Marks

- Explain why electrons in atoms occupy discrete energy levels rather than being able to possess any possible energy below that required for ionisation. **2**

**Electrons, with insufficient energy to escape, are confined in atoms by the electrostatic attraction of the nucleus and have wave-like properties. The electron wave must fit into this confined space but this is only possible with certain wavelengths. As the wavelength is related to the momentum and hence the kinetic energy, through the de Broglie relationship, this means that only certain discrete energies are possible.**

- A certain pigment is found to have an electronic excitation energy of $4.97 \times 10^{-19}$ J. What is the wavelength at which this molecule will absorb radiation? **3**

**The wavelength of light is related to its energy through Planck's equation:**

$$E = \frac{hc}{\lambda} \text{ or } \lambda = \frac{hc}{E}$$

**Substituting the values for Planck's constant (h), the speed of light (c) and the value of excitation energy gives:**

$$\lambda = \frac{(6.626\times10^{-34}\ \text{J s})(2.998\times10^{8}\ \text{m s}^{-1})}{(4.97\times10^{-18}\ \text{J})} = 4.00 \times 10^{-7}\ \text{m} = 400.\ \text{nm}$$

ANSWER: **$4.00 \times 10^{-7}$ m or 400. nm**

What colour do you expect this pigment to be? Explain your answer.

**Absorption at 400. nm corresponds to blue light. The colour of the pigment will be white light with the blue removed – the complementary colour.**

**From Newton's wheel, the complementary colour of blue is orange.**