5.1 Algebraic Pulley Problems

Example

Two particles of masses x kg and y kg are connected by a light inextensible string passing over a smooth fixed pulley. Both particles are hanging freely.

(i) Show that when the system is released from rest, the tension is,

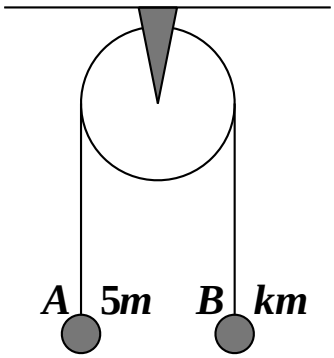
$$T = \frac{2xyg}{x + y}$$

(ii) Hence, find an elegant expression for the acceleration of each particle.

5.2 Exercise

Question 1

Examination Question from January 2010, M1, Q6



Two particles A and B have masses of $5m$ and km respectively, where $k < 5$. The particles are connected by a light inextensible string which passes over a smooth light fixed pulley. The system is held at rest with the string taut and the hanging parts of the string vertical and with A and B at the same height above a horizontal plane. The system is released from rest.

After release, A descends with acceleration $\frac{1}{4}g$

(a) Show that the tension in the string as A descends is $\frac{15}{4}mg$

[3 marks]

(b) Find the value of k

[3 marks]

(c) State how you have used the information that the pulley is smooth.

[1 mark]

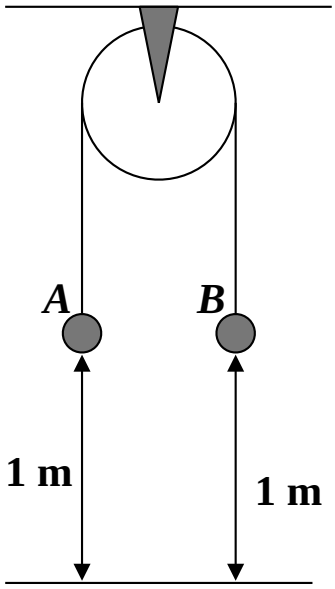
After descending for 1.2 seconds, the particle A reaches the plane. It is immediately brought to rest by the impact with the plane. The initial distance between B and the pulley is such that, in the subsequent motion, B does not reach the pulley.

(d) Find the greatest height reached by B above the plane.

[7 marks]

Question 2

Examination Question from May 2010, M1, Q8



Two particles *A* and *B* have mass 0.4 kg and 0.3 kg respectively. The particles are attached to the ends of a light inextensible string. The string passes over a small smooth pulley which is fixed above a horizontal floor. Both particles are held, with the string taut at a height of 1 metre above the floor. The particles are released from rest and in the subsequent motion *B* does not reach the pulley.

(a) Find the tension in the string immediately after the particles are released

[6 marks]

(b) Find the acceleration of *A* immediately after the particles are released

[2 marks]

When the particles have been moving for 0.5 seconds, the string breaks.

(c) Find the further time that elapses until *B* hits the floor

[9 marks]

Question 3

Two rocks, P and Q, are connected by an inextensible rope passing over a smooth pulley. Q is 3 kg heavier than P. Given that the tension in the rope is 35.9 Newtons, find the mass of each rock and the acceleration of the system.