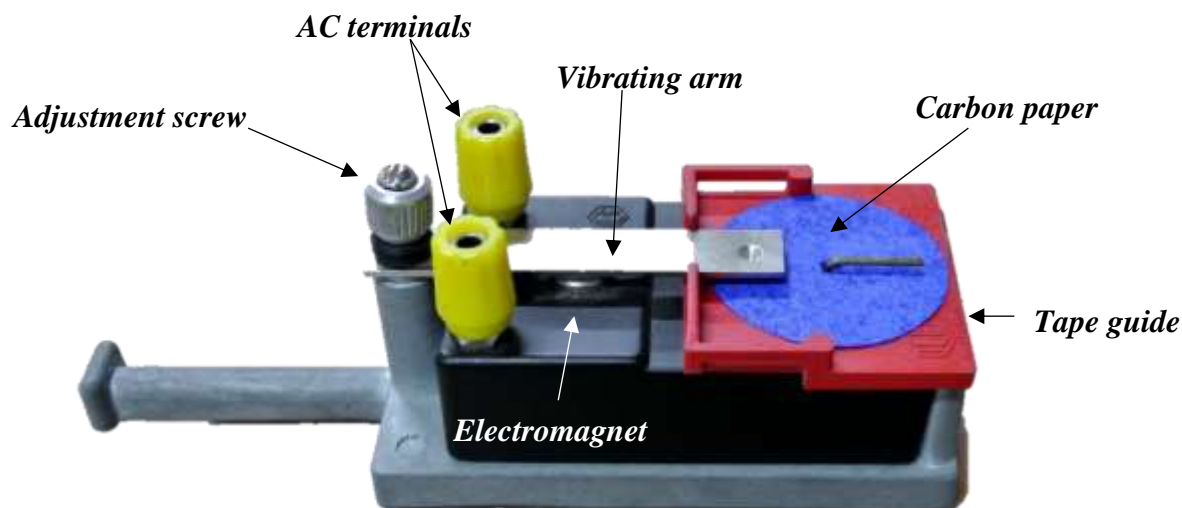


Section 10.2.3 – Ticker Timer

Ticker Timer

A ticker timer is a device used to record the motion of an object. It works by making marks upon a piece of tape at regular time intervals, which is in turn attached to a moving object. The spacing between the marks allows for the calculation of both velocity and acceleration.

Structure of a ticker timer



The Physics of the ticker timer

A voltage of 12 Volts AC (alternating current) at a frequency of 50Hz powers the ticker timer. This alternating voltage causes the vibrating arm to be attracted by and released from the electromagnet at a rate of 50 times a second.

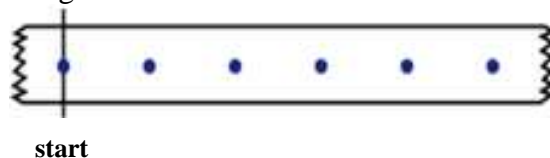
NB: 1 Hz = 1 event per second
50 Hz = 50 events per second

As the vibrating arm is pulled towards the electromagnet it strikes the carbon paper, under which the ticker timer tape is located, marking the paper with a small blue ink spot.

As the ticker timer tape is pulled through the tape guide a series of ink marks are made on the tape. The pattern of these dots can be used to analyse the motion of the object the tape is attached to.

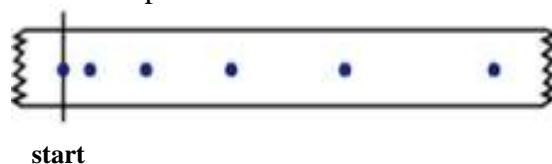
Sample tape 1 – Constant speed

In the case of tape that is pulled through the ticker timer at a constant speed, the dots are equally spaced, as can be seen in the diagram below.



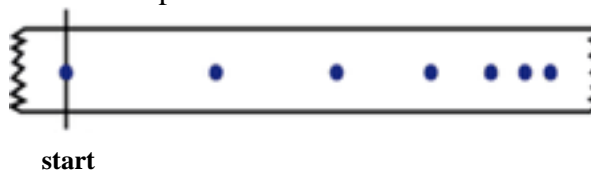
Sample tape 2 – Increasing speed

In the case of tape that is pulled through the ticker timer at an increasing speed, the spacing between each successive pair of dots is increasing, as can be seen in the diagram below. In this case more distance is being travelled in the same period of time.



