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Problem 30.7 (RHK)

In a typical lightening flash the potential difference between discharge points is about 1.0×10^9 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* 0^0 C.

Solution:

(a)

The potential difference between discharge points is

$V = 1.0\times10^9$ V.

The quantity of charge transferred during the discharge is $Q = 30$ C.

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

$U = 1.0\times10^9\times30 \text{ J} = 3.0\times10^{10}$ 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 0^0 C the amount of ice equal to ML_f, where the latent heat of fusion for water $L_f = 330$ kJ kg^{-1}. We therefore have

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