Student Response Sheet -Answer Sheet

School: _____

Student Names: _____

For each answer, fill in the blank or circle the correct response. For numerical responses, values should be given with the correct number of significant figures and units.

Tiebreakers - 26, 21, 12

1. _____302°F_____ (+1pt for correct value; +1 pt for correct units)

2. _____440-450K (+1pt) 445 K (+2pts)_____

3. Solid A- Butter Coconut Oil Palm Oil Shortening (1pt)

   Solid B- Butter Coconut Oil Palm Oil Shortening (1pt)

   Solid C- Butter Coconut Oil Palm Oil Shortening (1pt)

4. A B C D (1pt)

5. A B C D E (1pt)

6. A B C D (+1 pt for each correct, -1 pt for each incorrect, no negative scores)

7. A B C D E (1pt)

8. __11,000-12,000 J or 11-12 kJ (+1pt) 11,700 J or 11.7 kJ (+2pts) ___

9. A B C D E (1pt)

10. _____Gold_____ (1pt)

11. _____Lead_____ (1pt)

12. _____43,000-44,000 J (+1 pt) 43-44 kJ (+2 pts) 43.4 kJ (+3 pts) _____

13. A B C D (1pt)

14. True False (1pt)

15. _____Zeroth Law_____ (1pt)

16. A B C D E (1pt)

17. ___An adiabatic process is a process that **does NOT involve heat transfer.**____ (1pt)

18. A B C D (1pt)

19. _____65-70% (1pt) 67% (2pts)_____

20. A B C (1pt)

21. Pressure = Force/Area (+1pt) Volume = Area/Length (+1pt)

Work = Pressure x Volume = (Force/Area) x (Area x Length) = Force x Length (+1pt)

Total points possible (3pts)

22. A B C D (1pt)

23. A B C D (1pt)

24. A B C D (1pt)

25. A B C D (1pt)

26. _____phlogiston_____ (1pt)

27. __canon boring___ (1pt)

Thermodynamics Written Test

Answer all questions on the Student Response Sheet. Be sure all answers include the appropriate units. Any answers written on this test will NOT be scored.

Temperature Scales and Conversions

1. William wants to make homemade candy to give to his mom for her birthday. He is using a recipe that instructs him to heat the sugar mixture to boiling at a temperature of 150°C. William's candy thermometer, however, only reads temperatures in Fahrenheit. To what temperature, in °F, should William heat the sugar mixture?

2. As William was heating the sugar mixture, he noticed it beginning to turn brown. He immediately took the temperature of the mixture and found it to be 342°F. At this temperature, the sugar was beginning to carmelize. What temperature is this in Kelvin?

3. There are three containers of solid fats. The melting point of each of the fats was determined and the temperatures are found in the table below. Use the table of known fats and their melting points to determine the identity of the unknown fat solids.

Fat	Melting Point	Unknown Fat Solid	Melting Point
Butter	32°C	A	95°F
Coconut Oil	298K	B	115°F
Palm Oil	35°C	C	77°F
Shortening	574°R		

4. The quantity of heat required to raise the temperature of 1 gram of a substance 1°C is known as
    a. Calorie
    b. Joule
    c. calorie
    d. BTU

5. Which of the following temperature scales is based on the melting and boiling points of water?
    a. Celsius
    b. Fahrenheit
    c. Kelvin
    d. Celsius and Kelvin
    e. Celsius, Fahrenheit, Kelvin

6. Absolute zero is equal to ***(Circle ALL that apply.)***
    a. 0°C
    b. 0°F
    c. 0 K
    d. 0°R

Thermal Conductivity, Heat Capacity, Specific Heat, Latent Heat, Phases of Matter, Entropy, Enthalpy

7. Janelle is tasked with identifying an unknown metal by her Chemistry teacher. She uses her knowledge of calorimetry to aid her in her task. She places the metal in a beaker of water and heats it to a temperature of 85°C. Then, she places 100 mL of water in a coffee cup calorimeter, adds the metal, and measures the temperature of the water over time. The final temperature of the water and metal was 26°C. The metal has a mass of 80 grams. The initial temperature of the water was 20°C.

