Fixed pulley, loose pulley and block and tackle as simple machines

Objects of the experiments

- Measurement of the tensile force at a pulley block in dependence on the weight of the load suspended.
- Measurement of the tensile force with constant load in dependence on the number of used pulleys.

Principles

Fixed pulley , moveable pulley and pulley block are classical examples of simple machines. They are able to change the point of action, the direction or the magnitude of the force F, necessary to lift a load of weight G (see Fig. 1).

When a rope goes around a fixed pulley, it is possible to pull up the load with a force

$$F = G \qquad \text{(I)}$$

directed downward.

If a loose pulley is used, the force of gravitation G is distributed equally to both ends of the rope passing round, thereby dividing the force nesessary to pull up the load by two. By combination with a fixed pulley , the force nessesary to lift the load upward

$$F = \frac{G}{2} \qquad \text{(II)}$$

is directed downward.

The continuation of this principle results in the construction of the pulley block. If a pulley block with n pairs of fixed and loose pulleys is used, the force of gravitation G of the load suspended is equally distributed to n rope segments. Because the same tensile stress exists throughout the entire rope, the tensile force expended at the end of the rope is

$$F = \frac{G}{2 \cdot n} \qquad \text{(III)}$$

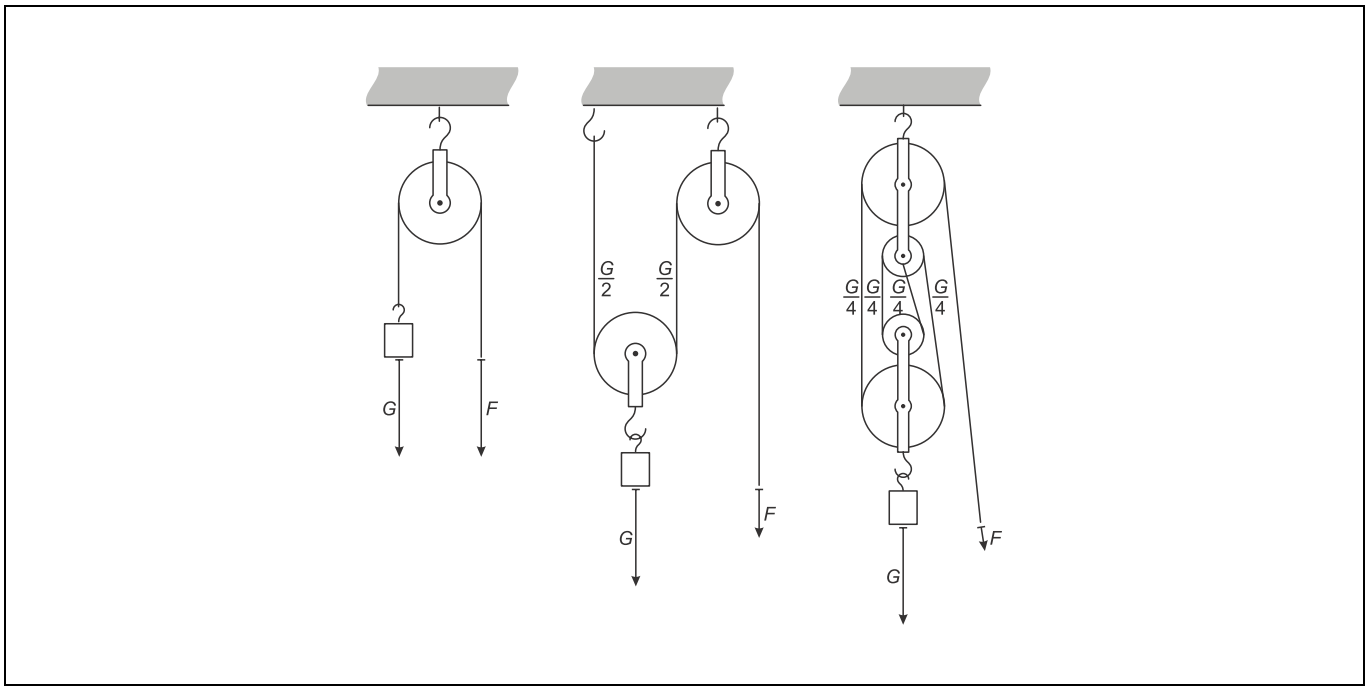


Fig. 1 Fixed pulley (left), loose pulley (middle) and pulley block (right)

Apparatus

1 Pulley block	342 28
1 Precision dynamometer 20.0 N	314 181
1 Set of 7 weights with hook	315 36
1 Large stand base	300 01
1 Stand rod 1 m	300 44
1 Stand rod 25 cm	300 41
1 Leybold multiclamp	301 01
additionally recommended:	
2 pulleys with hook and rod	341 65

Setup

– Mount stand rod 1 m on stand base and fix stand rod 25 cm horizontal at the upper end.

