Name:

Total Marks:

A level Applied Mathematics

Paper 3B Mechanics

Practice Paper M10

Time: 2 hours

Information for Candidates

- This practice paper is an adapted legacy old paper for the Edexcel GCE A Level Specifications
- There are 10 questions in this question paper
- The total mark for this paper is 94.
- The marks for **each** question are shown in brackets.
- Full marks may be obtained for answers to ALL questions

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 not gain full credit

Question 1

A ball is projected vertically upwards with a speed of 14.7 m s^{-1} from a point which is 49 m above horizontal ground. Modelling the ball as a particle moving freely under gravity, find

(a) the greatest height, above the ground, reached by the ball, **(4)**

(b) the speed with which the ball first strikes the ground, **(3)**

(c) the total time from when the ball is projected to when it first strikes the ground. **(3)**

(Total 10 marks)

Question 2

Two cars *P* and *Q* are moving in the same direction along the same straight horizontal road. Car *P* is moving with constant speed 25 m s^{-1}. At time $t = 0$, *P* overtakes *Q* which is moving with constant speed 20 m s^{-1}. From $t = T$ seconds, P decelerates uniformly, coming to rest at a point *X* which is 800 m from the point where *P* overtook *Q*. From $t = 25$ s, *Q* decelerates uniformly, coming to rest at the same point *X* at the same instant as *P*.

(a) Sketch, on the same axes, the speed-time graphs of the two cars for the period from $t = 0$ to the time when they both come to rest at the point *X*. **(4)**

(b) Find the value of *T*. **(8)**

(Total 12 marks)

Question 3

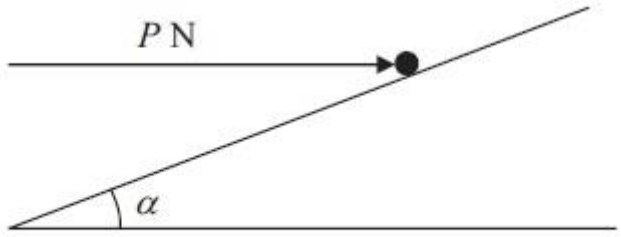

Figure 2

A particle of mass 0.4 kg is held at rest on a fixed rough plane by a horizontal force of magnitude *P* newtons. The force acts in the vertical plane containing the line of greatest slope of the inclined plane which passes through the particle. The plane is inclined to the horizontal at an angle *a*, where $\tan a = \frac{3}{4}$, as shown in Figure 2.

The coefficient of friction between the particle and the plane is $\frac{1}{3}$

Given that the particle is on the point of sliding up the plane, find

(a) the magnitude of the normal reaction between the particle and the plane, **(5)**

(b) the value of *P*. **(5)**

(Total 10 marks)

Question 4

A particle *P* is moving with constant velocity $(-3\mathbf{i} + 2\mathbf{j})$ m s^{-1}. At time $t = 6$ s *P* is at the point with position vector
$(-4\mathbf{i} - 7\mathbf{j})$ m. Find the distance of *P* from the origin at time $t = 2$ s. **(5)**

(Total 5 marks)

Question 5

A beam *AB* has length 6 m and weight 200 N. The beam rests in a horizontal position on two supports at the points *C* and *D*, where *AC* =1 m and *DB* =1 m. Two children, Sophie and Tom, each of weight 500 N, stand on the beam with Sophie standing twice as far from the end *B* as Tom. The beam remains horizontal and in equilibrium and the magnitude of the reaction at *D* is three times the magnitude of the reaction at *C*. By modelling the beam as a uniform rod and the two children as particles, find how far Tom is standing from the end *B*. **(7)**

(Total 7 marks)

Question 6

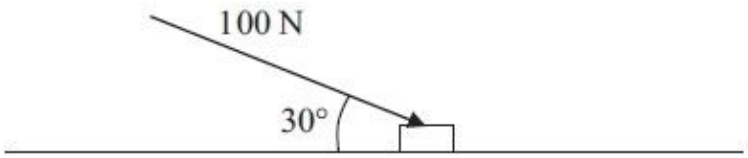

Figure 1

A small box is pushed along a floor. The floor is modelled as a rough horizontal plane and the box is modelled as a particle. The coefficient of friction between the box and the floor is $\frac{1}{2}$. The box is pushed by a force of magnitude 100 N which acts at an angle of 30º with the floor, as shown in Figure 1.

Given that the box moves with constant speed, find the mass of the box. **(7)**

(Total 7 marks)

Question 7

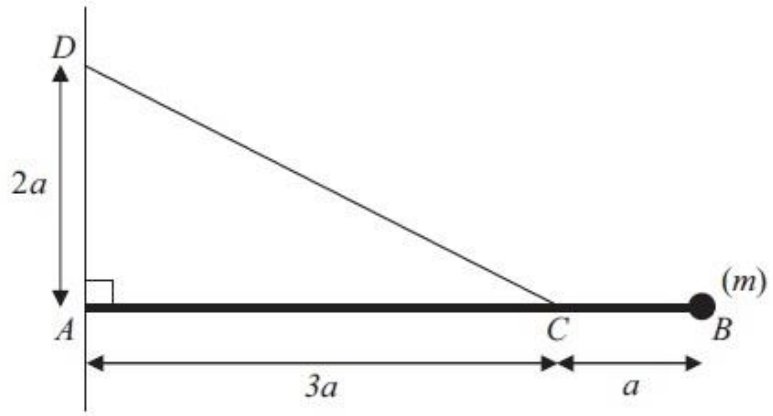

Figure 2

Figure 2 shows a uniform rod AB of mass m and length $4a$. The end A of the rod is freely hinged to a point on a vertical wall. A particle of mass m is attached to the rod at B. One end of a light inextensible string is attached to the rod at C, where $AC = 3a$. The other end of the string is attached to the wall at D, where $AD = 2a$ and D is vertically above A. The rod rests horizontally in equilibrium in a vertical plane perpendicular to the wall and the tension in the string is T.

