CENTRAL SCIENTIFIC COMPANY

OPERATING INSTRUCTIONS

Simple Form Jolly Balance
No. 07560

1. Introduction

The Simple Form Jolly Balance is used to

- determine the density of solids and liquids using Archimedes' principle
- measure the surface tension of liquids
- demonstrate simple harmonic motion
- verify Hooke's Law

This versatile instrument is very popular in high school and college physics laboratories.

2. Description

The instrument consists of a coil spring, two pans, a graduated metric scale mounted on a mirror, a beaker platform, and a support rod mounted on a base with leveling screws. The assembled apparatus is shown in Figure 1. The metric scale is graduated from 0 to 65cm in 1-millimeter divisions.

The heights of the spring, suspended pans, and metric scale can be adjusted by repositioning the friction clamps on the support rod. The height of the beaker platform can be adjusted by means of a thumb screw on the support rod. The overall height of the instrument is 104cm (41 inches).

3. Assembly

The Jolly Balance should be assembled as shown in Fig. 1. Screw the support rod firmly into the V-shaped base. Insert a leveling screw at the end of each leg of the base. Slide the platform assembly on the support rod and tighten the thumbscrew at a position about 11cm above the base. Slide the scale panel clamp onto the support rod by squeezing the ends of the clamp. Slip the end of the panel through the slot in the platform and release the ends of the clamp when the 59cm graduation on the scale reaches the platform level. In a similar fashion, slide the spring support arm on the support rod and clamp it a few centimeters below the top of the support rod.

Loosen the knurled knob at the free end of the spring support arm, bend the straight length of wire of the spring around the machine screw, and tighten the knob. Suspend the upper pan from the hook at the free end of the spring, and the lower pan from the hook at the bottom of the upper pan.

Set a level, such as the #88430 Torpedo Level, on the platform and level the instrument by adjusting the two leveling screws in the base. Straighten the cross wire above the upper pan. This wire, which serves as a scale pointer, must be parallel to the platform.

4. Operation

4.1 General: The acquisition of certain accessories will increase the value of the Jolly Balance as a laboratory demonstration device. Accessories recommended for this purpose include a light spring, a

length of piano wire, an adjustable platform, a clamp, a platinum-iridium ring, a glass evaporating dish, a beaker, a set of metric weights, a triple beam balance, and a stopwatch. See section 6, “Replacement Parts and Accessories,” for recommendations.

4.2 Specific Gravity Determination: A 250ml beaker is the only accessory required for this demonstration.

Fill the beaker to three-fourths of its capacity with distilled water and place it on the platform of the balance.

Adjust the heights of the spring arm support and the platform so that the lower pan is submerged and only a single wire cuts the surface. Read the scale, using the cross wire as a pointer, and record the reading as M1. Place the sample whose specific gravity you wish to determine in the upper pan and lower the platform so that the lower pan is again submerged to the same depth as before. Read the scale and record this reading as M2. The difference, M2 - M1, represents the weight of the sample in air.

Transfer the sample to the lower pan. Lower the platform once more and see that the pan is submerged to the same depth as before. Take the scale reading, M3. The difference M2 - M3 represents the weight of the sample in water.

From the data obtained, calculate the specific gravity of the sample:

$$d = \frac{\text{mass in air}}{\text{mass in water}} = \frac{M2 - M1}{M2 - M3}$$

4.3 Surface Tension Measurement: A very interesting surface tension experiment can be made if a platinum-iridium ring, 4 or 6cm in circumference, is available for use as an accessory. Additional accessories needed to measure the surface and/or interfacial tension of liquids with the Jolly Balance include: a light spring; a length of piano wire; a thermometer-type clamp; an adjustable platform; weights ranging from 500 to 1000mg; and an evaporating dish.

Form a loop at one end of a 25cm (10 inch) length of piano wire and attach the other end of the wire to the machine screw at the end of the spring support arm. Pass the end of the straight length of wire of the light spring through the piano wire loop and form the end into a connecting loop.

Lower the platform so that it rests on the base of the support stand, and move the scale panel upward until it abuts the spring support arm clamp. Attach the thermometer clamp to the support rod at a point just below the scale. Place the platform between the open jaws of the clamp, tightening the adjustment screw to hold it in place. Tighten the jaws of the clamp and make sure the platform is level.

