Newton's 3rd Law

Starter

1. **(Review of last lesson)** A particle is suspended in equilibrium by three light inextensible strings. The tension in the strings is $\begin{pmatrix} -2 \\ 1 \end{pmatrix}$ N, $\begin{pmatrix} 0 \\ -3 \end{pmatrix}$ N and $\begin{pmatrix} x \\ y \end{pmatrix}$ N. Find x and y.

Working: Since the forces are in equilibrium, the sum of the forces is zero.

$$\begin{pmatrix} -2 \\ 1 \end{pmatrix} + \begin{pmatrix} 0 \\ -3 \end{pmatrix} + \begin{pmatrix} x \\ y \end{pmatrix} = 0$$

$\mathbf{i}$: $\quad -2 + x = 0 \quad \Rightarrow \quad x = 2$

$\mathbf{j}$: $\quad 1 - 3 + y = 0 \quad \Rightarrow \quad y = 2$

$x = 2, y = 2$

E.g. 1 A person pushes a table in order to try and move it.

(a) The person pushes with a force of 30 N but the table does not move. What was the frictional force acting?

(b) This time the person pushes with a force of 55 N but the table still does not move. What was the frictional force acting?

Working:

(a) If the object does not move, the frictional force must be matching the pushing force.
So frictional force is 30 N

(b) Again the frictional force matches the pushing force.
So frictional force is 55 N

E.g. 2 Two ice skaters of mass 75 kg and 63 kg push against each other. If the 75 kg moves off with an acceleration of 3.7 m/s², find the acceleration of skater B.

Working:

$F = ma$ for 75 kg skater: $\quad F = 75 \times 3.7 = 277.5$

$F = ma$ for 63 kg skater: $\quad F = 63a$ where a is the acceleration

By Newton's 3rd law: $\quad 63a = 277.5$

$a \approx 4.40$

The acceleration of skater B is 4.40 m/s² (3 s.f.).

Video: Newton's 3rd Law

Solutions to Starter and E.g.s

Exercise

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