Sample tape 3 – Decreasing speed

In the case of tape that is pulled through the ticker timer at a decreasing speed, the spacing between each successive pair of dots is decreasing, as can be seen in the diagram below. In this case less distance is being travelled in the same period of time.



Measuring time upon a ticker timer tape

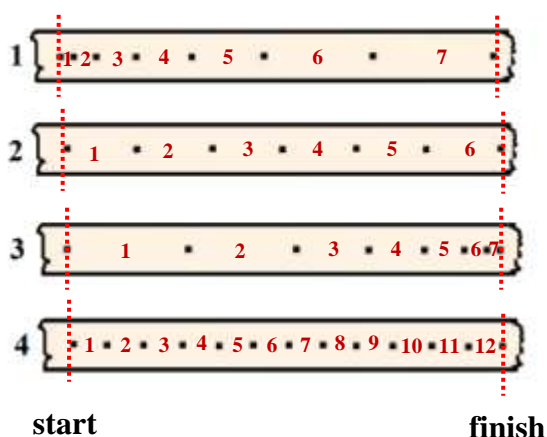
You would recall that the ticker timer strikes the paper tape at a frequency of 50 Hz, or 50 times per second. If you were divide 1 second by 50, you would have the time between each successive strikes of the vibrating arm and therefore the time between each successive marks upon the ticker tape.

NB: $f = 50 \text{ Hz}$ $T = \frac{1}{f}$
 $T = ?$ $T = \frac{1}{50}$
 $T = 0.02 \text{ sec}$

The symbol “T” represents the period or time between each pair of marks on the ticker tape

So to calculate the time between any 2 marks upon a ticker tape, you need only to count the number of gaps between the two marks and multiply the number of gaps by 0.02 seconds.

Sample tapes



Tape 1: 7 gaps \times 0.02 sec = 0.14 sec

Tape 2: 6 gaps \times 0.02 sec = 0.12 sec

Tape 3: 6 gaps \times 0.02 sec = 0.12 sec

Tape 4: 12 gaps \times 0.02 sec = 0.24 sec

Measuring average speed from a ticker timer tape

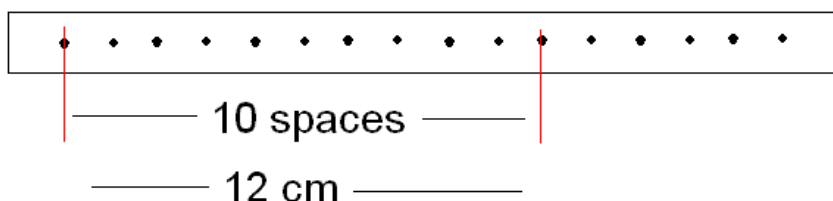
In order to measure the average speed upon a ticker timer tape, you need only to measure the distance between the two marks and the time taken between the same two marks.

Recall:

$$\text{Avg. Speed} = \frac{\text{Distance}}{\text{Time}}$$

Sample tape

Calculate the average speed of the following ticker timer tape.



Avg. Speed = ?

Distance = 12 cm
= 0.12 m

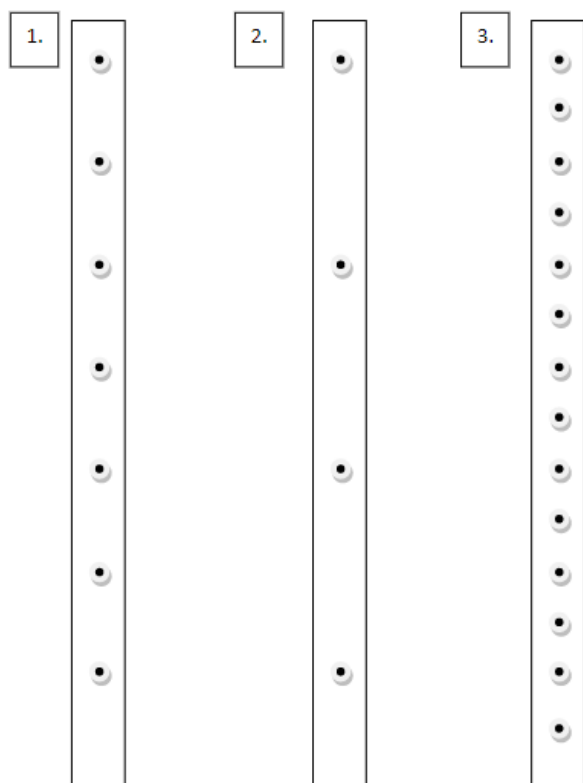
Time = 10 gaps \times 0.02 sec
= 0.2 sec

$$\text{Avg. Speed} = \frac{0.12}{0.2}$$

$$\text{Avg. Speed} = \underline{0.6 \text{ ms}^{-1}}$$

Example.1

Calculate the average speed for each of the three tapes shown below. Show calculations.



