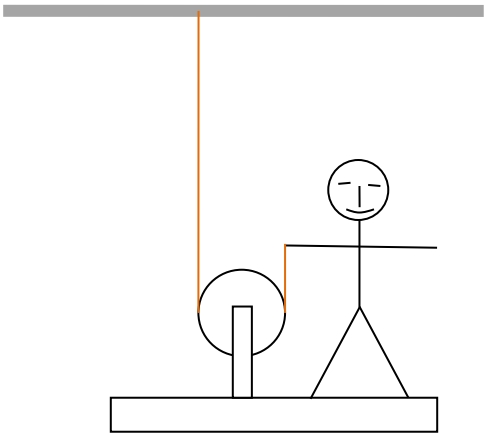
Teacher notes
Topic A

More free body diagrams and Newton's second law

A girl of mass 46 kg stands on a platform of mass 10 kg. She pulls on a string that goes around a pulley of mass 4.0 kg, accelerating upward. The other end of the string is attached to the ceiling. Take $g = 10\,\text{ms}^{-2}$.

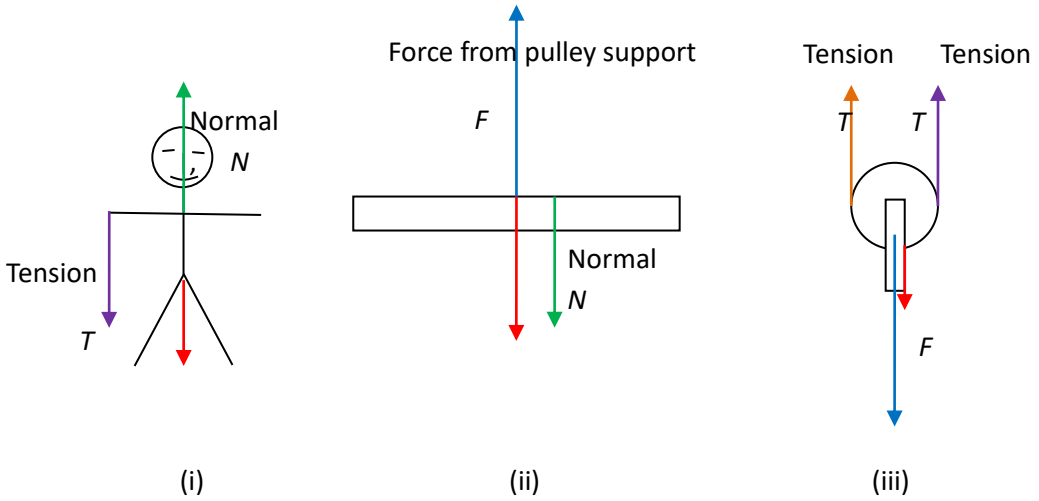


(a) Draw free body diagrams for
  (i) the girl,
  (ii) the platform,
  (iii) the pulley.

(b) Determine the forces involved in the problem given that the platform is accelerating upward at 1.5 m s^{-2}.

Answers

(a) Red arrows represent weights. Forces in the same color are "action-reaction" pairs.



(i) (ii) (iii)

(b) Applying second law to girl: $N-T-460=46\times1.5$. Applying it to platform: $F-N-100=10\times1.5$. Applying to pulley: $2T-F-40=4.0\times1.5$. So, we have three equations in three unknowns.

1) $N-T-460=69$
2) $F-N-100=15$
3) $2T-F-40=6.0$

But we can apply the second law to the entire system (girl, platform, pulley) to get $T-600=60\times1.5=90\Rightarrow T=690$ N. Now it is easy to find the other forces: From 1) we get $N-690-460=69\Rightarrow N=1219$ N. From 2) we get $F-1219-100=15\Rightarrow F=1334$ N. We no longer need equation 3) but we can use it as a check: $2T-F-30=2\times690-1334-40=6.0$.