**7** **(a)** Photoelectric emission experiments are carried out in a dark room.

**(i)** The circuit in Fig. 7.1a shows electrodes X and Y which are made of zinc.

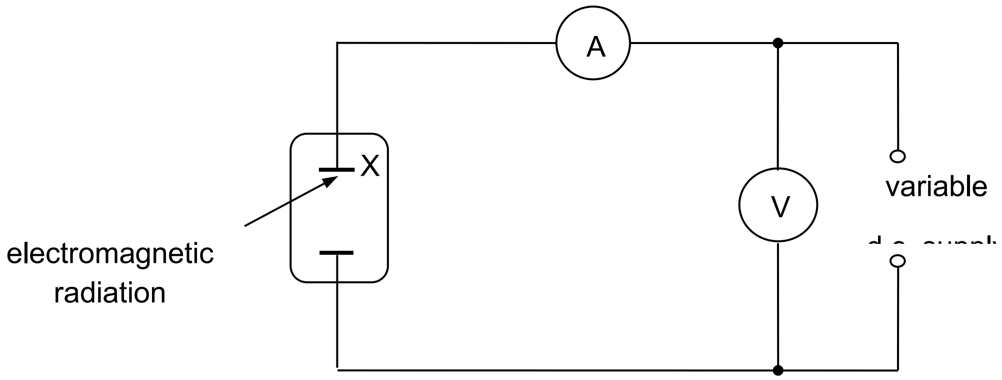


**Fig. 7.1a**

Current-voltage (*I-V*) characteristics in Fig. 7.1b is obtained when **<u>only</u>** electrode X is illuminated with light of wavelength 250 nm.

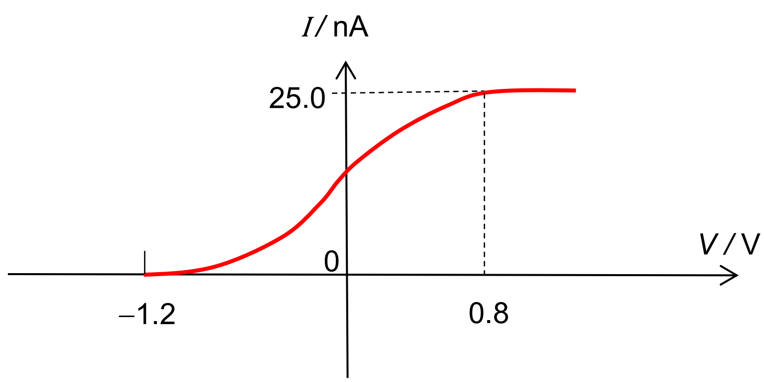


**Fig. 7.1b**

**1.** Show that the work function of zinc is 3.8 eV.

[2]

**2.** Explain why the stopping potential remains the same even when the intensity of the light is changed.

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…………………………………………………………………………….. [3]

**(ii)** The circuit in Fig. 7.2a shows electrodes X and Z. Electrode X is made of zinc, and electrode Z is made of nickel.

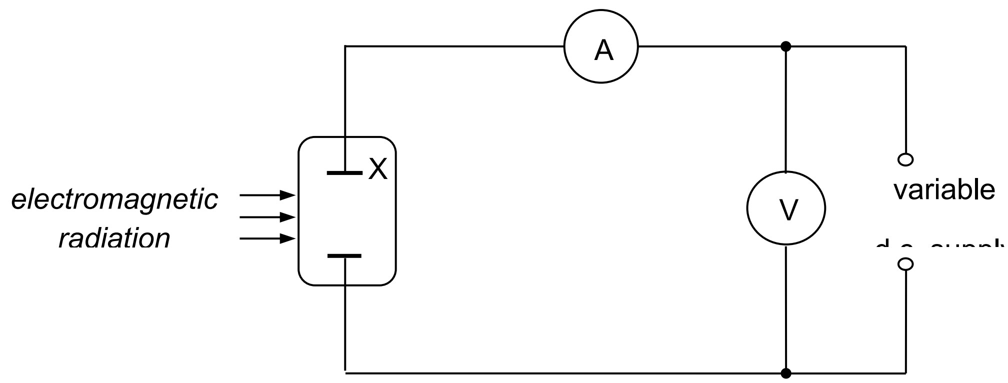


**Fig. 7.2a**

Current-voltage (*I-V*) characteristics is obtained when **both** electrodes are illuminated with a monochromatic light.

