

key Level I Physics pd:1

Thermal Unit

AT Thermal Unit (16)

Directions: Solve the following problems. Each is worth 5 points. Show all work.

1) An aluminum flagpole is 20.00m tall on a 12°F day. How much taller will the pole be on a day that is 98 °F

$$\Delta T = 98^\circ\text{F} - 12^\circ\text{F} = 86^\circ\text{F}$$

$$(86^\circ\text{F}) \left(\frac{5^\circ\text{C}}{9^\circ\text{F}} \right) \Rightarrow 47.8^\circ\text{C}$$

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

$$\Delta L = (20.00\text{m}) (24 \times 10^{-6}/^\circ\text{C}) (47.8^\circ\text{C})$$

$$\Delta L = 20.02\text{m}$$

0.02m

2) Determine how much ice at 32 °F will be needed to reduce 10kg of 212 °F water to 40 °F.

$$Q_{\text{melt Ice}} + Q_{\text{Water that was Ice}} + Q_{\text{Water}} = 0$$

$$mL + mC\Delta T + mC\Delta T = 0$$

$$m(3.33\text{J/kg}) + m(4190\text{J/kg}^\circ\text{C})(4.4) + (10\text{kg})(4190\text{J/kg}^\circ\text{C})(95.5^\circ\text{C})$$

$$m(3.5144 \times 10^3\text{J} + 4.0 \times 10^6\text{J}) = 0$$

$$m = 11\text{kg}$$

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Specific heat of water=4190 J/kg°C

Heat of fusion of water 3.33x10³J/kg

Stephan-Boltzman constant=5.67x10⁻⁸W/m²K⁴

3) An object is at 178°C , has an emissivity of 0.75 and an area of 3.5 m^2 , how long does it take to radiate 5,558 J of energy? $178^{\circ}\text{C} + 273\text{K}/^{\circ}\text{C} = 451\text{K}$

$$\frac{Q}{t} = \sigma e A T^4$$

$$\frac{Q}{\sigma e A T^4} = t$$

$$\frac{5,558\text{J}}{(5.67 \times 10^{-8})(0.75)(3.5\text{m}^2)(451\text{K})^4} = 0.95$$

4) A system absorbs 320J of heat and increases internal energy by 110J. How much work is done by the system?

Q 320J \rightarrow ΔU 110J \rightarrow $\text{Work} = 320\text{J} - 110\text{J} = 210\text{J}$

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Specific heat of water = $4190\text{ J/kg}^{\circ}\text{C}$

Heat of fusion of water $3.33 \times 10^5\text{ J/kg}$

Stephan-Boltzman constant = $5.67 \times 10^{-8}\text{ W/m}^2\text{K}^4$

5) A heat engine absorbs 780 J of heat from a heat reservoir and exhausts 510J. How efficient is the engine?

$$\frac{\%}{10} = \frac{W}{Q_H} = \frac{Q_H - Q_C}{Q_H} = \frac{780\text{J} - 510\text{J}}{780\text{J}} = 35\%$$

6) Determine how much work must be done by a refrigerator to remove 1,786 J of heat? The fridge has a COP of 1.6.

$$\text{COP} = \frac{Q_C}{W}$$

$$W = \frac{Q_C}{\text{COP}} = \frac{1786\text{J}}{1.6} = 1116\text{J}$$

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Specific heat of water=4190 J/kg°C

Heat of fusion of water 3.33x10⁵J/kg

Stephan-Boltzman constant=5.67x10⁻⁸W/m²K⁴