Particles and Waves (10 points)

Part A. Quantum particle in a box (1.4 points)

A.1 (0.4 pt)

$E_{\text{min}} =$

A.2 (0.6 pt)

$E_n =$

A.3 (0.4 pt)

$\lambda_{21} =$

Part B. Optical properties of molecules (2.1 points)

B.1 (0.8 pt)

Expression: $\lambda =$

Numerical value: $\lambda \approx$

B.2 (0.4 pt)

Absorption spectrum of Cy3 is shifted to (check): ☐ bluer ☐ redder

spectral region by $\Delta\lambda \approx$

B.3 (0.7 pt)

$K =$

B.4 (0.2 pt)

Numerical value: $\tau_{\text{Cy5}} \approx$

Part C. Bose-Einstein condensation (1.5 points)

C.1 (0.4 pt)

$p =$

$\lambda_{\mathrm{dB}} =$

C.2 (0.5 pt)

$\ell =$

$T_c =$

C.3 (0.6 pt)

Expression: $n_c =$

Numerical value: $n_c \approx$

Expression: $n_0 =$

Numerical value: $n_0/n_c \approx$

Part D. Three-beam optical lattices (5 points)

D.1 (1.4 pt)

$V(\vec{r}) =$

$\vec{b}_1 =$

$\vec{b}_2 =$

$\vec{b}_3 =$

D.2 (0.5 pt)

Argument:

D.3 (1.2 pt)

$V_{\mathrm{X}}(x) =$

$V_{\mathrm{Y}}(y) =$

Minimum (-a) of $V_{\mathrm{X}}(x)$: at $x =$

Maximum (-a) of $V_{\mathrm{X}}(x)$: at $x =$

Minimum (-a) of $V_{\mathrm{Y}}(y)$: at $y =$

Maximum (-a) of $V_{\mathrm{Y}}(y)$: at $y =$

D.4 (0.8 pt)

Ratio of the lattice constant to the laser wavelength: $a/\lambda_{\mathrm{las}} =$

Positions of all equivalent minima nearest to the origin:

D.5 (1.1 pt)

Expression: $n =$

Numerical value: $n \approx$