A01-732E-Y01

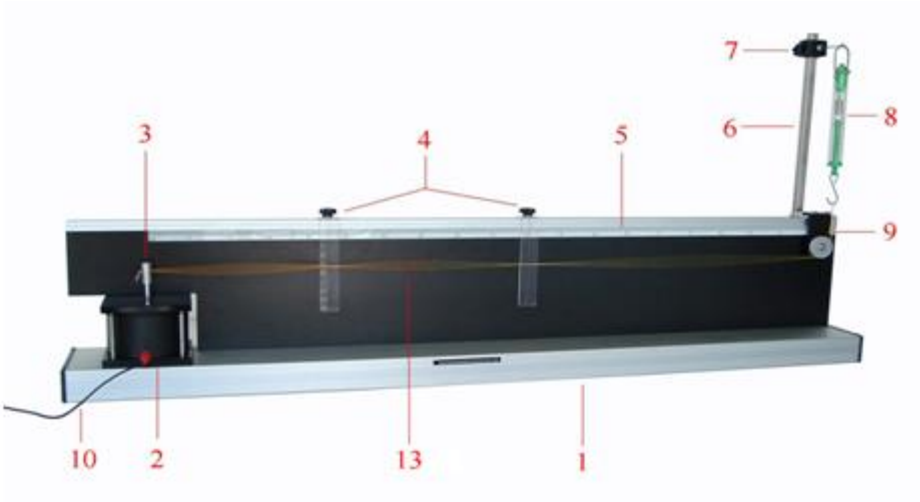
String Resonance

Purpose

Discuss relationships between propagation velocity, line tension and linear density during string resonance.

Instrument

No.	Accessory	Qty	No.	Accessory	Qty
1	Aluminum base	1	2	Wave driver	1
3	Rope holder	1	4	Transparent indicator	2
5	Blackboard	1	6	Support rod	1
7	Spring balance holder	1	8	Spring balance	1
9	Fixed pulley	1	10	AV wire	1
11	Digital frequency generator	1	12	DC power supply	1
13	Rope	1			



Theory

Take the pulse on the string as an example. For an observer, particles on the medium do not move with the propagation direction but the observer's point of view, the pulse propagates along the string. The enlarged moving pulse is shown in **Figure 1**. The string's linear density is μ and line tension is T. Use the string (length Δs) to perform a circular motion (radius R). The centripetal force of this circle is

$$F_c = 2T \times \sin\theta$$
$$\approx 2T \times \theta$$

According to the second law of Newton, the centripetal force is $F_c = ma$. m is the mass of string (length Δs). Thus,

$$m = \mu \Delta s$$

So the centripetal force is:

$$F_c = m \times a$$
$$= \mu \Delta s \times v^2 / R$$

From **Figure 1**, we know $\Delta s = R \times 2\theta$ so

$$F_c = 2T \times \theta = \mu R \times 2\theta \times v^2 / R$$

After simplification, the propagation velocity of pulse and the velocity of circular motion can be written as:

