

[Marking Scheme] *Theoretical Question 3*

Thermal Vibrations of Surface Atoms

(1)	1.3	(a) <i>wavelength of the matter wave</i> ➤ 0.6 for correct formula of the wavelength ➤ 0.4 for correct value of the wavelength ➤ 0.2 for significant digits ➤ 0.1 for unit
	2.7	(b) <i>angles of the diffracted beam</i> ➤ 0.6 for correct formula of path difference ➤ 1.0 for correct spacing of atomic rows ➤ 0.5 for correct value of first angle ➤ 0.5 for correct value of second angle ➤ 0.1 for no other solutions
(2)	3.6	(a) <i>vibration frequency of surface atoms</i> ➤ 0.4 for knowing $\vec{K}' - \vec{K} = 2K \cos \theta \hat{x}$ ➤ 0.3 for knowing $K = 2\pi / \lambda$ ➤ 0.3 for correct value of slope M' with 2 significant digits ➤ 0.3 for correct value of the mass of the atom with 3 significant digits ➤ 1.0 for correct relation between the slope M' and vibration frequency ➤ 1.0 for correct value of the vibration frequency ➤ 0.2 for 2 significant digits ➤ 0.1 for units
	2.4	(b) <i>root-mean-square displacement of surface atoms</i> ➤ 0.6 for total energy in terms of $\langle u_x^2 \rangle$ ➤ 1.0 for correct relation between $\langle u_x^2(t) \rangle$ and T ➤ 0.5 for correct value of $\sqrt{\langle u_x^2(t) \rangle}$ ➤ 0.2 for 2 significant digits ➤ 0.1 for units