Thermodynamics — Physics

Assignment #1 — Read pages 339 - 351.

1. What is thermal energy?
2. What is heat?
3. Is heat the same as thermal energy?
4. A block of gold has a temperature of 30°C and a block of iron has a temperature of 30°C. Do both blocks have the same amount of thermal energy?
5. The Joule is the standard unit of measurement for heat. Why was this unit named after James Prescott Joule?
6. What is the difference between the heat capacity of an object and the object's specific heat?

Use Table 15-1 on page 344 to find the specific heat for each substance in the following problems.

7. How many Joules of heat would a 50.0 gram block of copper have to absorb in order to change its temperature from 15°C to 80°C?
8. The temperature of a 200.0 gram jar of olive oil drops from 35° to 20°. How many Joules of heat did it lose?
9. A 1-Liter (1000 g) bottle of water absorbs 400,000 Joules of heat. If the initial temperature of the water was 3°C, what is the water's final temperature?
10. What is latent heat of fusion?
11. What is latent heat of vaporization?

Use Table 15-3 on page 349 to find melting points, boiling points, and latent heats.

12. A 500.0 g block of aluminum has a temperature of 20°C.
    a. What is the melting point of aluminum?
    b. How many Joules of heat are needed to heat the block to its melting point?
    c. How many Joules of heat are needed to melt the block?
13. An 80.0 gram ice cube is frozen to -10°C.
    a. How many Joules are needed to heat it to its melting point?
    b. How many Joules are needed to melt it?
    c. How many Joules are needed to heat the water from the melted ice up to its boiling point?
    d. How many Joules are needed to boil the water?
    e. How many Joules are needed to heat the steam to 120°C?
14. Honors: A 50.0 gram block of iron at 110.0°C is dropped into an insulated cup that contains 250.0 g of water at 22.0°C. Once the block and the water have reached thermal equilibrium, what will the temperature of both be?

15. List the three ways to transfer thermal energy.
16. It's raining and your shoes get very wet. You try to dry them off using a hair dry to blow warm air on them. Which process of heat transfer are you using?
17. You place a cold frying pan on a hot electric burner. A minute later when you touch the pan's metal handle, you get burned. By which process did thermal energy travel from the burner to your hand?
18. Write the three laws of thermodynamics.
19. What is a heat engine?
20. What does each variable stand for in the equation: $Q + W = \Delta U + E$
21. For each process listed below, one of the variables (Q, W, ΔU) will equal zero. Indicate which variable is zero for the process:
    a. Adiabatic
    b. Isothermal
    c. Isochoric
22. What does not change during an isobaric process?
23. A gas in a cylinder has a volume of 1.8 m^3 at a pressure of 1.2×10^5 Pa. The gas expands isobarically until its volume is 2.5 m^3, how much work did the gas do?
24. Draw a Pressure – Volume graph for the following process:

    Start: Gas in a cylinder has a volume of 3 m^3 at a pressure of 5×10^5 Pa.

    Step 1: It expands isobarically until its volume is 6 m^3.

    Step 2: The pressure in the cylinder drops to 1×10^5 Pa as the gas cools isochorically.

    Step 3: The gas is compressed isobarically until it has a volume of 3 m^3 again.

    Step 4: Then it is heated isochorically until its pressure is 5×10^5 Pa.
25. Calculate the amount of work that was done on (-) or by the gas (+) in each step of the process in Problem 24. (Show your calculations.) What is the total amount of work done by the gas?
26. Is the process in Problem 24 adiabatic?
27. What does ΔU equal for the complete cycle of the process in Problem 24?
28. Honors: A gas starts at a volume of 0.03 m^3 at a pressure of 5.0×10^4 Pa. Its volume and pressure change linearly until the volume is 0.08 m^3 and the pressure is 3.0×10^4 Pa. Then the gas is compressed isobarically until its volume is 0.03 m^3 at a pressure of 3.0×10^4 Pa. The gas is then heated isochorically until its pressure and volume match its initial conditions. Calculate the total work done by the gas and the total heat exchanged in one cycle.