3.4 Force and displacement on a fixed pulley

Task

Which forces and distances occur on a fixed pulley?

On a fixed pulley hold a mass in equilibrium with a spring balance; then move the spring balance a specific distance. Determine the distance that the mass moved.
Determine the correlation between distance and force through calculation and comparison with the measured data.

Use the space below for your own notes.

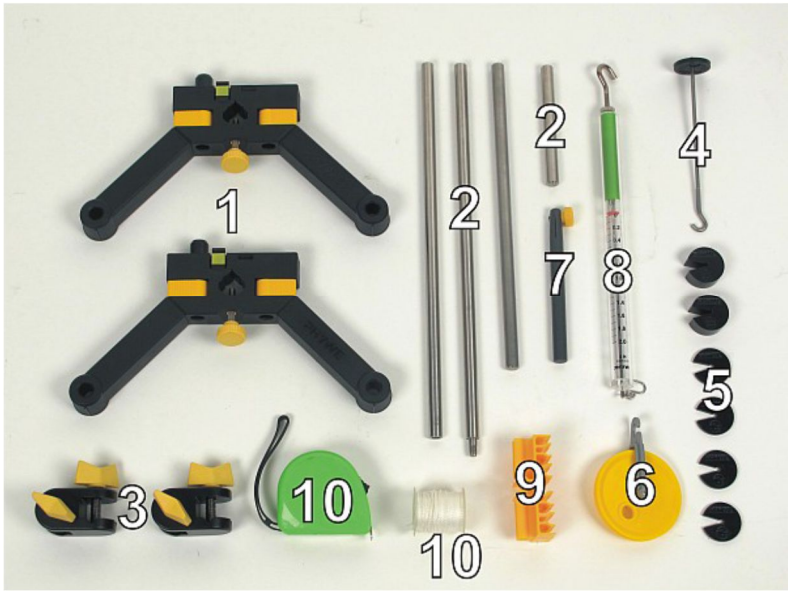
Material

Material from "TESS advanced Physics Set Mechanics 1, ME-1" (Order No. 15271-88)

Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod with hole, stainless steel, 100 mm	02036-01	1
2	Support rod, stainless steel 18/8, *l* = 250 mm, *d* = 10 mm	02031-01	1
2	Support rod, split in 2 rods, *l* = 600 mm	02035-00	1

3	Bosshead	02043-00	2
4	Weight holder for slotted weights, 10 g	02204-00	1
5	Slotted weight, black coloured, 10 g	02205-01	4
5	Slotted weight, black coloured, 50 g	02206-01	2
6	Pulley, movable, *d* = 65 mm, with hook	02262-00	1
7	Rod for pulley	02263-00	1
8	Spring balance, transparent, 2 N	03065-03	1
9	Glass tube holder with tape measure clamp	05961-00	1
10	Measuring tape, *l* = 2 m	09936-00	1
8	Fish line, in reel, *d* = 0.7 mm, 20 m	02089-00	80 cm
Additional Material			
	Adhesive tape		
	Scissors		1

Material required for the experiment



Setup

Set up a stand with the support base (Fig. 1). Push the 25 cm support rod into the hole of the support base (Fig. 2). Screw the two rods together to get a long one (Fig.3). Put this 60 cm support rod in the support base and fix it with the screw (Fig. 4).

