

20080415_0850

Answer

One gallon of water is frozen and lowered to a temperature of -20°C . How much energy is needed to turn all of this ice into steam at 100°C ? (Answer in kwh)

$$\text{Heat of vaporization} = 539 \text{ cal/g}$$

$$\text{Heat of fusion} = 80 \text{ cal/g}$$

$$\text{Specific heat of ice} = .53 \text{ cal/g}$$

$$\text{" " " water} = 1 \text{ cal/g}$$

$$\text{" " of steam} = .48 \text{ cal/g}$$

$$1 \text{ gal} = 3785 \text{ cm}^3$$

$$= 3785 \text{ grams}$$

$$\text{Heat to raise 1g from } -20^{\circ}\text{C to } 0^{\circ}\text{C} = (20)(.53) = 10.6 \text{ cal}$$

$$\text{" " change 1g Ice into 1g H}_2\text{O} = 80.0 \text{ cal}$$

$$\text{" " raise 1g from } 0^{\circ}\text{C to } 100^{\circ}\text{C} = 100.0 \text{ cal}$$

$$\text{" " change 1g H}_2\text{O into steam} = 539.0 \text{ cal}$$

$$\text{Total heat needed for 1g} = 729.6 \text{ cal}$$

For all the water.

$$\text{Heat needed} = (\# \text{ of grams})(\text{cal. needed per gram})$$

$$= (3785 \text{ g})(729.6 \text{ cal/g}) = 2761536 \text{ cal}$$

Convert into joules

$$\text{Energy} = (\# \text{ of calories})(4.19 \text{ J/cal})$$

$$= (2761536 \text{ cal})(4.19 \text{ J/cal})$$

$$= 11570835.84 \text{ J}$$

$$\text{Since } 1 \text{ kwh} = 3,600,000 \text{ J}$$

$$\text{Energy in kwh} = \frac{11570835.84 \text{ J}}{3,600,000 \text{ J/kwh}}$$

$$\text{Ans. } \longrightarrow E = 3.214121067 \text{ kwh}$$