Equipment Set for Powder Tracing U8400870

Instruction Sheet

08/08 ALF

1 Tracing plate
2 Brush
3 Powdered sulphur
4 Pulse generator and transformer

1. Safety instructions

The transformer conforms to all safety regulations for electrical measuring, control, monitoring and laboratory equipment, as specified under DIN EN 61010, Section 1, and the equipment has been designed to meet protection class II. It is intended for operation in a dry environment, suitable for the operation of electrical equipment and systems.

Safe operation of the equipment is guaranteed, provided it is used correctly. However, there is no guarantee of safety if the equipment is used in an improper or careless manner.

If it may be assumed for any reason that non-hazardous operation will not be possible (e.g. visible damage), the equipment should be switched off immediately and secured against any unintended use.

In schools and other educational institutions, the operation of the power supply unit must be supervised by qualified personnel.

- Before using the power supply unit for the first time, check the housing and the mains lead for any damage. In the event of any malfunction/operational defect or visible damage, switch off the unit immediately and secure it against unintended use.
- Before making any connections, check the experiment leads for damaged insulation and exposed wires.

2. Description

The equipment set for tracing powder patterns is designed for introducing students to the basic kinematics of two-dimensional motion and can be used in conjunction with the pendulum and plotting electrode (U8405640) for experiments demonstrating Kepler's 2nd law of planetary motion or with a pair of elastic spheres and plotting electrode (U8405630) for experiments on elastic collisions.

The equipment set consists of an insulated tracing plate with a 4 mm connecting socket, a time-signal generator and transformer in an impact-resistant

plastic housing with a permanently attached moulded mains plug and two 4 mm plugs on the secondary side of the transformer, a sprinkler can containing sulphur powder, and a small flat brush.

For countries with types of plugs different from the European standard, a universal mains plug (W10860) is also needed.

3. Equipment supplied

1 Tracing plate

1 Pulse generator and transformer

1 Sprinkler can with sulphur powder, 35 g

1 Brush

1 Manual

4. Technical data

Transformer:

Transformer:	Safety isolating transformer, short-circuit proof
Operating voltage:	115 V – 230 V
Output voltage:	115 V – 230 V, safe to touch
Protective resistance:	1 MΩ

Tracing plate

Dimensions:	390 x 270 mm²

5. Accessories

Pair of elastic balls with plotting electrode U8405630

Pair of balls with identical mass made of red plastic with sliding plotter electrode and metal ball chain.

Diameter:	70 mm each
Weight:	300 g each

Pendulum with plotting electrode U8405640

Cylindrical pendulum bob made of steel with sliding plotter electrode and metal ball chain.

Dimensions:	60 mm x 40 mm diam.
Weight:	500 g

6. Plotting movements in a plane using powder tracing

A plotting electrode slides over a plane counter-electrode that is insulated and covered in powdered sulphur. An AC voltage across the two electrodes results in the sulphur powder being attracted or repelled depending on the polarity of the plotting electrode. A trace thus appears in the powder with ridges that are formed at constant intervals of time. The distance between the ridges reflects the speed of the plotting electrode.

AC voltage is provided from the mains via high-resistance protective resistors. For a mains frequency of 50 Hz the time difference between light and dark patches of the trace is always 10 ms, while for 60 Hz the time interval would be 8.3 ms. The length of the individual ripples is thus proportional to the speed at which the plotter pen moves.

7. Sample experiments

7.1 Graphic depiction of speed and acceleration vectors for two-dimensional motion

- Use the brush to cover the tracing plate with a thin, even layer of powdered sulphur.
- Connect one pole of the clock and the transformer to the tracing plate and hold the other in your hand.
- Lightly brush your finger over the tracing plate to leave a trail.
- Since the ripples are so close together, always count ten of them from any starting point and mark a time with the back of the brush. Each mark should then be separated by a distance corresponding to 0.1 s.

To make an evaluation, the vectors can be drawn directly in the sulphur on the tracing plate. Alternatively it is possible to take a digital photograph of the plate and draw on this in ink or pencil (see fig. 1).

7.2 Confirmation of the law of equal areas for motion under the influence of a central force (Kepler's Second Law)

The following additional equipment is also needed:

1 Pendulum with plotting electrode	U8405640
2 Tripod Stand 150 mm	U13270
2 Stainless Steel Rod, 1000 mm	U15004
1 Stainless Steel Rod, 750 mm	U15003
3 Universal Clamp	U13255

- Set up the experiment as shown in Figure 2.
- Hang the pendulum bob centrally above the tracing plate and adjust its height so that the tip of the plotting electrode is always in contact with the plate during the oscillation of the pendulum bob.
- Using the brush, apply a layer of sulphur powder to the tracing plate.
- Connect one plug of the time-signal generator to the socket of the tracing plate and the other plug to the supporting stand.
- Mark the rest position of the pendulum bob on the tracing plate.

