

**ADVANCED SUBSIDIARY GCE  
MATHEMATICS**

**4728/01**

Mechanics 1

**FRIDAY 6 JUNE 2008**

Afternoon

Time: 1 hour 30 minutes

**Additional materials:** Answer Booklet (8 pages)  
List of Formulae (MF1)

**INSTRUCTIONS TO CANDIDATES**

- Write your name, centre number and candidate number in the spaces provided on the answer booklet.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question or is clearly appropriate.
- The acceleration due to gravity is denoted by  $g \text{ m s}^{-2}$ . Unless otherwise instructed, when a numerical value is needed, use  $g = 9.8$ .
- You are permitted to use a graphical calculator in this paper.

**INFORMATION FOR CANDIDATES**

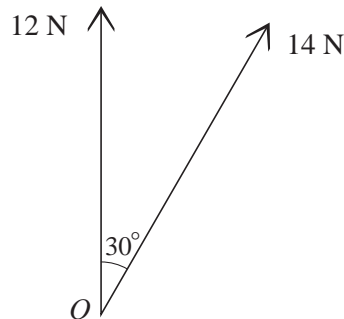
- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 72.
- **You are reminded of the need for clear presentation in your answers.**

This document consists of 4 printed pages.

- 1 A car of mass 900 kg is travelling in a straight line on a horizontal road. The driving force acting on the car is 600 N, and a resisting force of 240 N opposes the motion.

- (i) Show that the acceleration of the car is  $0.4 \text{ m s}^{-2}$ . [2]
- (ii) Calculate the time and the distance required for the speed of the car to increase from  $5 \text{ m s}^{-1}$  to  $9 \text{ m s}^{-1}$ . [4]

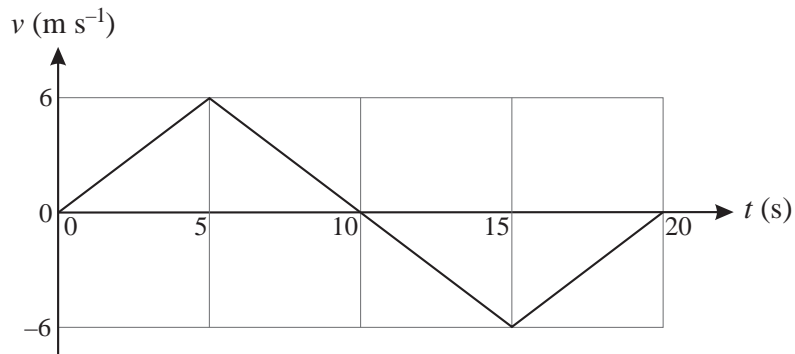
2



Two horizontal forces act at the point  $O$ . One force has magnitude 12 N and acts along a bearing of  $000^\circ$ . The other force has magnitude 14 N and acts along a bearing of  $030^\circ$  (see diagram).

- (i) Show that the resultant of the two forces has magnitude 25.1 N, correct to 3 significant figures. [5]
- (ii) Find the bearing of the line of action of the resultant. [3]

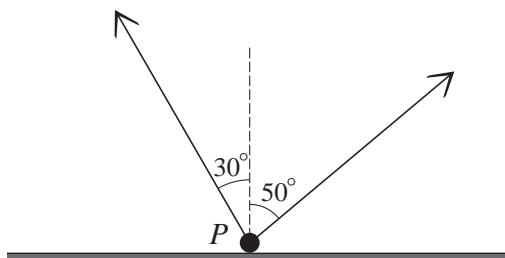
3



An athlete runs in a straight line from point  $A$  to point  $B$ , and back to point  $A$ . The diagram shows the  $(t, v)$  graph for the motion of the athlete. The graph consists of three straight line segments.

