Name:

Total Marks:

A level Applied Mathematics

Paper 3B Mechanics

Practice Paper M7

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

A car is moving along a straight horizontal road. At time $t = 0$, the car passes a point A with speed 25 m s^{-1}. The car moves with constant speed 25 m s^{-1} until $t = 10$ s. The car then decelerates uniformly for 8 s. At time $t = 18$ s, the speed of the car is V m s–1 and this speed is maintained until the car reaches the point B at time $t = 30$ s.

(a) Sketch, in the space below, a speed–time graph to show the motion of the car from A to B

(3)

Given that $AB = 526$ m, find

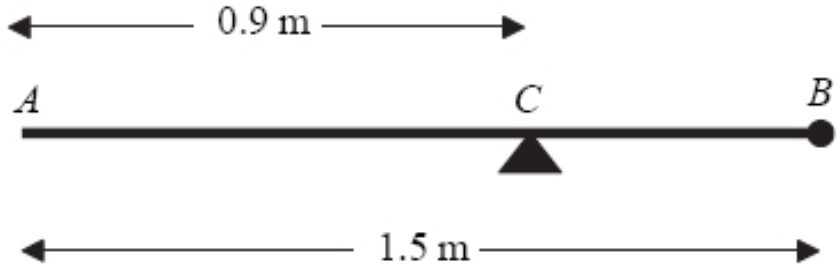
(b) the value of V, **(5)**

(c) the deceleration of the car between $t = 10$ s and $t = 18$ s. **(3)**

(Total 11 marks)

Question 2

Figure 2



A uniform rod AB has length 1.5 m and mass 8 kg. A particle of mass m kg is attached to the rod at B. The rod is supported at the point C, where $AC = 0.9$ m, and the system is in equilibrium with AB horizontal, as shown in Figure 2.

(a) Show that $m = 2$. **(4)**

A particle of mass 5 kg is now attached to the rod at A and the support is moved from C to a point D of the rod. The system, including both particles, is again in equilibrium with AB horizontal.

(b) Find the distance AD. **(5)**

(Total 9 marks)

Question 3

A boat B is moving with constant velocity. At noon, B is at the point with position vector $(3\mathbf{i} - 4\mathbf{j})$ km with respect to a fixed origin O. At 1430 on the same day, B is at the point with position vector $(8\mathbf{i} + 11\mathbf{j})$ km.

(a) Find the velocity of B, giving your answer in the form $p\mathbf{i} + q\mathbf{j}$. **(3)**

At time t hours after noon, the position vector of B is $\mathbf{b}$ km.

(b) Find, in terms of t, an expression for $\mathbf{b}$. **(3)**

(Total 6 marks)

Question 4

A particle P of mass 0.5 kg moves under the action of a single force $\mathbf{F}$ newtons. At time t seconds, the velocity $\mathbf{v}$ m s^{-1} of P is given by

$$\mathbf{v} = 3t^2\mathbf{i} + (1 - 4t)\mathbf{j}.$$

Find

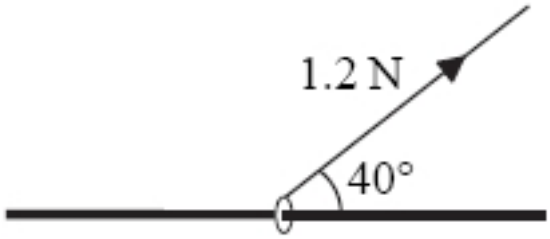
(a) the acceleration of P at time t seconds, **(2)**

(b) the magnitude of $\mathbf{F}$ when $t = 2$. **(4)**

(Total 6 marks)

Question 5

Figure 3



A small ring of mass 0.25 kg is threaded on a fixed rough horizontal rod. The ring is pulled upwards by a light string which makes an angle 40° with the horizontal, as shown in Figure 3. The string and the rod are in the same vertical plane. The tension in the string is 1.2 N and the coefficient of friction between the ring and the rod is μ. Given that the ring is in limiting equilibrium, find

