

**THERMODYNAMICS WRITTEN TEST PORTION  
GOPHER INVITATIONAL  
JANUARY 6TH 2018**

NAMES \_\_\_\_\_

TEAM NAME AND NUMBER \_\_\_\_\_

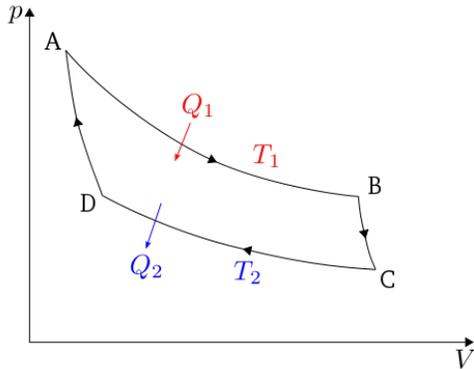
SCHOOL \_\_\_\_\_

**TIME ALLOWED: 30 MINUTES**

**DO NOT TURN THE PAGE UNTIL YOU ARE INSTRUCTED TO DO SO.**

**Multiple Choice:** Identify the choice that best completes the statement or answers the question. Then write the letter of the choice on the line provided next to the question number.

- \_\_\_\_ 1. What is the caloric theory of heat?
- Heat is the sum of vibratory motion and energy from a substance's molecules/atoms.
  - Heat is a fluid that flows from hot to cold bodies.
  - Heat is derived from fire, one of the 4 elements.
  - Heat is a vacuum that takes away warmth.
- \_\_\_\_ 2. The idea of heat death as a consequence of the laws of thermodynamics was first proposed by which person?
- James Prescott Joule
  - William Thompson (aka Lord Kelvin)
  - William Rankine
  - Ludwig Boltzmann
- \_\_\_\_ 3. Which of the following people had a famous thought experiment that suggested how the 2nd law of thermodynamics might be violated?
- James Prescott Joule
  - Nicolas Leonard Sadi Carnot
  - James Clerk Maxwell
  - Anders Celsius
- \_\_\_\_ 4. Who first coined the word "Thermodynamics"?
- William Thompson (aka Lord Kelvin)
  - Galileo Galilei
  - Walther Hermann Nernst
  - Anders Celsius
- \_\_\_\_ 5. Who invented the first mercury-in-glass thermometer?
- Anders Celsius
  - William Thompson (aka Lord Kelvin)
  - Rudolf Julius Emanuel Clausius
  - Daniel Gabriel Fahrenheit
- \_\_\_\_ 6. What is the 2nd law of thermodynamics?
- Heat can never be created or destroyed.
  - The entropy of a perfect crystal at 0 K is 0.
  - Heat flows from hot to cold bodies.
  - $\Delta S_{\text{Universe}} > 0$



- \_\_\_ 7. What happens in step A(going towards B) of the diagram pictured above?
- isothermal expansion of the gas
  - the surroundings do work on the gas, increasing its internal energy and compressing it
  - The gas expansion causes the gas to cool to the "cold" temperature,  $T_2$ .
  - Entropy remains unchanged
- \_\_\_ 8. What happens in step D(going towards A) of the diagram pictured above?
- Isentropic expansion of the gas
  - Isothermal expansion of the gas
  - Isentropic compression of the gas
  - Isothermal compression of the gas
- \_\_\_ 9. When air is forced to rise, it expands and its temperature decreases. Which phrase describes this process?
- Adiabatic cooling
  - Adiabatic heating
  - Isobaric heating
  - Isochoric heating
- \_\_\_ 10. What would be the efficiency of a Carnot engine operating with boiling water as one reservoir and a freezing mixture of ice and water as the other reservoir?
- 26%
  - 98%
  - 27%
  - 100%
- \_\_\_ 11 a. What temperature scale has its main modern uses in some Italian and Swiss factories for measuring milk temperature during cheese production?
- Rømer
  - Rankine
  - Delisle
  - Réaumur
- \_\_\_ 11 b. What temperature scale, other than the Kelvin, uses an absolute scale?

- a) Rømer
- b) Rankine
- c) Delisle
- d) Réaumur

\_\_\_ 12. Which of the following is **not** equivalent to 1 Joule?

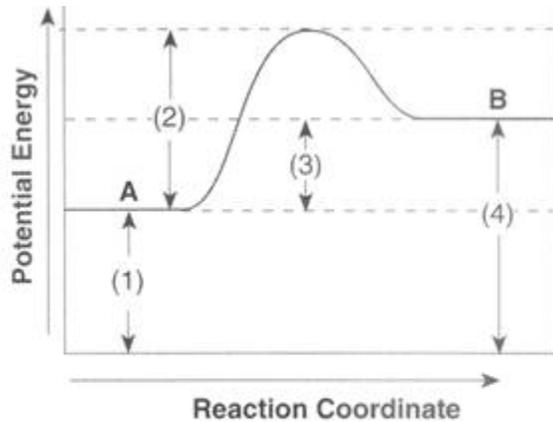
- a) N\*m
- b)  $\text{kg}\cdot\text{m}^2/\text{s}^2$
- c) C\*V
- d) Pa\*m

\_\_\_ 13. Which of the following is **not** equivalent to 1 calorie?

- a) 4.184 J
- b)  $2.611\cdot 10^{19}$  eV
- c)  $1.162\cdot 10^{-6}$  kWh
- d) 0.003985 BTU

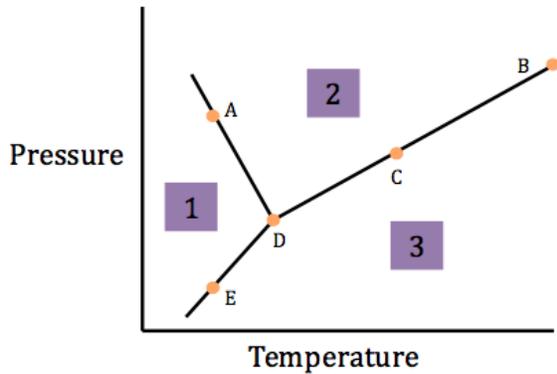
\_\_\_ 14. What is heat conductivity in nonmetals is mainly due to?

- a) Lattice vibrations (phonons)
- b) Free electrons
- c) Nucleus binding energy
- d) Electron repulsion



\_\_\_ 15. In the enthalpy diagram above, which labeled arrow represents the activation energy?

- a) 1
- b) 2
- c) 3
- d) 4



\_\_\_\_ 16. The specified phase transition for this question is from point 1 to point 2 on the diagram above. What kind of latent heat is required for this transition?

- a) Latent heat of vaporization
- b) Latent heat of sublimation
- c) Latent heat of fusion
- d) Latent heat flux

\_\_\_\_ 17. If heat  $Q$  flows reversibly from the system to the surroundings at  $T_0$ ...

- a) entropy increase of the surroundings is  $Q/T_0$
- b) entropy of the system is reduced by  $Q/T_0$
- c) system has lost entropy to the surroundings
- d) all of the above

**Calculation Questions:** Answer the questions below, write neatly, and show your work. Make sure your final answers have the correct number of significant figures. Draw a box around your final answer.

1. Given a Carnot engine that absorbs 750 J of energy from a tank of hot water with a final temperature of 300.0 K, what is the initial temperature, in Kelvin, if 600.0 J of work was done by the system?

