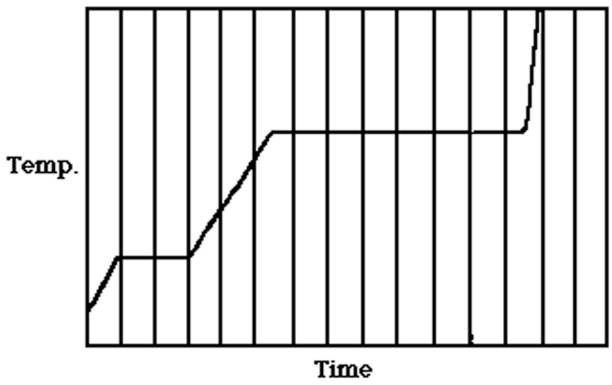
1) If you wanted to know how much the temperature of a particular piece of material would rise when a known amount of heat was added to it, which of the following quantities would be most helpful to know?
   A) density
   B) coefficient of linear expansion
   C) thermal conductivity
   D) specific heat
   E) initial temperature

2) Which one of the following quantities is the *smallest* unit of heat energy?
   A) Btu B) calorie C) kilocalorie D) joule

3) Object 1 has three times the specific heat capacity and four times the mass of Object 2. The two objects are given the same amount of heat. If the temperature of Object 1 changes by an amount ΔT, the change in temperature of Object 2 will be
   A) $12\Delta T$. B) $\frac{3}{4}\Delta$T. C) $\frac{4}{3}\Delta T$. D) ΔT. E) $6\Delta T$.

4) Object 1 has three times the specific heat capacity and four times the mass of Object 2. The two objects are heated from the same initial temperature, T_0, to the same final temperature T_f. During this process, if Object 1 absorbs heat Q, the amount of heat absorbed by Object 2 will be
   A) 6Q. B) $\frac{3}{4}Q$. C) $\frac{1}{12}Q$. D) $\frac{4}{3}Q$. E) $12Q$.

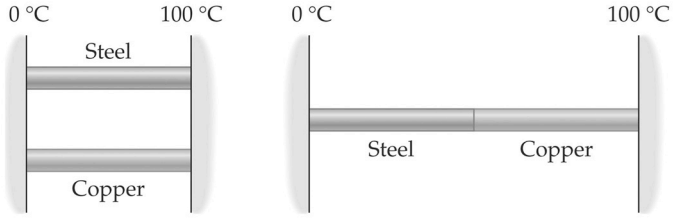
5) The figure shows a graph of the temperature of a pure substance as a function of time as heat is added to it at a constant rate in a closed container. If L_F is the latent heat of fusion of this substance and L_V is its latent heat of vaporization, what is the value of the ratio L_V/L_F?



   A) 3.5 B) 4.5 C) 7.2 D) 5.0 E) 1.5

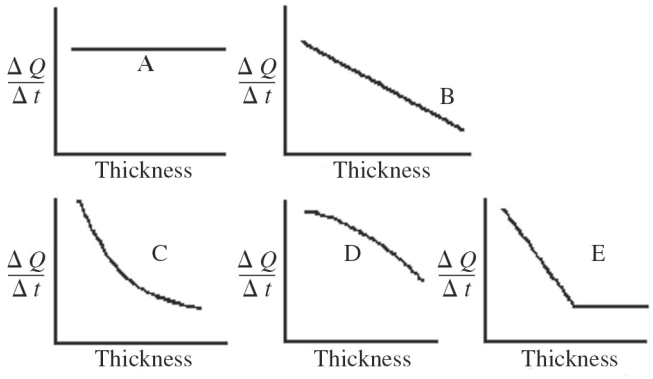
6) A solid cylindrical bar conducts heat at a rate of 25 W from a hot to a cold reservoir under steady state conditions. If both the length and the diameter of this bar are doubled, the rate at which it will conduct heat between these reservoirs will be
   A) 12.5 W B) 100 W C) 25 W D) 50 W E) 200 W

7) Two metal rods are to be used to conduct heat from a region at 100°C to a region at 0°C as shown in the figure. The rods can be placed in parallel, as shown on the left, or in series, as on the right. When steady state flow is established, the heat conducted in the series arrangement is



A) the same as the heat conducted with the rods in parallel.
B) less than the heat conducted with the rods in parallel.
C) greater than the heat conducted with the rods in parallel.

