Answer on Question #76633, Chemistry / General Chemistry

Which element will exhibit the photoelectric effect with light of the longest wavelength?

a. K

b. Rb

c. Mg

d. Ca

Solution

To answer this question we should use the equation for photoelectric effect:

$$E_{photon} = KE_{electron} + \Phi$$

Φ - is work function

Find work functions of K, Rb, Mg, Ca from the table data:

Metal	Work function,Φ (eV)	Work function, Φ,(J)
K	2.29	$3.67 \cdot 10^{-19}$
Rb	2.261	$3.62 \cdot 10^{-19}$
Mg	3.66	$5.86 \cdot 10^{-19}$
Ca	2.87	$4.60 \cdot 10^{-19}$

$$E_{photon} = h\nu = \frac{hc}{\lambda}$$

Then

$$\frac{hc}{\lambda} = KE_{electron} + \Phi$$

To observe photoelectric effect treshold should be obtained, i.e $\lambda=\lambda_0$, where $KE_{electron}=0$

$$\frac{hc}{\lambda} = \Phi \Rightarrow \lambda = \frac{hc}{\Phi}$$

$$\lambda(K) = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{3.67 \times 10^{-19}} = 5.42 \times 10^{-7}(\text{m}) = 542\ (\text{nm})$$

$$\lambda(Rb) = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{3.62 \times 10^{-19}} = 5.49 \times 10^{-7}(\text{m}) = 549\ (\text{nm})$$

$$\lambda(Mg) = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{5.86 \times 10^{-19}} = 3.39 \times 10^{-7}(\text{m}) = 339\ (\text{nm})$$

$$\lambda(Ca) = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{4.60 \times 10^{-19}} = 4.32 \times 10^{-7}(\text{m}) = 432\ (\text{nm})$$

We can see from these calculations that Rb will exhibit the photoelectric effect with light of the longest wavelength λ(Rb) =549 nm.

Answer: b. Rb