Edexcel GCE

Core Mathematics M1

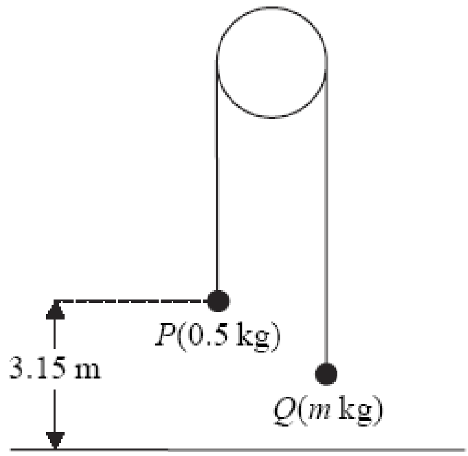
Dynamics (F=ma)

Materials required for examination	**Items included with question papers**
Mathematical Formulae (Green)	Nil

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner. Answers without working may gain no credit.

1. **Figure 4**



Two particles P and Q have mass 0.5 kg and m kg respectively, where $m < 0.5$. The particles are connected by a light inextensible string which passes over a smooth, fixed pulley. Initially P is 3.15 m above horizontal ground. The particles are released from rest with the string taut and the hanging parts of the string vertical, as shown in Figure 4. After P has been descending for 1.5 s, it strikes the ground. Particle P reaches the ground before Q has reached the pulley.

(*a*) Show that the acceleration of P as it descends is 2.8 m s^{-2}.

(3)

(*b*) Find the tension in the string as P descends.

(3)

(*c*) Show that $m = \frac{5}{18}$.

(4)

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

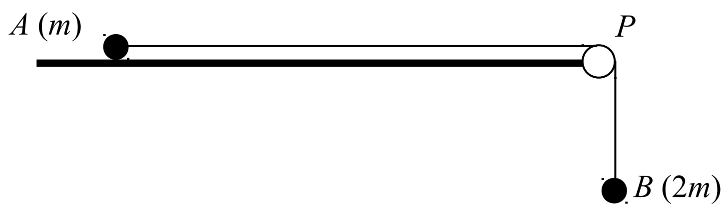
(1)

When P strikes the ground, P does not rebound and the string becomes slack. Particle Q then moves freely under gravity, without reaching the pulley, until the string becomes taut again.

(*e*) Find the time between the instant when P strikes the ground and the instant when the string becomes taut again.

(6)

2. **Figure 3**



Two particles A and B, of mass m and $2m$ respectively, are attached to the ends of a light inextensible string. The particle A lies on a rough horizontal table. The string passes over a small smooth pulley P fixed on the edge of the table. The particle B hangs freely below the pulley, as shown in Figure 3. The coefficient of friction between A and the table is μ. The particles are released from rest with the string taut. Immediately after release, the magnitude of the acceleration of A and B is $\frac{4}{9}g$. By writing down separate equations of motion for A and B,

(*a*) find the tension in the string immediately after the particles begin to move,

(3)

(*b*) show that $\mu = \frac{2}{3}$.

(5)

When B has fallen a distance h, it hits the ground and does not rebound. Particle A is then a distance $\frac{1}{3}h$ from P.

(*c*) Find the speed of A as it reaches P.

(6)

(*d*) State how you have used the information that the string is light.

(1)

3. 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)

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,

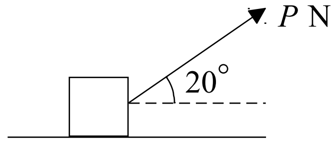
(*c*) find the distance moved by the car in the first 4 s after the tow-rope breaks.

(6)

(*d*) State how you have used the modelling assumption that the tow-rope is inextensible.

(1)

4. **Figure 3**



A box of mass 30 kg is being pulled along rough horizontal ground at a constant speed using a rope. The rope makes an angle of 20° with the ground, as shown in Figure 3. The coefficient of friction between the box and the ground is 0.4. The box is modelled as a particle and the rope as a light, inextensible string. The tension in the rope is *P* newtons.

(*a*) Find the value of *P*.

(8)

The tension in the rope is now increased to 150 N.

(*b*) Find the acceleration of the box.

(6)

5. A car of mass 800 kg pulls a trailer of mass 200 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 400 N and 200 N respectively. The engine of the car produces a constant horizontal driving force on the car of magnitude 1200 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 100 N,

(*c*) find the value of F.

(7)

6.

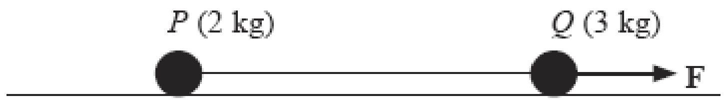


Figure 4

Two particles P and Q, of mass 2 kg and 3 kg respectively, are joined by a light inextensible string. Initially the particles are at rest on a rough horizontal plane with the string taut. A constant force **F** of magnitude 30 N is applied to Q in the direction PQ, as shown in Figure 4. The force is applied for 3 s and during this time Q travels a distance of 6 m. The coefficient of friction between each particle and the plane is μ. Find

(*a*) the acceleration of Q,

(2)

(*b*) the value of μ,

(4)

(*c*) the tension in the string.

(4)

(*d*) State how in your calculation you have used the information that the string is inextensible.

(1)

When the particles have moved for 3 s, the force **F** is removed.

(*e*) Find the time between the instant that the force is removed and the instant that Q comes to rest.

(4)