___ 1 A 240 g piece of lead is heated to 100.0 °C and is then placed in a 400 g copper container holding 500 g of water. The specific heat of copper is $c = 0.386\,\mathrm{kJ/\,kg\,K}$. The container and the water had an initial temperature of 18.0 °C. When thermal equilibrium is reached, the final temperature of the system is 19.2 °C. If no heat has been lost from the system, what is the specific heat of the lead? (the specific heat of water is 4.180 kJ/kg K)

A) 0.139 kJ/ kg K B) 0.236 kJ/ kg K C) 0.153 kJ/ kg K D) 0.125 kJ/ kg K E) 0.180 kJ/ kg K

Solution:

Let c_x be the specific heat of x. Let m_x be the mass of x. Let $T_\mathrm{i,x}$ be the initial temperature of x. Let T_f be the final temperature of the whole system. The fact that the heat released by the lead equals the heat obsorbed by the container and the water gives:

$$(T_\mathrm{i,lead} - T_\mathrm{f})m_\mathrm{lead}c_\mathrm{lead} = (T_\mathrm{f} - T_\mathrm{i,container})(m_\mathrm{water}c_\mathrm{water} + m_\mathrm{copper}c_\mathrm{copper})$$

Divide through by $(T_\mathrm{i,lead} - T_\mathrm{f})m_\mathrm{lead}$ and substitute the numbers. This gives $c_\mathrm{lead} = 0.139\,\mathrm{kJ/\,kg\,K}$

The correct answer is: A

../chapter18-tex-new/PLIN/chapter18-011.plin

___ 2 A block of mass 0.200 kg slides across a rough horizontal surface with coefficient of kinetic friction $\mu_k = 0.500$. What is the change in entropy after the block has moved a distance of 2.00 m? The temperature of the block and surrounding is 21 °C. ($g = 9.8\,\mathrm{m/\,s^2}$)

A) $13.3 \times 10^{-3}\,\mathrm{J/\,K}$ B) 0 C) $12.0 \times 10^{-3}\,\mathrm{J/\,K}$
D) $6.67 \times 10^{-3}\,\mathrm{J/\,K}$ E) $3.33 \times 10^{-3}\,\mathrm{J/\,K}$

Solution:

The work done over distance d is $\Delta W = \mu_k mgd = 1.96\,\mathrm{J}$. This is converted to heat. The change in entropy is $\Delta S = \Delta Q/T = 1.96\,\mathrm{J}/294\,\mathrm{K} = 6.67 \times 10^{-3}\,\mathrm{J/\,K}$

The correct answer is: D

../chapter19-tex-new/PLIN/chapter19-058.plin

___ 3 A clock pendulum made of aluminum, which has a coefficient of linear expansion of $24.0 \times 10^{-6}\,\mathrm{K^{-1}}$, has a period of exactly 1 s at 18 °C. Before a homeowner leaves town for one week, e turns the thermostat down to 10°C. When e returns, the clock is

A) exactly on time. B) slow by 58 s C) slow by 116 s
D) fast by 58 s E) fast by 116 s

Solution:

The period of a pendulum is proportional to the square root of its length. At the lower temperature the length and period are shorter.

The ratio of the period is the ratio of the square roots of the lengths. That is $\sqrt{\frac{L+\Delta L}{L}} = \sqrt{1 + \frac{\Delta L}{L}}$
Use: $\sqrt{1+x} \approx 1 + \frac{1}{2}x$ for $|x| \ll 1$.

With $\frac{\Delta L}{L} = \alpha \Delta T = 0.000192$ we find that the pendulum gains $\frac{1}{2}\frac{\Delta L}{L} = 0.0000960$ cycles per second. In a week this amounts to $7 \times 24 \times 60 \times 60 \times 0.0000960 = 58$

The correct answer is: D

../chapter20-tex-new/PLIN/chapter20-003.plin

___ 4 The coefficient of thermal expansion of water at $20\,^\circ\mathrm{C}$ is $0.207 \times 10^{-3}\,\mathrm{K}^{-1}$. A thin glass tube contains a 75 cm column of water at $20\,^\circ\mathrm{C}$. If the thermal expansion of the glass tube is negligible, by how much does the length of the column of water expand when it is heated to $90\,^\circ\mathrm{C}$?

A) 21.7 mm B) 54.3 mm C) 10.9 mm D) 43.5 mm E) 32.6 mm

The tube expands by $0.000207\,\mathrm{K}^{-1} \times (90 - 20)\,\mathrm{K} \times 75\,\mathrm{cm} = 10.9\,\mathrm{mm}$.

The correct answer is: C

../chapter20-tex-new/PLIN/chapter20-009.plin

___ 5 The dimensionless length L of an object varies with dimensioless temperature T according to a mathematical function $L(T)$ defined by $T \mapsto 4\,T^2 + 2\,T + 3$ [Note: $x \mapsto f(x)$ indicates the function that produces output $f(x)$ for input x.] The coefficient of linear expansion of this object is given by the following function:

A) $T \mapsto 8\,T + 2$ B) $T \mapsto \frac{2\,(4\,T+1)}{4\,T^2+2\,T+3}$ C) $T \mapsto \frac{4\,T^3+3\,T^2+9\,T}{3\,(4\,T^2+2\,T+3)}$ D) $T \mapsto \frac{4}{3}\,T^3 + T^2 + 3\,T$ E) $T \mapsto 8 \quad T/L$

Solution:

$\Delta L = \alpha L \Delta T$, so $\alpha = (\partial L/\partial T)/L$, which yileds the mathematical function $T \mapsto \frac{2\,(4\,T+1)}{4\,T^2+2\,T+3}$

The correct answer is: B

../chapter20-tex-new/PLIN/chapter20-017.plin

___ 6 In operation an aluminum flywheel within an engine gearbox increases its temperature by $T\,^\circ\mathrm{C}$. Assuming the flywheel to be a uniform circular disk, calculate the percentage change in the moment of inertia of the flywheel. (Coefficient of linear expansion for Al $= 24 \times 10^{-6}/\,\mathrm{K}$.)

A) 0.34% B) 0.048% C) 0.096% D) 0.19% E) 0.29%

Solution:

If α is the coefficient of linear expansion, the radius of the disk undergoes a fractional expansion by $\alpha\Delta T$ if the temperature increases by ΔT. The moment of inertia is proportional the square of the radius and therefore changes by a fraction $2\alpha\Delta T = 0.19\%$. Recall that $(1 + x)^2 \approx 1 + 2x$ for $|x| \ll 1$.

The correct answer is: D

../chapter20-tex-new/PLIN/chapter20-019.plin

1. A
2. D
3. D
4. C
5. B
6. D