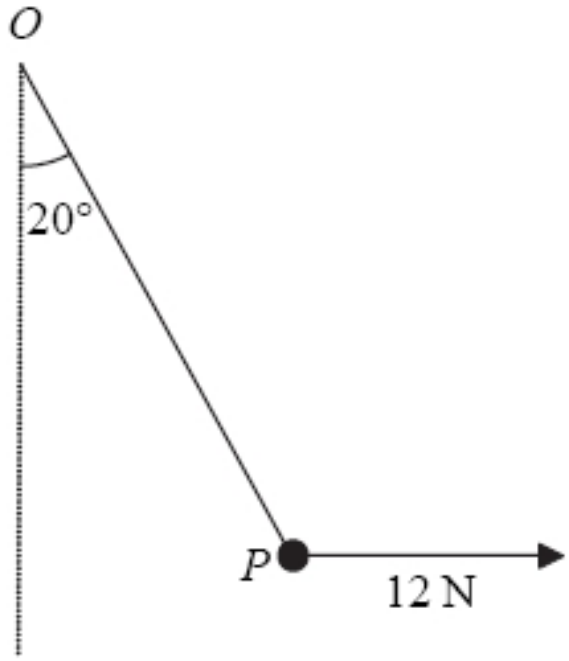
(a) the normal reaction between the ring and the rod, **(4)**

(b) the value of μ. **(6)**

(Total 10 marks)

Question 6

Figure 1



A particle P is attached to one end of a light inextensible string. The other end of the string is attached to a fixed point O. A horizontal force of magnitude 12 N is applied to P. The particle P is in equilibrium with the string taut and OP making an angle of 20° with the downward vertical, as shown in Figure 1.

Find

(a) the tension in the string, **(3)**

(b) the weight of P. **(4)**

(Total 7 marks)

Question 7

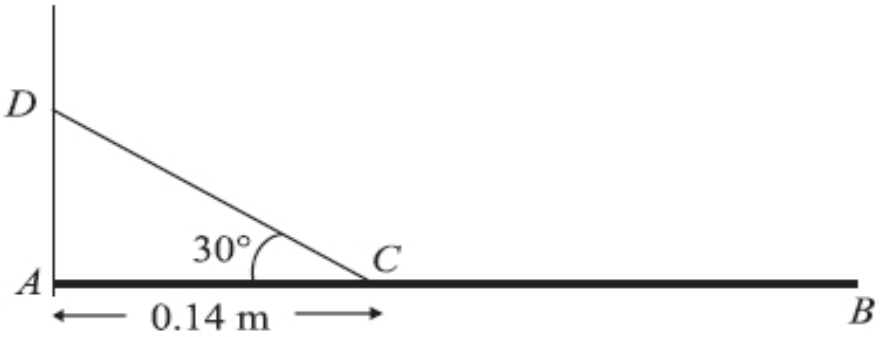


Figure 3

A uniform beam AB of mass 2 kg is freely hinged at one end A to a vertical wall. The beam is held in equilibrium in a horizontal position by a rope which is attached to a point C on the beam, where $AC = 0.14$ m. The rope is attached to the point D on the wall vertically above A, where $\angle ACD = 30°$, as shown in Figure 3. The beam is modelled as a uniform rod and the rope as a light inextensible string. The tension in the rope is 63 N.

Find

(a) the length of AB, **(4)**

(b) the magnitude of the resultant reaction of the hinge on the beam at A. **(5)**

(Total 9 marks)

Question 8

A particle P moves on the x-axis. At time t seconds the velocity of P is v m s^{-1} in the direction of x increasing, where v is given by

$$v = \begin{cases} 8t - \frac{3}{2}t^2, & 0 \leqslant t \leqslant 4, \\ 16 - 2t, & t > 4. \end{cases}$$

When $t = 0$, P is at the origin O. Find

(a) the greatest speed of P in the interval $0 \leq t \leq 4$, **(4)**

(b) the distance of P from O when $t = 4$, **(3)**

(c) the time at which P is instantaneously at rest for $t > 4$, **(1)**

(d) the total distance travelled by P in the first 10 s of its motion. **(8)**

(Total 16 marks)

