Name:

Total Marks:

A level Applied Mathematics

Paper 3B Mechanics

Practice Paper M8

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 100.
- 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

At time $t = 0$, a particle is projected vertically upwards with speed u m s $^{-1}$ from a point 10 m above the ground. At time T seconds, the particle hits the ground with speed 17.5 m s $^{-1}$. Find

(a) the value of u, **(3)**

(b) the value of T. **(4)**

(Total 7 marks)

Question 2

A car is moving along a straight horizontal road. The speed of the car as it passes the point A is 25 m s $^{-1}$ and the car maintains this speed for 30 s. The car then decelerates uniformly to a speed of 10 m s $^{-1}$. The speed of 10 m s $^{-1}$ is then maintained until the car passes the point B. The time taken to travel from A to B is 90 s and AB = 1410 m.

(a) Sketch a speed-time graph to show the motion of the car from A to B. **(2)**

(b) Calculate the deceleration of the car as it decelerates from 25 m s^{-1} to 10 m s $^{-1}$. **(7)**

(Total 9 marks)

Question 3

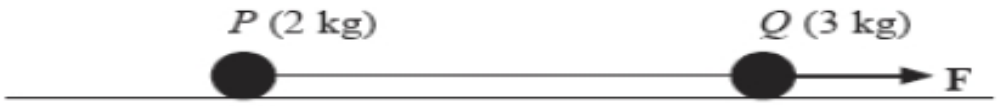

Figure 4

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)**

(Total 15 marks)

Question 4

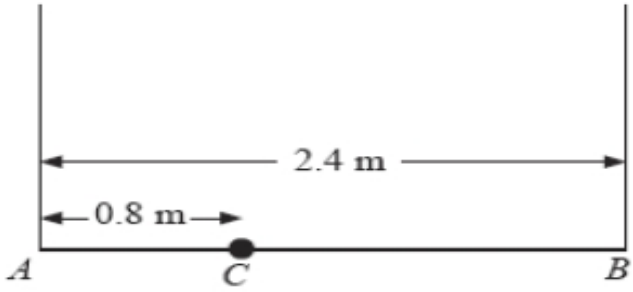

Figure 2

A plank AB has mass 12 kg and length 2.4 m. A load of mass 8 kg is attached to the plank at the point C, where $AC = 0.8$ m. The loaded plank is held in equilibrium, with AB horizontal, by two vertical ropes, one attached at A and the other attached at B, as shown in Figure 2. The plank is modelled as a uniform rod, the load as a particle and the ropes as light inextensible strings.

(a) Find the tension in the rope attached at B. **(4)**

The plank is now modelled as a non-uniform rod. With the new model, the tension in the rope attached at A is 10 N greater than the tension in the rope attached at B.

(b) Find the distance of the centre of mass of the plank from A. **(6)**

(Total 10 marks)

Question 5

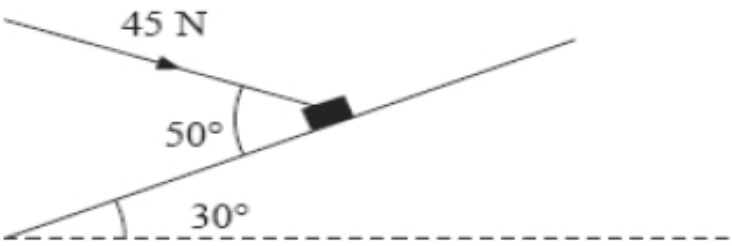

Figure 3

A package of mass 4 kg lies on a rough plane inclined at 30° to the horizontal. The package is held in equilibrium by a force of magnitude 45 N acting at an angle of 50° to the plane, as shown in Figure 3. The force is acting in a vertical plane through a line of greatest slope of the plane. The package is in equilibrium on the point of moving up the plane. The package is modelled as a particle. Find

(a) the magnitude of the normal reaction of the plane on the package, **(5)**

(b) the coefficient of friction between the plane and the package. **(6)**

(Total 11 marks)

Question 6

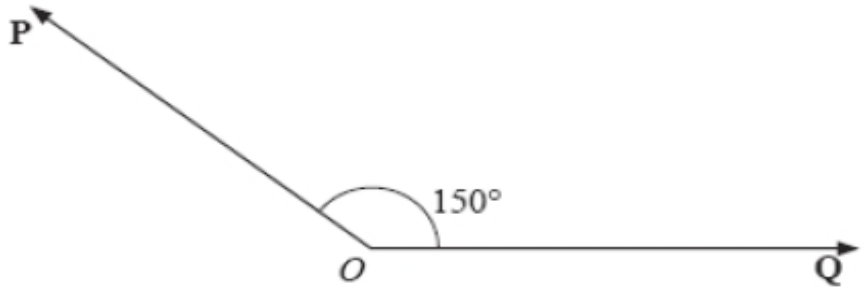

Figure 1

Two forces **P** and **Q** act on a particle at a point *O*. The force **P** has magnitude 15 N and the force **Q** has magnitude *X* newtons. The angle between **P** and **Q** is 150°, as shown in Figure 1. The resultant of **P** and **Q** is **R**.