**1.** When the light has a wavelength of 250 nm, the *I-V* characteristics is as shown in Fig. 7.2b.

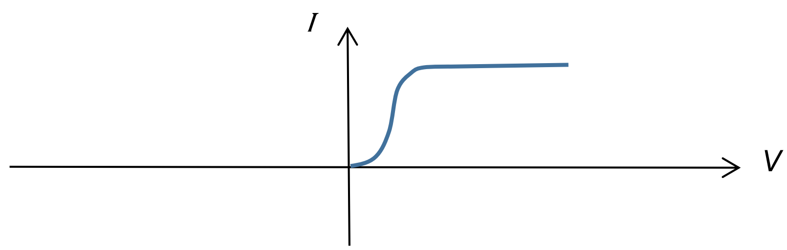


**Fig. 7.2b**

Explain why the photocurrent has positive values only.

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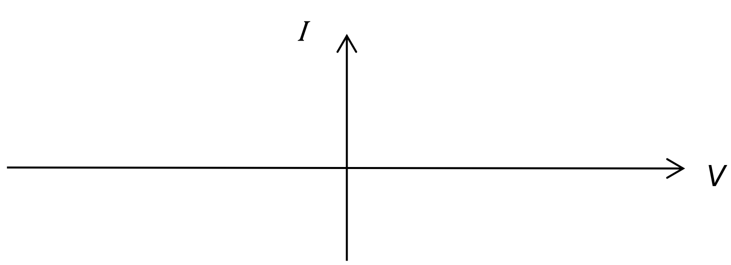
.................................................................................... [2]

**2.** When the light has a wavelength of 100 nm, the *I-V* characteristics is as shown in Fig. 7.2c.



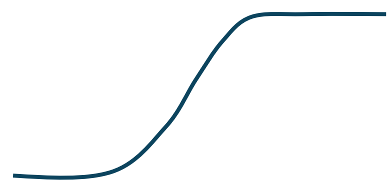


**Fig. 7.2c**

Explain why the photocurrent has both positive and negative values.

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…………………………………………………………………………………....

…………………………………………………………………………… [2]

**(b)** The X-ray spectrum consists of a broad continuous spectrum and a series of sharp lines known as the characteristic peaks.

Fig. 7.3 shows two X-ray spectra lines produced during X-ray emissions.

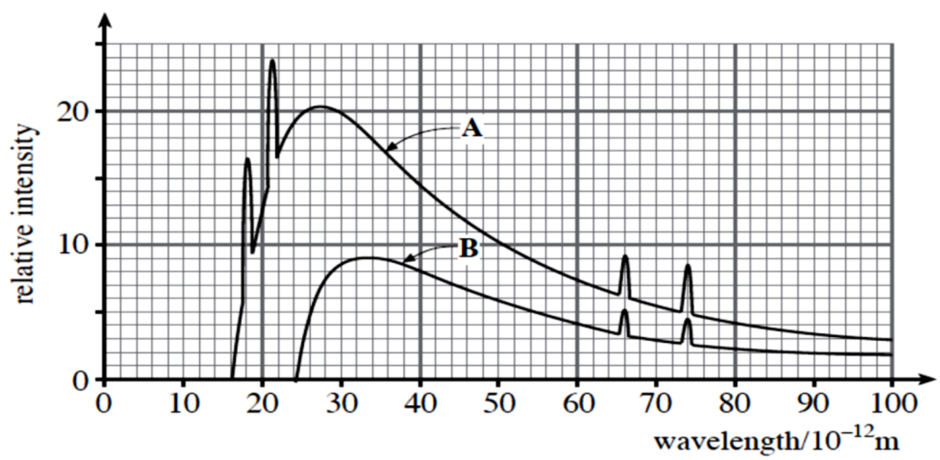


**Fig. 7.3**

**(i)** State and explain

**1.** one **similarity** between graphs A and B.

……………………………………………………………………………………..

