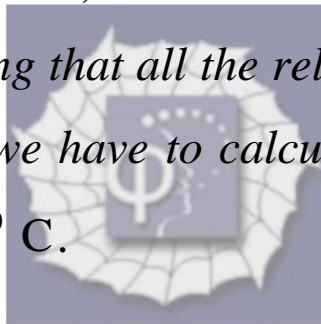


**338.**

**Problem 30.7 (RHK)**

*In a typical lightning flash the potential difference between discharge points is about  $1.0 \times 10^9$  V and the quantity of charge transferred is about 30 C. We have to find (a) the energy released. (b) Assuming that all the released energy could be used to accelerate a 1200 kg automobile from rest, we have to calculate its final speed. (c) Assuming that all the released energy could be used to melt ice, we have to calculate the amount of ice that can melt at  $0^\circ$  C.*



**Solution:**

(a)

The potential difference between discharge points is

$$V = 1.0 \times 10^9 \text{ V}.$$

The quantity of charge transferred during the discharge is

$$Q = 30 \text{ C}.$$

Therefore, the potential energy that is released during the discharge is

$$U = 1.0 \times 10^9 \times 30 \text{ J} = 3.0 \times 10^{10} \text{ J}.$$

(b)

If this much amount of energy could be used to accelerate a 1200 kg automobile from rest, the final speed  $v$  of the automobile will be

$$\frac{1}{2} \times 1200 \times v^2 = 3.0 \times 10^{10} \text{ J.}$$

And

$$v = \sqrt{\frac{3.0 \times 10^{10}}{600}} \text{ m s}^{-1}$$
$$= 7.07 \text{ km s}^{-1}.$$

(c)

The energy released in the discharge will melt at  $0^\circ \text{ C}$  the amount of ice equal to  $ML_f$ , where the latent heat of fusion for water  $L_f = 330 \text{ kJ kg}^{-1}$ . We therefore have

$$M = \frac{3.0 \times 10^{10}}{333 \times 10^3} \text{ kg} = 9.01 \times 10^4 \text{ kg.}$$