Multiple Choice Questions:

1. Heat energy will spontaneously always flow in the direction of _____.
a. a higher temperature
b. a lower temperature
c. up, since heat rises
d. a smaller heat capacity

2. Your feet feel warmer on a rug than on a tile floor because the rug
a. is usually warmer than the tile
b. is a better insulator than tile
c. has more internal energy than tile for the same mass
d. all of these

3. An object with a high specific heat will _____.
a. lose its heat very fast
b. decrease in temperature quite fast if removed from the heat source
c. take considerably more heat to raise its temperature
d. always be water

Problems

1. Suppose you left a 100W light bulb on continuously for one month. If the electricity generation and transmission efficiency is 30%, how much chemical energy (in joules) was wasted *at the power plant* for this oversight? If the fuel consumption for one meal in Cambodia using a kerosene wick stove is 6MJ (1MJ=1,000,000 joules), how many equivalent meals could be obtained with this wasted energy? Waste = Total – Useful

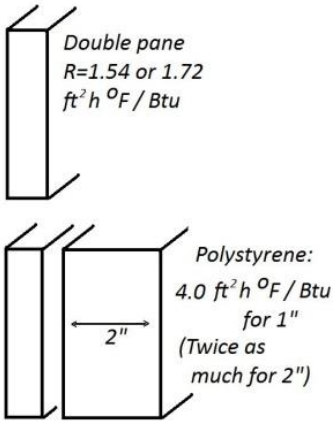
P=100W
t=1mo=30da

2. How much electrical energy (in kWh) is needed to heat the water in a well-insulated electric hot water heater of capacity 40 gal from 20ºC to 50ºC (68ºF to 122ºF)? Use units of Btu/lb/°F.

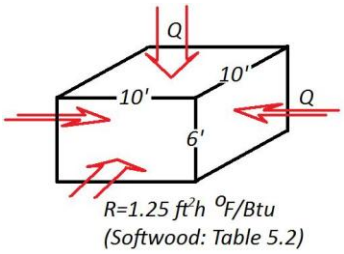
3. A wall is made up of four elements, as follows:
   ½" wood siding (lapped) [$R_1 = 0.81\ ft^2 \cdot h \cdot °F/Btu$]
   ½" plywood sheathing [$R_2 = 0.62\ ft^2 \cdot h \cdot °F/Btu$]
   3½" fiberglass [$R_3 = 10.9\ ft^2 \cdot h \cdot °F/Btu$]
   ½" Sheetrock [$R_4 = 0.45\ ft^2 \cdot h \cdot °F/Btu$]

Using the R-values above, how many Btu per hour per square foot will be lost through the wall when the outside temperature is 50°F colder than the inside?

4. Heat loss through windows is substantial. What percentage savings will be gained by covering a double-pane window with 2-in. sheet of rigid polystyrene board?



5. A room air conditioner has a capacity of 6000 Btu/h. Would this be sufficient to maintain the temperature of a small hut at 70ºF when the outside temperature is 95ºF? Assume the hut is 10ft × 10ft × 6ft and the exterior surfaces are made of 1-in. softwood.



6. Suppose the solar radiation is $850 W/m^2$ and you can collect 20% of the energy that falls on the reflecting surface of a solar hot dog cooker. If you need 240W for the cooker, what is the minimum collector area required?

http://www.humboldt.edu/~ccat/solarcooking/parabolic/parabolic%20deep%20focus%20%20cooker%20photo,%20bangladesh.gif

7. What maximum percentage of the 40,000 Btu/h heating needs of a house in St Cloud in Minnesota in January can be met with a flat plate collector of area 700ft^2? Assume that the collector is tilted at an angle equal to the latitude, and the system efficiency is 50%. (daily radiation in St Cloud 1410 Btu/ft^2/day).

8. If all of our [US] needs for oil were to be provided by that available from the estimated reserves located in the Arctic National Wildlife Reserve, how long would that supply last, assuming no growth in demand? (assuming that the US uses 19 million barrels of crude oil per day. So the 3 to 5 billion barrels would last....)

9. For a gasification project being planned, 26,000 tons of coal per day will be used to produce 250,000,000ft^3/d of natural gas. If the coal is rated at 8700 Btu/lb and the gas at 950 Btu/ft^3, what will be the efficiency of this plant? (Metric ton = 1000kg=2200lb. British ton = 2000lb. Use the metric ton.)

10.If the efficiency of a geothermal plant is half that of a fossil-fuel plant, then how much more waste heat will be discharged to the environment from a geothermal facility than from a fossil-fuel plant with the same electrical output?

	FossilFuel	*Geothermal*
Efficiency	33%	16.5%
Waste	67%	83.5%

11. You might challenge the assertion that batteries are inexpensive energy converters. Calculate the price per kilowatt-hour for a 12-V automobile battery with a 50 amp-hour capacity that sells for $40. If its weight is 45 lb, what is the energy density in watt-hours per pound?

Weight=45lb
Price=$40
V=12V
Q=50Ah

12. Explain what a PCM is, two reasons why it is useful, and two properties of an ideal PCM.

13. Describe what each of the following quantities represent in the context of a heat engine: Q_h, Q_c, T_h, T_c, and W.

14. The power to a 1500W space heater in a Winthrop dorm is left on for three months during the winter.

a) Calculate the electrical energy consumed by the heater, in both kW•hr and Btu
b) In NY state, residential customers pay nearly \$0.18/kW•hr. Calculate the power bill (in dollars) for this space heater for three months. (Notice that the money wasted by the heater is about 2/3 of this value, if we assume electricity to be about 3′ as expensive as whatever primary fuel is used in heating the dorms.)

15. A British thermal unit (Btu) is a unit of heat in the British system of units. One Btu is defined as the heat needed to raise 1 lb of water by 1 F°. Show that

1Btu= 0.252 Kcal=1056J.

16. How many joules and kilocalories are generated when the brakes are used to bring a 1200-kg car to rest from a speed of 95km/h?

17. A 31.5-g glass thermometer reads 23.6°C before it is placed in 135 mL of water. When the water and thermometer come to equilibrium, the thermometer reads 39.2°C. What was the original temperature of the water? [*Hint*: Ignore the mass of fluid inside the glass thermometer.]

18. Estimate the Calorie content of 65 g of candy from the following measurements. A 15-g sample of the candy is placed in a small aluminum container of mass 0.325 kg filled with oxygen. This container is placed in 2.00 kg of water in an aluminum calorimeter cup of mass 0.624 kg at an initial temperature of 15.0°C. The oxygen-candy mixture in the small container is ignited, and the final temperature of the whole system is 53.5°C.

19. In a hot day's race, a bicyclist consumes 8.0 L of water over the span of 3.5 hours. Making the approximation that all of the cyclist's energy goes into evaporating this water as sweat, how much energy in kcal did the rider use during the ride? (Since the efficiency of the rider is only about 20%, most of the energy consumed does go to heat, so our approximation is not far off.)

20. At a crime scene, the forensic investigator notes that the 7.2-g lead bullet that was stopped in a doorframe apparently melted completely on impact. Assuming the bullet was shot at room

temperature (20°C), what does the investigator calculate as the minimum muzzle velocity of the gun?