

Thermodynamics

C Division
Raisbeck Invitational
December 2, 2017

Team Number: _____

School Name: _____

Team Name: _____

Team Members: _____

Read each question carefully. Be sure to show work, include proper units and remember to report answer with proper significant figures.

Part i. Temperature (13 POINTS)

1. _____ What are the units of specific heat capacity **(1 POINT)**
 - A. $\text{J/g}^\circ\text{C}$
 - B. $\text{J g}/^\circ\text{C}$
 - C. $\text{J g }^\circ\text{C}$
 - D. $1/\text{J g }^\circ\text{C}$

Convert the following temperatures:

2. Find Celsius equivalent of 41.2°F **(2 POINTS)**
3. Convert 36.60°C to Fahrenheit. **(2 POINTS)**
4. Convert 26°F to Kelvin. **(4 POINTS)**
5. A new temperature scale is to be used where freezing and boiling temperature of water is at -100°N and 100°N respectively. Calculate Absolute Zero in $^\circ\text{N}$ **(4 POINTS)**

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ii. Thermal calculations (2 POINTS EACH = 14 POINTS):

6. _____ A 15.75 g piece of iron absorbs 1086.75 joules of heat energy, and its temperature changes from 25°C to 175°C. Calculate the specific heat capacity of iron.
- A. 0.46 J/g°C
 B. 1.65 J/g°C
 C. 2.59 J/g°C
 D. 3.39 J/g°C
7. _____ A 12.5 gram piece of iron ($c = 0.450 \text{ J/g}^\circ\text{C}$) has an initial temperature of 1.0×10^2 °C. When the iron loses exactly 25.0 J of energy, its final temperature is _____, and is an _____ process.
- A. -4.4 °C, exothermic
 B. -4.4 °C, endothermic
 C. 95.6 °C, exothermic
 D. 95.6 °C, endothermic
8. _____ How much heat is needed to raise the temperature of 10.0 g of aluminum from 22.0°C to 55.0°C, if the specific heat of aluminum is 0.900 J/g °C?
- A. 297 J
 B. 0.003 J
 C. 297 J/g°C
 D. 0.003 J/g°C
9. _____ Entropy will generally increase when
- I. A molecule is broken into two or more smaller molecules.
 II. A reaction occurs that results in an increase in the number of moles of gas.
 III. A solid changes to a liquid.
 IV. A liquid changes to a gas.
- A. I only
 B. II only
 C. III only
 D. IV only
 E. I, II, III, and IV

Predict whether condition would be spontaneous.

10. Formation of H ₂ O ₂ : $2\text{H}_2\text{O}_{(l)} + \text{O}_{2(g)} \rightarrow 2\text{H}_2\text{O}_{2(l)}$	SPONTANEOUS	NOT SPONTANEOUS
11. Formation of a salt water solution	SPONTANEOUS	NOT SPONTANEOUS
12. Formation of starch by bonding glucose molecules.	SPONTANEOUS	NOT SPONTANEOUS

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iii. Thermodynamic laws and processes (10 POINTS)

13. _____ What condition is necessary for a process to be adiabatic?
- Heat enters, but doesn't leave while process occurs.
 - Heat doesn't enter, but leaves while the process occurs.
 - Heat enters and leaves while process occurs.
 - No heat enters or eaves while the process occurs.
14. _____ How does the Second Law of Thermodynamics relate to the direction of heat flow?
- It defines that heat flow direction in a system is constant.
 - It defines that heat flow direction is conserved.
 - It defines that heat flow direction moves from areas with more heat to areas with less heat.
 - It defines that heat flow direction moves from areas with less heat to areas with more heat.
15. _____ Under what circumstances can entropy decrease in a system?
- Only when NO work is done on a system.
 - Only when energy is
 - Only with work or other organized energy input
 - Entropy can never decrease in a system.
16. _____ When work is done on a system, internal energy _____ and temperature _____.
- increases, increases
 - decreases, decreases
 - increases, decreases
 - decreases, increases
17. _____ When air is adiabatically compressed, temperature _____. When air adiabatically expands, temperature _____.
- increases, increases
 - decreases, decreases
 - increases, decreases
 - decreases, increases

iv. History of thermodynamics: Match each scientist to a thermodynamic contribution (8 POINTS)

15. _____ Sir John Leslie	a. Invented the first commercial steam engine .
16. _____ Robert Boyle	b. Introduced the terms Latent Heat and Specific Heat .
17. _____ Thomas Saveray	c. Recognized the importance of blackbody radiation
18. _____ Joseph Black	d. Successfully combined Charles, Boyle's and Gay-Lussac's Gas Laws.
19. _____ Emile Clapeyron	e. Connected electrochemical cell voltage to thermodynamics
20. _____ Walter Nernst	f. A gases volume is inversely proportional to pressure in a closed system at constant temperature.
21. _____ Steven Hawking	g. Considered the " Father of Thermodynamics "
22. _____ Nicholas Sadi Carnot	h. Used thermodynamics to predict behavior of black holes