INSTRUCTION:

a. Answer the following questions on the answer paper provided by the exam committee
b. During work you can open one note in a note sheet on A4 paper.
c. Can use a calculator but may not use a cell phone during the TEST

1. An electron with mass $m = 9.1 \times 10^{-31}\ kg$ moves after the system is heated to 500 K . Determine the wavelength de Broglie electrons (Boltzmann's constant $k = 1.38 \times 10^{-23}$ J/K and Planck's constant h= 6.63×10^{-34} Js)
   Hint: The kinetic energy of an electron is the same as the thermal energy of an electron and consider the electron as a single particle.

2. The wave deviation function is expressed as:

$$\Psi(x) = \begin{cases} \sqrt{\frac{2}{L}} \sin \frac{\pi x}{L} & 0 < x < L \\ 0 & \end{cases}$$

   etc

   a. Calculate the positional uncertainty as $\Delta x = \{\langle x^2 \rangle - \langle x \rangle^2\}^{1/2}$
   b. Calculate the momentum uncertainty as: $\Delta p = \{\langle p^2 \rangle - \langle p \rangle^2\}^{1/2}$
   c. Prove that for the wave function above we get the equation Heisenberg uncertainty $\Delta x\ \Delta p_x \geq \frac{h}{2}$

   Hint: The average function can be calculated from:
   $\langle x \rangle = \int_{-\infty}^{\infty} x|\Psi(x)|^2 dx$ dan $\langle p_x \rangle = \int_{-\infty}^{\infty} |\Psi * (x)| \frac{h}{i} \frac{\partial}{\partial x} \Psi(x) dx$

3. Show that there is no negative energy solution for the yang particle trapped in a well of potential energy

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

   etc