NTU PHYSICS CHALLENGE (ADVANCED LEVEL)

Name: _____

Identifier No. _____

Instructions:

1. This is an **BONUS QUESTION**. Marks scored may be used for prize ranking purpose.

2. Write down the solution steps on next page. This answer sheet will be collected.

Question:

Figure 1 shows a simple pendulum consisting of a small mass at the end of a light, inextensible string. It swings from an initial position of $\theta = 10^{\circ}$, for which it would have a period T_0. It hits a slanted wall elastically, which is at angle $\phi = 5^{\circ}$ to the vertical.

a) Let the angular velocity immediately before and after hitting the wall be ω_1 and ω_2, respectively, which angular velocity is greater? (5 marks)

b) Assume θ and ϕ are small angles, so the pendulum undergoes simple harmonic motion. Draw the force diagrams of the pendulum when the string is vertical and swinging to the left. (5 marks)

c) When the pendulum hits the wall, what is the new period of oscillation in terms of T_0? (10 marks)

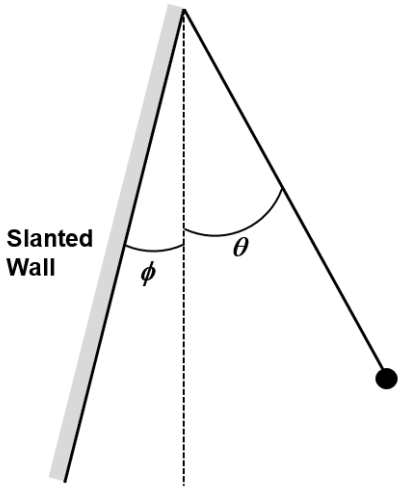

Figure 1

YOUR ANSWER:

a). Due to conservation of energy (from elastic collision), the angular velocities are the same.

b). When the string is vertical, there only two forces along the vertical line in opposite directions. One is the gravitational force, the other is the tension force in the string. The second force is larger.

c). The simple harmonic motion implies $\Theta = \Theta_0 \cos \omega t$, where $\Theta_0 = 10^0$ before the collision, and given the period we know $\omega = 2\pi/T_0$

Let the time it takes to swing from the initial position to -5^0 is T, so we know $-5^0 = 10^0 \cos 2\pi T/T_0$, giving $\frac{2\pi T}{T_0} = 2\pi/3$ and thus $T = T_0/3$

Thus the total new period is $2 * \left(\frac{T_0}{3}\right) = \frac{2T_0}{3}$

− END OF PAPER −