Suspend the platinum-iridium ring of known circumference and wire diameter from the hook at the free end of the spring. Place a small strip of paper on the ring to serve as a platform. Record the scale reading using the cross piece of the stirrup as the pointer indicator. Calibrate the scale by adding weights in the 500 to 1000mg range to the platform and record the scale readings. Calculate the weight required per scale division of the spring elongation. Plot a calibration curve.

Remove the platinum-iridium ring and heat it in the oxidizing portion of a gas flame. Replace the ring on the spring.

Fill a clean evaporating dish to three-fourths of its capacity with distilled water and place it on the adjustable platform.

Raise the platform until the ring is submerged about 2 or 3mm below the surface, then lower the platform until the ring is just below the surface. Record the scale reading and consider it to be zero base.

Turn the platform adjustment screw very slowly to lower the platform. Continue turning the screw until the film breaks and immediately note the scale reading. This reading minus the zero base reading is the measure of the elongation of the spring.

Convert the elongation measurement to grams using the calibration curve. Calculate the surface tension from the dimensions of the platinum ring and the elongation measurement. The circumference of the ring is in centimeters. The measurement must be converted from grams to dynes.

Example: Suppose that a weight of 0.9g is found by consulting the calibration curve. The surface tension is calculated according to the formula

$$= \frac{W\,g}{2L}$$

where W = weight in grams (0.9)
L = circumference of ring in cm (6.0)
g = acceleration of gravity in cm/sec2 (980.3)

Then

$$= \frac{0.9 \;\; 980.3}{2 \;\; 6} = 73.5 \text{ dynes/cm}$$

4.4 Simple Harmonic Motion: Remove and set aside the evaporating dish, light spring, and length of music wire used in the surface tension measurements, as well as the lower pan of the balance.

Accessories needed to demonstrate simple harmonic motion are: a triple beam balance, a stop watch, and a set of weights ranging from 5 to 50g.

Weigh the heavy spring and the upper pan on a triple beam balance. Suspend the spring and pan from the spring support arm, and add a weight sufficient to extend the spring 5 or 6cm.

Grasp the pan lightly, and pull it down a short distance, being careful to avoid any lateral motion. Release the pan. With a timing device or a stop watch, observe the time required for a given number of complete cycles or vibrations. A sufficiently large number of cycles, such as 50, should be chosen to give an accurately-measurable time interval for one cycle. Take a series of eight to ten measurements for uniformly increasing loads.

Tabulate the data, using the following headings:

Total mass in grams of the spring/pan/mass system
Total number of cycles
Total time in seconds
Period (total time/number of cycles)
Period2

Plot a curve to show the relationship between total mass and square of the period.

4.5 Verification of Hooke's Law: The setup used for demonstrating simple harmonic motion is satisfactory for confirming Hooke's Law. A set of weights ranging from 5 to 50g is the only accessory

needed for this demonstration.

Add a weight to the pan sufficient to extend the spring 5 or 6cm. Note the scale reading, and consider it as the zero reading. Take a series of eight to ten additional readings for weight loads increasing up to 35 or 40 grams.

Subtract the zero reading from each of these successive readings. Plot a graph of elongation of the spring vs. mass in grams. A straight line graph confirms Hooke's Law, which states that stresses below the elastic limit are proportional to strain.

5. Maintenance

The Jolly Balance requires no special maintenance. Should any difficulty develop, contact Central Scientific Company, giving all details of the problem. Do not return this apparatus without written authorization from Central Scientific Company.

6. Replacement Parts and Accessories

Description	Cat. No.
Upper Scale Pan	07564
Lower Scale Pan	07568
Light Spring	07508
Heavy Spring	07512
Platform	00677-6
Thermometer Clamp	12254
Glass Evaporating Dish, 80mm dia.	14650-01
Mass Set, 50g x 0.01g	09122-05
Beaker, 250ml	14269-25
Interruption-Type Stopwatch, .2s/30min	73516
Piano Wire, B&S#22, 50m Roll	89720-01
Triple Beam Balance	03626

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