

Thermal Test

AT Thermal Test (15).doc

Directions: Solve the following problems. Each is worth 5 points. Show all work and circle your answers. Needed tables are in the back.

1) Concrete highway slabs are poured in lengths of 10.0m. how wide should the gaps be between the slabs to ensure no contact stress over a temperature range of 0°F-100°F

$$\Delta T = (100^\circ\text{F}) \left(\frac{5^\circ\text{C}}{9^\circ\text{C}} \right) = 55.6^\circ\text{C}$$

$$\Delta L = L_0 \alpha \Delta T$$

$$\Delta L = (10\text{m}) (12 \times 10^{-6}/^\circ\text{C}) (55.6^\circ\text{C})$$

$$\Delta L = 6.67 \times 10^{-3}\text{m}$$

2) A man's gold wedding ring has an inner diameter of 2.4 cm at room temperature. If the ring is dropped into boiling water, what is the change in the inner diameter of the ring?

$$r = 1.2 \text{ cm}$$

$$C = 2\pi r = (2\pi)(1.2 \text{ cm}) = 7.536 \text{ cm}$$

$$\Delta L = L_0 \alpha \Delta T$$

$$\Delta L = (7.536 \text{ cm})(60^\circ\text{C})(14 \times 10^{-6}/^\circ\text{C})$$

$$\Delta L = 6.33 \times 10^{-3} \text{ cm}$$

$$L_{\text{final}} = 7.536 \text{ cm} + 6.33 \times 10^{-3} \text{ cm}$$

$$L = 7.5423 \text{ cm}$$

$$C = \pi d$$

$$\text{Body Temp} \approx 100^\circ\text{F}$$

$$\approx 38^\circ\text{C}$$

$$\Delta T \approx 60^\circ\text{C}$$

$$\Delta L = (2.4 \text{ cm})(14 \times 10^{-6}/^\circ\text{C})(60^\circ\text{C})$$

$$\Delta L = 2 \times 10^{-3} \text{ cm}$$

3) One morning when the temperature is 10°C an employee of a rental car company fills the 25 gallon gas tank of a car to the top, and then parks the car a short distance away. That afternoon, the temperature hits 20°C . Gasoline trips out of the fill neck of the tank. How much gas is lost?

$$\Delta V = V_0 \beta \Delta T$$

$$\Delta V = (25 \text{ gal}) (9.5 \times 10^{-4}) (10^{\circ}\text{C})$$

$$\Delta V = .24 \text{ Gal}$$

4) An electric immersion heater has a power rating of 1500W. The heater is placed in water at 72°F. How long will it take to boil?

$$72^{\circ}\text{F} \Rightarrow 22^{\circ}\text{C}$$

$$P = \frac{Q}{t}$$

$$t = \frac{Q}{P} = \frac{mc\Delta T}{P} = \frac{(1\text{kg})(4190\text{J/kg}^{\circ}\text{C})(78^{\circ}\text{C})}{(1500\text{W})}$$

$$t = 218\text{s} = 3.6\text{min}$$

5) The glass pane in a window has dimensions of 2 m x 1.5m and is 4 mm thick. How much energy will be conducted through the glass in 1 hour if the difference of each side of the glass is 2°C

$$\frac{\Delta Q}{t} = \frac{kA\Delta T}{d}$$

$$Q = \frac{(kA\Delta T)t}{d}$$

$$Q = \frac{(1.05 \text{ J/smK})(2 \text{ m})(1.5 \text{ m})(2^\circ \text{C})(3600 \text{ s})}{.004 \text{ m}}$$

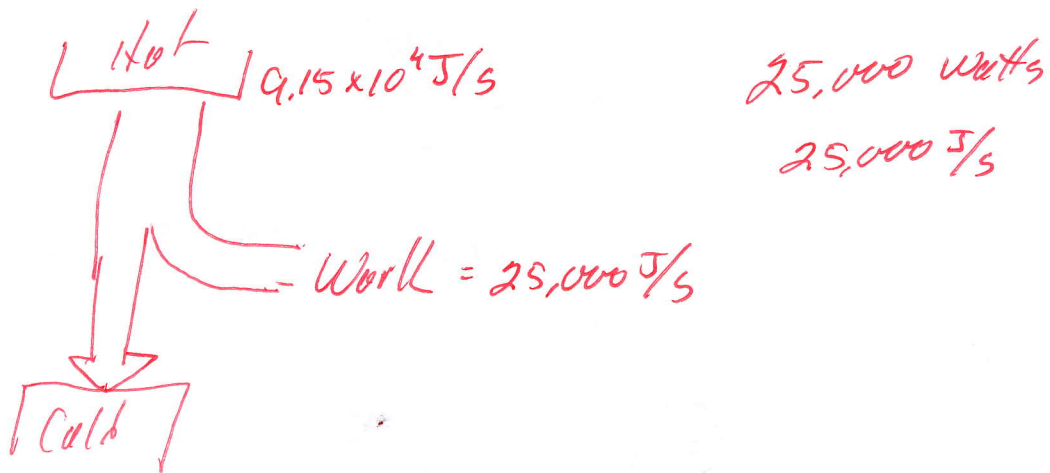
$$Q = 5.67 \times 10^6 \text{ J}$$

6) An engine consumes 7.87×10^4 kcal of energy per hour. Determine the efficiency of the engine if it produces 25kW of power.

$$1 \text{ J} = .239 \text{ cal}$$

$$7.87 \times 10^4 \text{ kcal} = (7.87 \times 10^7 \text{ cal}) \left(\frac{1 \text{ J}}{.239 \text{ cal}} \right) = 3.29 \times 10^8 \text{ J per hour}$$

$$9.15 \times 10^4 \text{ J}$$



$$EFF = \frac{W}{Q_{in}} = \frac{25,000 \text{ J/s}}{9.15 \times 10^4 \text{ J/s}} = 27\%$$

7) An engine runs by absorbing energy for a 500K source when exhausting at 320K . Determine the work that is done each cycle.

180J

8) A refrigerator takes in heat from its low temperature reservoir at a rate of 1.5kW when work is done at a rate of 2.5kW. Determine the rate of thermal energy given off by the unit.

