Student Name: ____________________
Date: ____________________

Activity Sheet
Thermodynamics

Part I: Watch your teacher's demonstration and answer the following.

1. What was done and what happened as a result?

2. Adiabatic means ____

____

____

3. What happened to the temperature and the internal energy of the sample of gas trapped in the syringe when the plunger was rapidly pressed down?

4. What was the source of the additional internal energy?

5. What other technique could have produced the same result?

6. What formula summarizes what we have learned?

ΔU = ________ + ________ ***(This is the ________ Law of Thermodynamics)***

7. The Second Law of Thermodynamics is centered around the concept of ________________. Entropy is represented by the letter ________.

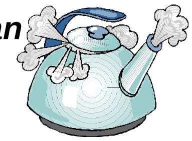
8. The pressure, temperature, and volume of a sample of gas define its ________________.

9. There are a number of ways that the large number of gas particles could be arranged in terms of position and velocity to produce that macrostate. Each of these individual possibilities is called a ________________. The number of microstates may be represented by ________.

10. The formal definition for entropy is based on the formula _____ = $k_B \ln \Omega$.

11. Changes in entropy nearly always involve a flow of heat as per the formula Δ____ = Q/T.

12. When heat flows into an object (as in when water is boiled) there is an _______________ in the entropy of the sample.



13. When heat flows out of an object (as in when water freezes in an ice tray) there is a _______________ in the entropy of the sample.

14. During the adiabatic compression of the fire syringe, the entropy of the sample does _______________ change.

15. Over time, as heat left the fire syringe, the entropy of the gas sample went _______________.

15. When heat left the fire syringe, the entropy of the environment went _______________.

16. Using the formula Δs = Q/T, determine if the net change in entropy was up or down. _______________

This result is summed up by the Second Law of Thermodynamics:

Δs_{net} _____ 0.

A chemist might phrase it as, "energy spontaneously disperses, if it is not hindered, causing a net increase in entropy", but the idea is the same.

An understanding of entropy can help you interpret your experiences more accurately and correctly _______________ what will happen in a variety of situations.

Part II: Follow the directions and answer the associated questions.

17. Hold a rubber band against your top lip and stretch it out quickly. What do you notice about the rubber band?

18. Hold the rubber band against your top lip and let it contract quickly. What do you notice about the rubber band?

19. A rubber band consists of long chains of a _______________ called polyisoprene. To keep the rubber from feeling "tacky" the strands are held together (_______________-_______________) with sulfur.

20. Pulling quickly on the rubber band caused it to stretch _______________.

21. Since there was no net transfer of heat, the entropy change of the rubber band during the adiabatic stretching was _______ J/K.

22. Work was done on the rubber band as it was stretched, so its internal energy was _______________ after stretching than it was initially.

23. What happened to the number of conformational microstates as the rubber band was stretched? $W_{conformational}$ _______________ (i.e. Were there more or less possible arrangements for the chains once it was stretched?)

24. Since the stretching of the rubber band was an adiabatic change, there was no change in entropy. How was the entropy of the rubber band maintained at its original level during the stretching process? $W_{vibrational}$ _______________

25. The higher vibrational rate caused the temperature of the rubber band to _______________. That's why the rubber band felt _______________ after it was stretched.

26. Over time, the stretched rubber band equilibrated thermally with the room, meaning that the rubber band and its surroundings were at the same _______________.

27. When the rubber band was allowed to contract adiabatically, the amount of heat that left the rubber band was _______ J.

28. The adiabatic contraction of the rubber band produced many more conformational microstates, but the entropy of the rubber band stayed constant because the number of vibrational microstates _______________.

29. The loss of vibrational energy caused the temperature of the adiabatically contracted rubber band to _______________ causing it to feel _______________.

30. Compare the compression of the fire syringe with the stretching of the rubber band. (i.e. In what ways were they similar?)

31. Contrast the compression of the fire syringe with the stretching of the rubber band. (i.e. In what ways were they different?)

Part III: Predict and test as indicated.

32. Note the set-up in which a spring is supporting a mass. What do you think will happen as the spring is heated and why?

33. What actually happened when the spring was heated?

34. Note the set-up in which a rubber band is supporting a mass. What do you think will happen as the spring is heated and why?

35. What actually happened when the rubber band was heated?

Part IV: Watch your teacher's demonstrations and answer the following.

36. When rubber is cooled below its "glass transition temperature" the randomly-arranged (i.e. amorphous) polymer chains have trouble slipping past each other. This creates a brittle elastic state. Describe what happens when a stretched rubber band is dipped into liquid nitrogen for several seconds.

37. Describe what happens to the rubber band when it is suddenly stressed while it is below its glass transition temperature.

38. What are some other materials that exhibit a glass transition temperature?