Given that the angle between **R** and **Q** is 50°, find

(a) the magnitude of **R**, **(4)**

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

(Total 9 marks)

Question 7

A particle *P* of mass 0.4 kg moves under the action of a single constant force **F** newtons. The acceleration of *P* is $(6\mathbf{i} + 8\mathbf{j})$ m s^{-2} . Find

(a) the angle between the acceleration and **i**, **(2)**

(b) the magnitude of **F**. **(3)**

At time *t* seconds the velocity of *P* is **v** m s^{-1} . Given that when $t = 0$, $\mathbf{v} = 9\mathbf{i} - 10\mathbf{j}$,

(c) find the velocity of *P* when $t = 5$. **(3)**

(Total 8 marks)

Question 8

A particle *P* of mass 0.5 kg is moving under the action of a single force **F** newtons. At time *t* seconds,

$$\mathbf{F} = (6t - 5)\,\mathbf{i} + (t^2 - 2t)\,\mathbf{j}.$$

The velocity of *P* at time *t* seconds is **v** m s^{-1}. When $t = 0$, $\mathbf{v} = \mathbf{i} - 4\mathbf{j}$.

Find **v** at time *t* seconds. **(6)**

(Total 6 marks)

Question 9

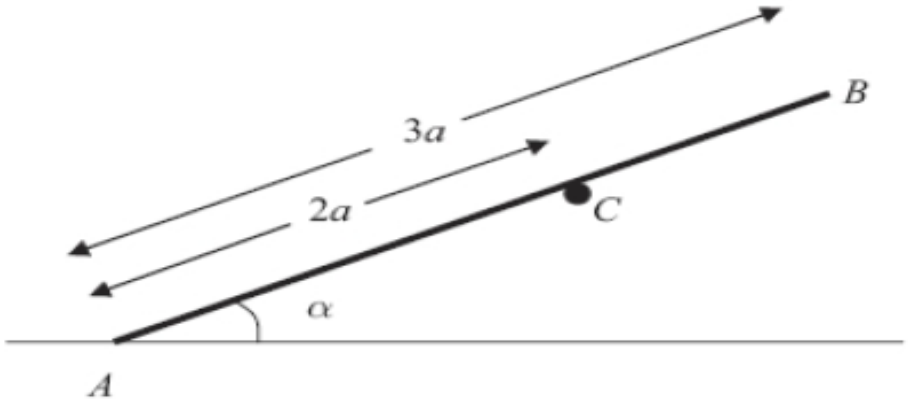

Figure 2

A plank rests in equilibrium against a fixed horizontal pole. The plank is modelled as a uniform rod AB and the pole as a smooth horizontal peg perpendicular to the vertical plane containing AB. The rod has length $3a$ and weight W and rests on the peg at C, where $AC = 2a$. The end A of the rod rests on rough horizontal ground and AB makes an angle α with the ground, as shown in Figure 2.

(a) Show that the normal reaction on the rod at A is $\frac{1}{4}(4 - 3\cos^2\alpha)W$. **(6)**

Given that the rod is in limiting equilibrium and that $\cos\alpha = \frac{2}{3}$,

(b) find the coefficient of friction between the rod and the ground. **(5)**

(Total 11 marks)

Question 10

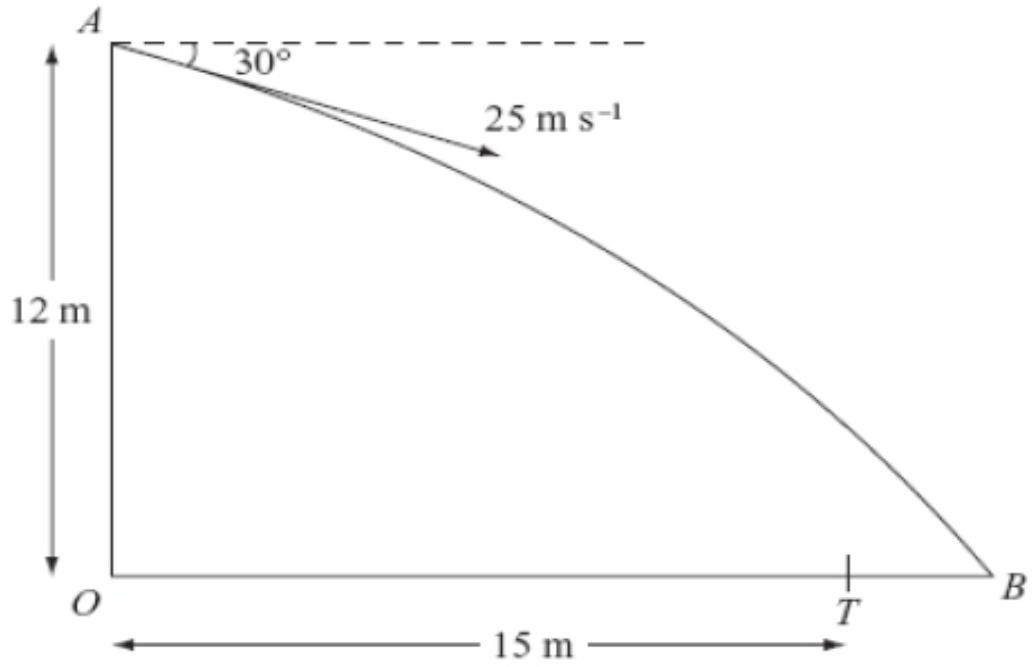

Figure 4

A ball is thrown from a point A at a target, which is on horizontal ground. The point A is 12 m above the point O on the ground. The ball is thrown from A with speed 25 m s^{-1} at an angle of 30° below the horizontal. The ball is modelled as a particle and the target as a point T. The distance OT is 15 m. The ball misses the target and hits the ground at the point B, where OTB is a straight line, as shown in Figure 4. Find

(a) the time taken by the ball to travel from A to B, **(5)**

(b) the distance TB. **(4)**

The point X is on the path of the ball vertically above T.

(c) Find the speed of the ball at X. **(5)**

(Total 14 marks)

TOTAL FOR PAPER IS 100 MARKS