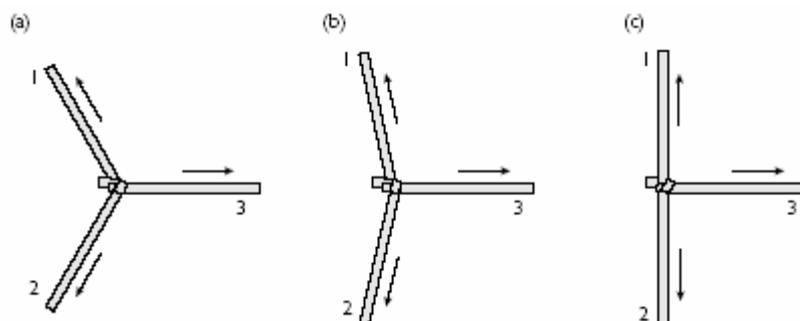


TAP 202- 1: Forces in different directions

Use the arrangement shown below to explore the effect of pulling ropes in different directions but still trying to maintain equilibrium. Try the things suggested below, and think about and discuss the questions as you go along.



Initially arrange the ropes horizontally so that they make equal angles of 120° with each other as in Figure (a) above. The force in a rope that is being pulled is called the **tension**.

What does symmetry suggest about the tension in each rope?

Since you aren't measuring any forces here you cannot test your answer directly, but you might try the following argument: keeping the angles the same, rotate in your threesome around the knot through 120° so that one rope has replaced its neighbour.

Do you feel any difference in the rope you are holding?

(You might think this reasoning is a bit of a cheat, but in fact arguments based on symmetry can be extremely powerful tools in making theoretical predictions in physics.)

What do you have to do to the tensions to produce an arrangement like Figure (b)?

How do the tensions in ropes 1 and 2 compare with that in 3?

Is it ever possible to produce the arrangement in Figure (c) by pulling on the ropes?

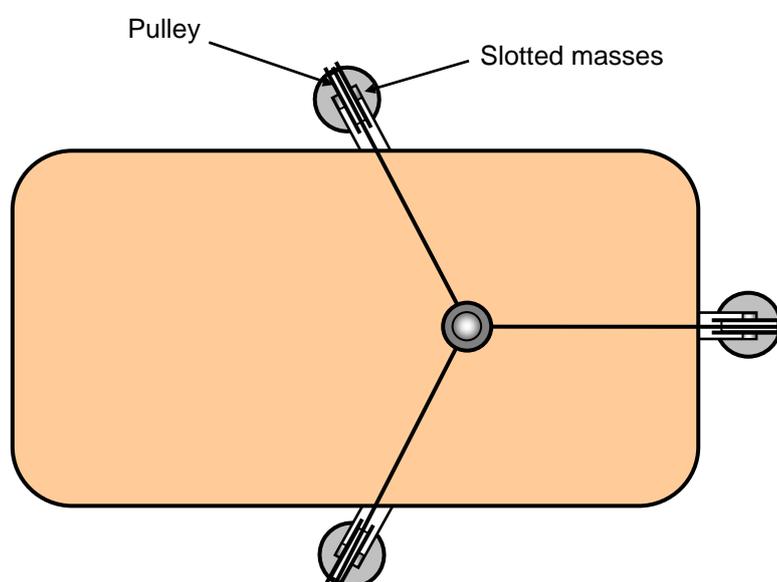
Practical advice

This section uses a series of activities to develop ideas about combining and resolving vectors.

Students with a strong mathematical background and aptitude could be asked to work through this section independently of the teacher, in pairs or small groups— a lot of good learning can take place like this. In order to identify any problems, students can be asked to discuss with you their results from the activities and their answers to the questions. On the other hand, students whose maths background is weak will probably need a lot of support and should not be left to struggle.

This is a qualitative look at the directional aspect of forces, starting from an intuitive symmetrical arrangement. We recommend using climbing ropes and doing the activity in a large space. It is not essential to use climbing ropes but their use is strongly recommended.

Alternatively, use bench pulleys and slotted masses as shown below



Technicians Note:

Apparatus

- ✓ 2 lengths of rope (approx. 4 m and 2 m long) with the short length firmly knotted to the middle of the longer

Optional

- ✓ three bench pulleys
- ✓ slotted masses $3 \times 10 \times 0.1$ kg

A rich source of climbing rope data, including testing procedures, is the BEAL catalogue. The UK distributor is:

LYON Equipment

Dent

Sedbergh

Cumbria LA10 5QL

External references

This activity is taken from Salters Horners Advanced Physics, AS, Section Higher, Faster, Stronger, HFS Activity 11