Question 9

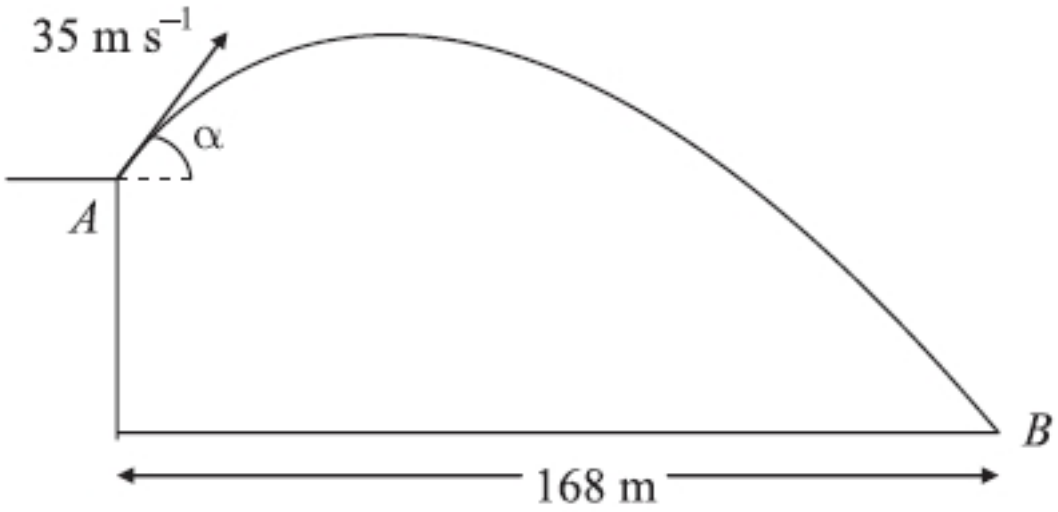


Figure 4

A golf ball P is projected with speed 35 m s^{-1} from a point A on a cliff above horizontal ground.

The angle of projection is α to the horizontal, where $\tan \alpha = \frac{4}{3}$. The ball moves freely under gravity and hits the ground at the point B, as shown in Figure 4.

(a) Find the greatest height of P above the level of A. **(3)**

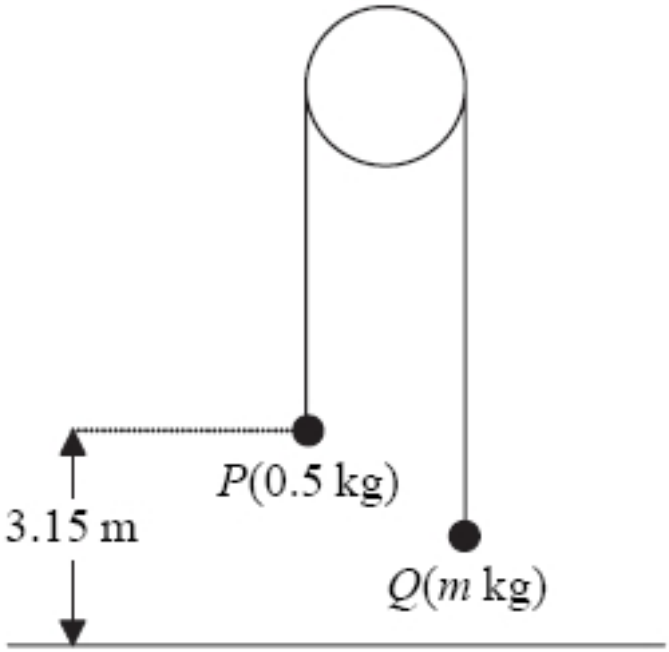
The horizontal distance from A to B is 168 m.

(b) Find the height of A above the ground. **(6)**

(Total 9 marks)

Question 10

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)**

(Total 17 marks)

TOTAL FOR PAPER IS 100 MARKS