Heat & Temperature Practice Items

1. 100 ^{o}C converted to Kelvin scale is which of the following?

A. 212 K
B. 273 K
C. 298 K
D. 373 K

2. The amount of heat necessary to raise one gram of a substance one degree of temperature (K or ^{o}C) is called

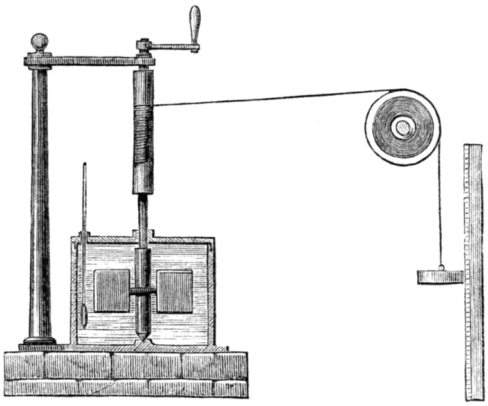
A. one calorie
B. the specific heat capacity
C. the heat capacity of the body
D. the molar heat capacity

3. A floutist tunes her flute in the cool air-conditioned environment of the hotel room 20 °C where the speed of sound through air is approximately 343 m/s. The coefficient linear expansion for steel is 1.1×10^{-5} $(^{o}C)^{-1}$. When she begins to play that evening under the hot stage lighting the temperature on stage will be 25 °C. The speed of sound through air is 346 m/s at 25 °C. When she begins to play

A. Her flute will sound slightly flat.
B. Her flute will sound slightly sharp.
C. Her flute will be in tune.
D. impossible to determine from given information.

4. The figure below shows a contemporary engraving depicting Joule's apparatus for measuring the mechanical equivalent of heat. What temperature change will occur for 100ml of water as the 1kg weight in the apparatus descends 0.8m?

A. 0.02 ^{o}C
B. 0.08 ^{o}C
C. 0.2 ^{o}C
D. 0.4 ^{o}C



5. What is the minimum energy required to transform a 100 g piece of ice at -50 ^{o}C into steam?

C_{ice} = 0.5 cal/g ^{o}C $H_{f(H20)}$ = 79.7 cal/g
$C_{H20(l)}$ = 1.0 cal/g ^{o}C $H_{v(H20)}$ = 539 cal/g
C_{steam} = 0.5 cal/g ^{o}C

A. 15.0 kcal
B. 15.0 kcal
C. 74.5 kca
D. 149 kcal

6. The temperature of the triple point of water

A. decreases with pressure
B. increases with pressure
C. equals 273.16 K
D. is higher than the critical temperature

7. The interior temperature of a house is maintained at 27°C. As compared to the day (17°C) what is the percentage increase in the rate of heat loss at night (7°C) through the walls of the home?

A. 50%
B. 97%
C. 100%
D. 200%

8. Which of the following energy conservation measures for the home minimizes heat losses by conduction?

A. Installation of double-glazed windows
B. Placement of tight-fitting dampers in fireplaces
C. Weather stripping windows and outside doors
D. Use of exhaust fans only when necessary

9. A stone wall is erected across the entire south side of a house behind glass where it can absorb direct solar radiation and serve as a thermal storage mass. It is designed to store 500MJ of thermal energy as it warms up from 16°C at 7 A.M. to 36°F at 5 P.M. The specific heat of the stone used is 0.8 kJ/kg-°C. Find the weight of stone required for the wall.

A. 8.0×10^3 kg
B. 1.4×10^4 kg
C. 3.1×10^4 kg
D. 5.6×10^4 kg

10. If the temperature of the surface of the sun were twice as great, the insolation on the side of the planet Mercury facing the sun would be approximately:

A. 2 times greater
B. 4 times greater
C. 8 times greater
D. 16 times greater

11. An Antarctic observation post is constructed on stilts as a cube with inner dimensions 2m on edge. The four walls, floor and the ceiling are 0.25m thick, constructed from reinforced styrofoam (thermal conductivity: 0.031 W/m·°C). To prevent the temperature inside from dropping below 20°C when the temperature outside is –30°C, what is the approximate minimum generator power required for heating?

