Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

Exam style practice papers

Exercise MM1A, Question 5

Question:

The diagram shows two particles that are connected by a light, inelastic string that passes over a smooth, light pulley. One of the particles is on a rough horizontal surface and the other is hanging freely.
The particle on the surface has mass 9 kg and the other particle has mass 5 kg. The coefficient of friction between the particle and the surface is 0.2. The particles are released from rest.

(a) Find the acceleration of the particles. (5 marks)

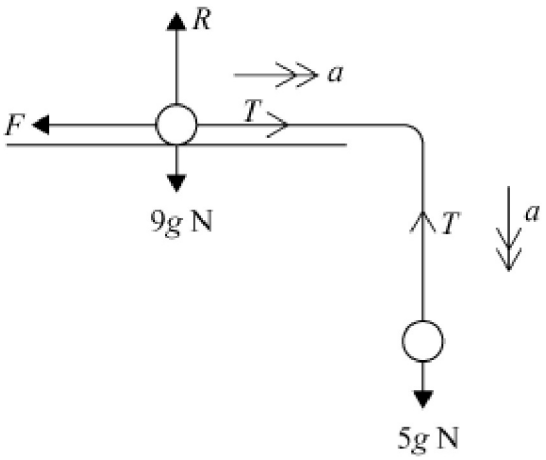
(b) Find the tension in the string. (2 marks)

(c) When the particles have been moving for 1 second the string breaks and the particle on the surface slows down and stops before it reaches the pulley. Find the total distance travelled by this particle. (5 marks)

Solution:

(a) For 9 kg particle, resolve vertically

$R = 9g$
Using $F = \mu R$,
$F = 0.2 \times 9g$
$= 17.64$



Using $F = ma$, for 5 kg particle; $5g - T = 5a$ [1]
for 9 kg particle; $T - F = 9a$
Adding $5g - F = 14a$
$14a = 5g - 17.64$
$14a = 31.36$
$a = 2.24$

Acceleration is 2.24 m s^{-2}

(b) From [1] $T = 5g - 5a$
$= 37.8$

$\therefore$ Tension is 37.8 N

(c) To find the speed of the particles just before the string breaks,

use $v = u + at$
$v = 2.24 \times 1$
$= 2.24$ m s^{-1}

Distance travelled in this 1 second,

using $s = ut + \frac{1}{2}at^2$

$s = \frac{1}{2} \times 2.24 \times 1^2 = 1.12$ m

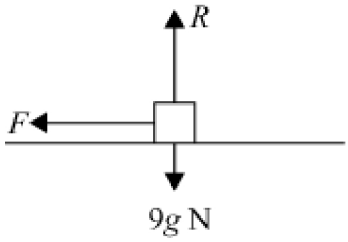
Particle of mass 9 kg moves under frictional force
(R and $9g$ N cancel each other)

Using $F = ma$,
$-17.64 = 9a$
$a = -1.96$ m s^{-2}

To find the distance moved after the string breaks,

$v^2 = u^2 + 2as$
$2.24^2 = 2 \times 1.96 \times s$
$s = \frac{2.24^2}{2 \times 1.96}$
$s = 1.28$ m

$\therefore$ Total distance travelled is 1.12 + 1.28
= 2.4 m



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