$$v = (T/\mu)^{1/2}$$

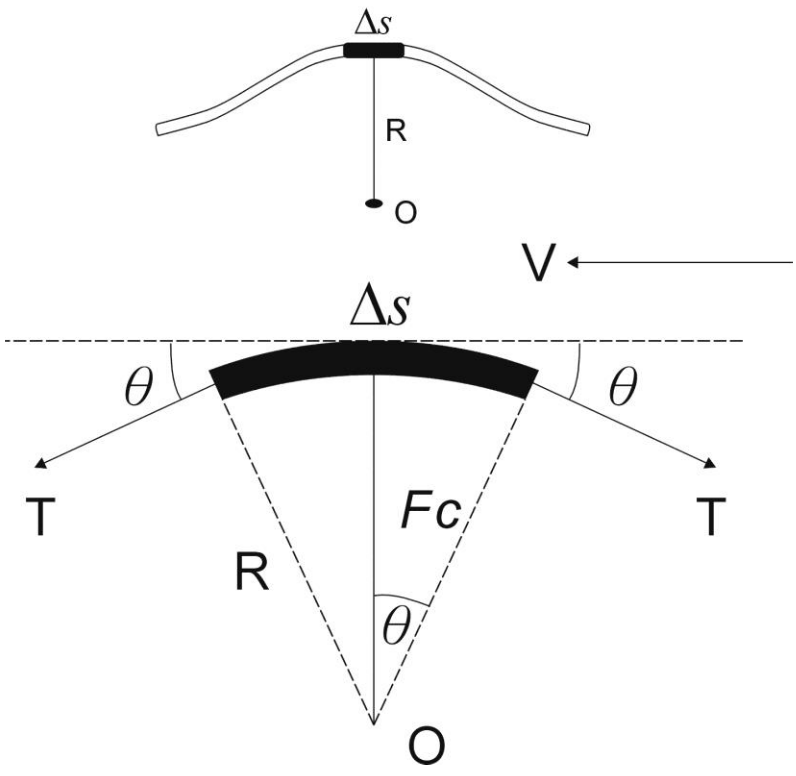
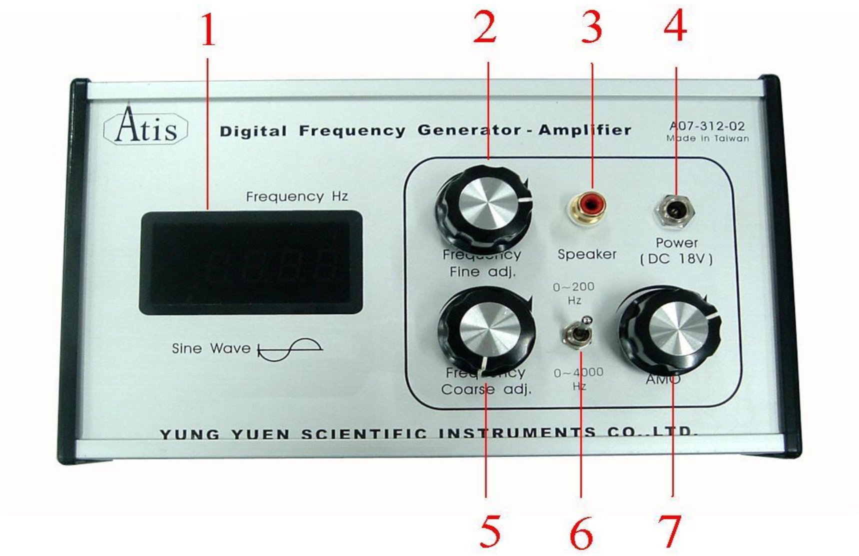


Figure 1

Procedure

Figure 2



No.	Accessory	No.	Accessory
1	Frequency display	2	Frequency adjustment (fine tune)
3	Speaker	4	Power
5	Frequency adjustment (coarse tune)	6	Frequency switcher
7	Amplitude adjustment button		

I. Relationship between wave velocity v and tension T:

1. Set up the experiment as **Figure 2**. Use the AV wire to connect the Digital frequency generator and wave driver. Set the frequency at low frequency.

2. Record the reading of rope in medium density.

3. Adjust the tension T to 0.5N.

4. Adjust the vibrating frequency and measure at least three standing waves. Record their wave length λ and frequency f. Use the equation $v = \lambda \times f$ to calculate the velocity v.

5. Adjust the tension to 1N, 1.5N, 2N and 2.5N. Repeat procedure 4. Measure the velocities of different tensions.

6. Draw a figure of v^2 and T to verify the relationship of v and T.

II. Relationship between wave velocity and linear density

1. Keep tension T at certain position (1N). Record the linear density μ of ropes.

2. Adjust the vibrating frequency and measure at least three standing waves. Record their wave length λ and frequency f. Use the equation $v = \lambda \times f$ to calculate the velocity v.

3. Change ropes with different density and repeat procedure 1 and 2. Measure the velocity of different ropes.

4. Draw a figure of v^2 and $1 / \mu$. Verify the relationship between v and $1 / \mu$.

Experiment result

I. Relationship between wave velocity v and tension T:

Linear density μ=________g/m

Trail	1	2	3	4	5
Tension T （N）					
Frequency f					
Wave length λ （m）					
Velocity v （m/s）					
v^2					

II. Relationship between velocity v and linear density μ

Tension T=________N

Trail	1	2	3	4	5
Linear density μ （g/m）					
Frequency f					
Wave length λ （m）					
Velocity v （m/s）					
v^2					
1 / μ					

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