Paper Reference(s)

6677

Edexcel GCE

Mechanics M1
(New Syllabus)
Advanced/Advanced Subsidiary
Monday 14 January 2002 – Afternoon
Time: 1 hour 30 minutes

Materials required for examination	Items included with question papers
Answer Book (AB16)	Nil
Mathematical Formulae (Lilac)	
Graph Paper (ASG2)	

Candidates may use any calculator EXCEPT those with the facility for symbolic algebra, differentiation and/or integration. Thus candidates may NOT use calculators such as the Texas Instruments TI 89, TI 92, Casio CFX 9970G, Hewlett Packard HP 48G

Instructions to Candidates

In the boxes on the answer book, write the name of the examining body (Edexcel), your centre number, candidate number, the unit title (Mechanics M1), the paper reference (6677), your surname, other name and signature.
Whenever a numerical value of g is required, take g = 9.8 m s^{-2}.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
This paper has eight questions. Pages 7 and 8 are blank.

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. A ball of mass 0.3 kg is moving vertically downwards with speed 8 m s^{-1} when it hits the floor which is smooth and horizontal. It rebounds vertically from the floor with speed 6 m s^{-1}. Find the magnitude of the impulse exerted by the floor on the ball.

(3)

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2. A railway truck *A* of mass 1800 kg is moving along a straight horizontal track with speed 4 m s^{-1}. It collides directly with a stationary truck *B* of mass 1200 kg on the same track. In the collision, *A* and *B* are coupled and move off together.

(*a*) Find the speed of the trucks immediately after the collision.

(3)

After the collision, the trucks experience a constant resistive force of magnitude *R* newtons. They come to rest 8 s after the collision.

(*b*) Find *R*.

(3)

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3. A racing car moves with constant acceleration along a straight horizontal road. It passes the point *O* with speed 12 m s^{-1}. It passes the point *A* 4 s later with speed 60 m s^{-1}.

(*a*) Show that the acceleration of the car is 12 m s^{-2}.

(2)

(*b*) Find the distance *OA*.

(3)

The point *B* is the mid-point of *OA*.

(*c*) Find, to 3 significant figures, the speed of the car when it passes *B*.

(3)

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4. A motor scooter and a van set off along a straight road. They both start from rest at the same time and level with each other. The scooter accelerates with constant acceleration until it reaches its top speed of 20 m s^{-1}. It then maintains a constant speed of 20 m s^{-1}. The van accelerates with constant acceleration for 10 s until it reaches its top speed V m s^{-1}, $V > 20$. It then maintains a constant speed of V m s^{-1}. The van draws level with the scooter when the scooter has been travelling for 40 s at its top speed. The total distance travelled by each vehicle is then 850 m.

(*a*) Sketch on the same diagram the speed-time graphs of both vehicles to illustrate their motion from the time when they start to the time when the van overtakes the scooter.

(3)

(*b*) Find the time for which the scooter is accelerating.

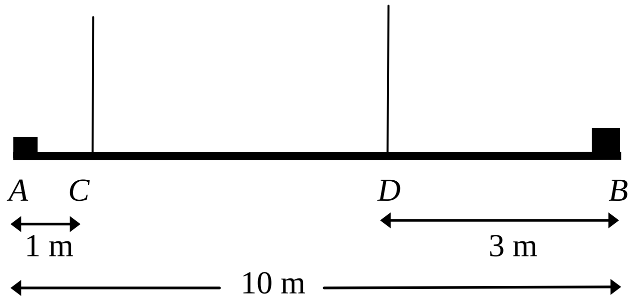
(3)

(*c*) Find the top speed of the van.

(3)

TURN OVER FOR QUESTION 5

5. **Figure 1**



A heavy uniform steel girder *AB* has length 10 m. A load of weight 150 N is attached to the girder at *A* and a load of weight 250 N is attached to the girder at *B*. The loaded girder hangs in equilibrium in a horizontal position, held by two vertical steel cables attached to the girder at the points *C* and *D*, where *AC* = 1 m and *DB* = 3 m, as shown in Fig. 1. The girder is modelled as a uniform rod, the loads as particles and the cables as light inextensible strings. The tension in the cable at *D* is three times the tension in the cable at *C*.

(*a*) Draw a diagram showing all the forces acting on the girder.