Measuring average acceleration from a ticker timer tape

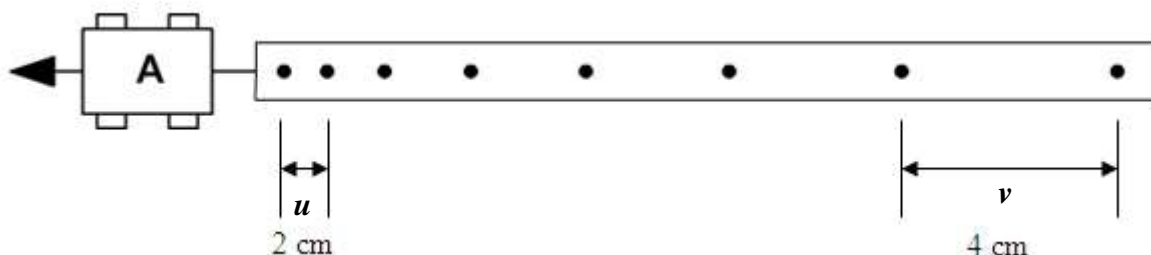
In order to measure the average acceleration upon a ticker timer tape, you need to measure an initial speed (u), a final speed (v) and the time between both speeds (t).

$$a = \frac{v - u}{t}$$

Where a represents acceleration (ms^{-2})
 v represents the final velocity (ms^{-1})
 u represents the initial velocity (ms^{-1})
 t represents the time taken (s)

Sample Tape

Calculate the average acceleration for the trolley A from the ticker timer tape below



Step.1 Find initial velocity (u)

Avg. Speed = ?
 Distance = 2 cm
 = 0.02 m
 Time = 1 gaps \times 0.02 sec
 = 0.02 sec

$$\text{Avg. Speed} = \frac{0.02}{0.02}$$

$$\text{Avg. Speed} = 1.0 \text{ ms}^{-1}$$

\therefore Initial speed (u) = 1.0 ms^{-1}

Step.2 Find final velocity (v)

Avg. Speed = ?
 Distance = 4 cm
 = 0.04 m
 Time = 1 gaps \times 0.02 sec
 = 0.02 sec

$$\text{Avg. Speed} = \frac{0.04}{0.02}$$

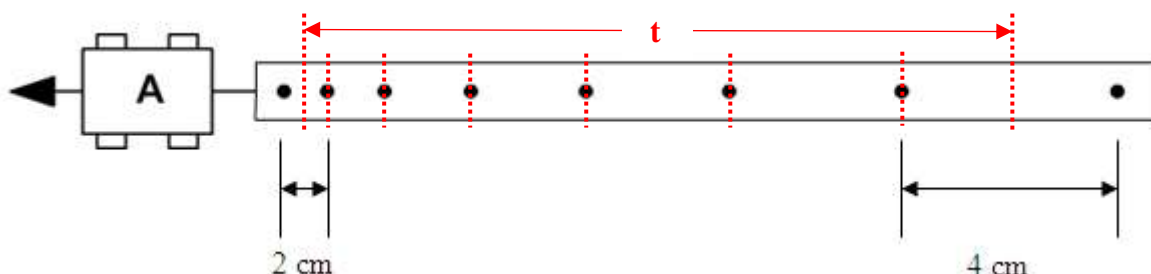
$$\text{Avg. Speed} = 2.0 \text{ ms}^{-1}$$

\therefore Final speed (v) = 2.0 ms^{-1}

Step.3 Find the time between the two velocities (u & v)

When calculating the time between the initial speed (u) and the final speed (v), you **DO NOT** simply count the gaps between the first and the last mark on the tape.

The calculated values for u and v , shown above, are both averages. So the time taken between both speeds should be taken from the **midpoint of u** to the **midpoint of v** .



