Thermodynamics, Written Test TEAM#: C-_____
Raisbeck Invitational, Dec 2, 2017 Student names: _____ _____

KEY

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

Part i. Temperature scales and conversions, definitions of heat units

1. ___**A**___What are the units of specific heat capacity
   a. **J/g° C**
   b. J g/°C
   c. J g °C
   d. 1/J g °C

Convert the following temperatures:
[°C] = 5/9([°F] -32) or [°C] = 0.5556 ([°F] -32)
[°F] = 9/5 [°C] + 32 or [°F] = 1.8 [°C] + 32
K = °C + 273.15

2. Find Celsius equivalent of 41.2°F
   [°F] = (41.2-32) ×5⁄9 = **5.11° C**

3. Convert 36.60°C to Fahrenheit.
   [°F] = 36.60 × 9⁄5 + 32 = **97.88°F**

4. Convert 26°F to Kelvin.
   First, convert from °F to °C
   [°C] = 5/9([°26] -32) = -3.3°C

   Then convert to Kelvin
   K = -3.3 + 273.15 = 269.85 = **269.9 K**

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 °N

Total Scale in N = 100 – (-100) = 200 Total Scale in C = 100 - 0 = 100

(Current Temp) / (Overall Scale) = x/200 = -273.15/100

f(x)=ax+b
Two points GIVEN: Freezing point: −100°N and boiling point is +100°N.
This corresponds to 0° C and 100° C and gives:

f(0) = b = −100 f(100) = 100a + b= 100 → 100a − 100=100 →a=200/100=2
Therefore: f(x)=2x−100 This gives that f(−273.15)=−646.3°N

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ii. Thermal calculations:

6. ____**A**____ 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. _____**C** ___A 12.5 gram piece of iron (c = 0.450 J/g°C) has an initial temperature of 1.0 x 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. ___**A**_____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. ____**E**____Entropy will generally increase when
   V. A molecule is broken into two or more smaller molecules.
   VI. A reaction occurs that results in an increase in the number of moles of gas.
   VII. A solid changes to a liquid.
   VIII. 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_2O_2: $2H_2O_{(l)} + O_{2(g)} \rightarrow 2H_2O_{2(l)}$	**NOT SPONTANEOUS**
11. Formation of a salt water solution	**SPONTANEOUS**
12. Formation of starch by bonding glucose molecules.	**NOT SPONTANEOUS**

iii. Thermodynamic laws and processes

13. __**D**___ What condition is necessary for a process to be adiabatic?
   - a. Heat enters, but doesn't leave while process occurs.
   - b. Heat doesn't enter, but leaves while the process occurs.
   - c. Heat enters and leaves while process occurs.
   - **d. No heat enters or eaves while the process occurs.**

14. ___C___ How does the Second Law of Thermodynamics relate to the direction of heat flow?
- **a.** It defines that heat flow direction in a system is constant.
- **b.** It defines that heat flow direction is conserved.
- **c. It defines that heat flow direction moves from areas with more heat to areas with less heat.**
- d. It defines that heat flow direction moves from areas with less heat to areas with more heat.

15. **___B___** Under what circumstances can entropy decrease in a system?
- **a.** Only when NO work is done on a system.
- b. Only when energy is
- **c. Only with work or other organized energy input**
- **d.** Entropy can never decrease in a system.

16. **___A___** When work is done on a system, internal energy _____ and temperature _____.
- **a. increases, increases**
- b. decreases, decreases
- c. increases, decreases
- d. decreases, increases

17. **___C___** When air is adiabatically compressed, temperature _____. When air adiabatically expands, temperature _____.
- a. increases, increases
- b. decreases, decreases
- **c. increases, decreases**
- d. decreases, increases

iv. History of thermodynamics: Match each scientist to a Thermodynamic Contribution (8 POINTS)

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

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Event parameters

Water Temp = 75°C
Volume = 125 mL

Time for water run: 30 minutes
Time for to take the test: 25 minutes

Logistics
Water from controlled sources
Stay with partner