

# Free Fall Apparatus

## Solenoid Release without Timer



**MF1871-501 (1.5m Fall, Solenoid Release, w/o Timer)**

### Description:

This IEC 'Free Fall Apparatus' is adjustable up to 1.5m fall. The cable from the solenoid is connected to the IEC timer and the stainless steel ball is held by the solenoid at an exact height from the lower platform. The instant that the timing is started, the solenoid automatically drops the ball. When the ball strikes the lower platform, the timer is instantly stopped. Timer LB4064-101 has special solenoid release circuit.

### Kit Contents:

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|--|---|
| 1 pce. Base plate with storage container for balls..   | 1 pce. Lower Platform with STOP terminals.                      |
| 1 pce. Aluminium rail and 4x mounting screws for attachment to base plate, with adjustable plastic covered metric scale. | 1 pce. Ball, stainless steel, 20mm and 15mm diameter (nominal). |
| 1 pce. Upper Platform with solenoid and socket for ball release.   | 1 pce. Cables for connecting solenoid and platform.             |

Length: 300mm	Width: 160mm	Height: 1640mm	Weight: 3.8kg
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## Electronic Digital Led Timer:

For accurate measurement of the time taken for a ball to fall approximately 1.5 metre, the model MF1871-501 Free Fall Apparatus is normally used with the IEC digital LED display timer model LB4064-101, which has a special 'solenoid release' socket on the rear panel. Times to 99.9999 Sec x 0.1 millisecond, then 999.999 Sec x 1 millisecond. Timer is mains power operated and crystal locked for high accuracy. Instructions are packed with timer.

## Assembly of Equipment:

1. Take the aluminium rail with the platforms. The upper platform is the one with the Solenoid fitted to it. Slide the upper platform (Solenoid side first) on to the rail so that it is close to the plastic end cap on the far end of the rail. The platform should project to the right hand side when looking at the scale (see drawing). Slide the lower platform (without Solenoid) on to the rail so that it is level with the end of the aluminium rail. The two platforms should be projecting the same direction.
2. Remove the 4x screws from plastic bag, take the base and using the screws, fit the base to the rail (see illustration). Tighten screws firmly.
3. Stand the unit on a table and be sure the scale shows 1500mm at the top and Zero at the bottom. With the lower platform **resting on the base**, the scale should have the Zero mark in line with the UPPER edge of the lower platform. Position the upper platform until the LOWER edge is in line with the 1500mm line on the scale (choose the correct reference level step for the size of ball being used – see illustration for assistance). Lock both platforms firmly in place with the thumb screws provided.
4. Note that the upper platform provides two levels to be used as reference edges against the scale. To help to understand this, support the large  $\frac{3}{4}$ " or 20mm diameter ball under the upper platform so that it is pressing upwards. Notice that the lowest point of the ball is in line with the bottom edge of the platform and therefore is in line with the lower reference edge against the scale. The lowest point of the smaller  $\frac{5}{8}$ " or 16mm ball aligns with the higher reference edge.
5. Take the LB4064-101 mains operated LED Electronic timer and connect the special cable with the 'RCA' plugs to the socket on the rear panel marked 'Solenoid Release'. Plug the other end into the socket provided on the upper platform.
6. Take the two cables with the banana plugs and connect to the 'STOP' sockets on the timer and connect to the banana sockets provided on the lower platform.
7. Plug the timer into the mains power outlet. The solenoid on the upper platform will now be energised and will attract and support the weight of either stainless steel ball.
8. Support a ball into the underside of the upper platform and it will attract and stay on the magnetic tip of the solenoid.
9. Press STOP then press RESET button on the timer to zero the timer and to set the operation Mode. Select Start/Stop function on the timer.
10. Press the START button on the timer. The ball should be released and should fall to hit the lower plate. The timer should stop exactly when the lower plate is struck. The timer will display the fall time.



## Using The IEC Timer: LB4064-101 (With Solenoid Release Circuit)

This Digital Timer with red LED display is designed to be viewed by the students in the classroom and is provided with a 'Solenoid Release' socket on the rear panel.

'AutoMode' feature: After the external connections are made, the timer automatically sets its open circuit / closed circuit mode of operation each time the STOP and RESET buttons are pressed sequentially. This useful feature makes the instrument very easy to use for any timing experiment.

Please note that complete information is provided with the timer.

## Perform the Experiment:

Connect the timer to the Free Fall unit as explained above and load a ball into the upper platform ready to fall. Set the upper platform to the correct reference edge against the scale for the fall distance desired. Perform 'AutoMode' then press the START button to release the ball and to automatically start the timer. Read the fall time on the display.

Repeat experiment several times and allow the readings to load into memory automatically. Use the memory average function to display the average fall time of several falls.

## Calculations to Determine 'g':

Using  $d$  = distance fallen by the ball (metres).

