Both Hanging Freely

Question Paper 1

Level	A Level
Subject	Maths
Exam Board	AQA
Module	Mechanics 1
Topic	Connected Particles
Sub Topic	Both hanging freely
Booklet	Question Paper - 1

Time Allowed: **49 minutes**

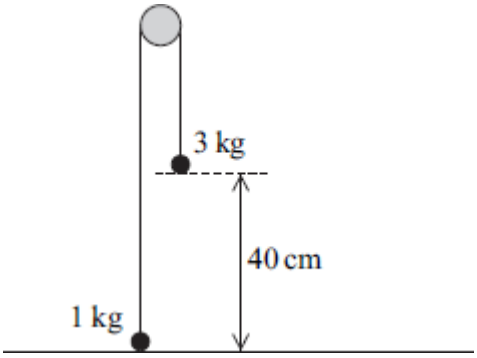
Score: **/41**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

Q1. Two particles are connected by a light inextensible string that passes over a smooth peg. The particles have masses of 3 kg and 1 kg. The 1 kg particle is pulled down to ground level, where it is 40 cm below the level of the 3 kg particle, as shown in the diagram.



The particles are released from rest with the string vertical above each particle. Assume that no resistance forces act on the particles as they move.

(a) By forming two equations of motion, one for each particle, find the magnitude of the acceleration of the particles after they have been released but before the 3 kg particle hits the ground.

(5)

(b) Find the speed of the 1 kg particle when the 3 kg particle hits the ground.

(2)

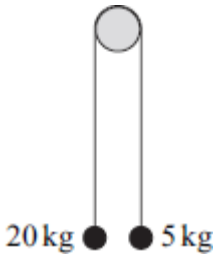
(c) After the 3 kg particle has hit the ground, the 1 kg particle continues to move and the string is now slack. Find the maximum height above ground level reached by the 1 kg particle.

(3)

(d) If a constant air resistance force also acts on the particles as they move, explain how this would change your answer for the acceleration in part (a). Give a reason for your answer.

(2)
(Total 12 marks)

Q2. Two particles have masses of 20 kg and 5 kg. They are connected by a light inextensible string that passes over a smooth fixed peg, as shown in the diagram.

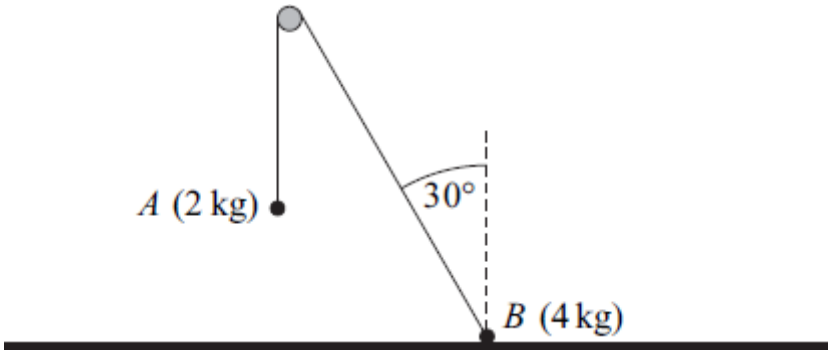


The particles are released from rest.

By forming two equations of motion, find the magnitude of the acceleration of the particles.

(Total 4 marks)

Q3. Two particles, A and B, are connected by a light inextensible string which passes over a smooth peg. Particle A has mass 2 kg and particle B has mass 4 kg. Particle A hangs freely with the string vertical. Particle B is at rest in equilibrium on a rough horizontal surface with the string at an angle of 30° to the vertical. The particles, peg and string are shown in the diagram.



(a) By considering particle A, find the tension in the string.

(2)

(b) Draw a diagram to show the forces acting on particle B.

(2)

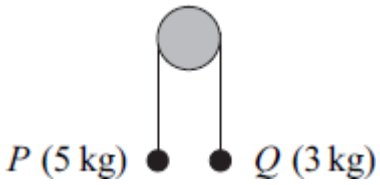
(c) Show that the magnitude of the normal reaction force acting on particle B is 22.2 newtons, correct to three significant figures.

(3)

(d) Find the least possible value of the coefficient of friction between particle B and the surface.

(4)
(Total 11 marks)

Q4. Two particles, P and Q, are connected by a string that passes over a fixed smooth peg, as shown in the diagram. The mass of P is 5 kg and the mass of Q is 3 kg.



The particles are released from rest in the position shown.

(a) By forming an equation of motion for each particle, show that the magnitude of the acceleration of each particle is 2.45 m s^{-2}.

(5)

(b) Find the tension in the string.

(2)

(c) State **two** modelling assumptions that you have made about the string.

(2)

(d) Particle P hits the floor when it has moved 0.196 metres and Q has not reached the peg.

(i) Find the time that it takes P to reach the floor.

(3)

(ii) Find the speed of P when it hits the floor.

(2)
(Total 14 marks)