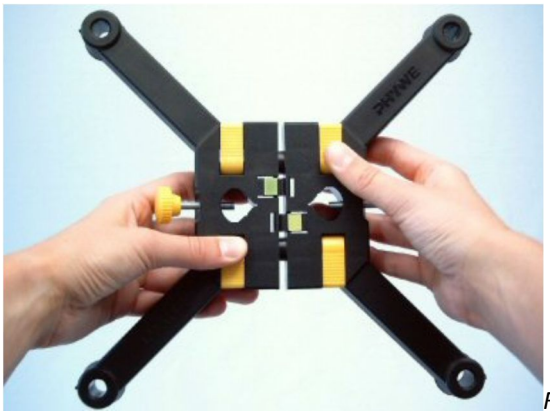


Fig. 1

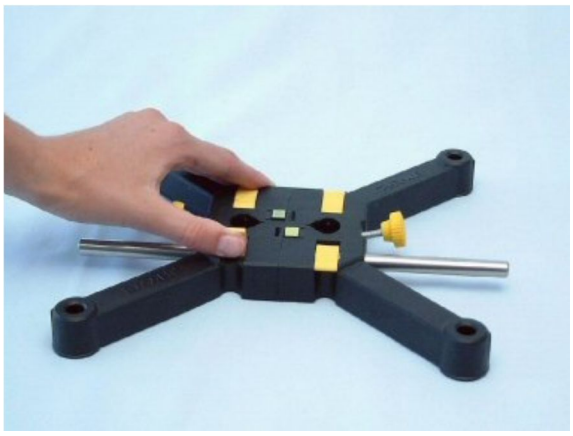


Fig. 2


Fig. 3

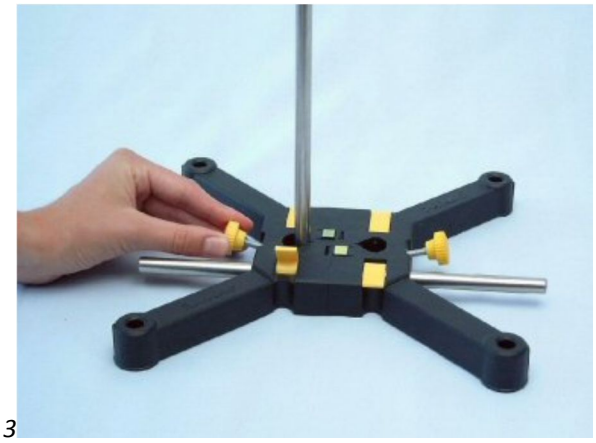


Fig. 4

Fix the pulley to the "rod for pulley" (Fig. 5) and clamp it with the bosshead to the long support rod (Fig. 6).


Fig. 5

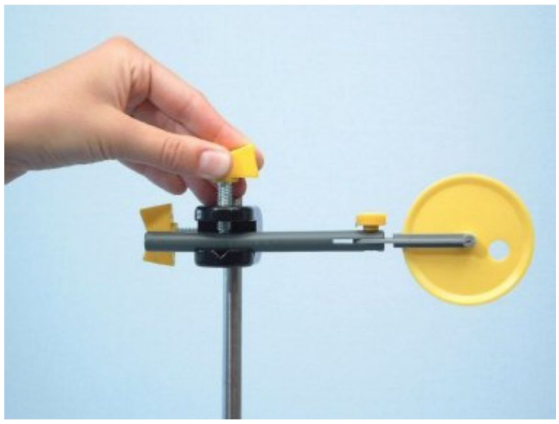


Fig. 6

Clamp the measuring tape and the short support rod in the glass tube holder (Fig. 7 and Fig. 8) and clamp the short rod in the second bosshead to the 60 cm support rod (Fig. 9).

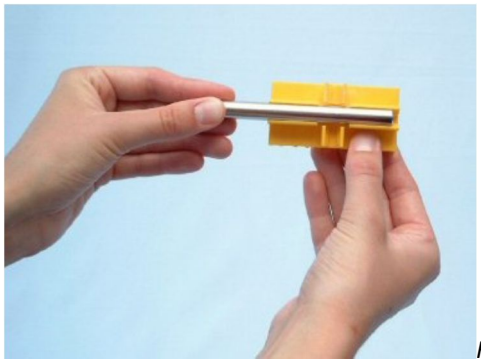


Fig. 7

Fig. 8

Fig. 9

Attach the free end of the measuring tape with a piece of adhesive tape to the table top. Connect the spring balance to the weight holder through the pulley with a piece of fish line about 70 cm long. Set the upside down spring balance to zero (Fig. 10).

Fig. 10

Action

Place four 10 g mass pieces on the weight holder. For hanging the slotted weight up the weight holder, you should slip the slotted weight over the top of the weight holder (Fig. 11).

