

SSSS Thermodynamics Key 2017

Names: _____

Team and Team Number: _____

Raw Score: _____

Grading Instructions: All questions and parts of questions are worth 1 pt unless otherwise noted next to the question in parentheses. For such questions, guidelines for point assignment are given.

1.
 - a. 30 °C
 - b. 19 ° C
 - c. Thermal equilibrium
 - d. 19 °C
 - e. 0th law of thermodynamics
 - f. 0.5 pt – Noting that the any/all objects can be put into contact with another hotter or colder substance
1 pt – Noting that the properties of a rock are harder to measure than those of others (eg. Water/air change in volume/pressure measurably around room temperature).
0.5 pt – Thus water or air would work as thermometers. (2)
2. Matching (each correct worth 0.5 pts)
 - a. VI
 - b. V
 - c. III
 - d. I
 - e. IV
 - f. II
3. 1,000 calories
4.
 - a. Neither, or they should have the same temperature
 - b. The bowl of water
 - c. The bowl of water for both
5.
 - a. 0.784 J kg⁻¹ K⁻¹
 - b. 0.5 pt – It would not change.
1 pt – Noting that increasing mass would change the ΔT or variants that specific heat only depends on the type of substance and not mass. (1.5)
 - c. Aluminum
 - d. L = 456 kJ/kg
 - e. 0.5 pt – A bad conductor.
1 pt – Noting that good conductors have lower specific heats or are easier to melt. (1.5)
6.
 - a. 1.07 x 10⁻³ m³
 - b. 1.53 x 10⁷ Pa
 - c. 595 J
 - d. Isobaric
 - e. 0 J
 - f. Answer with these steps:
 - i. $\Delta U = Q - W$ (0.5)
 - ii. If adiabatic, $\Delta U = -W$ (0.5)
 - iii. If isobaric, $\Delta U = Q - W$ (0.5)
 - iv. 0.5 pt – More work would be done in the adiabatic case.

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1 pt – Variants, like:

In the adiabatic case only work is done OR In the isobaric case, energy is “shared” between Q and W. (1.5)

g. **Answer with these steps:**

- i. **Carnot efficiency**
- ii. **0.367**
- iii. **218 J**
- iv. **0.5 pt – 750 J**

0.5 pt – No, not enough work

7.

- a. **The 2nd law of thermodynamics**
- b. **Ice freezing = surroundings gain more heat or entropy than the ice loses (universal increase). (1.5)**
- c. **0.5 pt – It would not be possible**
0.5 pt – Stating the 2nd Law in own words (eg. Heat cannot only go from a colder system to a hotter system)
0.5 pt – Explain something analogous to the ice cube (eg. The freezer/fan must net release some heat) (1.5)

8. **The 3rd law of thermodynamics**

9. **(Nicolas Léonard) Sadi Carnot**

10. **William Thomson, 1st Baron Kelvin (accept “Lord Kelvin” or “Kelvin”) (0.5)**

11. **Willard Gibbs**

12. **Latent Heat**

13. **Albert Einstein**

14. **Matching: (each correct worth 0.5 pts)**

Example	Form of Energy Transfer
Blood circulation in a warm blooded animal	B
Sunlight	C
Popping popcorn in the microwave	C
Space Heater	B
The heat you feel from touching a smartphone	A
Solar Panels	C
Rubbing your hands together	A

15. **1 pt – Dark objects absorb more radiation/have higher emissivity**

0.5 pt – The stripes should be “hotter”/brighter in the infrared.

0.5 pt – White = the normally black stripes. (2)