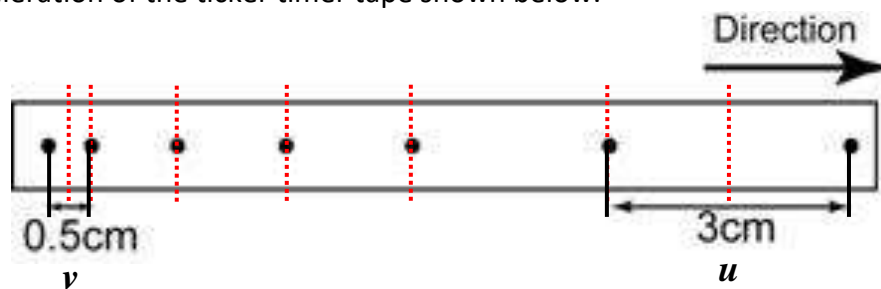
\therefore Time = 6 gaps \times 0.02 sec = 0.12 sec

Step.4 Calculate acceleration (a)

$$a = \frac{v - u}{t} = \frac{2.0 - 1.0}{0.12} = 8.3 \text{ ms}^{-2}$$

Example 2

Find the acceleration of the ticker timer tape shown below.



Step.1 Find initial velocity (u)

Avg. Speed = ?

Distance = 3 cm

= 0.03 m

Time = 1 gaps \times 0.02 sec

= 0.02 sec

$$\text{Avg. Speed} = \frac{0.03}{0.02}$$

$$\text{Avg. Speed} = \underline{1.5 \text{ ms}^{-1}}$$

\therefore Initial speed (u) = 1.5 ms^{-1}

Step.2 Find final velocity (v)

Avg. Speed = ?

Distance = 0.5 cm

= 0.005 m

Time = 1 gaps \times 0.02 sec

= 0.02 sec

$$\text{Avg. Speed} = \frac{0.005}{0.02}$$

$$\text{Avg. Speed} = \underline{0.25 \text{ ms}^{-1}}$$

\therefore Final speed (v) = 0.25 ms^{-1}

Step.3 Find the time between the two velocities (u & v)

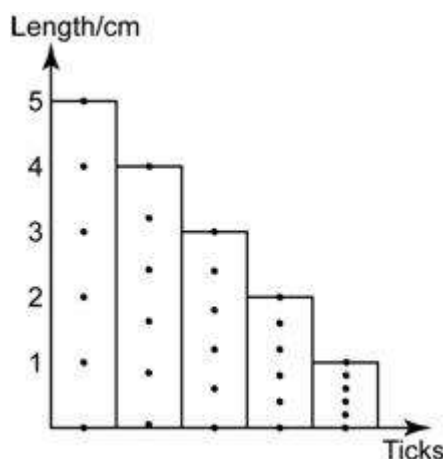
Time = 5 gaps \times 0.02 sec = 0.10 sec

Step.4 Calculate acceleration (a)

$$a = \frac{v - u}{t} = \frac{0.25 - 1.5}{0.10} = -12.5 \text{ ms}^{-2}$$

Example 3

Find the acceleration of the ticker timer tape shown below.



NB: Whilst this arrangement of the ticker timer tape looks foreign. It is the same as before, only the tape has been cut up into sections of 5 gaps, or 0.1 sec, each.

Step.1 Find initial velocity (u)

Avg. Speed = ?
Distance = 5 cm
 = 0.05 m
Time = 5 gaps \times 0.02 sec
 = 0.10 sec

$$\text{Avg. Speed} = \frac{0.05}{0.10}$$

$$\text{Avg. Speed} = \underline{0.5 \text{ ms}^{-1}}$$

\therefore Initial speed (u) = 0.5 ms^{-1}

Step.2 Find final velocity (v)

Avg. Speed = ?
Distance = 1.0 cm
 = 0.01 m
Time = 5 gaps \times 0.02 sec
 = 0.10 sec

$$\text{Avg. Speed} = \frac{0.01}{0.10}$$

$$\text{Avg. Speed} = \underline{0.10 \text{ ms}^{-1}}$$

\therefore Final speed (v) = 0.10 ms^{-1}

Step.3 Find the time between the two velocities (u & v)

Time = 20 gaps \times 0.02 sec = 0.40 sec

Step.4 Calculate acceleration (a)

$$a = \frac{v - u}{t} = \frac{0.10 - 0.5}{0.40} = -1.0 \text{ ms}^{-2}$$