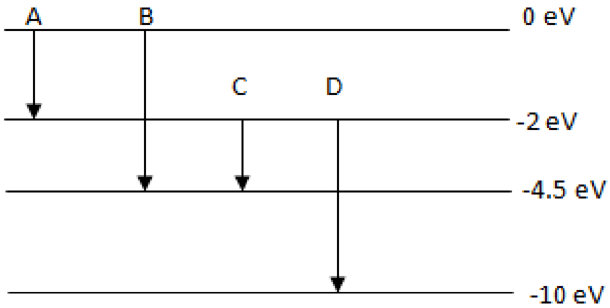
Q21. (a) The energy levels of an atom are as shown below. Which of them will result in the transition of a photon of wavelength 276 nm?



(b) Which transition corresponds to emission of radiation of maximum wavelength?

Ans. (a) **Considering element A**

Ground state energy= E_1 = -2 eV and Energy of the Excited state = E_2 = 0 eV

Difference of Energy States E = $E_2 - E_1$ = 0 – (-2) = 2 eV

$\therefore$ Wavelength of photon emitted, $\lambda = \frac{hc}{E} = \frac{6.626\times10^{-34}\times3\times10^{8}}{2\times1.6\times10^{-19}} = \frac{19.878\times10^{-7}}{3.2}$
$= 6.211 \times 10^{-7}$ m $= 621.1$ nm.

Considering element B

E_1 = -4.5 eV, E_2 = 0 eV Difference in energy states =E = $E_2 - E_1$ = 0 – (- 4.5) = 4.5 eV

$\therefore \lambda = \frac{6.626\times10^{-34}\times3\times10^{8}}{4.5\times1.6\times10^{-19}} = \frac{19.878\times10^{-7}}{7.2} = 2.760 \times 10^{-7}$ m $= 276$ nm.

Considering element C

E_1 = -4.5 eV, E_2 = -2 eV Difference in energy states = E = $E_2 - E_1$ = -2 – (- 4.5) = 2.5 eV

$\therefore \lambda = \frac{6.626\times10^{-34}\times3\times10^{8}}{2.5\times1.6\times10^{-19}} = \frac{19.878\times10^{-7}}{4} = 4.969 \times 10^{-7}$ m $= 496.9$ nm.

Conserding element D

E_1 = -10 eV, E_2 = -2 eV Difference in energy stages =E = $E_2 - E_1$ = -2 – (- 10) = 8 eV

$\therefore \lambda = \frac{6.626\times10^{-34}\times3\times10^{8}}{8\times1.6\times10^{-19}} = \frac{19.878\times10^{-7}}{12.8} = 1.552 \times 10^{-7}$ m $= 155.2$ nm.

$\therefore$ *Element B has a photon of wavelength 276 nm.*

(b) From the above results we find element A emits maximum wavelength= 621 nm.

Q22. A proton and an alpha particle are accelerated through the same potential. Which one of the two has (i) greater value of de-Broglie wavelength associated with it, and (ii) less kinetic energy? Justify your answers.

Answer

We know that de-Broglie wavelength λ associated with potential V is $\lambda = \frac{h}{\sqrt{2meV}}$

$\therefore \lambda \propto \frac{1}{\sqrt{m}}$ [For V (potential) is same]

Since mass of alpha particle is larger than a proton $\therefore \lambda_{proton} > \lambda_{alpha}$, Proton will be associated with grater de-Broglie wavelength.

(ii) Since $KE = hv = h\frac{c}{\lambda}$

$E \propto \frac{1}{\lambda}$ Since $\lambda_{proton} > \lambda_{alpha}$

$\therefore$ Kinetic energy of proton (K_{proton}) is less than Kinetic Energy of Alpha (K_{alpha})

Q23. In a single slit diffraction experiment, when a tiny circular obstacle is placed in the path of light from a distant source, a bright spot is seen at the centre of the shadow of the obstacle. Explain why?
State two points of diffraction between the interference patterns obtained in Young's double slit experiment and the diffraction pattern due to a single slit.

Answer

The bright spot is due to constructive interference of waves due to diffraction from the edge of the circular obstacle.

Difference between Interference and Diffraction fringes pattern :

Pattern in Interfernce	Pattern in Diffraction
1. All bright fringes are equally bright, width of the fringes is equal in interference	1. The brightness of successive bright fringes from the centre goes on decreasing, width of fringes are not equal.
2. The region of minimum intensity is perfectly dark in interference.	2. In diffraction region of minimum intensity are not perfectly dark.