Option B — Quantum Physics and Nuclear Physics

B1. (a) (i) 13.6 eV **[1]**

(ii) $E = \frac{hc}{\lambda}$;

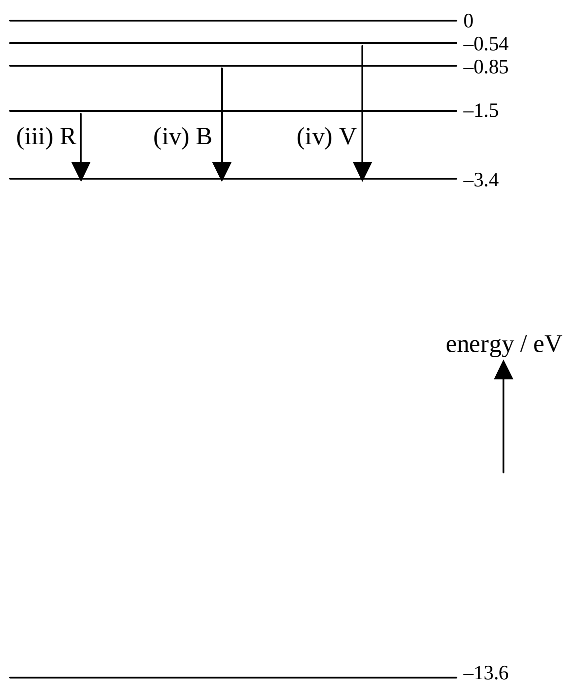
$= \frac{6.6\times10^{-34}\times3\times10^{8}}{6.6\times10^{-7}} = 3\times10^{-19}\text{ J}$;

$= \frac{3\times10^{-19}}{1.6\times10^{-19}}$;

$= 1.9\text{ eV}$ **[3]**

(iii) *see diagram below.* **[1]**

(iv) *see diagram below.* **[1]**
Both must be correct to award ***[1]****.*



(b) $p^2 = 2mE$;

$= 2\times9.1\times10^{-31}\times13.6\times1.6\times10^{-19}$;

to give $p = 2.0\times10^{-24}\text{ N s}$;

$\lambda = \frac{h}{p} = \frac{6.6\times10^{-34}}{2.0\times10^{-24}}$;

$= 3.3\times10^{-10}\text{ m}$ **[4]**

(c) (the model) assumes that electrons are described by wave functions / *OWTTE*;
wave(s) associated with electron(s) is/are bounded by the atom;
this means that for the electron in the ground state the wavelength is $\approx 10^{-10}$ m / *OWTTE*; ***[3]***
These are the basic marking points but candidates might answer with a diagram as well.

B2. (a) the probability that a (particular) nucleus will decay in unit time;

or

$\lambda = \frac{\frac{dN}{dt}}{N}$ with terms defined; ***[1]***

(b) (i) (electro) weak; ***[1]***

(ii) charged vector boson/W boson; ***[1]***
Accept W^{+}, W^{-} ***or*** Z^{0}.

(c) original mass of potassium $= 24 + 5.0 = 29\,\text{mg}$;
recognize to use $N = N_0 e^{-\lambda t}$;
$5.0 = 29\,\text{e}^{-(5.3\times 10^{-10}\,t)}$;
to give $t = 3.3 \times 10^{9}$ year; ***[4]***