Carrying out the experiment

a) Use of Pulleys (341 65):

a1)Fixed pulley:

– Attach a pulley with a piece of demonstration line to the horizontal stand rod according to fig. 2 and check the knot.
– Loop the demonstration line around the pulley.
– Suspend the weight 2 kg at the end of the rope and determine force *F* required to raise the weight.
– Suspend smaller weights and repeat measurement of force *F*.

a2) Fixed and loose pulley:

– Tie up the demonstration line to the stand rod and pass the line around the fixed and the moveable pulley according to Fig. 3.
– Suspend weight 2 kg from the hook of the moveable pulley and and determine force *F* required to raise the weight.
– Suspend smaller weights and repeat measurement of force *F* .

Fig. 2 Setup with fixed pulley

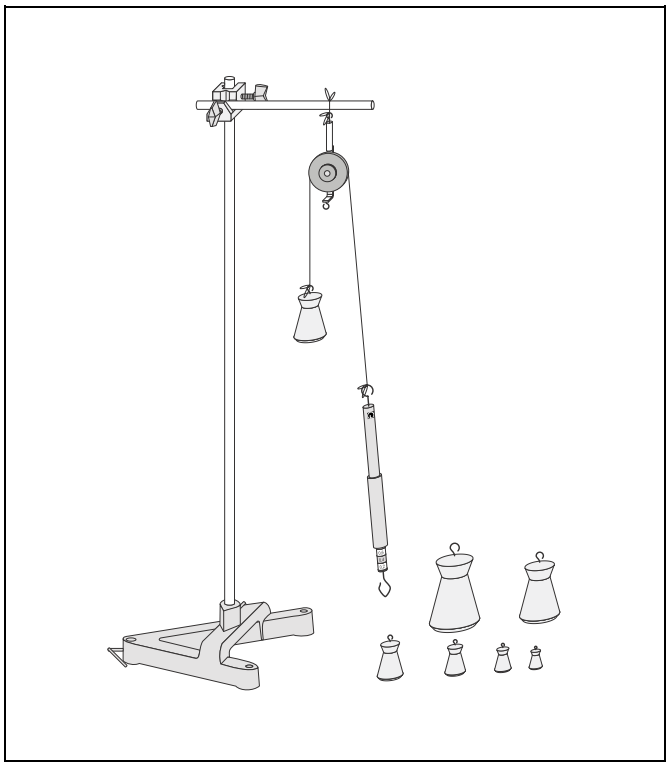
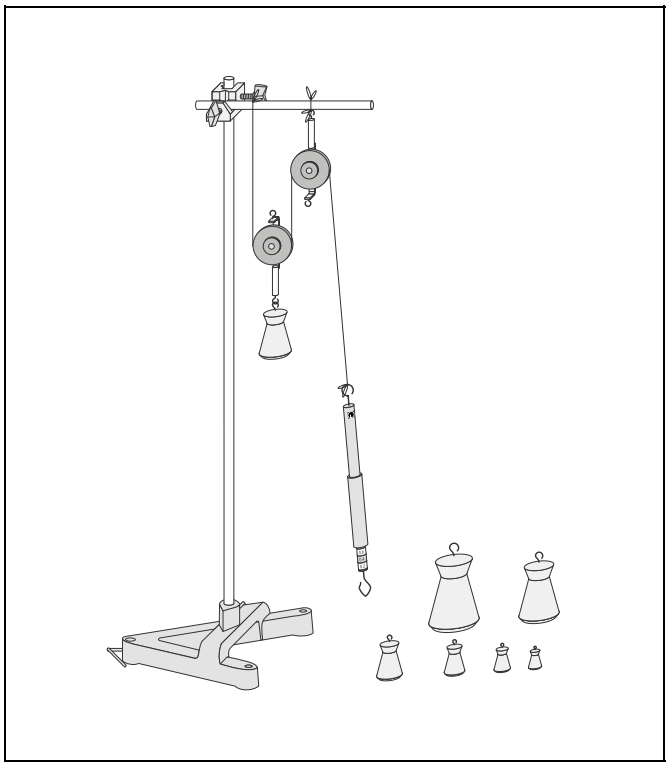


