Test Exchange

Thermodynamics (C) Test

Team Name: _____ Team Number: _____

Score: _____ / 43

Questions are worth between 1 and 3 points. Show calculations for all open-ended math questions in order to receive partial credit.

1. Which of the following temperature scales was notably the first scale to use 0 degrees as the freezing point of water? (1 point)
    a. Réamur
    b. Celsius
    c. Newton
    d. Delisle

2. Which of these is not an assumption made by the kinetic molecular theory? (1 point)
    a. Gas molecules undergo elastic collisions only
    b. There are no forces of attraction between particles
    c. Gases have random, constant motion and have energy in the form of kinetic energy
    d. Gas particles are relatively close together and occupy large portions of container volumes
    e. All of these are assumptions made by the kinetic molecular theory

3. Sadi Carnot, is known for all of the following achievements except? (1 point)
    a. Formalized the second law of thermodynamics
    b. Defined the concept of entropy
    c. Assisted in deriving the Gibbs-Free Energy equation
    d. Established a thermodynamic model for heat engines

4. The Kelvin temperature scale has been historically defined by which of the following? (1 point)
    a. Standard temperature and pressure
    b. Triple point of water
    c. The melting point of helium gas
    d. Vapor pressure of water at STP

5. Which of the following describes the process that occurs in this diagram at A? (1 point)
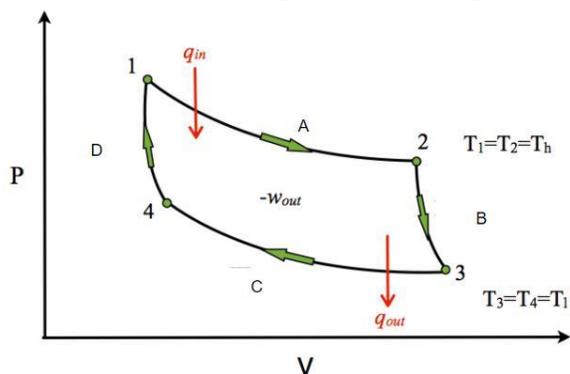
   a. A reversible isothermal gas expansion process
   b. A reversible adiabatic gas expansion process
   c. A reversible isothermal gas compression process
   d. A reversible adiabatic gas compression process

6. Write the equation formed by Van der Waals Equation if interparticle interactions are negligible and the common name of this equation. (1 point for equation, 1 point for name)

7. Label the parts of this apparatus and in the space below, briefly describe what this device is used for. (1 point each)

1. _____
2. _____
3. _____
4. _____
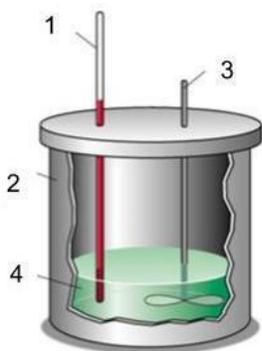
8. Helium gas and nitrogen gas have been added to an excavated container that can hold 1 liter. (4 points total)

   a. Which gas is most likely to exhibit deviation from kinetic molecular theory and why? (1 point for correct gas, 1 point for explanation)

   b. What is the ratio between the effusion rates of helium to nitrogen gas if a pinhole is cut out of the box? Show calculations. (2 points)

   c. The box is subjected to a constant external temperature. Which gas would you expect to have the greatest average speed and why? (1 point for gas, 1 point for explanation)

9. The number of microstates of a thermodynamic system is 10^24. Calculate the entropy of the system (1 point)
  - a. 7.6*10^-22
  - b. 8.6*10^-24
  - c. 2.5*10^-17
  - d. 6.2*10^-30

10. Given a hot dry rock system with a thermal conductivity of 1.38 in W/m*K , a temperature difference of 30 C, and a thickness of 80 m, what is the heat flow in a cross sectional area of 20 square meters. (1 point)
  - a. 10.35 W
  - b. 12.40 W
  - c. 9.9 W
  - d. 29020 W
  - e. 66420 W

11. Given a reaction, circle spontaneous or nonspontaneous for each reaction. (1 point each)
  - a. Lighting a match: spontaneous/ nonspontaneous
  - b. Iron rusting: spontaneous/ nonspontaneous
  - c. Mercury solidifies at room temperature: spontaneous/ nonspontaneous