- Connect the time-signal generator and the transformer to the mains supply.
- Give the pendulum bob a push so that it draws ellipses on the tracing plate.
- For the evaluation, draw just one complete ellipse on the plate and stop the pendulum bob after the circuit.
- Determine graphically the centre of the trace that has been drawn and the points on the curved path where the distance from the centre is a maximum and a minimum.
- Measure the areas swept by the radius vector up to these points and compare them. For simplicity the calculation can be performed by treating the areas as triangles.

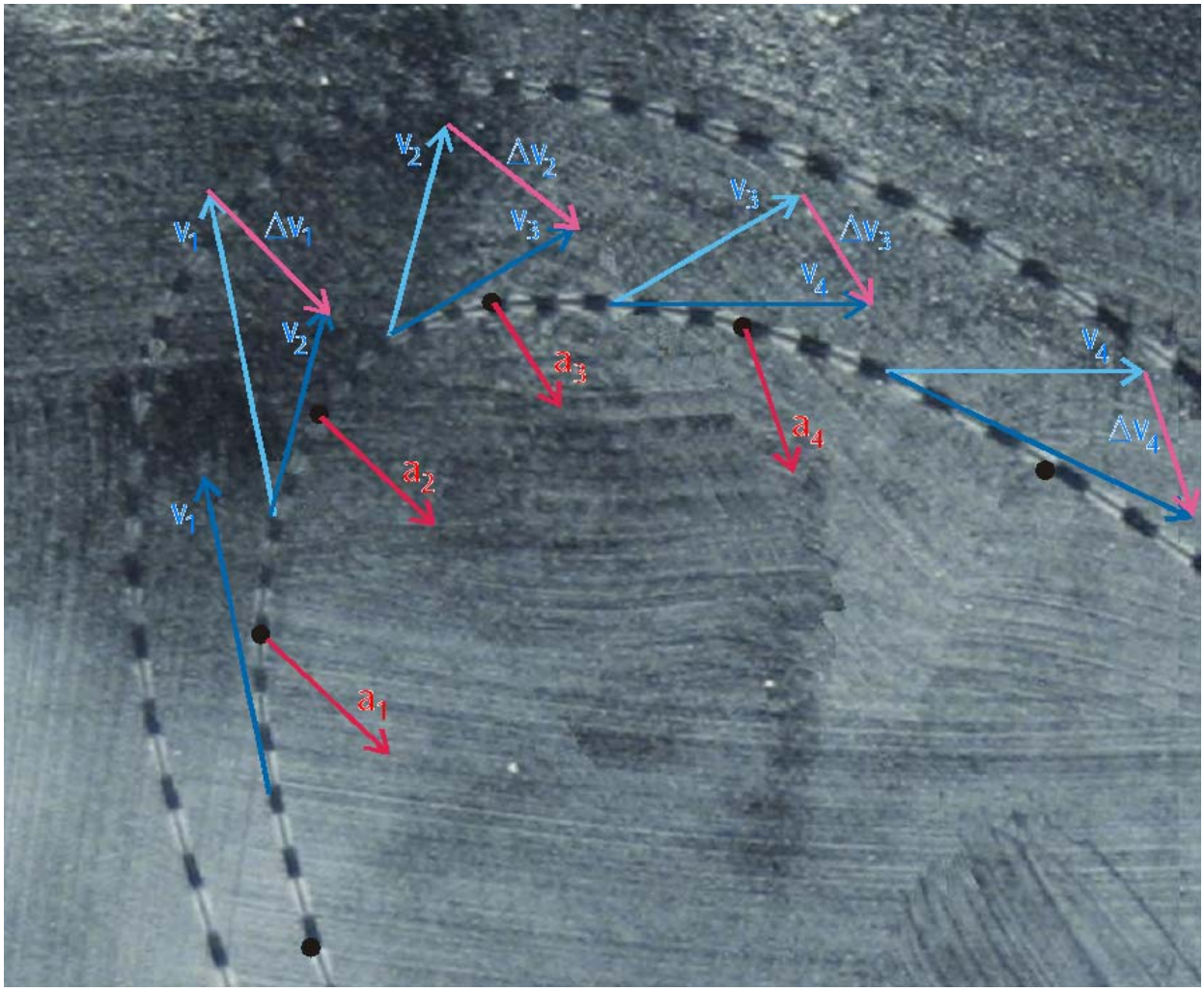

Fig. 1 Graphic depiction of speed and acceleration vectors for two-dimensional motion

Fig. 2 Experiment set-up: Confirmation of Kepler's second law