Title: **Simple Harmonic Motion**

Objective:

Show that the motion of a simple pendulum is simple harmonic, sinusoidal and independent of amplitude.

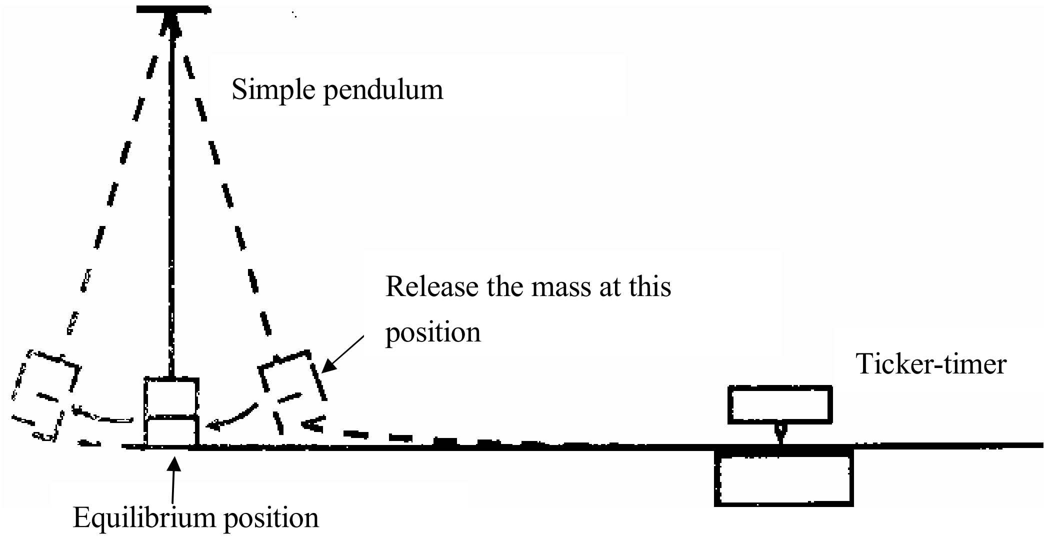
Introduction:

Simple harmonic motion is defined as the motion of a particle whose acceleration is always directed towards the equilibrium point and is directly proportional to the displacement of the particle from that point. In the experiment, a simple pendulum will be stuck on the paper tape. the motion of simple pendulum is then investigated.

Procedure:

1. Using a string of length 1.2m,suspend the 0.5 kg ringed mass vertically from the retort stand-and-clamp.
2. Adjust the position of the clamp so that the mass is about 5 cm above the ground.
3. Cut a ticker-tape of length about 1 m. Write down "Start" on one end and stick that end of the tape to the bottom of the mass.
4. Pass the free end of the tape through the ticker-timer and straighten the tape.
5. Put a cross one the tape at the position just beneath the pin of the ticker-timer to indicate the equilibrium position of the mass.
6. Pull the mass towards the ticker-timer through different distance.

7. Switch on the timer and at the same time release the mass. Stop the timer when the mass reaches the opposite side.



Question Answering:

8a) A motion which said to be S.H.M. if the acceleration of the motion is always directed toward a fixed point and the magnitudes of the acceleration is directly proportional to the displacement to the fixed point.

8b) a= - k x, where k is a constant

a is the acceleration of the motion

x is the displacement of the motion

8c) a , x are directed oppositely and a is directly proportional to x.

8d) For S.H.M., $a=-\omega^2 x$

8e) $v= -A\omega \sin\omega t$

$a= -A\omega^2\cos\omega t$

9)

When the ringed mass of a simple pendulum is performing an oscillation with small θ ,there is a net restoring force(-mgsin θ).

By Newton's second law, we get:

$$F=ma$$

$$ma= -mg\sin\theta$$

For very small θ (measured in radians),

So, a=-(g/L)x (since sin θ θ =x/L)

Comparing with $a= -\omega^2 x$, $g/L=\omega^2$ and we get that T(period)= $2\pi\sqrt{(L/g)}$

10) We have to record the amplitude and the time taken by the mass to travel half of period.

12a) When the simple pendulum starts from the extreme point (amplitude of the oscillation) , it's velocity is zero . When it moves towards the equilibrium point, it accelerates. Once it reaches the equilibrium point, it's velocity is the maximum and the acceleration becomes zero. Leaving the equilibrium point, it decelerates and it's velocity decreases. The velocity finally becomes zero again when it reaches another extreme point. The motion is then repeated and comes to stop after several times because of air resistance.

12b) It is the graph which is symmetrically reflected along x-axis of displacement-time graph.

12c)Slope: 〔30-(-30)〕/〔(-3.2)-3.0〕=9.67 s^{-2}

By $a=-\omega^2 x$, we can get that the slope indicate $-\omega^2$.

12d) By $T=2\pi/\omega$,

We know that period is independent with amplitude, so period is unchanged.

By maximum $V=A\omega$,

When amplitude is doubled, the maximum velocity will be doubled.

12e) The period found from x-t graph is different from that the period found from

a-x graph.

period found from x-t graph=2.08s

period found from a-x graph=$2\pi/\sqrt{12.81}$ =2.02s

Different in period: 2.08-2.02=0.06s

12f) The un-expectation is caused by the drawing of graph. The graph used for the report is human-drawn, but not use computer. There are errors when we choose the data for drawing different types of graph. Furthermore, there are other factors such as air resistance to affect the period of the oscillation.

Discussions:

There are several points we need to pay attention when carrying out this experiment.

First, for getting more accurate experimental result, it is suggested that the person who is responsible for timing the period of the oscillation should not change to minimize the personal error.

Second, it is worth to note that simple harmonic motion must be a liner motion, the angle made by the simple pendulum and the vertical shouldn't be too large, said to be within 10°.

Third, we need to ensure the oscillation of simple pendulum is a planar motion, otherwise, it can not be defined as simple harmonic motion.

Forth, from 12d), we should pay attention that the period of the simple pendulum is independent of the amplitude. That is, no matter ho the amplitude changes, the period of the simple pendulum keeps constant.

<u>Precautions:</u>

1) Ensure the pendulum oscillates with small amplitude(within 10°).

2) Make sure the pendulum oscillates on the same vertical plane.

3) Use a heavy and small bob in performing the experiment.

4) Measure L to the center of the bob.

<u>Sources of errors:</u>

1) The amplitude of the oscillation is not small, and it is not a S.H.M. and $\sin\theta = \theta$ does not hold.

2) Buoyancy of the air will reduce down force on mass affect the velocity of the simple pendulum.

3) The mass used is not a point mass.

Conclusion:

From the experimental result, we find that the acceleration of the simple pendulum is always directed towards the equilibrium point and is directly proportional to the displacement. Therefore, the motion of simple pendulum is simple harmonic, sinusoidal and independent of amplitude.