(2)

Find

(*b*) the tension in the cable at *C*,

(5)

(*c*) the weight of the girder.

(2)

(*d*) Explain how you have used the fact that the girder is uniform.

(1)

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6. A particle *P*, of mass 3 kg, moves under the action of two constant forces (6**i** + 2**j**) N and (3**i – 5j)** N.

(*a*) Find, in the form (*a***i** + *b***j)** N, the resultant force **F** acting on *P*.

(1)

(*b*) Find, in degrees to one decimal place, the angle between **F** and **j.**

(3)

(*c*) Find the acceleration of *P*, giving your answer as a vector.

(2)

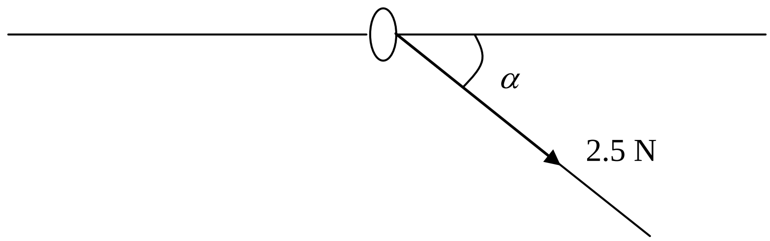
The initial velocity of *P* is (–2**i** + **j)** m s^{-1}.

(*d*) Find, to 3 significant figures, the speed of *P* after 2 s.

(5)

7.

Figure 2

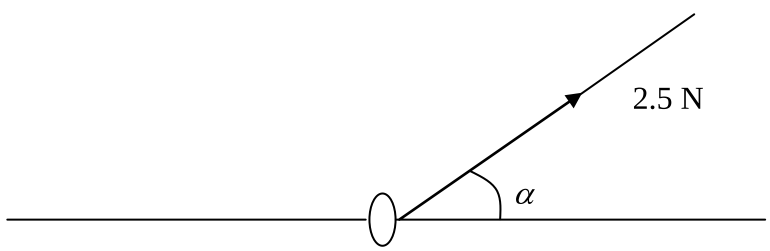


A ring of mass 0.3 kg is threaded on a fixed, rough horizontal curtain pole. A light inextensible string is attached to the ring. The string and the pole lie in the same vertical plane. The ring is pulled downwards by the string which makes an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$ as shown in Fig. 2. The tension in the string is 2.5 N. Given that, in this position, the ring is in limiting equilibrium,

(a) find the coefficient of friction between the ring and the pole.

(8)

Figure 3



The direction of the string is now altered so that the ring is pulled upwards. The string lies in the same vertical plane as before and again makes an angle α with the horizontal, as shown in Fig. 3. The tension in the string is again 2.5 N.

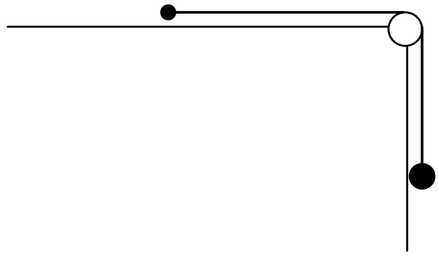
(b) Find the normal reaction exerted by the pole on the ring.

(2)

(c) State whether the ring is in equilibrium in the position shown in Fig. 3, giving a brief justification for your answer. You need make no further detailed calculation of the forces acting.

(2)

8. **Figure 4**



Two particles P and Q have masses $3m$ and $5m$ respectively. They are connected by a light inextensible string which passes over a small smooth light pulley fixed at the edge of a rough horizontal table. Particle P lies on the table and particle Q hangs freely below the pulley, as shown in Fig. 4. The coefficient of friction between P and the table is 0.6. The system is released from rest with the string taut. For the period before Q hits the floor or P reaches the pulley,

(*a*) write down an equation of motion for each particle separately,

(4)

(*b*) find, in terms of g, the acceleration of Q,

(4)

(*c*) find, in terms of m and g, the tension in the string.

(2)

When Q has moved a distance h, it hits the floor and the string becomes slack. Given that P remains on the table during the subsequent motion and does not reach the pulley,

(*d*) find, in terms of h, the distance moved by P after the string becomes slack until P comes to rest.

(6)

END