(a) Show that $T = mg\sqrt{13}$. **(5)**

The particle of mass m at B is removed from the rod and replaced by a particle of mass M which is attached to the rod at B. The string breaks if the tension exceeds $2mg\sqrt{13}$. Given that the string does not break,

(b) show that $M \leq \frac{5}{2}m$. **(3)**

(Total 8 marks)

Question 8

A particle P moves on the x-axis. The acceleration of P at time t seconds, $t \geq 0$, is $(3t + 5)$ m s^{-2} in the positive x-direction. When $t = 0$, the velocity of P is 2 m s^{-1} in the positive x-direction. When $t = T$, the velocity of P is 6 m s^{-1} in the positive x-direction. Find the value of T. **(6)**

(Total 6 marks)

Question 9

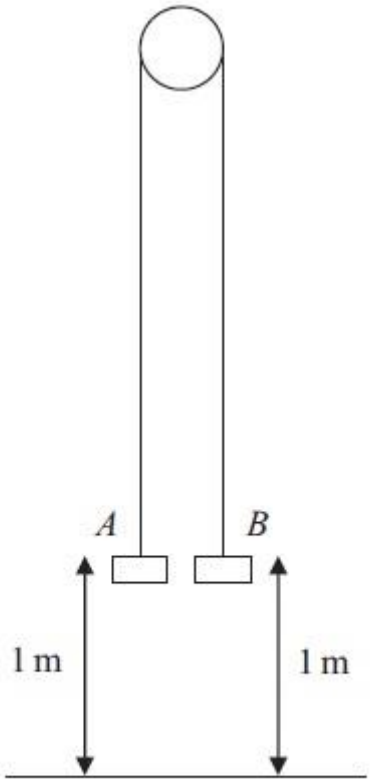

Figure 3

Two particles A and B have mass 0.4 kg and 0.3 kg respectively. The particles are attached to the ends of a light inextensible string. The string passes over a small smooth pulley which is fixed above a horizontal floor. Both particles are held, with the string taut, at a height of 1m above the floor, as shown in Figure 3. The particles are released from rest and in the subsequent motion B does not reach the pulley.

(a) Find the tension in the string immediately after the particles are released. **(6)**

(b) Find the acceleration of A immediately after the particles are released. **(2)**

When the particles have been moving for 0.5 s, the string breaks.

(c) Find the further time that elapses until B hits the floor. **(9)**

(Total 17 marks)

Question 10

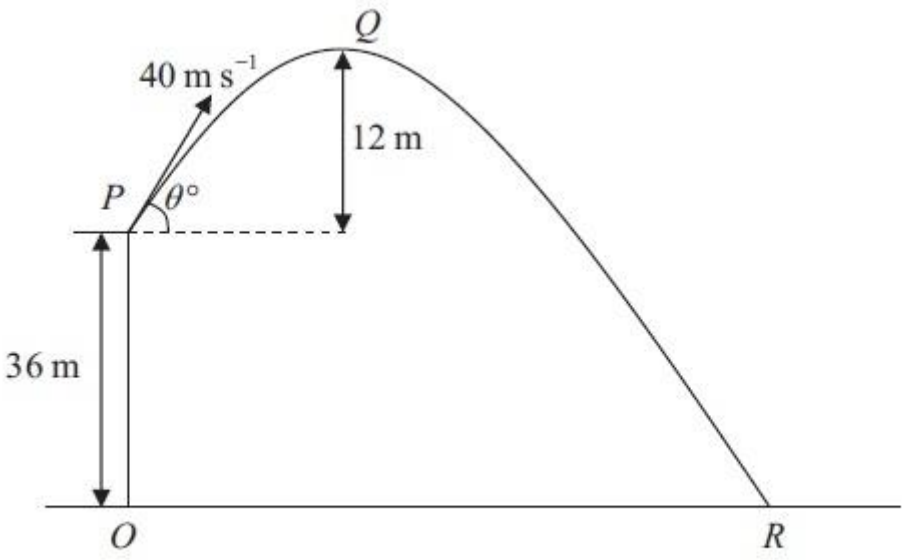

Figure 3

A ball is projected with speed 40 m s^{-1} from a point P on a cliff above horizontal ground. The point O on the ground is vertically below P and OP is 36 m. The ball is projected at an angle θ° to the horizontal. The point Q is the highest point of the path of the ball and is 12 m above the level of P. The ball moves freely under gravity and hits the ground at the point R, as shown in Figure 3. Find

(a) the value of θ, **(3)**

(b) the distance OR, **(6)**

(c) the speed of the ball as it hits the ground at R. **(3)**

(Total 12 marks)

TOTAL FOR PAPER IS 94 MARKS