

## 1 Question 1

Calculate the energy carried by a photon of frequency  $1.0 \times 10^{15} \text{ Hz}$  ( $h = 6.6 \times 10^{-34} \text{ J} \cdot \text{s}$ ).

$$E_{\text{photon}} = hf = 6.6 \times 10^{-34} \text{ J} \cdot \text{s} \times 1.0 \times 10^{15} \text{ Hz} = 6.6 \times 10^{-19} \text{ J}$$

## 2 Question 2

What is the momentum of an electron whose energy is 1000eV? What is the de Broglie wavelength? ( $1\text{eV} = 1.6 \times 10^{-19} \text{ J}$ ) Mass of the electron,  $m_{e^-} = 9 \times 10^{-31} \text{ kg}$ .

$$E_e = \frac{p^2}{2m_e} \rightarrow p_e = \sqrt{2m_e E_e}$$

We need to convert eV to joules(J).

$$E_e(\text{J}) = 1000\text{eV} \cdot 1.6 \times 10^{-19} \frac{\text{J}}{\text{eV}} = 1.6 \times 10^{-16} \text{ J}$$

$$p_e = \sqrt{2 * 9.0 \times 10^{-31} \text{ kg} \cdot 1.6 \times 10^{-16} \text{ J}} = 1.7 \times 10^{-23} \text{ kg} \frac{\text{m}}{\text{s}}$$

Now we use the de Broglie relation to find  $\lambda_e$ ,

$$\lambda_e = \frac{h}{p_e} = \frac{6.6 \times 10^{-34} \text{ J} \cdot \text{s}}{1.7 \times 10^{-23} \text{ kg} \frac{\text{m}}{\text{s}}} = 3.9 \times 10^{-11} \text{ m} = 39 \text{ pm} = 0.039 \text{ nm}.$$

## 3 Question 3

State the Pauli exclusion principle.

The Pauli exclusion principle states that no two *fermions* can exist in the same **quantum state**. In the case of the atom, no two electrons can share the same 4 **quantum numbers**.

Examples of fermions are,

- electrons
- protons
- quarks

All fermions share the same property of  $\frac{1}{2}$  interger spin(interges being 1, 2, 3... so on).

Neutrons are **not** fermions since they do not have  $\frac{1}{2}$  interger spin.