723.

Problem 39.29P (HRW)

Suppose the fractional efficiency of a caesium surface (*with work function* 1.80 eV) *is* 1.0×10^{-16}; *that is, on average one electron is emitted for every* 10^{16} *photons that fall on the surface. We have to find the current of electrons emitted from such a surface if it were illuminated with* 600 nm *light from a* 2.00 mW *laser and all the emitted electrons took part in the charge flow*.

Solution:

Power of the laser beam which is illuminating the caesium surface is 2.00 mW and wavelength of its light is 600 nm. Energy of a 600 nm photon can be found from the relation

$$\varepsilon = \frac{hc}{\lambda} = \frac{1240 \text{ eV . nm}}{\lambda} = \frac{1240}{600} \text{ eV} = 2.067 \text{ eV}.$$

The number of photons that strike the caesium surface can be obtained by dividing the power of the laser beam with the energy of each photon. We find

$$n = \frac{2.0 \times 10^{-3}\ \text{J s}^{-1}}{2.067 \times 1.602 \times 10^{-19}\ \text{J}} = 6.04 \times 10^{15}\ \text{per second.}$$

As the fractional efficiency of the given caesium surface is 1.0×10^{-16}, the number of photoelectrons emitted per second will be

$$n' = n \times 1.0 \times 10^{-16} = 6.04 \times 10^{15} \times 10^{-16}\ \text{s}^{-1}$$
$$= 0.604\ \text{s}^{-1}.$$

As charge of an electron is $1.6 \times 10^{-19}\ \text{C}$, current of the photoelectrons will be

$$i = n'e = 0.604 \times 1.602 \times 10^{-19}\ \text{C s}^{-1} = 9.67 \times 10^{-20}\ \text{A.}$$