8) An architect is interested in estimating the rate of heat loss, $\Delta Q/\Delta t$, through a sheet of insulating material as a function of the thickness of the sheet. Assuming fixed temperatures on the two faces of the sheet and steady state heat flow, which one of the graphs shown in the figure best represents the rate of heat transfer as a function of the thickness of the insulating sheet?



A) A B) B C) C D) D E) E

9) On a cold day, a piece of metal feels much colder to the touch than a piece of wood. This is due to the difference in which one of the following physical properties of these materials?
A) emissivity
B) density
C) specific heat
D) thermal conductivity
E) mass

10) If, with steady state heat flow established, you double the thickness of a wall built from solid uniform material, the rate of heat loss for a given temperature difference across the thickness will
A) become four times its original value.
B) become one–half its original value.
C) become one–fourth its original value.
D) also double.
E) become $1/\sqrt{2}$ of its original value.

11) The process in which heat flows by the mass movement of molecules from one place to another is known as
A) convection. B) conduction. C) radiation.

12) An object having a fixed emissivity of 0.725 radiates heat at a rate of 10 W when it is at an absolute temperature T. If its temperature is doubled to $2T$, at what rate will it now radiate?

A) 40 W B) 320 W C) 20 W D) 80 W E) 160 W

13) If the absolute temperature of an object is tripled, the thermal power radiated by this object (assuming that its emissivity and size are not affected by the temperature change) will

A) increase by a factor of 3.
B) increase by a factor of 9.
C) increase by a factor of 18.
D) increase by a factor of 81.
E) increase by a factor of 27.

14) By what primary heat transfer mechanism does the sun warm the earth?

A) conduction
B) convection
C) radiation
D) All of the above processes are equally important in combination.

15) A 4.0–kg aluminum block is originally at 10°C. If 160 kJ of heat is added to the block, what is its final temperature? The specific heat capacity of aluminum is 910 J/kg • K.

16) A 5.00–g lead BB moving at 44.0 m/s penetrates a wood block and comes to rest inside the block. If half of its kinetic energy is absorbed by the BB, what is the change in the temperature of the BB? The specific heat of lead is 128 J/kg • K.

17) A glass beaker of unknown mass contains 74.0 ml of water. The system absorbs 2000.0 cal of heat and the temperature rises 20.0°C as a result. What is the mass of the beaker? The specific heat of glass is 0.18 cal/g • °C, and that of water is 1.0 cal/g • C°.

18) In grinding a steel knife, the metal can get as hot as 400°C. If the blade has a mass of 80 g, what is the minimum amount of water needed at 20°C if the water is to remain liquid and not rise above 100°C when the hot blade is quenched in it? The specific heat of the steel is 0.11 cal/g • C° and the specific heat of water is 1.0 cal/g • C°.

19) A 2294–kg sample of water at 0° C is cooled to –36° C, and freezes in the process. How much heat is liberated? For water L_F = 334,000 J/kg and $L_V = 2.256 \times 10^6$ J/kg. The specific heat of ice is 2050 J/kg • K.

20) A beaker of negligible heat capacity contains 456 g of ice at –25.0°C. A lab technician begins to supply heat to the container at the rate of 1000 J/min. How long after starting will it take before the temperature starts to rise above 0°C? The specific heat of ice is 2090 J/kg • K and the latent heat of fusion of water is 33.5×10^4 J/kg.

21) How much heat must be added to a 8.0–kg block of ice at –8°C to change it to water at 14°C? The specific heat of ice is 2050 J/kg • C°, the specific heat of water is 4186 J/kg • C°, the latent heat of fusion of ice is 334,000 J/kg, and 1 cal = 4.186 J.

22) A person tries to heat up her bath water by adding 5.0 L of water at 80°C to 60 L of water at 30°C. What is the final temperature of the bath water?

23) A lab student drops a 400.0–g piece of metal at 120.0°C into a cup containing 450.0 g of water at 15.0°C. After waiting for a few minutes, the student measures that the final temperature of the system is 40.0°C. What is the specific heat of the metal, assuming that no significant heat is exchanged with the surroundings or the cup? The specific heat of water is 4186 J/kg • K.