- (i) Calculate the initial acceleration of the athlete. [2]
- (ii) Calculate the total distance the athlete runs. [3]
- (iii) Calculate the velocity of the athlete when  $t = 17$ . [3]

4



A particle  $P$  of weight  $30\text{ N}$  rests on a horizontal plane.  $P$  is attached to two light strings making angles of  $30^\circ$  and  $50^\circ$  with the upward vertical, as shown in the diagram. The tension in each string is  $15\text{ N}$ , and the particle is in limiting equilibrium. Find

- (i) the magnitude and direction of the frictional force on  $P$ , [3]  
 (ii) the coefficient of friction between  $P$  and the plane. [5]

5 A railway wagon  $A$  of mass  $2400\text{ kg}$  and moving with speed  $5\text{ m s}^{-1}$  collides with railway wagon  $B$  which has mass  $3600\text{ kg}$  and is moving towards  $A$  with speed  $3\text{ m s}^{-1}$ . Immediately after the collision the speeds of  $A$  and  $B$  are equal.

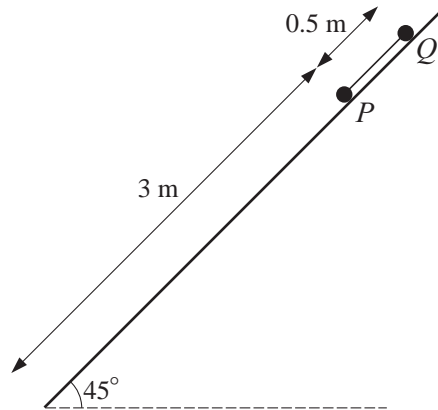
- (i) Given that the two wagons are moving in the same direction after the collision, find their common speed. State which wagon has changed its direction of motion. [5]  
 (ii) Given instead that  $A$  and  $B$  are moving with equal speeds in opposite directions after the collision, calculate  
 (a) the speed of the wagons,  
 (b) the change in the momentum of  $A$  as a result of the collision. [5]

6 A model train travels along a straight track. At time  $t$  seconds after setting out from station  $A$ , the train has velocity  $v\text{ m s}^{-1}$  and displacement  $x$  metres from  $A$ . It is given that for  $0 \leq t \leq 7$

$$x = 0.01t^4 - 0.16t^3 + 0.72t^2.$$

After leaving  $A$  the train comes to instantaneous rest at station  $B$ .

- (i) Express  $v$  in terms of  $t$ . Verify that when  $t = 2$  the velocity of the train is  $1.28\text{ m s}^{-1}$ . [3]  
 (ii) Express the acceleration of the train in terms of  $t$ , and hence show that when the acceleration of the train is zero  $t^2 - 8t + 12 = 0$ . [3]  
 (iii) Calculate the minimum value of  $v$ . [4]  
 (iv) Sketch the  $(t, v)$  graph for the train, and state the direction of motion of the train when it leaves  $B$ . [4]  
 (v) Calculate the distance  $AB$ . [2]



Two particles  $P$  and  $Q$  are joined by a taut light inextensible string which is parallel to a line of greatest slope on an inclined plane on which the particles are initially held at rest. The string is  $0.5\text{ m}$  long, and the plane is inclined at  $45^\circ$  to the horizontal.  $P$  is below the level of  $Q$  and  $3\text{ m}$  from the foot of the plane (see diagram). Each particle has mass  $0.2\text{ kg}$ . Contact between  $P$  and the plane is smooth. The coefficient of friction between  $Q$  and the plane is  $1$ . The particles are released from rest and begin to move down the plane.

- (i) Show that the magnitude of the frictional force acting on  $Q$  is  $1.386\text{ N}$ , correct to 4 significant figures. [2]
- (ii) Show that the particles accelerate at  $3.465\text{ m s}^{-2}$ , correct to 4 significant figures, and calculate the tension in the string. [5]
- (iii) Calculate the speed of the particles at the instant when  $Q$  reaches the initial position of  $P$ . [2]

At the instant when  $Q$  reaches the initial position of  $P$ ,  $Q$  becomes detached from the string and the two particles travel independently to the foot of the plane.

- (iv) Show that  $Q$  descends at constant speed, and calculate the time interval between the arrival of  $P$  and the arrival of  $Q$  at the foot of the plane. [7]