from most other substances? Include a description of the physical characteristics in your answer. K/U

Table 2 Data Collected during the Heating of a Substance

Time (min)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5
Temperature (°C)	37	43	49	55	55	55	56	64	70	80	86	90	90	90	100

6.1 - Solutions

2. - as kinetic energy increases particles are able to vibrate more
   - increased vibration allows the particles to separate more from each other.

$T_C = T_K - 273$

4.

	Boiling Pt (°C)	Boiling Pt (K)
sodium	882.9 °C	1155.9 K
helium	-268.78 °C	4.22 K
Copper	2567 °C	2840 K
mercury	357 °C	630 K

6. - moving from warm to cold removes thermal energy in the form of kinetic energy
   - with less kinetic energy particles vibrate less, and take up less space, resulting in a decrease in volume (height drops)

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6.2 - Solutions

#1 Thermal energy is the combination of internal energies.

Thermal Energy (internal) = Kinetic Energy + Potential Energy

Temperature is a guage of the amount of Kinetic energy.

Heat is the action of thermal energy being transferred from a warm object to a cold object.

#3 A tile floor can transfer the thermal energy from your feet faster (conductor) than carpet (insulator). The departure of thermal energy is what we "feel" as cold.

#5 (a) copper pot - good conductor - low "c" value

(b) wooden spoon - good insulator - poor conduction

(c) metal ice cube tray - good conductor; draws thermal energy out quickly

(d) down filled bag - good insulator - lots of empty spaces

6.3 - Solutions

#1 specific heat capacity - energy required to raise 1 kg of a material 1°C

#2 $Q = mc\Delta t$

$Q = (0.025)(240)(30)$

$Q = 180\,J$ (absorbed)

#3 $Q = mc\Delta t$

$Q = (0.260)(4.18 \times 10^3)(-19)$

$Q = -23{,}712\,J$ (released)

#4 $Q = mc\Delta t$

$-1520 = (0.050)(c)(-80)$

releases ↓

$380 = c \rightarrow \therefore$ the metal is copper.

#6 $Q_{in} + Q_{abs} = 0$ (gold / alcohol)

$mc\Delta t + mc\Delta t = 0$

* specific gravity of ethyl alcohol $S_g = 0.789\ g/mL$

$m(129)(27-95) + \left(\frac{0.789 \times 500}{1000}\right)(2460)(27-25) = 0$ (released)

$-8772m + 1940.94 = 0$

$1940.94 = 8772m$

$0.221\ kg = m$ of gold

#7 $Q_{in} + Q_{abs} = 0$ (water / metal)

$mc\Delta t + mc\Delta t = 0$

$3(4.18 \times 10^3)(36-40) + 2(c)(36-(-25)) = 0$

$-50160 + 122c = 0$

$122c = 50160$

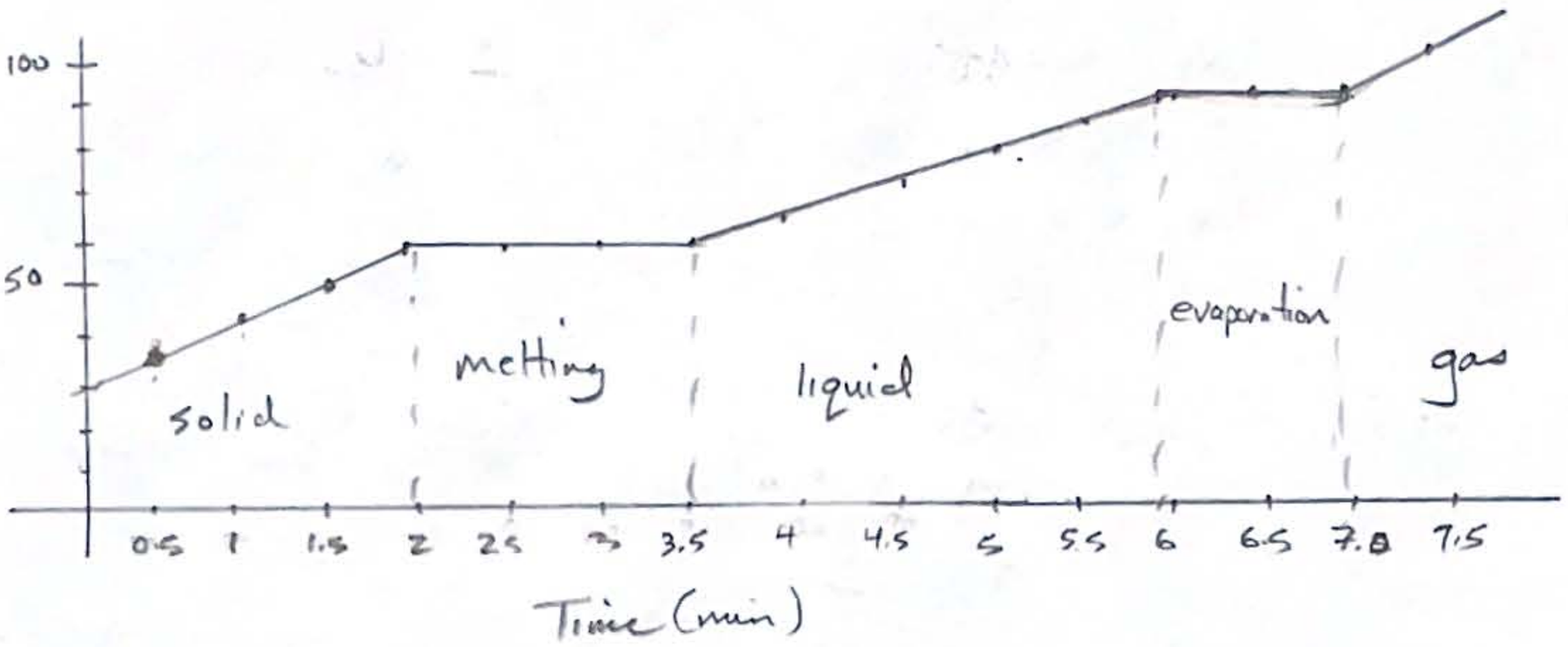
$c = 411.15\ \frac{J}{kg \cdot C^\circ}$

6.4 - Solutions

#1 (a) 
change in state – change in E_p
change in temp (dropping) – E_k dropping

(b) cooling graph – temp is dropping
– thermal energy is "released"

#2



melting pt → 55°C boiling - 90°C

#3
- water molecules would increase in vibration until 100°C, then the spacing would increase
- changing from liquid to gas – temperature would stay the same; thermal energy would change the E_p of the water

#6
$Q = mL_{fusion}$
$Q = 2.40\,(1.1 \times 10^6)$
$Q = 2.64 \times 10^6\ J$