International Master's Programs of Chemical Engineering in the Graduate School of Engineering, Kyushu University (Academic Year from October, 2026)

Subject：Basic Chemistry　(1 sheet)

1.　(25 points)

Answer the following questions.

Consider a particle of mass m confined in a one-dimensional infinitely deep square well potential of width L. The potential energy $V(x)$ is defined as follows:

$$V(x) = \begin{cases} 0 & (0 \le x \le L) \\ \infty & (x < 0,\ x > L) \end{cases}$$

(1.1) Write the time-independent Schrödinger equation inside the well and find the general solution for the wave function $\Psi_n(x)$.

(1.2) Describe the energy eigenvalues E_n.

(1.3) Calculate the probability of finding the particle in the region $0 \le x \le L/4$ for the ground state (n =1).

(1.4) Prove that the wave functions of $\Psi_1(x)$ and $\Psi_3(x)$ are orthogonal.

2.　(15 points)

Answer the following questions.

Consider the following reaction where (*S*)-3-bromo-3-methylhexane reacts with water (H_2O) in an ethanol/water mixture. The reaction proceeds via an S_N1 mechanism. The specific rotation of (*S*)-3-bromo-3-methylhexane is $[\alpha] = +25.0°$.

(2.1) Describe the specific rotation of the product and explain the reason.

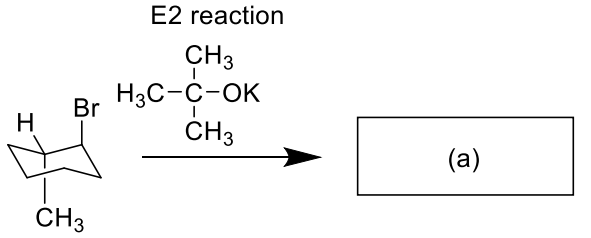
(2.2) If the concentration of (*S*)-3-bromo-3-methylhexane is constant, and the amount of the H_2O is doubled, how will the reaction rate change? Describe the rate equation for this reaction.

3.　(10 points)

Fill the blank.

Write the chemical formula and show the three-dimensional structure clearly.

(3.1)



(3.2)