Answer on question #62179, Chemistry / General Chemistry

The work function for chromium metal is 7.0 x 10^{-19} J (4.37 eV). What wavelength of radiation must be used to eject electrons with a velocity of 2300 km/s? Please answer in units of nm.

The mass of an electron is 9.10939 × 10^{-31} kg.

Solution:

Einstein's equation for the photoelectric effect

$$h\nu = A + W$$

Where,
Energy of photon: E = h×v = h×c/λ
The work function for chromiumis A
Planck constant h = 6.626×10^{-34} J s; c = speed of light = 2.998×10^{8} m s^{-1}; 1 nm = 1×10^{-9} m;
velocity of 2300 km/s = 2300×10^{6} m/s

The kinetic energy of the emitted electron

$$W = \frac{mv^2}{2} = \frac{9.10939 \cdot 10^{-31}\ kg \times (2300 \times 10^6\ m/s)^2}{2} = 2.409 \cdot 10^{-18} J$$

Hence,

$$\lambda = \frac{ch}{A + W}$$

$$\lambda = \frac{6.626 \cdot 10^{-34}\ J\ s \times 2.998 \times 10^8\ m\ s^{-1}}{7.0 \cdot 10^{-19} J + 2.409 \cdot 10^{-18} J} = \frac{19.865 \cdot 10^{-26} Jm}{3.109 \cdot 10^{-18} J} = 6.39 \cdot 10^{-8} m = 63.9\ nm$$

Answer: 63.9 nm