Write your name here

Surname	Other Names

AS/A Level Mathematics

F = ma

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

• Use **black** ink or ball-point pen.
• If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
• **Fill in the boxes** at the top of this page with your name.
• Answer **all** questions and ensure that your answers to parts of questions are clearly labelled..
• Answer the questions in the spaces provided
– there may be more space than you need.
• You should show sufficient working to make your methods clear.
Answers without working may not gain full credit.
• Answers should be given to three significant figures unless otherwise stated.

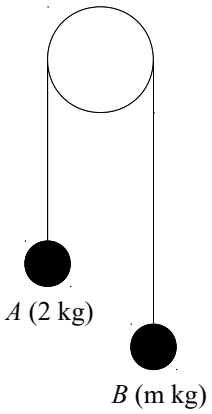
Information

• The marks for **each** question are shown in brackets
– use this as a guide as to how much time to spend on each question.

Advice

• Read each question carefully before you start to answer it.
• Try to answer every question.
• Check your answers if you have time at the end.

1 Two particles A and B have mass of 2 kg and m kg respectively, where $m < 2$. The particles are connected by a light inextensible string which passes over a smooth, fixed pulley. Initially A is 3 m above horizontal ground. The string is released from rest with the string taut and the hanging parts of the string vertical. After A has been descending for 2.5 s it strikes the ground. Particle A reaches the ground before B reaches the pulley.



(a) Show that the acceleration of A as it descends is 0.96 ms^{-2} **(3)**

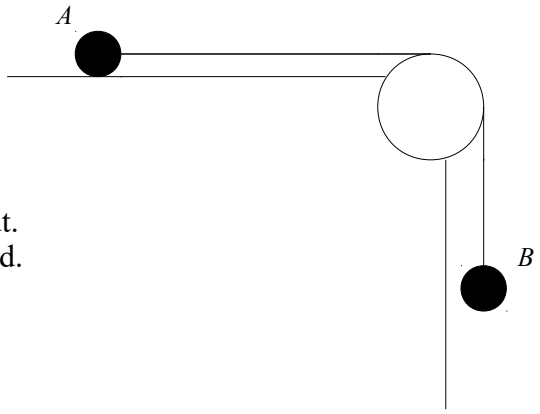
(b) Show that the mass of B is 1.64 kg **(7)**

(c) State how you have used the information that the string is inextensible. **(1)**

(Total for question 1 is 11 marks)

---

2 A particle A of mass 5 kg rests on a smooth horizontal table. Particle A is attached to one end of a light inextensible string which passes over a smooth pulley fixed to the edge of the table. The other end of the string is attached to particle B of mass 4 kg which hangs freely below the pulley 1.4 m above the ground. The system is released from rest with the string taut. Particle A does not reach the pulley before B reaches the ground.



(a) Find the tension in the string before B hits the ground. **(4)**

(b) Find the time taken by B to reach the ground. **(5)**

(Total for question 2 is 9 marks)

---

3 A car of mass 750 kg pulls a trailer of mass 300 kg along a straight horizontal road using a light towbar which is parallel to the road. The horizontal resistances to motion of the car and the trailer have magnitudes 250 N and 100 N respectively. The engine of the car produces a constant horizontal driving force on the car of magnitude 1600 N. Find

(a) the acceleration of the car and trailer, **(3)**

(b) the magnitude of the tension in the towbar. **(3)**

The car is moving along the road when the driver sees a hazard ahead. He reduces the force produced by the engine to zero and applies the brakes. The brakes produce a force on the car of magnitude F newtons and the car and trailer decelerate. Given that the resistances to motion are unchanged and the magnitude of the thrust in the towbar is 80 N,

(c) find the value of F. **(7)**

(Total for question 3 is 13 marks)

4 A car is towing a trailer along a straight horizontal road by means of a horizontal tow-rope.
The mass of the car is 1400 kg. The mass of the trailer is 700 kg. The car and the trailer are modelled as particles and the tow-rope as a light inextensible string. The resistances to motion of the car and the trailer are assumed to be constant and of magnitude 630 N and 280 N respectively.
The driving force on the car, due to its engine, is 2380 N. Find

(a) the acceleration of the car, **(3)**

(b) the tension in the tow-rope **(3)**

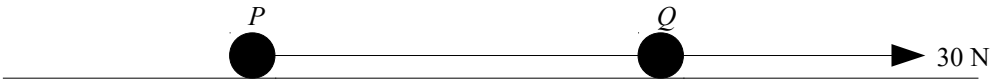
(c) state how you have used the assumption that the car and trailer are modelled as particles. **(1)**

When the car and trailer are moving at 12 m s^{-1}, the tow-rope breaks. Assuming that the driving force on the car and the resistances to motion are unchanged,

(d) find the distance moved by the car in the first 4 s after the tow-rope breaks. **(6)**

(Total for question 4 is 13 marks)

5



Two particles P and Q, of mass 4 kg and 6 kg respectively, are joined by a light horizontal rod.
The particles are initially at rest when a constant force F of magnitude 30 N is applied to Q, as shown in the diagram. The force is applied for 5 s.
During the motion, the resistance to P has a constant magnitude of 2 N and the resistance to Q has a constant magnitude of 4 N. Find

(a) the acceleration of the particles as the system moves under the action of the 30 N force. **(3)**

(b) the speed of the particles after 5 seconds. **(2)**

(c) the tension in the rod as the system moves under the action of the 30 N force. **(3)**

After 5 seconds the force is removed and the system decelerates to rest.
The resistances to motion are unchanged.

(d) Find the distance moved by P as the system decelerates. **(4)**

(e) Find the thrust in the rod as the system decelerates. **(3)**

(Total for question 5 is 15 marks)