24) A 0.600–kg piece of metal X is heated to 100°C and placed in an aluminum can of mass 0.200–kg which contains 0.500 kg of water initially at 17.3°C. The final equilibrium temperature of the mixture is 20.2°C, what is the specific heat of metal X? The specific heats of water and aluminum are 4186 J/kg • K (water) and 910 J/kg • K (aluminum).

25) A 44.0–g block of ice at –15.0°C is dropped into a calorimeter (of negligible heat capacity) containing 100 g of water at 5.0°C. When equilibrium is reached, how much of the ice will have melted? The specific heat of ice is 2090 J/kg • K, that of water is 4186 J/kg • K, and the latent heat of fusion of water is 33.5×10^4 J/kg.

26) Two experimental runs are performed to determine the calorimetric properties of an alcohol which has a melting point of –10.0° C. In the first run, a 200–g cube of frozen alcohol, at the melting point, is added to 300 g of water at 20.0°C in a styrofoam container. When thermal equilibrium is reached, the alcohol–water solution is at a temperature of 5.0°C. In the second run, an identical cube of alcohol is added to 500 g of water at 20.0°C and the temperature at thermal equilibrium is 10.0°C. The specific heat capacity of water is 4190 J/kg • K. Assume no heat is exchanged with the styrofoam container and the surroundings. What is the heat of fusion of the alcohol?

27) A heat–conducting rod that is wrapped in insulation is constructed with a 0.15–m length of alloy A and a 0.40–m length of alloy B, joined end–to–end. Both pieces have cross–sectional areas of 0.0020 m^2. The thermal conductivity of alloy B is known to be 1.8 times as great as that for alloy A. The end of the rod in alloy A is maintained at a temperature of 10°C, and the other end of the rod is maintained at an unknown temperature. When steady state flow has been established, the temperature at the junction of the alloys is measured to be 40° C, and the rate of heat flow in the rod is measured at 56 W. What is the temperature of the end of the rod in alloy B?

28) A solid concrete wall has dimensions 4.0 m × 2.4 m and is 30 cm thick. The thermal conductivity of the concrete is 1.3 W/m • K, and it separates a basement from the ground outside. The inner surface of the wall is at 18°C, and the outside surface is at 6°C. How much heat flows through the wall every hour?

29) Two metal rods, one silver and the other gold, are attached to each other end–to–end. The free end of the silver rod is immersed in a steam chamber at 100°C, and the free end of the gold rod in an ice water bath at 0°C. The rods are both 5.0 cm long and have a square cross–section that is 2.0 cm on a side. No heat is exchanged between the rods and their surroundings, except at the ends. What is the temperature at the point where the two rods are in contact with one another? The thermal conductivity of silver is 417 W/m • K, and that of gold is 291 W/m • K.

30) In an experiment to measure the thermal conductivity of a certain material, a slab of material 10.0 mm thick separates a steam chamber from a block of ice with a square cross–section with dimensions 8.00 cm × 8.00 cm. After 5.00 min of running the experiment, 64.0 g of ice have melted. What is the thermal conductivity of this material? The latent heat of fusion of water is 33.5×10^4 J/kg, the latent heat of vaporization of water is 2.256×10^6 J/kg, and both the ice and water are under 1.00 atm of pressure.

31) What is the *net* power that a person with surface area of 1.20 m^2 radiates if his emissivity is 0.895, his skin temperature is 27°C, and he is in a room that is at a temperature of 17°C? ($\sigma = 5.67 \times 10^{-8}$ W/m^2 • K^4)

32) In an electric furnace used for refining steel, the temperature is monitored by measuring the radiant power emitted through a small hole in the wall of the furnace, of area 0.5 cm^2. This hole acts like a perfect blackbody radiator having the same temperature as the interior of the furnace. If the temperature of the furnace (and therefore of the hole) is to be maintained at 1650°C, how much power will the hole radiate?

Answer Key
Testname: HW_CH14_HEAT

1) D
2) D
3) A
4) C
5) A
6) D
7) B
8) C
9) D
10) B
11) A
12) E
13) D
14) C
15) 54°C
16) 3.78 K
17) 140 g
18) 33 g
19) 935,000 kJ
20) 177 min
21) 780 kcal
22) 34°C
23) 1470 J/kg • K
24) 140 J/kg • K
25) 2.1 g
26) 6.3×10^4 J/kg
27) 84°C
28) 1.8 MJ
29) 59°C
30) 1.12 W/m • K
31) 62.6 W
32) 40 W