Q. In a historical experiment to determine Planck's constant, a metal surface was irradiated with light of different wavelengths. The emitted photoelectron energies were measured by applying a stopping potential. The relevant data for the wavelength ($\lambda$) of incident light and the corresponding stopping potential ($V_0$) are given below:

| $\lambda (\mu m)$ | $V_0$ (Volt) |
|---|---|
| 0.3 | 2.0 |
| 0.4 | 1.0 |
| 0.5 | 0.4 |

Given that $c = 3 \times 10^8 ms^{-1}$ and $e = 1.6 \times 10^{-19} C$, Planck's constant (in units of J s) found from such an experiment is : (A) $6.0 \times 10^{-34}$ (B) $6.4 \times 10^{-34}$ (C) $6.6 \times 10^{-34}$ (D) $6.8 \times 10^{-34}$

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Solution)

$$KE_{max} = hc/\lambda - \phi$$

$$eV_s = hc/\lambda - \phi$$

$$1.6\times10^{-19}\times2 = \frac{h\times3\times10^8}{3000\times10^{-10}} - \phi \quad \text{... (i)}$$

$$1.6\times10^{-19}\times1 = \frac{h\times3\times10^8}{4000\times10^{-10}} - \phi \quad \text{... (ii)}$$

$$\text{From (ii)}\ \phi = \frac{h\times3\times10^8}{4000\times10^{-10}} - 1.6\times10^{-19}$$

$$1.6\times10^{-19}\times2 = \frac{h\times3\times10^8}{3000\times10^{-10}} - \frac{h\times3\times10^8}{4000\times10^{-10}} + 1.6\times10^{-19}$$

$$1.6\times10^{-19}=\frac{h\times3\times10^{8}}{10^{-7}}\left(\frac{1}{3}-\frac{1}{4}\right)=\frac{h\times3\times10^{8}}{10^{-7}}\left[\frac{4-3}{12}\right]$$

$$1.6\times10^{-19}=\frac{h\times3\times10^{8}}{10^{-7}}\times\frac{1}{12}$$

$$1.6\times4\times\frac{10^{-19}\times10^{-7}}{10^{8}}=h$$

$$6.4\times10^{-34}\ \text{Js}=h$$