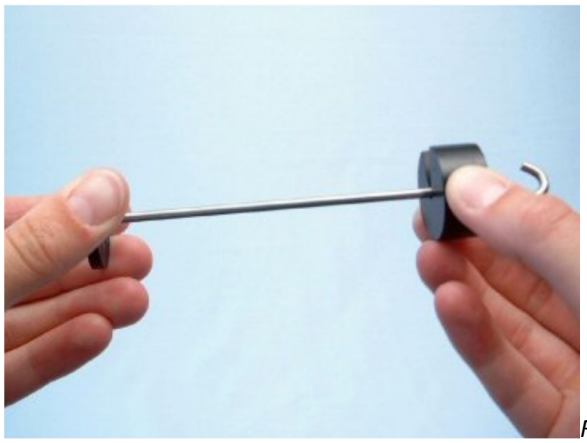


Fig. 11

- Hold the mass (load) with the spring balance so that it is suspended just above the table top (Fig. 12), i.e. $h_{l0} = 0$.
- Read F_f in N on the spring balance's indicator. Also measure the heights of the lower end of the spring balance h_{f0}.
- Hook the supporting hook of the spring balance onto the support base and read the heights of the lower end of the spring balance h_{f1} and of the mass h_{l1} on the measuring tape (Fig. 13).
- Record the measured values in Table 1 on the Results page.
- Repeat these measurements, first, with a mass of 100 g and, then, with 150 g. Add the measured values to Table 1.

Fig. 12

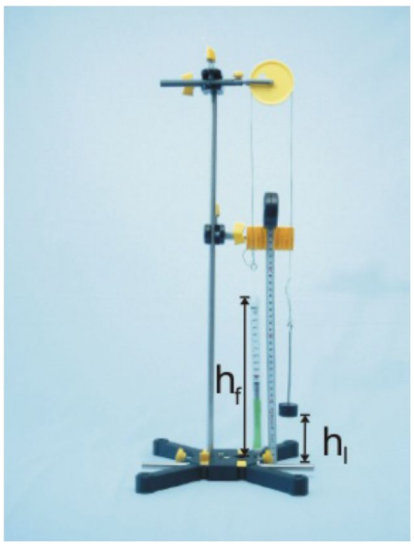


Fig. 13

In order to disassemble the support base you should press the yellow buttons (Fig. 14).

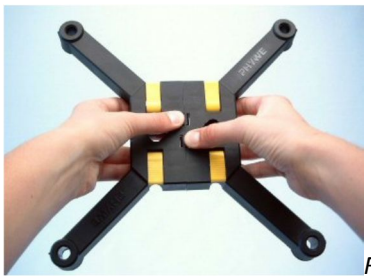


Fig. 14

Results

Table 1

h_{l0} = 0 cm

m in g	F_f in N	h_{f0} in cm	h_{l1} in cm	h_{f1} in cm	F_l in N	s_l in cm	s_f in cm
50							
100							
150							

Comparison Table

m in g	$F_f \times s_f$ in Ncm	$F_l \times s_l$ in Ncm
50		
100		
150		

Evaluation

Question 1:

From the mass m calculate the weight (force) of the load F_l and record the value obtained in Table 1 on the Results page.

Question 2:

From the difference h_{l1} - h_{l0} calculate the load distance s_l; from the difference h_{f0} - h_{f1} the force distance s_f. Record the values obtained in the table in the Action page.

Question 3:

What is the correlation between load distance to force distance on a fixed pulley?

Question 4:

From the force F_f and the force distance s_f calculate the product $F_f \times s_f$ for the three masses and record these values in the Comparison Table on the Results page.

Question 5:

In the same way, calculate the product $F_l \times s_l$ from the load F_l and the load distance s_l; record these values in the Comparison Table, too.

Question 6:

Compare the results with each other, what do you notice?

Question 7:

Do the distances along the line change when the angle of the acting force is changed?

Question 8:

Does the force change after a deflection of its direction by a fixed pulley?

Question 9:

What tasks can be performed with a fixed pulley?