……………………………………………………………………………………... [1]

**2.** one <u>**difference**</u> between graphs A and B.

……………………………………………………………………………………...

…………………………………………………………………………………….. [1]

**(ii)** Determine the potential difference to accelerate the bombarding electrons in graph A.

potential difference = ……………………… V [3]

Fig. 7.4 shows three sets of X-ray spectra produced by different accelerating potentials 100 kV, 80 kV and 50 kV with the same target.

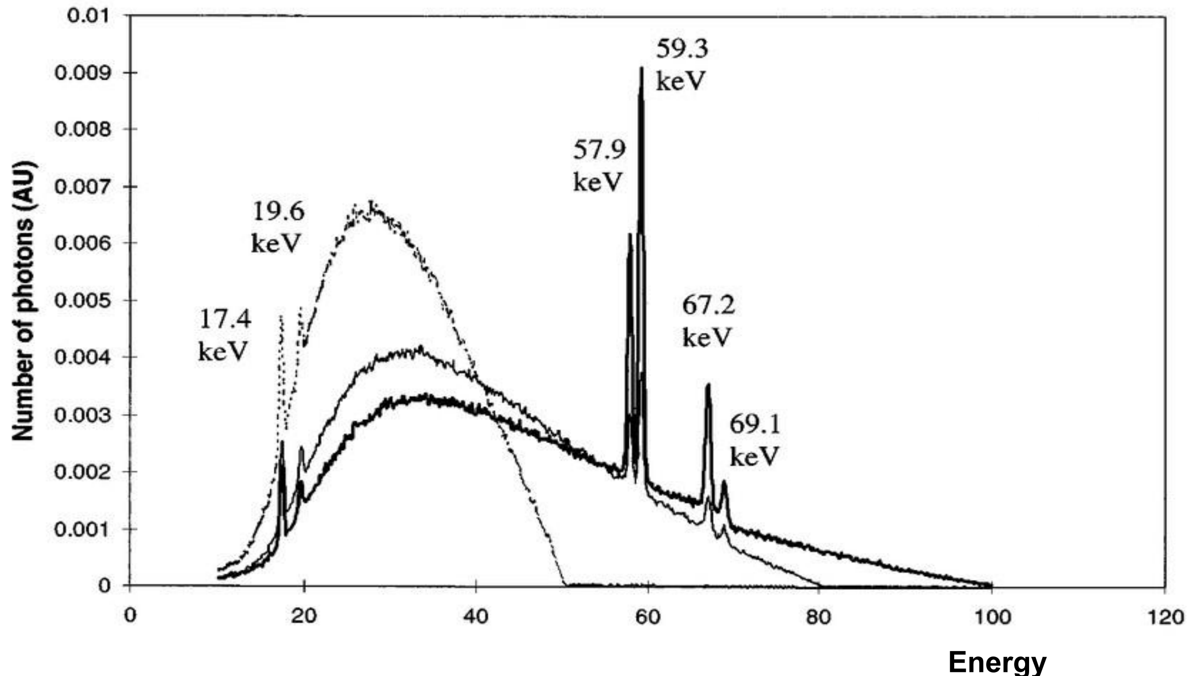


**Fig. 7.4**

A simplified set of energies of levels K, L, M, and N of tungsten and molybdenum are provided in Fig. 7.5. For a more detailed analysis, Level L is split into 2 levels $L_I$ and $L_{II}$.

| level | energy of level of tungsten / eV | energy of level of molybdenum / eV |
|---|---|---|
| N | - 594.1 | - 63.2 |
| M | - 2820 | - 506.3 |
| $L_{II}$ | - 10207 | - 2520 |
| $L_I$ | - 12100 | - 2625 |
| K | - 69525 | - 20000 |

**Fig. 7.5**

**(iii)** Use the table in Fig. 7.5 to determine the **<u>two</u>** least energetic photons ($K_\alpha$ lines) produced when electrons transit to level K

**1.** in tungsten, and

energies of photons = ………….. keV, ………… keV

**2.** in molybdenum.

energies of photons = ………….. keV, ………… keV [2]

**(iv)** Comment on the element(s) used to make the target based on your calculations in **(iii)** and Fig. 7.4.

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…………………………………………………………………………………………… [4]

**End of Paper**