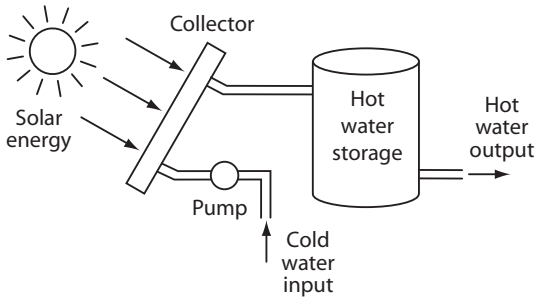
A. 25 W
B. 150 W
C. 600 W
D. 2.4 kW

12. A glass blower's furnace is radiating heat through a 100cm^2 port at a rate of 2400W. What is the approximate temperature inside the furnace? (Stefan's constant = 5.67×10^{-8} W/m^2·K^4)

A. 800 K
B. 973 K
C. 1167 K
D. 1440 K

Passage (Questions 13-17)

Solar water heaters come in a wide variety of designs. Almost all include a collector and storage tank. The performance of a solar collector is affected by numerous factors including absorber plate design, absorber coating, collector glazing, collector insulation, and the orientation of the collector. The ambient air temperature and the intensity of the insolation incident on the collector are additional factors affecting the performance of a solar collector.



Collector efficiency, η, is defined as the ratio of the usable energy output, E_o, to the incident solar radiation, I. There are two primary reasons that a solar collector system will not operate at 100% efficiency. Firstly, not all incident solar radiation is absorbed by the collector. Absorptance, A, of the collector refers to the ratio of absorbed solar energy to incident solar energy. Secondly, because the absorber plate has a temperature greater than the surroundings, absorbed solar energy will leave collector plate by conduction, radiation, and convection. Assuming that heat losses are proportional to the difference between the average temperature of the upper surface of the absorber plate, T_p and the ambient air temperature, T_a, for a particular unglazed collector at a given wind-speed, the thermal loss coefficient, U_L, expressed in W/m^2·C°, reflects the combined different modes of heat loss per unit area of the collector as a single critical factor for evaluating flat-plate collector performance.

The expression for the efficiency of an unglazed collector is as follows:

$$\eta = \frac{E_o}{I} = A - \frac{U_L(T_p - T_a)}{I}$$

Unglazed collectors are low-temperature collectors designed to operate at temperatures fairly close to the ambient air temperature. Stagnation temperature refers to the maximum achievable temperature for a solar collector with a stagnant fluid (no motion) at a given ambient wind speed. Efficiency is zero because all of the absorbed energy must be lost to the surroundings. Because their stagnation temperatures are low compared to glazed collectors, unglazed collectors are not usually designed for operating temperatures greater than 5C° to 10C° above ambient temperature.

13. The water flow rate through a bank of solar collectors in a solar water heater is 35 L/hour. The water-in temperature is 30°C, and the water-off temperature is 45°C. What is the power output of this solar water heater?

A. 126 W
B. 146 W
C. 525 W
D. 610 W

14. A 5m length of copper pipe runs from a solar collector panel to a hot water storage tank. At 8 A.M. the pipe temperature is 10°C. At 5 P.M. the temperature has increased to 50°C. Given that the coefficient of linear expansion for copper is 1.7×10^{-5}, how much will the length of the pipe have increased?

A. 0.4 mm
B. 3.4 mm
C. 6.8 mm
D. 3.4 cm

15. A solar collector system is 100% efficient if

A. energy losses from the collector are zero
B. the absorptance of the collector is 100%
C. usable energy output equals incident solar energy
D. the collector temperature equals ambient temperature

16. Which of the following would increase subsequent to the installation of a glass plate and casement over the absorber plate of a solar collector system?

A. the amount of solar radiation reaching the collector plate
B. the stagnation temperature of the solar collector system
C. the thermal loss coefficient of the collector system
D. convection losses from the collector plate

17. At the stagnation temperature of a solar collector system

A. water stops flowing through the collector.
B. the maximum temperature for the collector is reached for given insolation and ambient wind conditions.
C. the temperature is 5C° to 10C° above ambient temperature for glazed collectors.
D. usable energy equals absorbed incident solar energy.