Fig. 3 Setup with fixed and loose pulley



b) Use of pulley block (342 28)

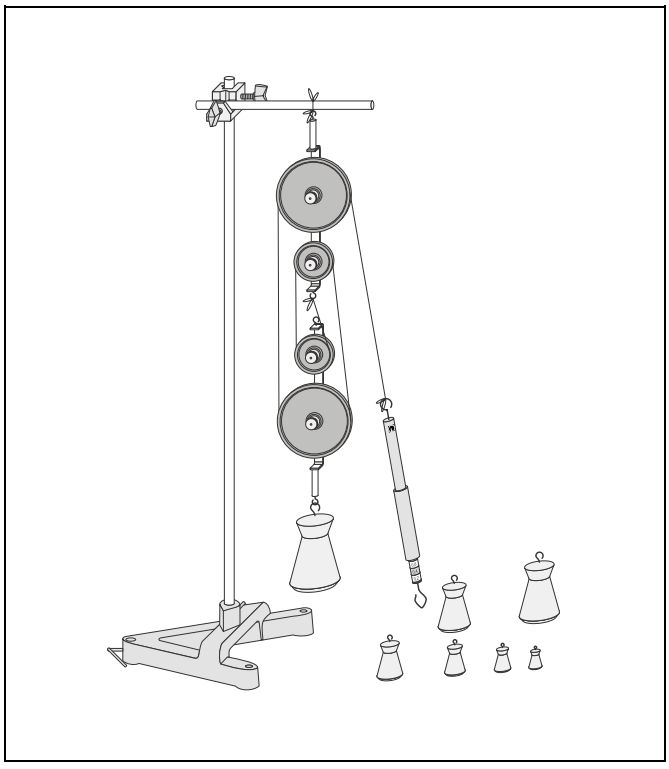
– Fix a pair of pulleys of the pulley block (342 28) with a piece of demonstration line to the horizontal stand rod according to fig. 4 and check the knot.

If only the pulley block is available:

– First loop the demonstration line only around pulley 1 (fixed pulley).
– Suspend weight 2 kg at the end of the line and determine force *F* required to raise the weight.
– Tie up the demonstration line at the hook of the pair of pulleys and pass the line though pulley 2, afterwards through pulley 1 (fixed and moveable pulley) .
– Suspend weight 2 kg from the hook of the lower pair of pulleys and determine force *F* required to raise the weight.

– Loop demonstration line around the 4 pulleys according to fig. 4.
– Suspend weight 2 kg from the hook of the lower pair of pulleys and determine force *F* required to raise the weight.
– Suspend weights 3 kg, 4 kg and 5 kg and repeat measurement of force.

Fig. 4 Setup with pulley block



Measuring example

Fixed Pulley:

Table 1: The force *F* required to lift the mass *m*

$\frac{m}{\text{kg}}$	$\frac{G}{\text{N}}$	$\frac{F}{\text{N}}$
1	10	10
2	20	20

Fixed and loose pulley:

Table 2: The force *F* required to lift the mass *m*

$\frac{m}{\text{kg}}$	$\frac{G}{\text{N}}$	$\frac{F}{\text{N}}$
1	10	5
2	20	10

Pulley block with two pairs of pulleys

Table 3: The force *F* required to lift the mass *m*

$\frac{m}{\text{kg}}$	$\frac{G}{\text{N}}$	$\frac{F}{\text{N}}$
1	10	2.5
2	20	5
4	40	10

Evaluation and results

In the case of a fixed pulley, the force *F* required to lift up a mass *m* is equal to the gravitational force *G*. If a loose pulley or a pulley block is used, the required force is divided by 2 and 4 respectively.

© by Leybold Didactic GmbH
Printed in the Federal Republic of Germany
Technical alterations reserved