12. Calculate the actual gas constant for 1 L for 1 mole of hydrogen gas at 2 atm and 20 degrees Celsius. (3 points)

13. Which material listed below is known for having the most thermal diffusivity? (1 point)

       a. Steel
       b. Gold
       c. Graphite
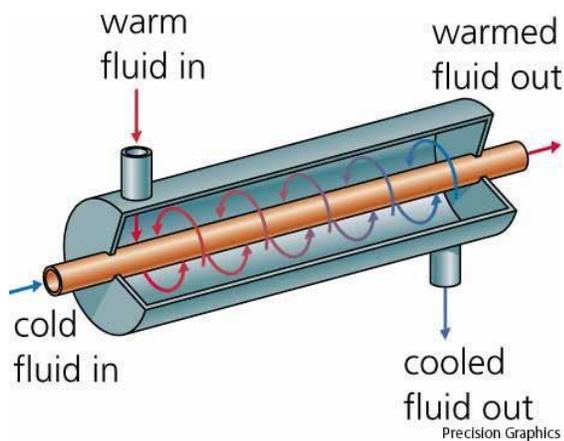   d. Inconel
       e. Silicon

14. Anisotropic heating of materials usually results from which of the following: (1 point)

       a. Point source heating
       b. Tempered variances
       c. Rapid increases in microstates
       d. Non-cubic crystal structures

15. Determine the compressibility of a solid with a volume of 3.24 cubic meters and a volumetric pressure derivative of 35.3 cubic meters per pascal. (1 point)

       a. -114.372
       b. -10.89
       c. -2.74
       d. -1.886

Use the following image for questions 16-18.

warm fluid in
warmed fluid out
cold fluid in
cooled fluid out
Precision Graphics

16. Which famous scientist developed the basis for the system pictured above? (1 point)

       a. Sadi Carnot
       b. James Maxwell
       c. Josiah Gibbs
       d. Walther Nernst

17. Where would this type of system be found? (1 point)
    a. Space heating
    b. Air conditioning
    c. Petroleum refineries
    d. Sewage treatment
    e. Geothermal heat pumps
    f. All of these

18. Which of the following are ways to optimize such designs? (1 point)

    I. Maximizing the pressure drop

    II. Maximizing the thermal performance

    III. Minimizing the entropy generation

    a. I only
    b. II only
    c. I and III
    d. I and II
    e. II and III

19. Which of the following best describes residual entropy? (1 point)
    a. The remaining entropy after a substance has achieved thermal equilibrium
    b. The difference in entropy between a non-equilibrium state and crystal state of a substance close to absolute zero
    c. The caloric energy count in the system as it approaches absolute zero
    d. None of the above

20. Define sorption calorimetry: (2 points)

21.   Based on Carnot's theorem, an engine can have a maximum efficiency that is defined by the temperature of it's cold and hot reservoir. If the cold reservoir is 300 K and the hot reservoir is 400 K. What is the maximum efficiency? (1 point)
   a. 0.75
   b. 0.3
   c. 0.45
   d. 0.25
   e. 1

22.   What is the driving force behind the piston in a Photo-Carnot engine? (1 point)
   a. Steam pressure
   b. Radiation pressure
   c. Electrical power
   d. Rotational momentum

23.   A Rijke tube converts _____ into _____ using _____.
       (1 point for each blank)

24.   The Delisle temperature scale is one of the only scales that: (1 point)

       a. Uses three fixed points to calibrate the scale
       b. Runs with increasing values for decreasing heat
       c. Utilizes more than 3000 gradations
       d. Has an exponentially changing scale

25.   How is the BTU defined? (2 points)

26.   The Joule-Thomson effect was discovered in _____. (1 point)

27.   Which of the following thermodynamics pioneers is accredited with the concept of internal energy? (1 point)

       a. Lord Kelvin
       b. Sadi Carnot
       c. Max Planck
       d. Rudolf J. Clausius

28.   In 1798, Benjamin Thompson began his _____ experiments. (1 point)