Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

6 Connected particles

Exercise A, Question 15

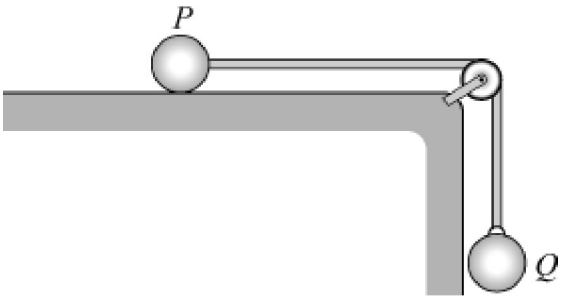
Question:

Two particles, P and Q, are connected by a light, inextensible string which passes over a smooth, fixed peg, as shown in the diagram.

The particle P is of mass $2m$ and Q is of mass m. The particle P is in contact with a horizontal surface, which may be modelled as either rough or smooth.

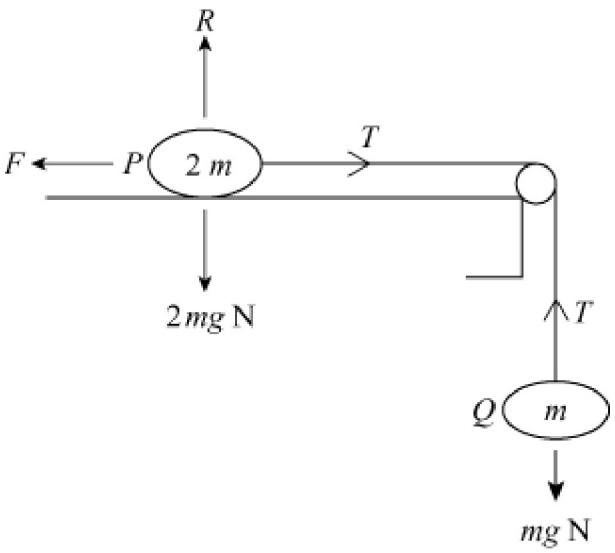
(a) In the first case, the surface is modelled as rough and the particle Q hangs at rest. The coefficient of friction between P and the surface is μ.
(i) Find the tension in the string.
(ii) Find the range of possible values of μ.

(b) In the second case, the surface is modelled as smooth. The system is released from rest with the string taut and the particle P moves towards the peg.
Find the tension in the string. [A]



Solution:

(a) (i) No movement, hence particle m is at rest.
Resolve vertically $mg - T = 0$
Tension is mg.

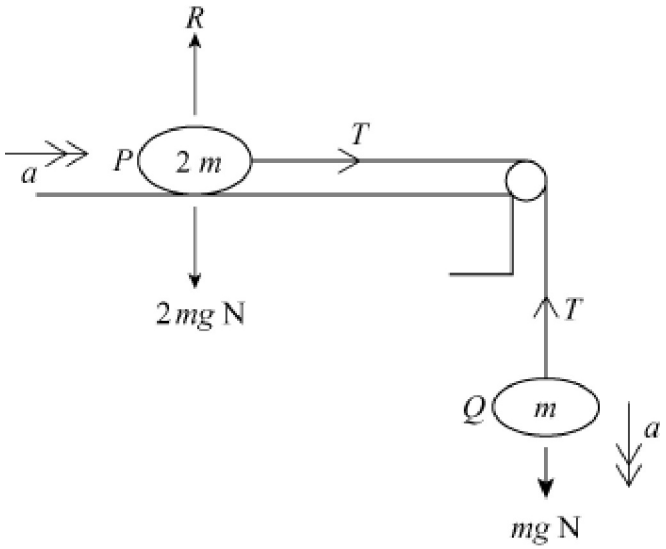


(ii) At P, resolve horizontally

$F = T = mg$
Resolve vertically $R = 2mg$

$F \leq \mu R$ (friction need not be limiting)
$\therefore mg \leq \mu.2mg$
i.e. $\mu \geq \frac{1}{2}$

(b)



Using $F = ma$
for Q; $mg - T = ma$
for P; $T = 2ma$ [1]
Adding $mg = 3ma$
$a = \frac{1}{3}g$

From [1]; $\therefore$ Tension is $\frac{2}{3}mg$.