$g$  = acceleration due to gravity (metres/sec/sec).

$u$  = initial velocity (metres/sec)

$v$  = final velocity (metres/sec).

$t$  = time of fall (seconds).

The basic formulae for behaviour under gravity are::

1.  $v = u + gt$

2.  $d = ut + \frac{1}{2} gt^2$

3.  $v^2 = u^2 + 2gd$

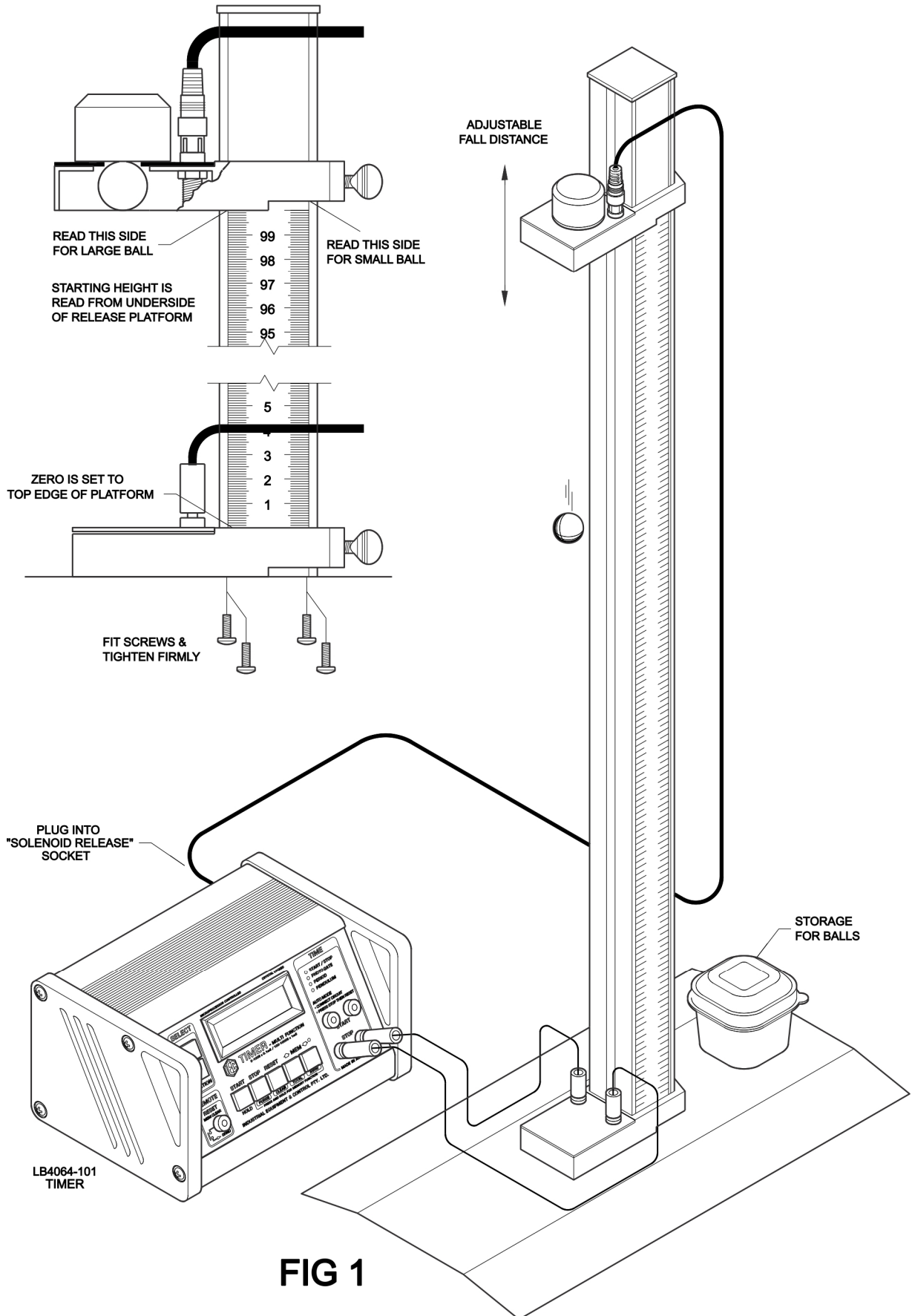
For 'Free Fall' we use formula #2:  $d = ut + \frac{1}{2} gt^2$

now, in this case, since  $u$  is zero, we can say:  $d = 0 + \frac{1}{2} gt^2$

thus:  $g = 2d/t^2$

Repeat the experiment several times and calculate an average value of 'g' by taking measurements of 'd' and 't'. Repeat the experiment with the other ball to prove that weight of the falling object does not affect the time taken to fall. Alter 'd' and re-calculate for 'g'. Determine final velocities after falling different distances.

Designed and manufactured in Australia



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