> Answers without **supporting work** or **necessary unit** will not be given full credit. If the
> meaning of the question isn't clear, please ask TA! You have **25mins** to complete this mini-test.

Q.1 Assume that a proton is moving on xy-plane and that you measure its speed $\vec{v} = (3 \cdot 10^6, 4 \cdot 10^6)$ [m/s], which can
be known with a precision of 1% in both direction. What is the minimum uncertainty (as allowed by uncertainty
principle in quantum theory) with which you can simultaneously measure the position of proton on this plane?
(10 point)

Q.2 One γ-ray photon with 511 keV emitted from some specific direction. After the photon undergoes two times
Compton scattering with two originally stationary electrons, the original incoming and final outgoing directions
of the photon are the same. If we know the kinetic energy of the first recoiling electron is 11 keV, what is the
scattering angle of the photon in the second Compton scattering process? (Hint: $m_e c^2 = 511 \ keV$) (10 points)