   Identify the metal

   a. Aluminum, 0.91 J/g°C
   b. Lead, 0.13 J/g°C
   c. Silver, 0.23 J/g°C
   d. Titanium, 0.54 J/g°C
   e. Zinc, 0.39 J/g°C

8. How much energy is required to completely melt 35.0 grams of ice at 0°C? The heat of fusion for water is 334 J/g.

9. Which of the following shows the correct change of state at standard pressure as energy is removed from water at 150°C until it reaches -25°C?

   a. Solid water, melting, liquid water, boiling, gaseous water
   b. Solid water, freezing, liquid water, boiling, gaseous water
   c. Gaseous water, boiling, liquid water, freezing, solid water
   d. Gaseous water, condensing, liquid water, freezing, solid water
   e. Liquid water, freezing, solid water

Use the following table for questions 10-12.

Substance	Melting point	Specific Heat at 20°C	$\triangle H_{fus}$
Aluminum	660°C	0.90 J/g°C	398 J/g
Gold	1064°C	0.126 J/g°C	63 J/g
Lead	328°C	0.128 J/g°C	23 J/g
Polystyrene	240°C	1.13 J/g°C	96.1 J/g
Water	0°C	4.18 J/g°C	334 J/g

10. Identify the substance that would be the best thermal conductor at 20°C.

11. Identify the substance that would be the best thermal conductor at its melting point.

12. If 100.0g of ice was placed in an insulated container, how much energy, in kilojoules, would need to be added to raise the temperature of the ice at 0°C to water at 25°C? Assume the energy absorbed by the container is negligible.

13. Which of the following changes results in an increase in entropy?
    a. $S_{(s)} \rightarrow S_{(l)}$
    b. $H_2O_{(g)} \rightarrow H_2O_{(l)}$
    c. $NaCl_{(aq)} \rightarrow NaCl_{(s)}$
    d. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$

Thermodynamic Laws and Processes

14. True or False In an isothermal process, all heat added to the system is used to do work.

15. When two systems are in equilibrium with a third system, then the first two systems are in equilibrium with each other. Which law of thermodynamics is this?

16. When examining the work done on or by a gas, the amount of work depends on which of the following values?
    a. Initial state of the gas
    b. Final state of the gas
    c. Process that produces the final state of the gas
    d. Both A and B
    e. All of the above

17. What is an adiabatic process?

18. The working substance in a Carnot cycle undergoes four successive changes. Determine the order of the changes.

    I. Compression by cooling at a constant low temperature
    II. Expansion by heating at a constant high temperature
    III. Reversible adiabatic compression
    IV. Reversible adiabatic expansion

    a. II, III, I, IV
    b. II, IV, I, III
    c. I, III, II, IV
    d. IV, II, III, I

19. In an automobile engine, the temperature of the gas at combustion is 923K and the temperature of the gas at exhaust is 308K. Calculate the Carnot efficiency of the engine.

20. What would happen to the efficiency of the automobile engine described above (question 16) if the temperature of the gas at exhaust was increased?
    a. The efficiency would increase.
    b. The efficiency would decrease.
    c. The efficiency would stay the same.

21. Using a variable analysis, prove mathematically that the work done by a gas is equal to the pressure times the volume during a change of volume given that scientists define work as the product of a force acting through a distance.

History of Thermodynamics

22. The first ice-calorimeter was used to calculate heat changes in chemical reactions by
    a. Joseph Black
    b. William Thomson
    c. James Prescott Joule
    d. Antoine Lavoisier

23. Which of the following areas of scientific research gave birth to the development of the field of thermodynamics?
    a. Heat of chemical reactions
    b. Latent Heat
    c. Steam engines
    d. Water wheels

24. Which scientist is known for developing a mechanical equivalent of heat?
    a. Joule
    b. Carnot
    c. Boltzman
    d. Clausius

25. Which scientist introduced the concept of entropy?
    a. Newton
    b. Joule
    c. Clausius
    d. Carnot

26. Prior to the modern understanding of heat, scientists believed that heat was a material substance. What name was given to the first known description of the substance of heat?

27. The first observation of heat as energy was made by Count Rumford. Rumford observations led him to the conclusion that the amount of heat that could be generated was infinite and the amount of heat generated was proportional to the amount of work done. What was Rumford observing that led to this conclusion?